DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

DIVISION OF BOTANY

PROGRESS REPORT OF THE DOMINION BOTANIST

H. T. GÜSSOW

FOR THE YEARS 1935 TO 1937 INCLUSIVE

Polyporus resinosus (Schrad.) Fr., a common wood-destroying fungus.

Printed by Authority of the Hon. J. G. GARDINER, Minister of Agriculture,
Ottawa, 1938.

EXPERIMENTAL FARMS BRANCH

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DIVISION OF BOTANY

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ECONOMIC BOTANY

Project Group No. 10.00

John Adams, Ottawa, Ont.

As usual the correspondence covered a great variety of subjects, such as the culture and collection of medicinal plants, ginseng, wild rice, etc., together with inquiries relating to ramie, chicory, vanilla, tung oil, fenugreek, *Strophanthus*, teasel, giant hyssop, coffee, vegetable dyes, plants containing tannin, Irish moss and other seaweeds, resistance of plants to cold, and other topics. Information was also sought regarding the culture of red squill, *Perilla*, *Coluria geoides*, and there was considerable correspondence dealing with plants used as insecticides, including *Pyrethrum*, derris root *(Deguelia elliptica)*, timbo root *(Enterolobium contortisiliquum)*, and cube root *(Lonchocarpus nicou)*. There were as usual inquiries relating to literature dealing with wild flowers.

The annual seed-exchange list containing the names of about 1,800 species was sent out each year to over 140 botanical gardens and similar institutions. The number of packets of seed received from foreign institutions during the three years was 3,112, 2,479, and 4,135 respectively. Of these, 360 packets were for the use of the Cereal Division, 450 packets for the National Research Council, and 37 packets for the experimental station at Summerland, B.C.

Packets sent out mainly to foreign countries, but also to correspondents in this country, numbered 9,156, 9,881, and 7,359 during the three years respectively. Amongst the largest consignments sent out in one year were 555 packets to Baku, U.S.S.R.; 502 to Hohenheim, Germany; 474 to Missouri Botanical Gardens, St. Louis, U.S.A.; 451 to Lu-Shan Arboretum, China; 400 to Glasgow, Scotland. Smaller lots were sent out to many other countries, including 201 packets to Taihoku, Formosa; 106 to Istanbul, Turkey; etc. During the year 1936 over 600 packets not obtainable otherwise were sent out to various persons in Canada.

Through the kindness of the Director of the Southern Scientific Research Institute at Novotscherkassk, U.S.S.R., two samples of commercial rice *(Oryza sativa)*, which did not require to be planted in water, were obtained for trial in 1936. One was a brown variety while the other was white. The seeds of both these varieties were sown in a small plot in the Arboretum on May 18 and the crop was harvested on October 3. The white rice produced taller plants than the brown variety, but in both cases a considerable quantity of well-ripened seeds was obtained. Both lots of seeds were passed on to the Cereal Division for further trial.

During 1936 seeds of four species of *Perilla* were obtained from foreign botanic gardens for trial in the next season. These were sown in the open ground on May 21, 1937. Three made good growth but in two of them the flowers had only reached the bud stage at the end of the growing season. The other species, *Perilla ocymoides*, ripened numerous seeds which were harvested on September 17. The seeds were handed over to the Division of Forage Plants for trial, and as the species is an annual there is a fair prospect of its culture meeting with success.

In answer to an inquiry from Vancouver Island some bulbs of red squill *(Urginea maritima)*, which forms the basis of a poison for rats, were imported from the south of France for trial. A few were sent to the experimental station at Harrow, Ont., and the larger part to the experimental station at Saanichton, B.C.

For the purpose of collecting plants and seeds for the herbarium and extending the knowledge of the distribution of plants in Eastern Canada, particularly those credited with causing hay-fever, a visit was paid to Anticosti island and the Gaspé peninsula in July and August, 1935. Some further species additional to the known flora of the island were secured as well as a series of specimens of an intergeneric grass hybrid *Agropyron repens* × *Elymus mollis*. It is worthy of note that during three successive annual visits to Anticosti island no Colorado beetle was observed attacking the potato crop, the leaves of which were remarkably fresh and green. Neither was late blight observed but some plants were affected with black-leg. Some wild raspberries were affected by an apparent virus disease which stunted the growth and caused the leaves to curl.

Neither on Anticosti island nor at eight places visited around the coast of Gaspé peninsula was either ragweed or poison ivy seen. On the other hand, species of *Artemisia* were found both on Anticosti and at several locations on the Peninsula. A few hours were spent on Bonaventure island, where about 100 species of plants were collected. Here also the Colorado beetle appeared to be absent.

Incidentally, thirty-one species of parasitic fungi were collected wherever they happened to be encountered. One of these had not been found previously in Canada, while another had not been reported east of Manitoba.

At the request of the owners of the island another short visit was paid to Anticosti in 1936 for the purpose of collecting plants and making observations on a problem relating to muskrats which had migrated from places where they had formerly been plentiful. It was supposed that this was due to scarcity of food but investigation proved that plants suitable for food were both varied and plentiful in the places deserted, and so the reason for the migration remains in obscurity. A few days were spent along the Potato river on the north shore of the island, where several species of plants not previously known to occur were collected. Along the Potato river valley and another smaller valley to the west some trees of white pine about a foot in diameter were located.

The Maritime Provinces were next visited mainly for the purpose of determining the distribution of ragweed. A careful inspection of Brackley Beach, P.E.I., failed to disclose the presence of this species, although it is known to occur sparingly elsewhere on the island. On the other hand, it was found to be much too plentiful at a number of places visited in Nova Scotia and New Brunswick.

In 1937 the survey for ragweed was continued in Nova Scotia, where a number of other localities were visited, including Cape Breton island. Some of the well-known resorts were found to be free from it while in others it occurred in greater or less abundance. The writer also represented the Division at the conjoint meeting at Wolfville in August of the Botanical Society of America and the American Society of Plant Taxonomists.

A revised edition of the bulletin on "Medicinal Plants" was published in 1936 and a further reprint of the same issue in 1937.

A final section of the "Bibliography of Canadian Plant Geography" by J. Adams and M. H. Norwell covering the period from 1931 to 1935 was published in 1936 as part of volume 21 of the "Transactions of the Royal Canadian Institute."

A number of short papers were published in the *Canadian Field Naturalist.* These were "Some Fungi from Anticosti island and Gaspé peninsula," September, 1935; "Further additions to the vascular plants of Anticosti island," November, 1935; "An intergeneric hybrid (*Agropyron* × *Elymus*) and some other plants from Anticosti island," October, 1936; "Some additions to the Flora of Prince Edward Island," October, 1937; "Some additional species from Anticosti island," December, 1937.

B. 10.01. MAINTENANCE OF REFERENCE HERBARIUM OF THE WILD PLANTS OF CANADA

E. W. Hart, Ottawa, Ont.

The herbarium contains approximately the following Canadian plant specimens, to which some exotic species, mostly from the eastern United States, have been added:—

Families	Genera	Species	Mounts
242	1,443	4,792	22,614

Of these the following were new:—

	Families	Genera	Species	Mounts
1935..	....	7	69	1,687
1936..	96	584	1,336	2,966
1937..	2	20	205	3,172
	98	611	1,610	7,825

Altogether 6,522 plants received from many parts of the Dominion, and some others from the adjacent United States, were identified.

A bulletin, which gives directions regarding the collection and preservation of plants, has been prepared to meet the demands of many interested correspondents.

Monthly botanical notes in a non-technical style have been written since September, 1936, and published as press articles through the Publicity and Extension Branch.

B. 10.06. SURVEY FOR EASTERN PASTURE IMPROVEMENT

Appraisal of methods

H. Groh and W. G. Dore,[1] Ottawa, Ont.

The reconnaissance type of survey, which has been employed since 1928, has been continued, although the quantitative value of data has been improved by making visual estimates of the component species. Also at the Quebec stations new series have been studied by a quadrat method to determine percentage area covered. The fact that a reconnaissance survey is less time consuming has outweighed considerations of statistical efficiency. Nevertheless a review of the extensive literature bearing on methods, has been made in preparation for a more technical approach to pasture herbage investigations whenever that becomes possible. Meanwhile the methods employed have served to secure the necessary inventory of species at each station. Although the listings tabulated over a period of ten years were obtained from plots lacking uniformity in size, history, etc., and on widely scattered survey dates, their number is sufficiently large to permit of their application in making the rougher comparisons between treatments, and in following the trends of species-change over a period of years. Indeed a good degree of conformity has been found to Raunkaier's Law of Frequency, which was deduced from repetition of more comparable listings. It must not be overlooked that only the practised eye of the same observer from year to year can secure estimates of value for comparison and, at best, numerous studies must await the application of impersonal, precise technique.

[1] Formerly Graduate Assistant.

Regional pasture floras

H. Groh, Ottawa, Ont.

A tabulation of over 250 species of pasture plants, useful and otherwise, is here condensed to show a few of the grass, legume, and weed plants dominant at each station, with their frequency indices. Frequency is not equivalent to, but is commonly indicative of, abundance or yield. Species of major importance comprise about five per cent of the total species present.

DOMINANT PLANTS IN PASTURES IN EASTERN CANADA

Station	Grasses	F.I.	Legumes	F.I.	Weeds	F.I.	No. of species	No. of surveys
Ottawa	Ky. blue grass Timothy	99 89	White clover Tufted vetch	95 73	Dandelion Yarrow Tall buttercup	99 95 78	109	258
Lennoxville	Timothy Red top	90 87	White clover Red clover	96 82	Orange hawkweed Yarrow Wood sorrel	97 82 82	152	446
Cap Rouge	Ky. blue grass Timothy	61 61	White clover	100	Ox-eye daisy Dandelion Bladder campion	100 94 89	73	18
Ste. Anne de la Pocatiere	Timothy Red fescue	88 64	Red clover Tufted vetch White clover	86 85 84	Yarrow Mouse-ear hawkweed	92 82	140	292
Fredericton	Brown top Timothy	95 78	White clover	98	Dandelion Ox-eye daisy Mouse-ear chickweed Mosses	86 85 82 81	137	769
Nappan	Brown top Timothy	97 90	White clover Red clover	93 81	Dandelion Ox-eye daisy King devil Tall buttercup	96 92 91 81	111	493
Kentville	Timothy	87	Red clover	81	Poverty grass (*Danthonia*) King devil	67 65	102	92
Charlottetown	Timothy Brown top	95 94	White clover Tufted vetch Alsike clover	100 87 86	Ox-eye daisy Stitchwort Creeping buttercup	97 94 87	103	63

Regional lists do not approach completeness until they combine a considerable number and variety of surveys. Pasture associations are much more complex at some stations than at others. Lists also are shorter as weeds give way to invigorated useful herbage under pasture improvement.

Taxonomy of pasture species

Dore, W. G. and H. Groh. List of grasses (Gramineae) of the Ottawa district. Canadian Field-Naturalist. 52: 53-55, 1938.

Critical study of all the grass collections made within a 30-mile radius of Ottawa has resulted in a list of 102 species.

In addition to the foregoing, a key for the identification of trifoliolate legumes in pastures, with drawings, has been prepared in photographic form for workers' use.

Seedings and treatments

H. Groh and W. G. Dore, Ottawa, Ont.

At most stations there has been found a rather prompt reversion of seeded pastures to practically the native associations of species. Native white clover persists or is renewed from seed in situations where commercial strains are apt

to be lost. Ready invaders are brown top in the East, and Kentucky blue grass, red fescue, etc., farther inland. Of seeded grasses, timothy, Kentucky blue grass, and red top, and mixtures containing these and the clovers, survive the winters and competition better than the less generally grown species, such as tall oat grass, meadow fescue, awnless brome grass, orchard grass and rough-stalked meadow grass. The rye grasses, crested wheat grass and lespedeza are of little use at these stations.

Among other treatment responses the following may be noted: close cutting results in quite a different stand of herbage from treatment as hay, and in particular encourages white clover; rotational grazing is of slight advantage compared with appropriate dressings of fertilizer; grasses respond to fertilizers, particularly to nitrogen, more than legumes and most weeds, and couch grass, in this respect, belongs with grasses; legumes respond more readily to superphosphate than to nitrogen, and are suppressed in some instances by ammonium sulphate; lime requirements of soils vary, and effects are slower and more lasting than those of fertilizers; a species succession, sometimes quite marked under soil amendments, is the displacement of moss in thin pastures by white clover, which in turn may yield to Kentucky blue grass and other species of the higher fertility levels; some weeds, like ox-eye daisy, orange hawkweed and king devil, diminish as fertility improves, while dandelion, buttercup and plantain maintain themselves very well. Other responses, more or less indicated, require the more exact quantitative methods for their analysis.

B. 10.08. PHENOLOGICAL INVESTIGATIONS

W. H. Minshall, Ottawa, Ont.

Dates of flowering have been recorded for a large proportion of the plants of the Ottawa district. For many the period of bloom is now fairly well defined, as well as the date of fruiting and seed maturity.

WEEDS AND POISONOUS PLANTS

Project Group No. 11.00

B. 11.01. IDENTIFICATION AND ERADICATION OF POISONOUS PLANTS

Groh, Herbert. Poison Ivy. Dom. Dept. Agric. Circ. 120. 1937.

Recognition of the plant, avoidance and treatment of the poisoning, and eradication are outlined. The aim in treatment is to neutralize and remove the toxic oil, or at a later stage to relieve irritation. Where eradication by cultivation or grubbing is not practicable, spraying with a ten per cent solution of sodium chlorate in water, until the foliage is completely wet, has given best results. The effects extend into the root system, but in rocky ground a second application is necessary later in the season.

Groh. Herbert. Plants responsible for hay fever. Dom. Dept. Agric. Circ. 127. 1927.

Of the agencies capable of inducing hay fever, ragweed combines in itself most potentialities for harm, although in their seasons tree and grass pollens are important. The peak of ragweed incidence in Canada is in the southern, closely settled, part of Ontario, and adjoining parts of Quebec. On most frontiers of settlement there is so little ragweed that these districts constitute a safe asylum for sufferers. In the West other ragweed allies, wormwoods and goosefoots, replace the common ragweed so that reactors in one region may sometimes find relief in permanent change of residence. The principal alternative to migration is desensitization with the specific pollen extract indicated by test.

B. 11.02. WEED SURVEY OF THE DOMINION

Weed distribution in Canada

H. Groh, Ottawa, Ont.

For each of around 1,000 weeds, poisonous plants, and introduced plants maintaining themselves unaided, occurrence records are on file. For 16 meridians, from the Atlantic to just west of Ottawa, the record for each weed from 15 years' surveys is mapped on a Mercator projection to show its distribution and frequence. From the 76th meridian westward the mapping is incomplete, and the network of surveys is less close. Practically all agricultural belts in Canada have now at least been partially surveyed. Newcomers to Canada, or to additional zones, are detected every year, and ordinarily their presence is recorded in published notes. Dog mustard (*Erucastrum gallicum (Willd.) O. E. Schulz*), first collected at Emerson, Man., in 1922, but only reported ten years later, has been recorded, by 1937, in every province except British Columbia. Thousands of weed specimens in support of records have been deposited in the division herbarium.

Weeds of the Ottawa district

H. Groh, Ottawa, Ont.

Surveys from 1923 on were extended in 1937 where necessary within a 30-mile radius, in order to complete a mapping of the district. Maps for 268 weeds have been made, and for each the frequency index has been worked out. Canada thistle proves to be first in frequency, followed closely by mullein and yarrow. A check list of adventive plants of the district has also been made as complete as possible.

Groh, Herbert. Leafy spurge—*Euphorbia Esula* or *virgata*? Sci. Agric. 15: 701-703. 1935.

The taxonomic difficulties with these perhaps doubtfully valid entities are attacked on the basis of more or less distinct leaf base outline, and the conclusion is reached that leafy spurge in Canada is *Euphorbia Esula* L. (A single colony in northern Saskatchewan with convincing field marks of *E. virgata* Waldst & Kit., has failed under greenhouse culture since to reproduce these clearly.)

Groh, Herbert. Creeping yellow cress, a weed in process of entrenchment. Sci. Agric. 16: 331-334. 1936.

The North American history is traced from 1838 to the present continent-wide distribution of this very persistent perennial. Various native and introduced allies are also reviewed. Measures for exclusion of similar invaders, and for suppression of outbreaks occurring are discussed; and the steady development of a clearing house of weed survey information in the division is advanced as of great potential value.

Groh, Herbert. Peace-Athabaska weeds, a reconnaissance appraisal. Dom. Dept. Agric. Tech. Bull. 7. 1937.

The second report on a quinquennial survey started in 1929 and designed to preserve for one such newer farming region its weed history. Separate tables are provided for the indigenous and the adventive weedy plants. For each species a percentage frequency index has been worked out from the 174 survey lists, and for each of the eight meridians involved. The proportion of adventive weeds is still lower than in older settled regions. Native perennials

are not as a rule highly aggressive, and other perennials are mostly still in limited colonies. Adventive annuals, on the other hand, with their free-seeding propensities, have already over-run the longer settled parts and penetrated to all parts. Wild oats, lamb's quarters, shepherd's purse and various members of the mustard family, present problems of immediate urgency. Provision of definite organization to back the existing inspection service, in keeping clean what has been already proved an ideal seed-growing country, is recommended.

B. 11.05. DESTRUCTION OF DANDELION

W. H. Minshall, Ottawa, Ont.

Studies of pH reactions of dandelion (and plantain) in comparison with some of the grasses with which such a weed would be associated in a lawn have extended over two years. Nutrient solutions adjusted to the following hydrogen-ion concentrations, pH 2·9, 3·4, 5·6, 6·3, and 6·9, were used. Brown top and creeping red fescue were found most tolerant to acidity, Chewing's fescue and red top were somewhat less so, and Kentucky blue grass, dandelion and plantain least tolerant. For the blue grass lawns of Ontario and their dandelions there would seem to be little prospect of selective treatment, but the difference in tolerance between the eastern brown top and dandelion appears to warrant further experiment.

B. 11.09. STUDIES IN SEED GERMINATION BEHAVIOUR

E. G. Anderson, Ottawa, Ont.

Seeds of about 100 weeds and other wild plants have been tested for five years at yearly intervals. Most of these tests commenced with freshly collected mature seed, and were continued for a time at monthly intervals to observe germination trends. One standardized testing procedure, as used in routine testing at the laboratories of the Seed Branch, has been adhered to thus far as a basis for a primary classification of reactions; this is to be followed by use of alternative methods which may secure germination responses which the first did not. Disregarding for the time this field of variation, it has been found that some seeds may germinate much better at maturity than later; others may exhibit delayed germination in various ways. Germination of some species is inherently not equal to that of others in percentage or duration of vitality. Individualities in various respects are coming to light which contribute to understanding of plant life histories.

B. 11.10. KEYS TO GOLDENRODS IN CANADA AND NEWFOUNDLAND

Hart, E. W., Keys to goldenrods in Canada and Newfoundland. Dom. Dept. Agr. Circ. 121. 1937.

This set of eleven keys (based upon that of Gray's New Manual, 7th edition) consists of a general key, and a separate one for each of nine provinces, and Newfoundland, together with directions as to how to employ them.

There is included an alphabetical list of species with references to their detailed descriptions in the current manuals and botanical magazines; a large proportion of which are represented in the herbarium and as growing plants at the Central Experimental Farm.

These keys form part of a monograph which includes detailed descriptions of 81 species, varieties and forms, also 55 illustrations. Owing to the cost, however, these descriptions and illustrations have not been published.

CEREAL DISEASE INVESTIGATIONS

Rusts: Project Group No. 20.00

B. 20.01. RESISTANCE OF TIMOTHY TO RUST (PUCCINIA GRAMINIS PHLEI-PRATENSIS (ERIKSS. AND HENN.) STAK. AND PIEM.

R. R. Hurst, Charlottetown, P.E.I.

In addition to 30 timothy strains under test in the laboratory plots, 300 selections have been studied in the greenhouse in regard to their reaction to rust. Inoculum from local sources was used as follows: Leaves were first moistened by means of an atomizer spray and the spores applied with a scalpel, after which the plants were placed in moist chambers, covered, and kept cool for 48 hours. Following this treatment they were placed on the greenhouse benches in an air temperature of approximately 68°F.

From results to date it would appear that a number of these selections are highly resistant to rust. Clones of the most promising sorts have been removed from the greenhouse into permanent plots for further study. Special mention should be made of the Scandinavian strain, "Gloria," which exhibits, consistently, a high degree of immunity to rust.

B. 20.06. PHYSIOLOGIC SPECIALIZATION IN PUCCINIA GRAMINIS AVENAE ERIKSS. AND HENN.

Margaret Newton and T. Johnson, Winnipeg, Man.

Studies on physiologic specialization in oat stem rust (*Puccinia graminis Avenae* Erikss. and Henn.) were carried on along lines parallel to those on wheat stem rust. From 1925 to 1936, some 1,650 isolations of oat stem rust were made from oats collected in different parts of Canada, and ten races were identified. Throughout the period, races 2 and 5 were by far the most common and widely distributed.

B. 20.07. THE CONSTANCY OF PHYSIOLOGIC RACES

T. Johnson and Margaret Newton, Winnipeg, Man.

Genetic studies of physiologic races of Puccinia graminis Tritici Erikss. and Henn.

Crosses and selfing studies with physiologic races of *Puccinia graminis Tritici* Erikss. and Henn., have established certain facts regarding the inheritance of pathogenic characteristics. In crosses between homozygous races producing an "0" type of infection on the variety Kanred and races producing a "4" type of infection, the "0" type is dominant in the F_1 hybrid race. In crosses between races producing an "0" or a "1" type of infection on the durum varieties Arnautka, Mindum, and Spelmar and races producing a "4" type of infection, the "4" type is generally dominant, although an indeterminate "x" type occasionally results. In crosses between races producing an "0" or "1" type of infection on the emmer variety Vernal and races producing a "4" type, the "0" or "1" types are dominant.

Newton, Margaret and Thorvaldur Johnson. Production of uredia and telia of *Puccinia graminis* on *Berberis vulgaris*. Nature 139: 800-801. 1937.

In selfing studies, in which barberry plants were infected with pure cultures of physiologic races of *Puccinia graminis Tritici*, two cultures showed a tendency to produce uredia and telia on the barberry. In one of these, an F_3 culture

derived from a cross between races 9 and 36, the ability to produce uredia and telia on the barberry is associated with a total suppression of aecial formation. In the other, derived from a field culture of race 21, about one-half of the pustules fail to produce aecia but frequently develop uredia and telia.

Johnson, Thorvaldur and Margaret Newton. The origin of abnormal rust characteristics through the inbreeding of physiologic races of *Puccinia graminis Tritici*. Can. Jour. Res. 16 (Sec. C): 38-52. 1938.

The inbreeding of physiologic races of *Puccinia graminis Tritici* by means of the selfing of certain selected strains for several successive generations has given rise to rust strains with various abnormal characteristics manifested not only in the uredial and telial stages but also in the pycnial and aecial stages. These abnormalities include: (1) Abnormal uredial colour—greyish-brown, orange, and white. (2) A decrease in the vigour of sporulation, that is, a tendency to form uredia that fail to rupture the epidermis of the wheat plant. (3) A decrease of pathogenic vigour in certain strains, as shown, for example, by a tendency towards an "x" type of infection in cultures descending from strains that appeared to be homozygous for the more vigorous "4" type of infection. (4) Loss of ability to produce aecia on the barberry. (5) The development of uredia and telia on the barberry by some strains that have, partially or entirely, lost the ability to produce aecia.

B. 20.11. STUDY ON THE SEXUAL BEHAVIOUR OF PLANT RUSTS

A. M. Brown and J. H. Craigie, Winnipeg, Man.

A total of 51 isolated monosporidial infections of *Puccinia coronata Elaeagni* Fraser and Ledingham, were obtained on leaves of *Elaeagnus commutata* Bernh. In the infections, no pycnia or pycnial nectar could be detected with the aid of a strong hand lens, consequently the transfer of nectar from one pustule to another was precluded. Within 18 days, aecia formed spontaneously in 49 of the infections, thereby indicating that this rust is homothallic. In three infections studied cytologically, the mycelium was uninucleate, the aeciospores binucleate, but it was not determined how the binucleate condition arose. Vestigial pycnia that did not rupture the epidermis occasionally occurred.

Inoculations of leaves of *Lathyrus venosus* Muhl. and *L. ochroleucus* Hook. with sporidia of *Uromyces Fabae* (Pers.) de Bary, gave rise to 60 selected well-separated monosporidial infections and to 30 compound infections. When the infections were 16 days old, the pycnial nectar of 50 of the monosporidial infections was intermixed, irrespective of the host species on which produced. In 47 cases aecia developed, and in 17 of these infections, uredia arose within a few days after the aecia appeared. The ten infections retained as checks developed no aecia.

Of the 30 compound pustules, 17 produced uredia but no aecia. The remaining 13 pustules continued in the haploid condition. On the basis of these results, *U. Fabae* is heterothallic, and may shorten its life cycle by suppressing aecia.

B. 20.13. THE SEASONAL DISTRIBUTION OF PHYSIOLOGIC RACES OF PUCCINIA GRAMINIS TRITICI IN CANADA

Margaret Newton and T. Johnson, Winnipeg, Man.

Newton, Margaret. The cereal rusts in Canada. Empire Jour. Expt. Agric. 6: 125-140. 1938.

From 1919, when the first physiologic races were isolated in Canada, until the present, a total of 53 physiologic races of wheat stem rust (*Puccinia graminis Tritici* Erikss. and Henn.) have been isolated from cereals and grasses

in the field. Although as many as 21 physiologic races were present in the fields in a single year, one or two races usually predominated. From 1934 to 1937, race 56 was the predominating race and formed over 50 per cent of the total isolations.

A study, from 1927 to 1937, of the proportion of physiologic races in the collections from Eastern Canada and British Columbia, where barberries are more or less common and hybridization between races is possible, and in the Prairie Provinces, where practically no barberries are present, shows that, out of 515 isolations of stem rust of wheat from Eastern Canada and British Columbia, 33 races were identified; and that, out of 1,944 isolations from the Prairie Provinces, only 36 races were identified. That is to say, the proportion of races was greater in the area where barberries are more or less common than in the area where practically no barberries are present. In the former, a different race was isolated for about every 15 cultures studied, and, in the latter, only one for every 54 cultures.

B. 20.15. PHYSIOLOGIC SPECIALIZATION OF PUCCINIA CORONATA AVENAE

B. Peturson, Winnipeg, Man.

During the years 1935-37, collections of crown rust of oats (*Puccinia coronata Avenae* Erikss. and Henn.) were obtained from many widely separated localities in Canada. From a total of 264 cultures studied, physiologic races 1, 2, 3, 4, 5, 6, 10, 24, 36, and 38 were isolated.

Each year physiologic races 1, 2, 3, and 4 comprised over 85 per cent of all isolations. These four races occurred both in Eastern and Western Canada. Races 2 and 3 were very rare in the West, but common in the East; races 1 and 4 predominated in the West.

B. 20.20. THE RELATION BETWEEN RUST INFECTION AND THE YIELD OF CEREAL CROPS

F. J. Greaney, Winnipeg, Man.

Field experiments to determine the effect of leaf rust (*Puccinia triticina* Erikss.) on the yield of wheat were made in 1934, 1935, and 1936. For the purpose of the study a strain of wheat (H 44-24 × Marquis cross) resistant to stem rust but susceptible to leaf rust was used. In 1934, 33 per cent of leaf rust occurred in the undusted plots of wheat at Winnipeg. This reduced the yield 4·0 bushels per acre, or 1·2 bushels per acre for each ten per cent of leaf rust. The weight per measured bushel of grain was also reduced two pounds by thirty-three per cent of leaf rust. Forty per cent of leaf rust reduced the yield 4·7 bushels per acre in 1935, or approximately 1·2 bushels per acre for each ten per cent of leaf rust. Leaf rust did not develop to any appreciable extent at Winnipeg in 1936.

During the five-year period 1931-36, field experiments were made to determine the effect of crown rust (*Puccinia coronata Avenae* Erikss. and Henn.) on the yield of oats. An oat strain (Hajira × Banner cross) resistant to stem rust but susceptible to crown rust was used. A statistically significant difference in yield between dusted (practically rust-free) and undusted plots of oats was obtained in 1932 and 1935 only. In these years each ten per cent of crown rust reduced the possible yield of oats 0·7 bushels per acre. The results of 1931, 1934, and 1936 were insignificant owing to light infections of crown rust in these years.

Greaney, F. J. Cereal rust losses in Western Canada. Sci. Agric. 16: 608-614. 1936.

Stem rust (*Puccinia graminis* Pers.) has been an important cause of economic loss during the present century in Western Canada. For the 11-year period 1925-35, a graded series of stem rust infections was obtained at Winnipeg each year by dusting field plots of wheat and oats with sulphur, and annual losses in grain yield and quality were determined. Data from these plots were used to estimate field losses from stem rust in Western Canada.

From 1925 to 1935 the average annual rust loss in Manitoba and Saskatchewas was 10·8 per cent of the possible wheat crop yield. From 1929 to 1934 the oat crop suffered an annual loss of 5·5 per cent. Evaluated in terms of dollars the total annual loss from stem rust of wheat and of oats in these two provinces was $34,895,000. Crop loss estimates based on the results of controlled experiments indicate that the annual loss caused by all cereal rusts in the three Prairie Provinces of Canada during the 11 years 1925-35, was $40,000,000.

B. 20.21. STUDIES OF THE EFFECT ENVIRONMENTAL FACTORS ON THE UREDIAL DEVELOPMENT OF CEREAL RUSTS

Margaret Newton and T. Johnson, Winnipeg, Man.

In 1931, a study of physiologic specialization in leaf rust of wheat (*Puccinia triticina* Erikss.) was begun at Winnipeg. Difficulties were encountered in the determination of physiologic races, owing to the sensitiveness of this rust to changes in environmental conditions, particularly temperature and light. An attempt, therefore, was made to ascertain the temperature most suitable, at Winnipeg, for the identification of physiologic races. A number of races were cultured simultaneously at constant temperatures of 60°, 65°, and 75° F. and their infection types compared. As a result of this study it was established that as at 65° F., the infection types of the majority of races most closely approached the accepted mean for the race (as established by Dr. C. O. Johnston), a temperature of 65° F. is more suitable for the identification of physiologic races than either 60° or 75° F. The different hosts were found to differ considerably in their sensitivity to temperature. Malakof and Loros were rather constant in reaction at temperatures from 60° to 75° F.; Carina, Brevit, and Hussar were usually rather resistant at the lower temperature and susceptible at the higher; and Webster, Mediterranean, and Democrat tended to susceptibility at the lower temperature and resistance at the higher.

Johnson, Thorvaldur and Margaret Newton. The effect of high temperatures on uredial development in cereal rusts. Can. Jour. Res. 15 (Sec. C): 425-432. 1937.

The effect of high temperatures on the development of stem rust and leaf rust on wheat seedlings and stem rust and crown rust on oat seedlings was studied in greenhouse experiments. The experimental results show that, for temperatures above the optimum for rust development, the higher the temperature the less vigorous the pustule development. Physiologic races that at ordinary temperatures produce a "4" type of infection tend to develop a "3" type or an "X" type at higher temperatures. At still higher temperatures the infection type becomes "2" or "1" or even merely necrotic flecks. Physiologic races of the same rust differ in their sensitiveness to temperature. In stem rust of wheat, races that had been inbred by repeated selfings for two or more generations, showed greater sensitiveness to temperature than races collected in the field. Leaf rust of wheat and crown rust of oats were less tolerant of high temperatures than stem rust of wheat.

B. 20.24. A STUDY OF THE PHYSIOLOGY OF PUCCINIA TRITICINA ERIKSS.

Margaret Newton and T. Johnson, Winnipeg, Man.

During the years 1931, 1933, 1934, and 1936, a total of 140 isolations of leaf rust of wheat (*Puccinia triticina* Erikss.) were made from wheat collected in different parts of Canada, and 32 races were identified. Although races 15, 31, and 56 occurred most frequently during the period indicated, a different physiologic race predominated almost every year.

Smuts: Project Group No. 21.00

B. 21.01. CONTROL OF BUNT OF WHEAT BY SEED TREATMENT

W. F. Hanna and W. Popp, Winnipeg, Man.

Hanna, W. F. and W. Popp. Bunt infection of spring wheat by soil-borne spores. Sci. Agric. 14: 257-258. 1934.
Hanna, W. F. and W. Popp. Experiments on the control of cereal smuts by seed treatment. Sci. Agric. 15: 745-752. 1935.
Hanna, W. F. and W. Popp. The production of smut-free seed. Dom. Dept. of Agric., Circ. 94. 1936.

During the past three years field tests have been made to determine the relative effectiveness of a number of fungicides in controlling smut. In these tests the best control of bunt of wheat was secured with the organic mercury dust, "New Improved Ceresan." Seed of wheat, barley, and oats (both hulled and hulless) that had been treated with this dust and stored in a barn for a year germinated better than untreated seed.

The following conclusions have been drawn from the results of experiments conducted from 1934 to 1937 to determine the effect of seed treatment on the yield of wheat, oats, and barley: (1) Treatment of smutty seed increased yield by controlling the smut. The largest increases were given by the dust treatments, and the smallest by formaldehyde. (2) Treatment of smut-free seed with formaldehyde sometimes reduced the yield. (3) Treatment of smut-free seed of wheat, barley, and hulled oats with dusts did not significantly increase the yield. (4) Smut-free seed of Laurel oats treated with New Improved Ceresan yielded significantly higher than untreated seed. (5) Seed of wheat, oats, and barley treated with New Improved Ceresan and stored for four months before seeding yielded as well as seed treated 24 hours before seeding. (6) High quality seed yielded significantly better than seed of inferior quality and treatment of the latter with a dust did not compensate for its lack of quality.

A solution containing one ounce of New Improved Ceresan in 20 gallons of water, or one ounce of "Leytosan" in ten gallons of water has been found to be suitable for treating slightly bunted wheat. If the solution is used in a treating machine of the "floater" type, ragweed seeds may be removed from the wheat during treatment.

B. 21.02. CONTROL OF COVERED SMUT OF BARLEY BY SEED TREATMENT

W. F. Hanna and W. Popp, Winnipeg, Man.

Hanna, W. F. and W. Popp. Experiments on the control of cereal smuts by seed treatment. Sci. Agric. 15: 745-752. 1935.

In tests of a number of seed-treating substances made during the past three years, the organic mercury dusts, New Improved Ceresan and Leytosan, have given the best control of covered smut of barley. Immersion of smutty seed

of barley for two minutes in a solution containing ¼ per cent New Improved Ceresan resulted in moderately good control of smut, but adversely affected seed germination. Seed treated with a weaker solution germinated well but produced a greater number of smutted plants.

B. 21.03. VARIETAL SUSCEPTIBILITY OF OATS TO LOOSE AND COVERED SMUTS

W. F. Hanna and W. Popp, Winnipeg, Man.

Oat-smut spores collected in the Maritime Provinces, Quebec, and in the Prairie Provinces have been used to inoculate varieties of oats possessing varying degrees of smut resistance. Some of the collections were found to be of *Ustilago Avenae* (Pers.) Jens., and others were of *U. levis* (K. and S.) Magn., but all proved to be very similar in pathogenicity.

B. 21.05. CONTROL OF LOOSE AND COVERED SMUTS OF OATS BY SEED TREATMENT

W. F. Hanna and W. Popp, Winnipeg, Man.

Hanna, W. F. and W. Popp. Experiments on the control of cereal smuts by seed treatment. Sci. Agric. 15: 745-752. 1935.
Hanna, W. F. and W. Popp. The production of smut-free seed. Dom. Dept. Agric., Circ. 94. 1936.

During the period 1935-37, 16 fungicides were used in plot tests to determine their effectiveness in controlling the loose and covered smuts of oats. The organic mercury dusts, New Improved Ceresan and Leytosan, proved to be effective smut preventives. Treatment of seed of hulless oats with New Improved Ceresan resulted in a pronounced improvement in its germination, and seed of hulled oats treated with this dust usually germinated better than untreated seed. Smutty seed of hulled oats that had been immersed for two minutes in a solution containing ⅛ per cent New Improved Ceresan germinated well, and produced a crop almost free from smut. Smutted oats treated in several different types of dusting machines have been grown in plots in the field. Certain machines distributed the dust over the seed more uniformly than others. The plots that had been sown with the most thoroughly dusted seed had the lowest percentages of smut.

B. 21.06. FACTORS INFLUENCING INFECTION WITH SMUTS

W. F. Hanna and W. Popp, Winnipeg, Man.

In the course of experiments made between 1930 and 1935, it was found that five-year-old seed of wheat and barley inoculated with loose smut produced as high a percentage of infected plants as freshly inoculated seed. The practice, sometimes suggested, of attempting to control the loose smuts of wheat and barley by using seed two or three years old cannot, therefore, be recommended.

A study has been made of the longevity of smut spores stored under different conditions. Spores of *Ustilago Tritici* (Pers.) Rost., *U. nuda* (Jens.) Rost., *U. Avenae* (Pers.) Jens., *U. levis* (K. and S.) Magn., *U. Hordei* (Pers.) K. and S., and *U. medians* Biedenkopf, retained their viability longer when stored at 10° C. than when stored at room temperature or at 10° C. over calcium chloride. Spores of the covered smuts of oats and barley lived much longer than spores of the loose smuts, including *U. medians*.

Storage for three years of the seed of oats and barley inoculated with spores of the covered smuts did not result in any decrease in the incidence of infection. Oat seed inoculated with loose-smut spores in 1934 produced a significantly

smaller proportion of smutted plants in 1936 than in 1935, and in 1937 a further drop in infection occurred. This suggests that seed-borne spores of *U. Avenae* lose their viability at much the same rate as spores stored in the laboratory. In other experiments it was found that the decline in infection with age was less rapid in seed naturally inoculated with *U. Avenae* than in artificially inoculated seed. The persistence of the smut in naturally inoculated seed was attributed to invasion of the inner glumes and the pericarp at the time of anthesis.

B. 21.08. VARIETAL REACTIONS OF WHEAT AND BARLEY TO COLLECTIONS OF LOOSE SMUT

W. F. Hanna and W. Popp, Winnipeg, Man.

Hanna, W. F. Effect of vernalization on the incidence of loose smut in wheat. Sci. Agric. 16: 404-407. 1936.
Hanna, W. F. Physiologic forms of loose smut of wheat. Can. Jour. Res. 15 (Sec. C): 141-153. 1937.

Four physiologic races of loose smut of wheat have been found in Manitoba. Two of these races were collected in the field, one on Reward and the other on Mindum. The two other races appeared in the course of artificial inoculations in the greenhouse. One of these races may have resulted from a mutation. The results of inoculation experiments indicate that different physiologic races of loose smut of wheat are present in Eastern and Western Canada. None of the 13 varieties of wheat used in the inoculation experiments proved to be resistant to all physiologic races. The inoculation of Reward, Marquis, Garnet, and Pentad × Marquis with their own spores for four generations did not result in appreciably increasing the infection on these varieties. It has also been shown that the healthy Reward plants that are sometimes present in a population grown from artificially inoculated seed are not resistant to loose smut, but have escaped infection because of faulty inoculation.

A second physiologic race of loose smut of barley has been found in Manitoba. This race attacks Trebi which is resistant to the other race of loose smut. Black loose smut of barley (*Ustilago medians* Biedenkopf) has been found in Manitoba. Good control of this smut was obtained with the organic mercury dusts, New Improved Ceresan and Leytosan.

B. 21.09. REACTIONS OF WHEAT VARIETIES TO BUNT

W. F. Hanna and W. Popp, Winnipeg, Man.

Two collections of bunt made in 1936, one at Fredericton, N.B., and the other at Indian Head, Sask., were compared in an inoculation experiment made at Winnipeg in 1937 with a collection of *Tilletia Tritici* (Bjerk.) Wint. and one of *T. levis* Kühn from Manitoba. Eight varieties of wheat selected as differential hosts were inoculated with the four collections of spores. The spores in the Fredericton collection were mostly of *T. Tritici;* those in the Indian Head collection were mostly of *T. levis.* The Fredericton collection was found to correspond in pathogenicity with *T. levis,* with the exception, however, that it produced a much heavier infection on Garnet. It is probably a second race of *T. Tritici.* The pathogenicity of the Indian Head collection was very similar to that of *T. levis.*

Each year the rust resistant wheats in the co-operative test have been inoculated with bunt to determine their resistance to *T. Tritici* and *T. levis.*

B. 21.10. REACTIONS OF BARLEY VARIETIES TO COVERED SMUT

W. F. Hanna and W. Popp, Winnipeg, Man.

Heavy infection on susceptible varieties of barley has been secured by inoculating the seed with a spore suspension containing 1 gm. of spores in 1,000 cc. of water. The inoculation was effected by covering the seed with the spore suspension, and then placing it in a desiccator from which the air was later withdrawn by means of a suction pump. After 15 minutes at reduced pressure, the seed was drained, then stored for 24 hours in a moist chamber at 20° C., and finally dried. The pathogenicity of *Ustilago Hordei* (Pers.) K. and S., collected in New Brunswick, Nova Scotia and Prince Edward Island, when tested by this method, was found to correspond very closely with that of one of the two physiologic races of this fungus found in Manitoba. A cross was made between the two races of *U. Hordei* found in Manitoba. The hybrid spores were able to infect varieties of barley that were resistant to one or other of the parent races.

B. 21.11. PHYSIOLOGY AND SEXUALITY OF USTILAGO AVENAE AND U. LEVIS

W. F. Hanna and W. Popp, Winnipeg, Man.

Seed of Longfellow and Abundance oats smutted with spores of *Ustilago Avenae* (Pers.) Jens., and *U. levis* (K. and S.) Magn., was sown in the field on two dates in 1935 for the purpose of determining the effect of host variety and date of seeding on the appearance of the smutted panicles. When rows of the two varieties sown on the same date were compared it was found that both species of smuts tended to destroy the glumes of Abundance more completely than those of Longfellow, thus making them more "loose" in appearance. Similarly, the early seeding produced more heads of the "loose" type than did the corresponding rows of the late seeding. From these results it is concluded that the appearance of smutted oat panicles is determined by the host variety, and the conditions under which it grows, as well as by the species of smut causing the infection.

In 1937 the pathogenicity of *Ustilago Avenae* and *U. levis* was compared with that of five generations of the hybrid spores *(U. Avenae* × *U. levis)*. Material for this comparison was obtained by sowing plots of Abundance and Anthony oats with seed that had been inoculated with the different kinds of spores. Both varieties gave the same relative reaction to *U. Avenae, U. levis,* and to the hybrid spores. The F_1 spores, as in other experiments, proved to be only weakly pathogenic, but with each succeeding generation the percentage of infection increased until, in the F_5 generation, it was almost equal to that of the two parents.

B. 21.—STUDIES ON THE EFFECT OF POWDERED PITCHBLENDE ORE UPON THE DEVELOPMENT OF BUNT OF WHEAT

W. C. Broadfoot, Edmonton, Alta.

Statistical analyses of the results of 1934, 1935 and 1936 showed that there were no significant differences in germination and yield of wheat (one, ten and five varieties in 1934, 1935 and 1936, respectively) treated with powdered pitchblende ore. Although there was a significant reduction in bunt infection as a result of treating with the ore (average reduction for the varieties tested in 1934, 1935 and 1936 was 6·2, 7·5 and 18·7 per cent, respectively), it could not be considered of practical importance. Considering the stimulative effect obtained with pitchblende on wheat, barley, and corn in other experiments, further tests are being conducted to determine if the reduction in bunt infection was due to fungicidal action of the ore or to stimulation of the plant by the ore.

Root-rots: Project Group No. 22.00

B. 22.02. STUDY OF "TAKE-ALL" (OPHIOBOLUS GRAMINIS) OF WHEAT

R. C. Russell, Saskatoon, Sask.

Previous work has shown that an isolate of *Ophiobolus graminis* Sacc., may vary from time to time in its pathogenicity to wheat. During the past three years an attempt was made to determine whether or not certain differences in environmental conditions, under which different cultures of the same isolate were kept, would affect their pathogenicity. Three separate cultures of two different isolates were tested several times each year. Up to the present, all of these cultures have tended to become less pathogenic. There has been no consistent correlation between the environmental conditions under which the cultures were grown and their pathogenicity.

At the same time eight isolates from different parts of the world (See Dom. Dept. Agric. Bull. 170, N.S., pp. 32-36, 1934) were kept growing on potato dextrose agar in a refrigerator and tested occasionally. At present the pathogenicity of the majority of these is low and most of them will be discarded unless they show signs of returning pathogenicity.

A histological study of the phenomena accompanying the infection of wheat, barley and oats by *O. graminis* has been started but this work has not yet been completed.

In 1936 seven varieties of rust resistant wheat together with Marquis, Reward, and Canus were compared with regard to their susceptibility in the seedling stage to *O. graminis*. No marked differences were detected.

Field experiments in 1935 were planned to study the effect of phosphatic fertilizers on the susceptibility of wheat to take-all. A heavy infection was obtained by artificial inoculation with *O. graminis* but the healthy wheat did not respond to the phosphates applied, possibly because the field had been manured a year or two previously. In 1936, four wheat varieties were compared under field conditions. While the two rust-resistant varieties, Apex and Thatcher, were not significantly more resistant to *O. graminis* than were Marquis and Reward yet they compared favourably with these standard varieties.

Russell, R. C. Take-all—A root-rot of cereal crops. Dom. Dept. Agric., Circ. 93. 1936.

This is an illustrated popular bulletin describing the symptoms of take-all and pointing out the methods by which it may be controlled.

B. 22.03. CO-OPERATIVE STUDIES ON VARIETAL RESISTANCE IN CEREALS TO THE ROOT-ROT DISEASES (IN CO-OPERATION WITH CEREALIST, UNIVERSITY OF SASKATCHEWAN)

Results of tests made in 1938

P. M. Simmonds, Saskatoon, Sask.

Small plot experiments conducted in co-operation with Dr. J. B. Harrington, of the Field Husbandry Department, University of Saskatchewan, indicated that real progress was being made in developing a practicable field procedure. Seed samples of plant breeding material were inoculated with *Helminthosporium sativum* to determine their reactions to this common root-rot fungus. In this way various new lines could be rated in comparison with ordinary varieties.

Dr. Russell conducted tests to determine the resistance of some wheat varieties against infection by *Ophiobolus graminis*. (See B. 22.02).

Similar tests were made by Mr. Sallans using the pathogen, *H. sativum* (See B. 22.05).

Results of tests made in 1937

B. J. Sallans, Saskatoon, Sask.

Readings for common root-rot infections of the *H. sativum* type, were made on samples of six wheat varieties grown at 14 locations in Saskatchewan. The varieties examined included Ceres, Thatcher, Apex, Marquis, Reward, and Renown. For the most part differences between varieties at any one location failed to be statistically significant. Considering the data as a whole, however, Reward in particular, and Renown to some extent, stood out as being least affected by common root-rot. This trend is contrary to previous results obtained at this laboratory. The severe drought conditions in 1937 may have influenced the degree of infection as shown by the lesions on the subcrown internode. The extent to which environmental conditions or age of the host may influence the expression of infection, as shown by subcrown internode lesions, is now under investigation.

B. 22.05. STUDY OF THE ROOT-ROT PROBLEM OF WHEAT AND BARLEY CAUSED BY HELMINTHOSPORIUM SATIVUM IN SASKATCHEWAN

B. J. Sallans, Saskatoon, Sask.

During the triennium, 1935-1937, work on this project has been directed toward a study of, (*a*) methods of inoculation (continued from previous years), (*b*) effects of various cultural practices on common root-rot, (*c*) tests of varietal reactions to the disease, (*d*) competition between wheat affected by root-rot and other plants and (*e*) water relations of diseased and healthy wheat.

Since the 1931-1934 report a new method of inoculation has been devised which has several advantages. It consists in applying a highly sporulating oat-hull culture of the fungus to moistened seed, drying, screening and seeding within a day or two.

Depth of seeding tests continued in 1935 and 1936 indicate that inoculated wheat sown at two inches suffers less injury than when sown at one, three, or four inches. Rate of seeding experiments in 1935 and 1936 at Indian Head indicate that the reduction in yield of wheat due to inoculation with *H. sativum* is least at a two bushel per acre rate and increases with successively lower rates of seeding.

Varietal reactions to inoculation with *H. sativum* were studied each year. No clear cut resistance was found in several varieties of wheat. Minor yet fairly constant differences were observed between Reward and some new varieties of Reward parentage and such varieties as Marquis, Apex, Thatcher and Ceres. However these differences occurred in the seedling stage. Reactions at later stages appear, in preliminary work, to differ from those of the seedling stage.

In 1937 a field test indicated that wheat inoculated with *H. sativum* is likely to suffer seriously if subjected to competition from other plants, such as weeds and flax. A healthy crop can compete successfully with them, but a crop that is thinned and retarded due to root-rot fails to suppress the weeds normally.

During 1936 and 1937 the use of water by plants in relation to infection by *H. sativum* was studied. Infected plants were no less efficient in the utilization of water than uninoculated plants. However, the diseased plants differed markedly in developmental processes from healthy plants. They were at first decidedly stunted, but at three to four weeks gained rapidly on the healthy

plants, when soil moisture was sufficiently abundant, until they were larger. The first few leaves of the inoculated plants were stunted but the later ones were larger than normal and more numerous. Soil moistures of 30 and 45 per cent of the water holding capacity of the soil did not favour recovery of inoculated plants while moistures of 60 and 75 per cent did.

B. 22.07. ROOT-ROT SURVEYS

In Manitoba

J. E. Machacek and F. J. Greaney, Winnipeg, Man.

Common root-rot of cereals, during the period 1935-37 was as prevalent as in previous years, but the most severe damage, particularly in 1935 and 1937, occurred in the southwestern part of the province. The disease resulted in a marked thinning of the stand, stunting and premature yellowing of the plants, and shrinking of the kernels. The most conspicuous feature of the disease in both of these years was the abundance of yellowed and wilted plants among the green healthy ones in the affected fields. This symptom was particularly noticeable in fields of oats and barley, but it occurred frequently in wheat fields as well.

Browning root-rot, first noticed in Manitoba in 1933, was found in many fields during the next three years, but no marked damage was evident. In 1937, however, most of the fields in the Dauphin-Grandview area were severely attacked. The use of fertilizer as a measure of control of this disease was well demonstrated in this area, as fields that received a light application of ammonium phosphate did not suffer from the disease; while adjacent fields that did not receive fertilizer, or patches within fertilized fields that through accident did not receive fertilizer, were severely damaged.

Take-all was found occasionally in traces but no damage due to this disease was visible.

In Saskatchewan

P. M. Simmonds and H. W. Mead, Saskatoon, Sask.

In 1935 a total of 411 fields were surveyed, 294 of wheat, 73 of oats, 36 of barley and 8 fields of rye. A trace of take-all was found in eight wheat fields. Prematurity blight was seen in small amounts in one field of wheat and four of oats. Browning root-rot was more widespread than in 1934. Several severely damaged fields were recorded. Common root-rot was prevalent in all cereals, although infections were usually slight. A few wheat fields were severely affected.

In 1936 a total of 365 fields were surveyed, 277 of wheat, 56 of oats, 21 of barley, 7 of rye and 4 fields of flax. A trace of take-all was found in five fields of wheat. Prematurity blight was seen in small amounts in four wheat fields and five oat fields. Browning root-rot was comparatively uncommon. Common root-rot was prevalent in all cereals with a few wheat fields showing moderate to severe injury.

In 1937 the severe drought reduced the crop area considerably. A total of 148 fields were surveyed, 115 of wheat, 18 of oats, 13 of barley and 2 fields of flax. A trace of take-all was found in only one wheat field. Prematurity blight was not widespread, but was severe on durum wheats at Saskatoon. Browning root-rot was observed in 36 of the 40 wheat fields examined on survey trips through northern Saskatchewan in June. It was prevalent in the Melfort district. Common root-rot occurred in 104 of the 115 wheat fields surveyed. The average infection was moderate.

B. 22.13. RELATION OF THE ASSOCIATION OF BACTERIA AND FUNGI TO THE PATHOGENICITY OF ROOT-ROTTING FUNGI

G. B. Sanford, Edmonton, Alta.

Sanford, G. B. Recent Canadian work on antibiosis. (Paper presented, by invitation, at Symposium on Antibiosis, at twenty-seventh annual meeting of The American Phytopathological Society, January, 1936, St. Louis, Missouri. Paper was not published.)

This paper comprised a review of the important contributions made by Canadians to the subject of antibiosis, as related to plant pathogens and the diseases caused by them. The work reviewed originated at the Dominion laboratories at Edmonton, Winnipeg and St. Catharines, and at the plant pathological laboratories of the University of Alberta and Macdonald College. Among the pathogens which were involved were: *Helminthosporium sativum, Ophiobolus graminis, Fusarium* sp., all root-rotting parasites of cereal crops; *Actinomyces scabies*, which causes common scab of potato; *Dibrotryon morbosum*, causing black knot of *Prunus domestica; Penicillium expansum* and *Sclerotinia fructicola*, which rot apples; *Botrytis* spp. and *Erwinia caratovora*, associated with rot of onions; and *Cladosporium fulvum, Botrytis*, sp., *Penicillium expansum* and *Sclerotinia fructicola* as associated with rot of tomatoes.

B. 22.16. THE EFFECT OF FERTILIZERS, ETC., ON THE DEVELOPMENT OF ROOT-ROT OF WHEAT

W. C. Broadfoot and L. E. Tyner, Edmonton, Alta.

Broadfoot, W. C., and L. E. Tyner. Studies on foot- and root-rot of wheat. V. The relation of phosphorus, potassium, nitrogen and calcium nutrition to the foot- and root-rot disease of wheat as caused by *Helminthosporium sativum* P., K. and B. Can. Jour. Res. 16 (Sec. C): 125-134. 1938.

The effect of different amounts of phosphorus, potassium, nitrogen and calcium upon the development of the foot-rot disease of wheat caused by *Helminthosporium sativum* P., K. and B. was studied in the greenhouse. The wheat grains were planted in sterilized pure quartz sand to which the necessary nutrients and spore suspension of the pathogen were added. The experiments were maintained under aseptic conditions during the first ten days. The disease increased when the ionic concentration of potassium, nitrogen and calcium was decreased below that of the complete nutrient solution, but no significant reduction of the disease was observed when the concentrations of all of the elements, including phosphorus, were increased above those in the complete nutrient solution. Apparently extremely small concentrations of phosphorus had no effect on the disease one way or the other. These conclusions apply to the disease on wheat in the seedling stage.

Broadfoot, W. C., and L. E. Tyner. Studies on foot- and root-rot of wheat. VI. A study of the disease in water-culture nutrients. (Completed for publication.)

The two foot-rot diseases of wheat caused by *Helminthosporium sativum* P. K. and B., and *Fusarium culmorum* (W.G.Sm.) Sacc., were studied in a water culture instead of the usual soil or sand substrate. The most satisfactory results were obtained by first germinating the grains in a specially designed tray, then securing infection of the young plants by adding inoculum to the tray, after which the seedlings were transplanted to the nutrient culture solution. Infection of the seedlings was distinctly increased when sugar was added to the infested nutrient solutions previous to the time of transplanting to it. It was less satisfactory when the inoculum, in a two per cent sugar spore suspension was added to the plant culture solution at the time the seedlings were transplanted; or

when the seed was immersed in a spore suspension, then dried and spread to germinate on the tray. Unsatisfactory infection was secured by adding a spore suspension in water, with or without sugar, to the plant culture solution at the time of transplanting the seedlings. Inoculating the seedlings with a spore suspension by means of a hypodermic needle also produced unsatisfactory infection. Shoot length, and particularly green and dry weight of the entire plant were reliable quantitative criteria for the evaluation of foot-rot damage.

The disease was increased when the ionic concentration of potassium, nitrogen and calcium was decreased below that of the complete nutrient solution, which results agree closely with previous experiments using silica sand as a substrate.

Greater reduction of chlorosis occurred when ferric tartrate was added to the plants infested with *H. sativum* or *F. culmorum* than when added to the control plants. Iron absorption by the host plant appeared to be facilitated by the presence of the pathogens.

The water culture method appears to offer several important advantages over the soil or sand substrate now commonly employed, in that both the degree of infection and the nutrition of the host can be controlled.

B. 22.19. THE PATHOGENICITY OF SOME ROOT-ROTTING FUNGI

J. E. Machacek, F. J. Greaney, and C. L. Johnston, Winnipeg, Man.

In 1936 and 1937 extensive greenhouse and fields tests with species of *Fusarium* and several isolates of *F. culmorum* (W.G.Sm.) Sacc., were made Greenhouse tests with five species of *Fusarium,* namely, *F. culmorum, F. avenaceum* (Fr.) Sacc., *F. Equiseti* (Cda.) Sacc., *F. oxysporum* Schl., and *F. redolens* Wr., showed that of these species (commonly isolated from root-rotted wheat, oat, barley, and rye plants) only the first was strongly pathogenic to wheat. Further greenhouse tests with 24 isolates of *F. culmorum,* collected from various sources, showed that these isolates varied greatly in their pathogenicity. One of these isolates, obtained originally in 1930 from the roots of Mindum wheat grown in Manitoba and carried in pure culture since that time, was more pathogenic than any of the others.

A field test with ten isolates of *F. culmorum,* and one isolate each of the other four species listed above, was made in 1937. As far as the collected data showed, the findings of the greenhouse tests were confirmed by the field experiment. Here again *F. culmorum* proved to be considerably more pathogenic to wheat than were the other four species, but there were marked differences in the pathogenicity of the *F. culmorum* isolates.

Machacek, J. E. and F. J. Greaney. The "Black-point" or "Kernel Smudge" disease of cereals. Can. Jour. Res. 16 (Sec. C): 84-113. 1938.

Certain fungi, namely, *Helminthosporium sativum* P.K. and B., *H. teres* Sacc., *Helminthosporium* spp., *Curvularia* spp., *Alternaria tenuis* Nees, and *A. Peglioni* Curzi, all of which occur in Manitoba soils and are also associated with root-rot of cereals, have been isolated from blackened kernels of wheat, rye, and barley. *Helminthosporium sativum* and the two species of *Alternaria,* however, are associated chiefly with such kernel discoloration; yet the symptoms of disease produced by these fungi appear to be indistinguishable. Invasion of the kernels by *H. sativum* results in a blighting of the seedlings arising from such kernels, while, in the case of kernels infected by *Alternaria,* this does not occur. The blight, however, can be prevented by seed disinfection with organic-mercury dusts.

The disease, under Manitoba conditions, apparently arises as a result of kernel infection at the time such kernels are maturing. The better developed

kernels are more often discoloured than the shrunken kernels. Air-borne spores of *Alternaria* and *Helminthosporium,* lodging on exposed kernels, are largely responsible for this seed infection. Data collected for several years indicate that such air-borne spores increase in number during the summer, the number reaching the peak in early August, and that most of the spores are carried into Manitoba from the south.

Samuel, G. and F. J. Greaney. Some observations on the occurrence of *Fusarium culmorum* on wheat. Trans. Brit. Myc. Soc. 21: 114-117. 1937.

A study of the fungi isolated from wheat plants collected in England in 1934 and 1935 showed that *Fusarium culmorum* was present on most of the roots and stem bases of apparently healthy as well as obviously diseased plants grown under similar field conditions. In spite of an appreciable amount of *F. culmorum* present on the roots at harvest time, the crops of three different fields gave excellent yields.

This study was continued in Manitoba in 1936 and 1937. Each year plants were obtained from three different wheat fields. Isolation work was begun about four weeks after the crop had been sown, and periodic isolations were made until it ripened.

In both years *Fusarium culmorum,* as well as other species of *Fusarium* including F. *avenaceum F. Equiseti, F.* Poae (Pk.) Wr., *F. sambueinum* Fuckel, and *F. Solani* (Mart.) App. and Wr., and a miscellaneous group of fungi consisting chiefly of species of *Penicillium, Rhizopus, Periconia, Chaetomium, Mucor, Alternaria, Gliocladium, Rhizoctonia, Helminthosporium,* and *Cephalosporium* were isolated just as frequently from apparently healthy as from obviously diseased plants of the same field sample. On the other hand, the number of diseased plants yielding *Helminthosporium sativum* was appreciably greater than the number of healthy plants yielding this fungus.

B. 22.24. THE INFLUENCE OF ENVIRONMENTAL FACTORS ON THE PATHOGENICITY AND CULTURAL CHARACTERISTICS OF ROOT-ROTTING FUNGI

J. E. Machacek, F. J. Greaney, and C. L. Johnston, Winnipeg, Man.

Machacek, J. E. and F. J. Greaney. Studies on the control of root-rot diseases of cereals. IV. Influence of mechanical seed injury on infection by *Fusarium culmorum* in wheat. Can. Jour. Res. 14 (Sec. C): 438-444. 1936.

Experiments have shown that, when sown, mechanically-injured seed of cereals is more subject than uninjured seed to invasion by root-rotting fungi that occur as seed contaminants or are present in infected soil. Seed so injured may fail to germinate; or, if it germinates, the resulting plants are weak and very susceptible to root-rot. Planting of mechanically-injured seed has resulted in decreased germination, high disease-rating, and decreases in yield proportional to the extent of seed injury.

Machacek, J. E. Preliminary investigations on the effect of excessive soil salinity on the incidence of cereal root-rots. Sci. Agric. 17: 215-224. 1936.

Data collected during the Manitoba cereal root-rot survey indicated that common root-rot caused more damage to cereals grown in heavily salinized soils than where salinity was not pronounced. Greenhouse experiments with magnesium sulphate confirmed the field observations, and at the same time showed that growing cereal plants were most severely damaged when the saline concentration was greatest in the vicinity of the root crown. It was demonstrated also that the growth of two major common root-rot fungi, *Helminthosporium sativum* P.K. and B., and *Fusarium culmorum* (W.G.Sm.) Sacc., was retarded only slightly at concentrations of magnesium sulphate that were lethal to plants of wheat, oats, and barley.

Five species of *Fusarium* commonly associated with cereal root-rots in Manitoba, namely, *Fusarium culmorum, F. Equiseti* (Cda.) Sacc., *F. avenaceum* (Fr.) Sacc., *F. oxysporum* Schl., and *F. redolens* Wr., were subjected to pathogenicity tests in greenhouse trials. Wheat plants were grown in soil artificially infested with each of these fungi at four different temperatures, 25°, 20°, 15° and 10° Centigrade. The results from quadruplicate trials showed that, of the five fungi, only *F. culmorum* was distinctly pathogenic to wheat seedlings, as indicated by seedling emergence, disease rating, and green weight of plants. The effect of temperature on the pathogenicity of *F. culmorum* was marked, the higher temperatures favouring disease development.

B. 22.25. A STUDY OF SEED TROUBLES IN RELATION TO ROOT-ROT OF CEREALS

H. W. Mead, Saskatoon, Sask.

Studies of the early development of roots of wheat in water cultures showed that the roots grew longer and branched more profusely in cultures with pH 5·85 than in those with pH 6·93. At the end of the experiment, the pH readings were 6·45 and 6·77 respectively.

Experiments dealing with the germinability of samples of wheat indicated that there were moderate differences between the samples, as shown by the types of seedlings they produced. Some of the samples, notably those of Marquis, Thatcher and Apex, produced more healthy seedlings than the others. When these healthy plants were transplanted in the field, along with those classified as fair and poor, the strong plants yielded 20 per cent more grain than the fair, and 60 per cent more than the poor. Early vigour is important in respect to root-rots. Other experiments with wheat of low vigour, such as rusted wheat, showed that it may suffer severely from attacks by root-rot fungi, but the severity of the attack could be reduced by treating the seed with a dust fungicide such as New Improved Ceresan or Leytonsan. Formalin was unsatisfactory.

Only small differences were shown in the rate of growth and height of wheat plants developing from seedlings classified as strong, fair and poor, and grown in soil in the greenhouse. However, the experiments showed that fewer fair and poor seedlings survived than strong ones.

Experiments with New Improved Ceresan and Leytosan showed that the volatile gases from these fungicides are capable of killing conidia of *Helminthosporium sativum* on wheat seeds and that the lethal effect increases with time of exposure. The conidia of this fungus were unable to germinate in the immediate neighbourhood of treated seeds, but well established mycelium grew over treated seeds and destroyed the young shoots and roots. The toxic effect of the fungicides on the conidia decreased as the period of storage of treated seeds was increased. Field tests showed that New Improved Ceresan and Leytosan were fairly effective in controlling seedling blight of wheat caused by *H. sativum*, and that these dusts gave such control whether applied one year, two months, one month or one day before seeding. However, some injury was done to the seed which carried the fungicides for a year.

Simmonds, P. M. and H. W. Mead. The examination of wheat seed to determine the disease factor. Sci. Agric. 16: 175-179. 1935.

The literature dealing with methods of examination of seed samples for the determination of seed-borne diseases was reviewed. Most of the methods proposed were discussed especially in relation to the examination of wheat seed. The results obtained, with wheat seed samples collected in Saskatchewan, showed that a good indication of the disease factor may be determined by a systematic examination.

B. 22.26. METHODS OF ROOT-ROT CONTROL IN CEREALS

J. E. Machacek and F. J. Greaney, Winnipeg, Man.

During the period 1935-37 efforts have been made to determine the value of seed disinfection as a method of preventing the development of root-rot in cereals. Experiments made in previous years had indicated that, for this purpose, organic-mercury preparations were very effective while formaldehyde and copper carbonate were not. Further experiments made during this period revealed that seed disinfection, so far as root-rot control is concerned, was justified only where the seed, or the soil in which the seed was sown, was badly contaminated by root-rotting fungi. In such cases seed disinfection with organic mercurials in the form of dusts prevented kernel decay in the soil, increased seedling emergence, prevented seedling blight, and usually resulted in marked increases in yields. The seed disinfection did not, however, protect cereal plants in the more advanced stages of growth from becoming attacked by root-rot fungi occurring in the soil.

Organic mercurials were found, in greenhouse trials, to be much superior to mercuric bichloride for the disinfection of wheat seed infected with *Helminthosporium sativum* P.K. and B. In a sample of Pentad wheat in which about 90 per cent of the kernels were infected with this fungus, disinfection with the former enabled most of the kernels to produce healthy seedlings, while, with the latter, nearly all the kernels produced blighted seedlings.

Attempts were made to study the combined effect of soil fertilization and seed disinfection under field conditions. The results of a two-year experiment showed that, when the seed used was healthy and uncontaminated by root-rotting fungi, no marked increase in yield over that obtained through the use of fertilizer alone could be secured.

B. 22.27. MISCELLANEOUS STUDIES IN THE ROOT-ROT PROBLEM OF CEREALS

Studies on the growth of wheat roots and the isolation of fungi

P. M. Simmonds, Saskatoon, Sask.

Simmonds, P. M., R. C. Russell and B. J. Sallans. A comparison of different types of root-rot of wheat by means of root excavation studies. Sci. Agric. 15: 680-700. 1935.

Three types of root-rot of wheat were investigated by excavating and studying the location and extent of the injury to the root system of affected plants in the field. Healthy plants growing under the same conditions were studied similarly for comparison. Common root-rot (*Helminthosporium sativum* and *Fusarium* spp.) was characterized by brown lesions on the subcrown internodes and on some of the roots by the time the wheat had reached the late seedling stage. The lesions increased in extent and severity as the season advanced. At maturity both roots and tops were considerably stunted and yield was reduced. Take-all *(Ophiobolus graminis)* was characterized by dark brown or black lesions on the seminal roots and subcrown internode while the plants were still in the seedling stage. In some cases, by midseason the entire seminal root system was almost completely destroyed. Affected plants were supported largely by the crown roots. Injury in most cases was severe with a distinct reduction in yield. Browning root-rot (*Pythium* spp.) first attacked and destroyed many of the lateral rootlets of the seminal root system. This caused a distinct retardation in growth. Affected plants recovered but suffered infections of the fine laterals and root tips throughout the season. The plants were late and the yield greatly reduced.

In each case the damage caused by root-rots to the host appeared to be approximately proportional to the portion of the root system destroyed.

Simmonds, P. M. and R. J. Ledingham. A study of the fungus flora of wheat roots. Sci. Agric. 18: 49-59. 1937.

Isolations were made from the subcrown internode and roots of wheat plants excavated at Saskatoon and Indian Head. A total of 806 isolates representing 27 genera were studied. The results for the two years were totalled and tabulated to show the vertical distribution and frequency of occurrence of the isolates for each station. More isolates were obtained from the first foot than from the lower levels, and more than 50 per cent of the total identified isolates were classed as pathogenic. Pathogenic fungi were rarely isolated from roots below the first foot. Direct microscopic examination of preserved material revealed the rare occurrence of lesions on the roots below the first foot. A fungus considered as of a mycorrhizal type was commonly seen in many of the seminal root collections. The pathologic significance of the results in studies of root diseases is briefly discussed.

Field tests and observations on the control of root-rots

R. C. Russell, Saskatoon, Sask.

Preliminary small plot tests were conducted on two farms in northeastern Saskatchewan in 1935. Two fertilizers, triple superphosphate and ammonium phosphate; one seed treatment, New Improved Ceresan, and one soil fungicide, calomel, were used. Take-all and browning root-rot did not occur in the test fields. Common root-rot was present, however, and was partly controlled by the fertilizer treatments according to data obtained on lesion ratings.

Similar tests were conducted in 1937. Although phosphatic fertilizer did not prevent infections by root-rot fungi, they did promote more vigorous growth with consequently less injury; this was observed to be particularly true in cases of browning root-rot where ammonium phosphate was used.

B. 22.30. VARIETAL REACTION OF CEREALS TO ROOT-ROT CAUSED BY SPECIES OF FUSARIUM AND HELMINTHOSPORIUM

F. J. Greaney and J. E. Machacek, Winnipeg, Man.

Greaney, F. J., J. E. Machacek, and C. L. Johnston. Varietal resistance of wheat and oats to root-rot caused by *Fusarium culmorum* and *Helminthosporium sativum*. Sci. Agric. 18: 500-523. 1938.

During the seven-year period 1930-36, several standard varieties and a large number of rust-resistant selections of spring wheat were tested for resistance to root-rot caused by *Fusarium culmorum* (W.G.Sm.) Sacc., and *Helminthosporium sativum* P.K. and B., as were also a lesser number of standard varieties and rust-resistant selections of oats, to root-rot caused by *Fusarium culmorum*.

A statistical study of the disease and yield data indicated that the disease-rating method of recording the intensity of root-rot caused by *F. culmorum* and *H. sativum* under field conditions is a fairly reliable one. Disease rating was significantly negatively associated with yield. Germinability, or rather the ability of wheat seed to produce young plants, varied greatly from year to year under Manitoba conditions. It was highest in varieties and selections most resistant to root-rot and lowest in the most susceptible ones. All the standard varieties of wheat tested, as well as most of the rust-resistant selections, were markedly susceptible to Fusarium-Helminthosporium root-rot. There were, however, significant differences in susceptibility among the varieties and selections. When grown under a wide range of field conditions, the wheats most resistant in one year to root-rot caused by *F. culmorum* were among the

most resistant in another year, and the most susceptible ones, among the most susceptible. Varieties most resistant to *F. culmorum* were fairly consistently resistant to *H. sativum*, while susceptibility to one was significantly associated with susceptibility to the other. The tests with oats showed, similarly, that there is a significant difference among oat varieties in their susceptibilty to root-rot caused by *F. culmorum*.

B. 22.31. STUDIES ON ROOT-ROT OF CEREALS CAUSED BY SPECIES OF RHIZOCTONIA

F. J. Greaney and J. E. Machacek, Winnipeg, Man.

During the last ten years the fungus *Rhizoctonia Solani* Kühn has been frequently isolated from the roots of wheat, oats, barley, and rye in Manitoba. Morphological, physiological, and pathogenicity studies with ten of these isolates were commenced in 1935. On the basis of sclerotial formation, cultural characters, and growth rate on various agar media, the isolates were very different physiologically. Several distinct physiological strains were distinguished. Two isolates from rye grew at a faster rate than the isolates from wheat, oats, and barley, and there was a marked difference in the growth rate of Canadian and Australian isolates of *R. Solani*. The isolates also exhibited marked differences in pathogenicity to young wheat plants. Studies to determine the relative pathogenicity of strains of *R. Solani*, *Fusarium culmorum* (W.G.Sm.) Sacc., and *Helminthosporium sativum* P.K. and B., originally isolated from the roots of cereal plants showed that, in comparison with the isolates of *F. culmorum* and *H. sativum*, most of the *Rhizoctonia* isolates were very weak parasites on wheat. The pathogenicity of the *Rhizoctonia* isolates was markedly influenced by environmental conditions.

Other Cereal Disease Projects: Project Group No. 23.00

B. 23.01. STUDIES OF BACTERIAL DISEASES OF WHEAT

W. A. F. Hagborg, Winnipeg, Man.

Hagborg, W. A. F. Black chaff, a composite disease. Can. Jour. Res. 14 (Sec. C): 347-359. 1936.

Owing to symptomatic irregularities occurring among plants affected by black chaff in field plots, a need was felt for a better knowledge of the causative relationships of the disease, in order that the experimental error might be reduced when testing the susceptibility to it of strains of wheat.

Microscopic examination of lesioned plants, isolation of micro-organisms from the lesions, and testing of the pathogenicity of several hundreds of isolates were combined to determine the cause of various types of black chaff discolorations. When it was found that one type of discoloration was apparently not caused by a micro-organism, environmental influences were used successfully to induce it.

Three distinct types of discoloration were found. One of these was caused by *Phytomonas translucens* (J.J. and R.) Bergey *et al.* f. sp. *undulosa* (S.J. and R.), the bacterial black-chaff organism; another yielded *Alternaria* consistently on isolation; and a third, to which the name internodal melanism has been given, appeared to be physiological in origin. *Phytomonas atrofaciens* (McC.) Bergey *et al.* was occasionally present in bacterial black-chaff lesions, associated with the bacterial black-chaff organism.

B. 23.02. MAINTENANCE OF PATHOGENIC FUNGI IN FIELD PLOTS FOR EXPERIMENTAL PURPOSES

F. J. Greaney and J. E. Machacek, Winnipeg, Man.

A large series of permanent plots (root-rot garden), artificially infested with various root-rotting fungi of cereals, were established at Winnipeg, Manitoba, in 1932. From 1932 to 1935 these plots were used to study the comparative susceptibility of wheat varieties to fungi most commonly associated with root-rot in Manitoba.

In each year of the test the degree of root-rot infection that occurred in the natural-soil plots of the root-rot garden was relatively severe, and the number of plants that emerged from 100 seeds was low. However, the amount of root-rot was still further increased and plant emergence considerably reduced by infesting the soil artificially with *Fusarium culmorum* (W.G.Sm.) Sacc., or with a miscellaneous group of fungi (*F. culmorum, H. sativum, Fusarium* spp. and others).

Positive attacks of common root-rot in field plots were induced each year by inoculating the seed and infesting the soil with *F. culmorum.* The effectiveness of this method of producing positive attacks was clearly established. The results showed that *F. culmorum* has a very detrimental effect on the yield of wheat. From 1932 to 1935 there was a progressive annual increase in the amount of root-rot occurring in plots artificially infested with this organism. A similar increase occurred on plots infested artificially with the mixed group of fungi. The results with *Helminthosporium sativum* P.K. and B., were not satisfactory, as all methods used in the Manitoba tests to induce positive attacks of common root-rot with *H. sativum* in field plots of wheat failed.

B. 23.03. EFFECT OF FERTILIZERS ON THE INCIDENCE AND SEVERITY OF CEREAL DISEASES

F. J. Greaney, Winnipeg, Man.

Greaney, F. J. The effect of phosphate deficiencies on infection of wheat by *Fusarium culmorum.* Can. Jour. Res. 16 (Sec. C): 27-37. 1938.

Greenhouse experiments were made to determine the effect of deficiencies in phosphate on infection of young wheat plants by *Fusarium culmorum* (W.G.Sm.) Sacc. Marquis wheat was grown in pot cultures of quartz sand with different types of manuring, including a fully manured control, and four series having deficiencies of phosphate. One half of the pots was inoculated with *F. culmorum* and sown with inoculated seed, the remainder served as uninoculated controls. The plants were grown for 36 days. The experimental data were treated by the analysis of variance method.

Under the conditions of the experiment, deficiencies in phosphate did not significantly increase or decrease the susceptibility of wheat plants to root-rot caused by *F. culmorum.* On the other hand, deficiencies in phosphate significantly reduced root development and total dry weight of the plants. The results suggest that the effect of phosphatic fertilizers is much more important on plant growth and yield than on the severity of infection by *F. culmorum.*

B. 23.06. OAT "BLAST" INVESTIGATIONS

T. Johnson and A. M. Brown, Winnipeg, Man.

Greenhouse experiments have been carried out on the effect of defoliation on the incidence of blast and on the effect of drought periods at different stages of growth on the development of blast. The experiments on defoliation have shown that progressive removal of the leaves, commencing about the time of

spikelet initiation, leads to a great increase in the percentage of blasted spikelets. Similar results were obtained in field experiments in which the leaves were partially destroyed by spraying them with dilute sulphuric acid shortly before the emergence of the panicles. Experiments on the effect of drought showed that a moisture deficiency at a period prior to spikelet differentiation tends to reduce the size of the panicle without leading to an increased percentage of blast, whereas a deficiency in moisture during or just subsequent to spikelet differentiation leads to a marked increase in the percentage of blasted spikelets.

Field experiments on the effect of rate of seeding on the incidence of blast, for rates of ½, 1, 1½, and 2 bushels per acre, have shown that there is a distinct tendency for the percentage of blast to decrease progressively with an increased rate of seeding.

Field experiments on date of seeding in relation to oat blast have been conducted for four years. Four sowings, at intervals of one week, were made each year, the first sowing usually being made at the end of the first week in May. The results varied considerably from year to year. In 1934 and 1936 the highest percentages of blast occurred in the second sowing. In 1935 the highest percentages of blast occurred in the third sowing and the lowest in the first. In 1937 the percentages were highest in the fourth sowing and lowest in the second. In all three years there was a tendency to a progressive decrease in the size of panicle from the first sowing to the last. Yield data (available for 1937 only) showed a progressive decrease in yield from the first to the last sowing. The decreased yield is attributable partly to the smaller size of panicle in the later sowings and partly to the higher percentage of blast in these sowings.

DISEASES OF FORAGE CROPS

Roots: Project Group No. 30.00

B. 30.01. CLUB ROOT INVESTIGATIONS

Resistance of varieties of turnips to club root

J. L. Howatt, Fredericton, N.B.

Contradictory results have been reported from several centres in the Maritime Provinces with respect to the resistance of the turnip variety Wilhelmsburger to the club root disease. In order to critically examine the matter, the variety Wilhelmsburger was grown in conjunction with the susceptible variety Ditmars in greenhouse pot culture on four club root infested soils collected from Charlottetown, Nappan, Kentville, and Fredericton. Hydrogen ion concentration determinations revealed that the Charlottetown and Nappan soils had pH values of 6·01 and 6·18 respectively, while the Kentville and Fredericton soils showed a pH value of 5·01. The soils were adjusted and maintained at four moisture levels, including 40, 50, 60, and 70 per cent of their water holding capacities.

The results of the test proved that the variety Wilhelmsburger showed high club root resistance at all the moisture levels on the Nappan and Charlottetown soils, but on the Kentville and Fredericton soils its resistance was little better than that of the susceptible variety Ditmars. Three possible solutions were advanced to account for these results: (1) the existence of biologic forms of *Plasmodiophora Brassicae*, (2) the operation of lethal chemical or physical soil factors, (3) variation in the spore load of the various soils.

Host range and biological specialization; control by lime

R. R. Hurst and G. W. Ayers, Charlottetown, P.E.I.

This project was undertaken to study fundamental phases of the club root problem. Special attention is being given to biological specialization of the pathogen and the role of native cruciferous hosts in maintaining the disease in the soil. The host range studies embrace cruciferous weeds; ornamental crucifers; and cultivated crucifers. Other phases include, amount of inoculum required, variations in the virulence of the pathogen, influence of lime and fertilizers on the disease, and studies of the symptoms with special reference to various types of hypertrophy.

Host susceptibility varied widely, some species being severely attacked, others weakly as indicated by large and small clubs, scattered clubs, and nodules, while several hosts escaped infection. It is also significant that infection of certain host species is determined by the source of infested soil. *Barbarea vulgaris,* for example, remained disease-free in Charlottetown soil, but contracted club root in Fredericton soil. Other investigators have believed this host to be immune to club root infection.

Difficulty was experienced in distinguishing between nodules and certain phases of club root. Nodules have their points of origin at the location of root hairs, it being difficult, if not impossible, to distinguish between primary nodules and swellings at the bases of root hairs. In addition, it was noted that many nodules are substantially connected with the root or bulb. Furthermore, greenhouse pathogenicity tests, using nodules only for inoculum, demonstrated their infectious nature, club root symptoms varying from definite nodules to clubbing and full disintegration of bulbs. Thus it would appear that nodules may be more intimately associated with club root than had been heretofore expressed or proved.

B. 30.02. THE NATURE, CAUSE, AND PREVENTION OF TURNIP BROWN-HEART

R. R. Hurst, Charlottetown, P.E.I.

Hurst, R. R, and D. J. MacLeod. Turnip brown-heart. Sci. Agric. 17: 209-214. 1937.

Large quantities of turnips are rejected yearly because of brown-heart, a disease which has been under investigation since 1928.

Brown-heart is not recognized by external symptoms. It may occur in very small turnips but is found most commonly in roots more than two inches in diameter. When cut through crosswise, typically affected turnips exhibit a clearly defined brownish, water-soaked, and glassy area. Spots, or intermediate stages, suggest a gradual tissue break-down. In advanced stages cavities frequently form, a condition occasionally associated with rot.

Tests conducted over a period of three years in the Maritime Provinces demonstrated that turnips require boron for normal development and further that the addition of this element to the land is a safeguard against brown-heart. Finely powdered borax has been the most satisfactory source of boron for this purpose, 15 to 20 pounds per acre giving highly satisfactory control without causing injury to ordinary crops in subsequent rotations.

Heavy liming of the soil predisposes the turnip to brown-heart, while naturally alkaline soils render borax less effective.

Proved methods of applying borax are as follows:—

(1) In the drill; (2) at the sides of the drills; (3) broadcast; (4) combined with the fertilizer and dispersed by means of ordinary machine spreaders.

Hurst, R. R. Brown-heart of turnips. Dom. Dept. Agric., Circ. 123. 1937.

Symptoms and harmful effects of brown-heart are discussed in this essentially practical publication. Reference is made to the roles of manure, kelp, lime, and soil type in relation to brown-heart. Its cause is attributed to the lack of boron in the soil, a plant food essential for the normal growth of turnips, yet required in exceedingly small amounts. Prevention of this disease is accomplished by applying borax to the soil at rates amounting to not less than 10 pounds nor greater than 20 pounds per acre.

Full instructions are given on the approved methods of handling borax as a soil corrective.

Unreported investigations

In continuing the studies on the symptoms of brown-heart it has been noted that this disorder may appear in turnips under two inches in diameter provided the tissue is fine in texture and not woody. Because of the gradual changes in radial lines appearing in turnip flesh it is oftentimes difficult to diagnose the disease with confidence, this being particularly true of small turnips in which these multitudinous radial lines impart a hard and woody character to the turnip. True brown-heart originates in the radial lines as small dots in the case of very slight symptoms, and spots, blotches, or streaks in the more severe type. Where radial lines are replaced by parenchymatous tissue brown-heart is absent. Rot may be associated with extreme brown-heart. Reduced susceptibility to brown-heart, either varietal or intravarietal, is attributed to the greater absorptive capacity of a more abundant and vigorous root system.

Investigations in New Brunswick

D. J. MacLeod, Fredericton, N.B.

The results of a series of practical tests conducted in eight localities in the province gave further evidence of the superiority of borax in combination with manure or fertilizer as a corrective for brown-heart of swedes. Tests of rates, and methods of application showed that the degree of control was proportional to the amount of the chemical applied, 10 pounds per acre direct in the drill being the minimum for effective control and 30 pounds, similarly applied, the maximum which could be used without injuring the plants. Borax was equally effective when applied at different depths, at the side or in the drill, in wet and dry form, before or after seeding, or as a spray when the plants were from four to twelve inches high. Diatomaceous earth, fine sieved earth, hydrated lime, or fertilizer were equally efficacious as carriers for borax. Boron in the form of boracic acid or borax was more effective than boracite. Catalase and peroxidase activity were greater in healthy swedes than diseased ones. The reducing sugar content of healthy swedes was 7·80 per cent and that of diseased roots 5·23 per cent.

Investigations in British Columbia

H. R. McLarty, Summerland, B.C.

McLarty, H. R. Better turnips may be grown with aid of boron. Country Life in British Columbia. 21: 12 May, 1937.

After describing the symptoms of brown-heart as it occurs in British Columbia, the author reports that an application of boric acid at the rate of 16 pounds per acre successfully controlled the disease. On the treated area 18 per cent of the roots were slightly affected, on the untreated 97 per cent were diseased. In a cooking test it was demonstrated that roots from the untreated plot were tough and unpalatable while those from the treated area were excellent for culinary purposes.

B. 30.04. DISEASE RESISTANCE OF ROOT CROPS

The influence of boron on root canker of garden beets

Walter Jones, Saanichton, B.C.

A dry rot or canker of the roots of garden beets is prevalent on Vancouver island. In 1935 and 1936, borax at the rate of 18 pounds per acre was applied to plants in an affected area at Saanichton. In the treated plots 27 per cent and 5·3 per cent of the roots were diseased, whilst in the untreated plots 42 per cent and 15 per cent were affected during the respective years.

Clovers: Project Group No. 31.00

B. 31.02. A STUDY OF THE VARIOUS ROOT-ROTS OF ALFALFA, COMMON CLOVER, SWEET CLOVER, AND OTHER LEGUMES CAUSING INJURY: (*a*) FOLLOWING WINTER DORMANCY PERIOD; (*b*) DURING ACTIVE GROWTH

M. W. Cormack, Edmonton, Alta.

Cormack, M. W. *Cylindrocarpon Ehrenbergi* Wr., and other species as root parasites of alfalfa and sweet clover in Alberta. Can. Jour. Res. 15 (Sec. C): 403-424. 1937.

Cylindrocarpon Ehrenbergi Wr., appears to be one of the most important pathogenic fungi associated with early spring injury of roots of alfalfa and sweet clover in Alberta. It occurs in virgin and cultivated soils. It produces distinctive symptoms, and is highly pathogenic in the early spring, but less virulent during the growing season. It can invade unwounded roots through lenticels or the basal tissues of branch roots, or by direct penetration. It is also pathogenic on roots of *Trifolium* spp. This species has not been previously reported on the legume forage crops, and very little is known concerning its parasitism on other plants.

On the roots of alfalfa and sweet clover *C. obtusisporum* (Cke. and Hark.) Wr., is slightly to moderately pathogenic, *C. radicicola* Wr., is very weakly pathogenic, and *C. olidum* Wr., is non-pathogenic. These species occur infrequently on diseased roots, and usually in association with *C. Ehrenbergi*. *C. radicicola* has been reported as an important root parasite of other plants.

Isolates of *C. Ehrenbergi* differ in degree of pathogenicity, and there is some evidence of host specialization. They also differ markedly in morphological and cultural characteristics, which, however, do not appear to be correlated with their parasitic abilities. The temperature range for growth of *C. Ehrenbergi* in pure culture is from —2° to 32° C., but different isolates do not have the same optima. Isolates with an optimum at about 19° C. caused the most damage in the early spring, while one which grew best at 24° C. proved the most virulent during summer. The optimum hydrogen ion concentration for growth of *C. Ehrenbergi* varies with the medium employed. Growth and spore germination studies indicate that the iso-electric point for the fungus lies at approximately pH 5·1.

Most of the commonly grown varieties of alfalfa and sweet clover are susceptible to attack by *C. Ehrenbergi*, but resistant species like *Medicago falcata* may prove valuable as plant breeding material. Apparently cereal crops are not attacked by the pathogen, therefore, they should be grown for several years in severely infested fields.

Cormack, M. W. *Fusarium* spp. as root parasites of alfalfa and sweet clover in Alberta. Can. Jour. Res. 15 (Sec. C): 493-510. 1937.

Five pathogenic species predominated among the numerous isolates of *Fusarium* obtained from diseased roots of alfalfa and sweet clover in Alberta. Of these, the closely related species *F. avenaceum* (Fr.) Sacc., and *F. arthro-*

sporioides Sherb., appear most important, because they occur commonly and can cause serious injury to the roots, both in the early spring and during the growing season. *F. culmorum* (W.G.Sm.) Sacc., is very virulent during the summer, but is apparently non-pathogenic in the early spring. At both times *F. Poae* (Peck) Wr., and *F. Scirpi* Lamb. and Fautr. var. *acuminatum* (Ell. and Ev.) Wr., usually behave as weak pathogens. With the exception of *F. avenaceum* on alfalfa and sweet clover, and *F. Scirpi* var. *acuminatum* on alfalfa, these species have not been previously reported as occurring on the host plants indicated.

Cardinal temperatures for growth in pure culture were:—*F. avenaceum* and *F. arthrosporioides*: —2°, 24°, and 34° C.; *F. culmorum*: 3°, 24° to 27°, and 34° to 36° C.; *F. Poae*: —2°, 20° to 24°, and 32° C.; *F. Scirpi* var. *acuminatum*: 1°, 24°, and 34° C. All five species grew well at hydrogen ion concentrations ranging from pH 4·0 to 9·5. Carbon dioxide concentrations up to 20 per cent had very little effect on the growth of *F. avenaceum*, *F. arthrosporioides*, or *F. Poae*, but the higher concentrations retarded the growth of *F. culmorum* and *F. Scirpi* var. *acuminatum*. The retarding effect of carbon dioxide was greater at 5° C. than at room temperature.

F. avenaceum produced more infection at temperatures up to 24° C. than at 27° C. At 27° C., infection was much lighter in dry soil than in moist soil. *F. culmorum* caused severe damage at 18° to 27° C., but did not attack the roots at low temperatures. *F. avenaceum* usually attacked roots of sweet clover more severely than those of alfalfa. All varieties of both hosts tested proved susceptible. In the absence of wounds, *F. avenaceum* readily entered roots through the basal tissues of branch roots, or through lenticels. Variant forms of this pathogen, which occurred frequently in pure culture, proved decidedly less pathogenic than the original isolates.

Alfalfa and sweet clover roots were attacked by an isolate of *F. avenaceum* obtained from diseased roots of *Vicia americana*. *F. avenaceum*, *F. arthrosporioides*, and *F. culmorum* from alfalfa and sweet clover proved pathogenic to roots of *Trifolium* spp. and to seedlings of wheat, oats, and barley. Certain isolates from the cereals were pathogenic to roots of alfalfa and sweet clover, and thus certain limits to crop rotation in reducing the root-rot damage caused by these pathogens are indicated.

B. 31.—BORON DEFICIENCY OF ALFALFA

H. R. McLarty, R. E. Fitzpatrick, J. C. Wilcox, and C. G. Woodbridge, Summerland, B.C.

McLarty, H. R., J. C. Wilcox, and C. G. Woodbridge. A yellowing of alfalfa due to boron deficiency. Sci. Agric. 17: 515-517. 1937.

Alfalfa in the interior of British Columbia commonly shows a light green or yellowish discoloration evenly distributed over the intercostal area of the leaves, or taking the form of streaks parallel to the veins if the leaf becomes affected only when fully developed. In severe cases the yellowing may affect the growing points, the new leaves being quite yellow, dwarfed, and showing practically no growth at the tip. Many of the leaves turn bronze or reddish, and some show both yellowing and bronzing. As a rule the midrib and veins remain green, and the discoloration becomes less conspicuous as it spreads towards the base. The edge of an affected leaf often turns whitish, and the marginal tissue dies, shrivels, and curls upward. The first growth in spring or after cutting is generally normal, and as a rule the upper leaves turn yellow only when well formed and the lower ones after the upper ones. The internodes are shortened and the plants stunted and squat.

Boric acid and borax were scattered on March 7 and 25, 1936, at rates ranging from two ounces to four pounds per tree, around the base of apple

trees in an orchard where affected alfalfa had been grown as a cover crop for some years. On each occasion the 2-ounce application slightly improved the colour and growth of the alfalfa, the four-ounce application markedly improved them, and the best result was given by the eight-ounce application; burning, however, was caused by all applications of four ounces or over, injury progressively increasing with increase in dosage. The alfalfa outside the areas treated remained sickly. Chemical analysis showed the boron content of the yellowed plants to be consistently lower than that of green ones.

DISEASES OF ORNAMENTAL PLANTS

Bulbs, Rhizomes, etc.: Project Group No. 40.00

B. 40.02. RESEARCH ON DISEASES AFFECTING BULBS GENERALLY

The botrytis blight of tulips

F. L. Drayton, Ottawa, Ont.

Drayton, F. L. The Botrytis blight or fire disease of tulips. Can. Hort. Home Mag. 60: 297-298. 1937.

In the control of this disease, the use of protective sprays and dusts has met with indifferent success, the rapid growth of the plant making it impossible to maintain a constant and uniform coverage of the chemicals. In a five year experiment just completed, excellent control has been obtained by a systematic elimination of diseased material. This procedure can be co-ordinated with the cultural routine, so that little or no expense is involved.

It is preferable to choose land which has not been planted to tulips for at least three years. The inspection and elimination of diseased material should commence just before planting. In doing this, the tunics of the bulbs should be removed, especially if the presence of the disease is suspected, and all bulbs showing sclerotia or lesions should be discarded. The next inspection should be carried out during the growing season, commencing as soon as the shoots appear. At this time, the primary infections, which are responsible for the later rapid spread of the disease, are evident as discoloured areas on the young shoots, such plants should be dug with a trowel and carefully destroyed. Later inspections of the plants should be made during their cultivation and when the flowers are being cut. Care should be taken to avoid the fall of the petals on the ground. Particularly favourable opportunities for spotting the presence of this disease are afforded at the time when the bulbs are being dug and while they are being cleaned. The bulbs should be stored under cool and well ventilated conditions. In addition to the above, the control of this disease is greatly facilitated by digging the bulbs every year.

Three tulip diseases of unusual occurrence

The grey bulb-rot disease of tulips was found in a low-lying garden in Rockcliffe, Ont. in May, 1935. Practically all of the plants in one section of the garden were dead. The fungus responsible for this disease was named *Sclerotium Tuliparum* by Klebahn in 1906, and in 1924 Whetzel and Arthur changed its name to *Rhizoctonia Tuliparum* on the basis of the structure of its sclerotia. This is only the second time in 20 years that an infection of this kind has been encountered and no infected bulbs have ever been found in imported stock.

A destructive disease of tulips was noted in 1935 and 1936. The first case was in Montreal and the other in Westmount, Que. In both gardens upwards of

50 per cent of the plants were dead before the flowers had opened. An examination of the plants showed that the bulbs were permeated by masses of black sclerotia. In pure culture the fungus proved to be identical with one isolated from diseased tulip bulbs sent to Cornell University from Corfu, N.Y., in 1931. It is also indistinguishable from cultures of a fungus isolated from sweet clover roots by Dr. Cormack of Edmonton. As a result of the investigations reported under project B. 70.21, this fungus appears to be an undescribed species of *Sclerotinia*.

An interesting interception of diseased tulip bulbs was made at the port of Vancouver in a shipment from Holland. In 2,000 bulbs of the variety Prince of Orange, 25 were infected and almost wholly destroyed by the fungus *Sclerotium Delphinii* Welch. This is the first record of the interception of this disease by the inspection service, although on previous occasions this fungus has been found on iris bulbs. Van Poeteren in 1931, reported a case of this disease in Holland on the tulip variety William Copeland.

Gladiolus diseases

Drayton, F. L. Corm rots menace gladiolus plantings. Can. Hort. Home Mag. 60: 277-279. 1937.

The three diseases, dry rot caused by *Sclerotinia Gladioli* Drayt., hard rot caused by *Septoria Gladioli* Pass., and scab caused by *Bacterium marginatum* McC. are described in detail. Some new data on the longevity of the dry rot fungus in soil are given. It was found that following the introduction of the pathogen into the soil by planting diseased corms, the fungus remained alive and was capable of infecting healthy gladioli planted in the same area ten years later. During the intervening years, non-susceptible plants of other kinds had been grown in that soil.

The *Botrytis, Fusarium,* and *Penicillium* storage rots are also described and some recommendations are made for the control of the diseases. The failure of chemical treatments of diseased corms or infested soil for the control of these diseases is discussed. Surface disinfestation is recommended for healthy corms selected from a mixture of healthy and diseased ones, and for diseased corms of valuable varieties, after the lesions have been excised.

Field experiments with gladioli

A. J. Hicks, Ottawa, Ont.

Soaks employed in experiments conducted in 1935 and 1936 were 1-1,000 corrosive sublimate, "Calogreen," two ounces in one gallon of water, and a seven per cent calcium hypochlorite solution.

Corms were planted immediately after treatment, on land which had grown gladioli for a number of years.

A few significant facts emerge from the general mass of information obtained from field experiments to date. Healthy corms treated before planting by soaking in either corrosive sublimate or Calogreen solutions, and planted on land which had produced many crops of diseased gladioli, produced a new crop of corms of which only from one to three per cent were diseased, whereas from 40 to 60 per cent of the corms harvested from the check untreated rows were so affected. Infected corms which were given the same treatments before planting yielded a comparatively clean crop, although the percentage of diseased individuals among the harvested corms was higher than that obtained when healthy corms were treated.

The soak in 1-1,000 corrosive sublimate can be prolonged from one to three days with advantage. Best results have been obtained with Calogreen, a substance with a calomel base. A one hour dip in a Calogreen solution was found to be most satisfactory.

The calcium hypochlorite solution was of no value as a dip treatment for gladiolus corms.

Results obtained in the many field experiments culminating in 1936 show that all corms should be treated before planting, and that corrosive sublimate and Calogreen dips are the best of all those which have been tried.

Of special interest to the small grower with a limited amount of land at his disposal is the fact that healthy treated bulbs will produce a crop practically free from disease. Another point of interest to those who may have small stocks of high priced varieties which have become infected is that such corms, after treatment, will produce corms, the large majority of which will be healthy.

Crocus hard rot

A shipment of crocus corms consigned to Toronto from Holland was intercepted because of disease in the fall of 1935.

Specimens of the variety Kathleen Parlow were found to have on them lesions identical in appearance with those of hard rot of gladioli. The spots were irregular, deeply sunken, and dark brown in colour. They had the typical water soaked area surrounding them, and bore a large number of what appeared to be immature pycnidia on their surfaces.

Isolations were made of portions of the involved tissue, and the fungus obtained was identified as *Septoria Gladioli* Pass., the organism causing hard rot of gladioli.

The significance of some common bulb troubles in the greenhouse

Botrytis Tulipae (Lib.) Lind, is commonly found causing a bulb spot of imported tulip bulbs.

In order to discover how stock so affected would grow under greenhouse forcing conditions, a number of typically affected bulbs received for examination were forced to bloom.

Although most of the bulbs produced leaf growth, less than 50 per cent of the resulting bloom could be classed as saleable. Among the plants which grew, leaf spotting and distortion were much in evidence. Flecking of the petals was observed on only two plants. A check lot of healthy tulips which were forced under the same conditions and at the same time as the diseased ones, produced healthy plants and good bloom.

A number of narcissus bulbs var. King Alfred, which had heated in transit were obtained from the importer and forced at Ottawa. Although the heating had been severe enough to cause a necrosis of the tissue of the outer fleshy scales, the flower bud appeared to be sound.

These bulbs produced an excellent crop of bloom which was superior in every respect to that obtained from a check lot of normal King Alfred bulbs.

The shipment from which the bulbs were taken was kept under observation during the forcing season and it was found that the bulbs forced well and produced a better-than-average crop.

Hyacinth bulbs bruise easily in transit, and this type of injury is usually followed by a soft rot of the affected tissue, which dries up on exposure to air. A number of bulbs so affected were planted, as also were an equal number of normal bulbs.

The bruised bulbs flowered as early as the healthy ones, but were more irregular in time of opening and in size, and were a little inferior in quality. All bloom produced, however, could be classed as saleable.

A survey of diseases affecting greenhouse-grown bulbous plants in Western Ontario

An inspection of the greenhouses and forcing establishments in Toronto and the surrounding district was carried out during the period, February 10 to 22, 1936. Sixteen establishments were visited, and many lots of growing bulbs whose previous history was known were examined.

Tulips: Tulip blight appeared in the flats as a form of leaf blight. The young leaves were attacked on emergence and became distorted. In most cases bloom was produced by such plants, although most of it would be unsaleable. In a few cases the disease took the form of a soft rot of the flower stem. Only one case of petal flecking was found. Most of the injury observed was due to freezing of the leaf tips which had occurred in the field at the time the flats were lifted to be brought indoors for forcing.

Narcissi: Ring disease, *Ditylenchus dipsaci* (Kühn) Filipjev, was prevalent among some of the early forcing varieties. One variety, King Alfred, was found to be heated on arrival in the fall of 1935. Specimens were cut open and a definite necrosis of the tissue of the outer fleshy scales was found, although the flower buds appeared sound. The bulbs were found to have flowered much earlier than usual and produced an excellent crop of good bloom. One lot of the variety King Alfred was a total loss, due to heating. Leaves and flower stalks were normal, but the bloom appeared blind.

Hyacinths: All bulbs seen were growing well. Yellows and white slime disease can readily be detected at the time of inspection and so are not greenhouse problems.

Bulbous Iris: Very few eelworm infested plants were found. Most of the bulbs which had either failed to start or had produced poor growth were decayed by *Penicillium* sp. Mosaic was common among the varieties, Wedgewood, Imperator, Supreme, Tingitana and White Excelsior.

Freesias: A disease of freesias caused by *Fusarium* sp. was commonly encountered as also was dry rot, *Sclerotinia Gladioli* Drayt. Sufficent evidence was obtained to warrant the conclusion that these diseases are both common and destructive to freesias grown in the greenhouse.

Crocuses: A Fusarium decay, often found affecting crocus corms, had caused a great deal of damage. In most cases, infected corms had failed to grow and had rotted in the soil.

Chloropicrin and other chemicals as soil disinfectants for nematodes

W. Newton, R. J. Hastings, and J. E. Bosher, Saanichton, B.C.

Newton, W., R. J. Hastings, and J. E. Bosher. The treatment of glasshouse soils with chloropicrin for the control of *Heterodera marioni* (Cornu) Goodey, and other soil pathogens. Can. Jour. Res. 15 (Sec. C): 182-186. 1937.

Chloropicrin in 1 cc. doses was lethal to nematodes at six inches from the point of inoculation or with a soil volume of one cubic foot. The chloropicrin costs $1.65 per pound or $8.50 to treat 2,000 cubic feet of glasshouse soil. Tetrachlorethane and ethylene dichloride also lowered the incidence of infection but were neither so effective as lethal agents or so beneficial to subsequent crops as chloropicrin.

The flooding and drying of soils had no significant effect upon their nematode populations.

The absorption of selenium compounds by narcissi or barley plants did not increase significantly their resistance to nematodes.

In spite of the lethal effect of urea solutions upon certain nematode parasites of animals, the common plant nematodes were not destroyed by immersion in one to ten per cent solutions for four days.

Sodium arsenate gave little promise as a nematicide. Concentrations greater than one per cent and a 20 hour immersion period were required to destroy suspensions of the preadult stage of *Ditylenchus dipsaci.*

The silver nitrate – potassium cyanide vacuo method for the control of the bulb nematode in narcissi

While the standard hot water method effectively controls the bulb nematode only when the narcissus bulbs are immersed in hot water shortly after lifting, the Saanichton silver nitrate – potassium cyanide vacuo method was proved to be effective up to the time of replanting in the field or glasshouse without causing significant injury to bulb growth or bloom.

The influence of storage upon the bulb nematode in iris

Although the bulb nematode continues to advance within narcissus bulbs in storage, evidence was obtained that in the Dutch iris, Wedgewood, there is little symptom development after the bulbs are lifted.

The nature of a bulb nematode infestation in iris

Newton, W., R. J. Hastings, and J. E. Bosher. The nematode disease of bulbous iris caused by *Ditylenchus dipsaci* (Kühn 1858) Filipjev 1936, and experiments on its control by bulb treatment. Can. Jour. Res. 15 (Sec. C): 178-181. 1937.

The current season nature of a bulb nematode infestation in iris was established in contrast with the perennial nature of infestations in narcissi.

Basal discoloration as revealed by the removal of the dry basal caps of Dutch iris was established as a diagnostic symptom in addition to the streaks on the outer fleshy scales and discoloration at the base of the stems. In English iris the basal discoloration symptom is quickly revealed by breaking apart the two largest bulbs in a cluster.

Death and chlorosis of Dutch iris plants in the field was found to be due to *Penicillium* spp. rather than to nematodes in nematode infested stock. Likewise the improvement in yields through immersion in cold solutions of mercury compounds could not be accounted for by the destruction of the nematode parasite. The destruction of fungus parasites, chiefly *Penicillium,* appeared to account for the benefit.

Nematode control in iris by hot water

The original attempts to destroy the bulb nematode in iris by hot water were unsuccessful. All lots immersed in hot water for one hour at 110 to 112° F. failed to grow. The death of the treated bulbs was apparently due in part to parasitism by *Penicillium* moulds. The hot water appeared to increase the susceptibility of iris bulb tissue to invasion by moulds. Evidence was obtained also that the bulb injury was accentuated by the lateness of the treatments. The original lots were treated in November. Later experiments proved that the iris may be freed from the bulb nematode without inducing a heavy mortality by immersion in water at 110 to 112° F. for a period up to two hours, provided the bulbs are treated shortly after they are harvested, and are dusted with Ceresan as soon as they are removed from the bath.

The establishment of three strains of Ditylenchus dipsaci (Kühn 1858) Filipjev 1936

Hastings, R. J. and W. Newton. Preliminary studies of the transfer of four strains of *Ditylenchus dipsaci* (Kühn 1858) Filipjev 1936. Can. Jour. Res. 15 (Sec. C): 168-174. 1937.

The bulb nematode was isolated from narcissus, Dutch iris, red clover, and strawberry. Cross inoculations and transfers to other hosts established tentatively the following three strains:—

(1) Red clover strain; characterized by the induction of swollen crowns and stunt in red clover seedlings.

(2) Strawberry strain; characterized by a limited host range and swollen crowns in strawberry seedlings, and entrance but non-induction of symptoms in red clover seedlings.

(3) Narcissus and iris strain; characterized by a wide host range and entrance but non-induction of symptoms in clover and strawberry.

No satisfactory technique of establishing the host range of the biological strains of *D. dipsaci* has been developed. The clamping of glass rings filled with a nematode suspension in moist pulverized peat to the foliage of test plants did not affect the test plants in a constant manner. The examination of seedlings after clarification in a lacto-phenol solution containing acid fuchsin gave more constant results. The seedlings were removed from infested soil shortly after they appeared above ground.

The reports of host specificness of the red clover strain were not confirmed, for the red clover strain entered white clover and alfalfa, hitherto considered resistant. Likewise, the reports of host specificness of the narcissus strain were not supported by experimental results. The narcisus strain entered red clover and oats, previously considered resistant.

The pathogenicity of the meadow nematode to narcissi and other crops

Evidence of a causal relationship between the meadow nematode, *Pratylenchus pratensis* and a root-rot of narcissi and strawberries was secured by the appearance of the root-rot in the same location when strawberries followed narcissi in a rotation. In both cases the nematode was associated with the fungus *Cylindrocarpon radicicola*. The same nematode and fungus was associated with a root-rot of raspberries near Hatzic. The host range of this nematode was extended experimentally to comprise distinct species of plants. Evidence was obtained also that the meadow nematode is pathogenic to potatoes, carrots, red clover, tomato, and spinach when the nematode was freed from associated organisms by passage through a peat medium, saturated with a 0·1 per cent solution of malachite green. To a lesser degree the meadow nematode was pathogenic to oats.

B. 40.09. VIRUS DISEASES OF BULBS

Tulip break

W. Newton and W. Jones, Saanichton, B.C.

The "break" virus reduced the vitality of the tulip plants in the seven varieties under test as judged by growth measurements of healthy and "break" infested plants. Evidence was obtained that it is not practical to rid a variety from the "break" virus when the percentage of infected plants is more than 30 per cent.

Annuals and Biennials: Project Group No. 41.00

B. 41.02. HOLLYHOCK RUST AND ITS CONTROL

R. R. Hurst, Charlottetown, P.E.I.

Sanitation, combined with a regular spraying schedule, effects satisfactory control of hollyhock rust. The measure of control, however, depends upon the thoroughness with which each phase of the preventive measures is carried out. Lime sulphur causes leaf injury and thus has questionable merit as a spray against hollyhock rust. According to the results of tests conducted in 1936 Bordeaux spray (4-4-40) may be regarded as a reliable means of controlling this disease. For best results applications should be made on or about June 15 and repeated at ten-day intervals. It is necessary to thoroughly coat the leaf surfaces and stems. The effectiveness of Bordeaux mixture is increased by the addition of a casein sticker. When obtaining young plants it is very important to avoid sources where rust has been a factor, otherwise the young plants may carry the rust with them. Infection in such instances becomes apparent late in the growing season, thus paving the way for a general outbreak the year following.

B. 41.05. ZINNIA WILT

G. E. Woolliams, Summerland, B.C.

Studies indicate that the *Fusarium* species causing zinnia wilt is indigenous to this section of the province. All colours and flower types of *Zinnia elegans* and the different species of the genus *Zinnia* are equally susceptible to this disease. It is possible for the zinnia wilt pathogen to infect China asters when they are grown in the greenhouse at high soil temperatures, but under normal field conditions China aster is immune. Potatoes and mangels are also immune under field conditions. Fusarium wilt of zinnias can be transmitted by seed, soil, root contamination, and by wound inoculation.

The practical method of control appears to be through the use of resistant strains. Selections have been made, and some are showing a high degree of resistance.

B. 41.—THE RESISTANCE OF SNAPDRAGON AND CHINA ASTER TO DISEASE

J. E. Bosher, Saanichton, B.C.

Four out of the ten wilt-resistant strains of China aster obtained from Messrs. Ball, Chicago, were immune to a Dutch culture of *Fusarium conglutinans Callistephi* Beach but none was resistant to inoculum from wilt infested soils secured locally.

The rust resistant strains of snapdragon produced by the Genetic Department of the University of California were not resistant to the local form of rust. Relatively resistant seedlings of possible commercial value were selected as seed plants in 1935. Seedlings therefrom exhibited a slight increase in resistance against the local rust form in 1936.

Perennials and Shrubs: Project Group No. 42.00

B. 42.03. VIRUS DISEASES OF THE DAHLIA

G. H. Berkeley and G. C. Chamberlain, St. Catharines, Ont.

Berkeley, G. H. Mosaic and ring spot, two dahlia diseases. Can. Hort. and Home Mag. 60: 25-26. 1937.

Preliminary work on this project has consisted mainly of a limited survey of a few large gardens, rogueing as a means of control, and the establishment of "disease gardens" at the laboratory where 212 plants consisting of 58 varieties were grown in 1937. In one garden careful rogueing and destruction of all infected tubers reduced virus infection in one year from 70 per cent to 12 per cent. Surveys of commercial gardens have indicated that mosaic is prevalent in many propagating beds and that considerable spread of mosaic originates from this source. A wide range of mosaic symptoms was found in the experimental plantings, suggesting considerable variation in varietal tolerance. A single patch-grafting experiment indicates that this method may be effective in transmitting mosaic and ring spot of dahlia.

FOREST PATHOLOGY

Deciduous Trees: Project Group No. 50.00

B. 50.01. WILLOW BLIGHT

K. A. Harrison, Kentville, N.S.

Five sprays of a 3-9-40 Bordeaux were found effective in controlling willow blight on the old French willows in the Grand Pre Memorial Park in 1929. The next year the number of sprays recommended was reduced to three and this number was used with satisfactory results until 1936. In 1936 rainy weather prevented the first application being applied at the recommended time and the disease made some headway. A further severe outbreak was experienced in 1937 and it is now obvious that three sprays are not sufficient and that at least five should be used when a season occurs that favours the spread of the associated organisms.

B. 50.03. HEARTWOOD DECAYS AND CANKER DISEASES OF POPLAR

Heartwood decays

C. G. Riley, Ottawa

Riley, C. G., and J. E. Bier. Extent of decay in poplar as indicated by the presence of sporophores of *Fomes igniarius* Linn. For. Chron. 10: 249-253. 1936.

Advanced heart-rot caused by *Fomes igniarius* is practically always accompanied by sporophores which serve as reliable indicators of the presence of this condition. Of the 71 sporophore-bearing mature trees which were analysed, more than 50 per cent contained sound log-lengths. In most instances, the approximate distance which decayed heartwood extends above and below the sporophores, is indicated by the size and number of sporophores.

Further work

Spore discharge studies in *F. igniarius* were conducted during the period, July 21 to Sept. 15, 1937. The following conclusions were reached: (1) Spore

discharge occurred abundantly, though irregularly, throughout the period stated. (2) There is great variation in spore discharge activities between different sporophores, even when occurring on the same tree. (3) Spore discharge is largely governed by moisture. Wet weather is accompanied by a pronounced increase in spore discharge which gradually diminishes, in some instances ceasing entirely, with the return of low humidity. This same tendency was also evident, in some instances, in a daily rhythm of spore discharge. (4) In general, sporophores on beech discharged spores more abundantly than did those on poplar and ironwood *(Ostrya)*.

Hypoxylon canker

J. E. Bier, Ottawa

Hypoxylon canker of poplar has been found to be of universal occurrence in southern and central Ontario. *Populus tremuloides* Michx. (trembling aspen) and *P. grandidentata* Michx. (large-toothed aspen) are seriously affected with cankers. Sample plot investigations in 10- to 15-year-old aspen stands demonstrate 13 to 26 per cent of the trees to be infected. The lesions occur commonly on the dominant trees. Cankers have been located on trees of all ages up to 65 years. The older trees are equally susceptible, but the cankers are found in the upper part of the bole.

Incipient cankers are invariably associated with wounds. Insect punctures, branch nodes, and mechanical wounds commonly serve as avenues of entrance. Trunk cankers on 10- to 15-year-old trees usually attain a length of three or more feet before the trees are killed. The diseased bark of older cankers is heavily infested with the larvae of secondary bark-boring beetles.

The fungus associated with the cankers is *Hypoxylon pruinatum* (Klotzsch) Cooke, the imperfect stage of which has been established and described for the first time.

Inoculation experiments have shown that *H. pruinatum* is a wound parasite on aspen. The imperfect fructifications become evident on induced cankers at the end of the first or during the second growing season. The first perithecia are produced approximately three years after inoculation, forming in the spring, summer or fall of the year. Several trees four to seven inches in diameter were killed by the fungus three and a half years after inoculation.

Canker diseases occurring on *Acer* and *Quercus* species have recently been discovered. Evidence to date indicates *H. Blakei* B. and C., to be the causal fungus.

Septoria canker

J. E. Bier, Ottawa

Observations in the field, confirmed by inoculation experiments, have demonstrated that *Septoria musiva* Peck, a North American fungus, produces destructive stem cankers, in addition to leaf injury, on certain strains of *Populus* introduced from Russia. To date cankers have been located on *P. Rasumowskiana* Schroed., *P. Petrowskyana* Schroed., and *P. berolinensis* Dipp.

The fungus has been found solely as a leaf-spot parasite on a number of native poplars, including *P. tacamahaca* Mill. (balsam poplar), *P. balsamifera* L. (cottonwood), *P. tremuloides* Michx. (trembling aspen) and *P. trichocarpa* Torr. and Gray, species of wide distribution in Canada and the United States.

The fungus may infect stems through wounds, opening buds, and also apparently through petioles of young diseased leaves. Primary canker growth occurs in current-year bark, soon girdling leader shoots and branches, later spreading from branches into the main stem, and finally resulting in the formation of perennial stem cankers. Pycnidia of the fungus are found abundantly on diseased leaves and current year twig infections.

Other diseases of deciduous trees

C. G. Riley, Ottawa

"Ink spot" disease of aspen leaves.

This disease, attributed to *Sclerotium bifrons* E. and E., which, in 1936 was present in almost epidemic abundance at the Petawawa forest experiment station, was entirely absent in 1937. This observation is mentioned here as affording a striking example of the apparently complete disappearance of a disease which only a year previously had been extremely prevalent.

Heartwood decay of oaks.

Polyporus obtusus Berk., a fungus hitherto reported from only a few locations in North America, has been found causing heart-rot of oaks at the Petawawa forest experiment station. A sample plot bearing 74 red and white oaks (*Quercus rubra* L. and *Q. alba* L.) was laid out in a centre of concentration of the disease. The trees were of two age-classes (15 and 24 years). All but one were found to be more or less seriously affected by the disease. The fungus enters by way of dead branches.

Coniferous Trees: Project Group No. 51.00

B. 51.05. STUDIES OF PINE RUSTS

C. G. Riley, Ottawa

Four species of "hard" pine in the Arboretum bear a branch-inhabiting *Peridermium* on prominent globose galls. These species are lodge-pole pine, western yellow pine, Austrian pine and Scotch pine. The results of inoculation experiments indicate that in some instances at least, notably on lodge-pole pine, the rust is capable of repeating, by means of aeciospores, without passing through a stage on an alternate host. There is circumstantial evidence that this is taking place in nature on each of the four host species under observation. There is further circumstantial evidence supported by one successful inoculation, that the form on western yellow pine is capable of infecting Austrian pine by means of aeciospores. A large number of additional inoculations have been made.

B. 51.06. DETERIORATION IN INSECT-KILLED SPRUCE ON THE GASPÉ PENINSULA

C. G. Riley, Ottawa

Riley, C. G. Investigation into rate of deterioration in insect-killed spruce on the Gaspé peninsula—Progress in 1935. Woodlands Rev. 7. Feb. 1936.

The trees considered in this paper are commercially mature white spruce, killed by the eastern spruce bark-beetle outbreak of 1931-34. To date, 81 trees have been analysed, representing periods of one to four years since death. The data indicate that the merchantable volume of trees that have stood for a period of four years since death, has been reduced by 3·2 per cent, due to decay.

Further work

Additional analyses, made in 1936, indicate that after a period of five years since death, the merchantable volume had been decreased by 4·1 per cent, an increase in decay per cent of 0·9 in the fifth year. The remaining trees, of which date of death is known, are being held over for analysis in 1938, so that no analyses were made in 1937.

Trees killed by the spruce sawfly are being studied separately from those killed by bark-beetles. For this purpose, 700 apparently dying trees were marked in 1935. These are being examined annually, and the date of death of each tree is recorded. They will be analysed some years hence, when the longest-dead trees shall have reached an advanced stage of decay.

Other Forestry Projects: Project Group No. 52.00

B. 52.02. ARRANGEMENT, INDEXING, AND ADDITIONS TO THE COLLECTION OF WOOD-DESTROYING FUNGI

Irene Mounce, Ruth Macrae and Mildred K. Nobles, Ottawa, Ont.

Mounce, Irene, and Henry A. C. Jackson. Two Canadian collections of *Cantharellus multiplex*. Mycologia 29: 286-288. 1937.

Nobles, Mildred K. First Canadian record of *Aleurodiscus subcruentatus*. Mycologia 29: 387-391. 1937.

During the years 1935-37, 2,847 specimens were incorporated into the herbarium, 1,742 specimens were received and 693 sent out to various workers. Canadian collections of the following species were of special interest: *Fomes Ellisianus* And., *Polyporus compactus* Overh., *P. distortus* (Schw.) Fr., *P. griseus* Peck, *P. obtusus* Berk., *Poria fimbriatella* (Peck) Sacc., *Aleurodiscus cerrusatus* (Bres.) v. Höhn. and Litsch., *A. subcruentatus* (B. and C.) Burt, *Asterostroma bicolor* Ell. and Ev., *Corticium coronilla* v. Höhn., *C. pallidum* Bres., *Grandinia helvetica* (Pers.) Fr., *Helicogloea pinicola* (Bourd. and Galz.) Baker, *Septobasidium pinicola* Snell, *Sebacina caesio-cinerea* (v. Höhn and Litsch.) Rogers, *S. podlachia* Bres., *S. dubia* (Bourd. and Galz.) Rogers, and *S. Eyrei* Wakefield. In addition six species of *Corticium*, three of *Hypochnus*, and one of *Peniophora* are believed to be undescribed.

Thanks are due to Dr. G. R. Bisby, Dr. Lee Bonar, Mr. H. A. C. Jackson, Dr. H. S. Jackson, Dr. E. Lepik, Dr. L. O. Overholts, Dr. H. Robak, Dr. J. A. Stevenson, Miss E. M. Wakefield and to many members of the staff for specimens contributed or sent in exchange. Sixty-one species of Thelephoraceae have been added to Dr. Bisby's list of "Fungi of Manitoba" 1929. Beside the regular indices a host index for the wood-destroying fungi has been compiled and a special index of all fungi represented in the herbarium from the Petawawa forest experiment station. The latter will form the nucleus for a mycological survey of that area, and be a guide for future collecting.

Mr. H. A. C. Jackson of Montreal has continued to make his coloured drawings of wood-destroying fungi and the division now has on loan, excellent illustrations of 27 species.

B. 52.06. PULPWOOD DETERIORATION STUDIES

C. G. Riley, Ottawa

The experimental pulpwood deterioration piles that were set up in 1932 and 1933, at Eagle Depot, Que., are still being examined annually. The 1937 examination revealed that the peeled spruce, piled in a dry site, was still perfectly sound. Varying degrees of decay were found in other piles, some of the unpeeled balsam being practically completely rotten.

FRUIT DISEASE INVESTIGATIONS

Pomaceous Fruits: Project Group No. 60.00

B. 60.01. STUDIES OF APPLE SCAB DISEASE

Seasonal development of apple scab

J. F. Hockey, Kentville, N.S.

Hockey, J. F. Notes on scab control. N.S. Fruit Growers' Ass. Report 72: 111-112. 1936.
Hockey, J. F. and J. A. Boyle. Factors affecting the prevalence and control of apple scab. (Illustrated lecture) N.S. Fruit Growers' Ass. Report 73: 103-105. 1937.

For the three years under review the perithecia of *Venturia inaequalis* (Cke.) Wint., matured earlier than the average date since 1924. During the years 1935, 1936, and 1937 mature ascospores were found in perithecia from one to three weeks before apple buds had reached the delayed dormant stage. The heaviest spore discharge periods have been between the "pre-pink" and "calyx" stages of development of the tree. Early autumn frosts have had a depressing effect on the growth of perithecia, but the latter have been abundant when frosts occurred after October 15. The first spring infections bearing conidia were found on June 5, 1935, May 19, 1936, and May 22, 1937, indicating the earlier infection periods during the two latter years.

Hockey, J. F. Observations on the development of "storage scab" of apples. N.S. Inst. Sci. Proc. 19: 212. 1936.

Late fruit infections and "storage scab" were of no consequence in 1935 and 1937, but caused a considerable loss of fruit in 1936, especially in that from poorly sprayed orchards. It has been found that "storage scab" is the result of late-season infections by conidia before harvest.

Factors affecting the development of perithecia

J. F. Hockey, Kentville, N.S.

Observations were made on the development of perithecia on leaves which had fallen from the trees at different dates in the autumn of 1936. The greatest numbers of perithecia were produced on leaves collected October 15. Leaves with severe scab lesions present at the time of leaf fall, produced fewer perithecia per square centimetre and earlier maturity of ascopores than leaves from fruit spurs collected at the same time.

A few young trees were sprayed in the fall of 1936, the leaves collected and placed in cages for overwintering. None of the treatments appeared to inhibit the growth of perithecia. Solutions of three per cent formaldehyde and one per cent commercial urea caused a slight stimulation to the fungus. An apparent earlier maturity of perithecia resulted where trees were sprayed with one per cent solutions of copper sulphate, calcium nitrate, or potassium hydroxide, or three per cent hydrated lime.

Effect of chemicals on fallen leaves

J. A. Boyle, Kentville, N.S.

Unsprayed apple leaves were treated with 20 different chemical compounds used as different concentrations. The treated leaves were put in cheesecloth bags and placed on the ground outside.

When the leaves were examined in the spring of 1937, it was found that several treatments had produced an apparent inhibiting effect on the develop-

ment of apple scab perithecia compared with the controls. A winter wash oil used at dilutions of one, five, and ten per cent was effective in arresting any subsequent development of the fungus. An apparent stimulating effect on the development of perithecia was obtained with one per cent solutions of sodium hydroxide or copper sulphate, and a 7½-15-100 or 25-50-100 Bordeaux mixture.

Investigations in New Brunswick

S. F. Clarkson and J. L. Howatt, Fredericton, N.B.

Due to the dry weather conditions prevailing throughout the growing season in 1935, apple scab was of little importance to orchardists. Liberation of ascospores began May 22, but conditions were unfavourable for the establishment of the disease. Scab infection was severe on both foliage and fruit in 1936. The earliest recorded discharge of ascospores took place this season, ejections being recorded on May 2. Heavy and extended ascospore discharges coupled with modifications of the standard spray schedule were jointly responsible for a scab condition more destructive than usual. Climatic conditions favoured the abundant production of perithecia on the over wintered leaves in 1937 and ascospores were matured and ready for discharge April 28. Unfavourable weather conditions retarded spore ejection until May 11. In general, scab infection, was less severe than in 1936.

As a result of observation and spraying experiments, it was concluded that scab control was best effected when a 3-10-40 Bordeaux spray was applied in the green tip, pink, and two post-calyx applications, and lime sulphur 1-40, plus the addition of four pounds of iron sulphate in the calyx spray.

Investigations in Quebec

C. Perrault, Ste. Anne de la Pocatière, Que.

During the last three years apple scab has made its appearance in the lower St. Lawrence region between June 13 and 29. On account of unfavourable weather conditions during autumn and winter months preceding the spring of 1935 and 1937, perithecia were checked in their normal development and there was no discharge of ascospores. During these springs no trace of the fungus could be found on apple leaves, young twigs or buds. In 1936 ascospore discharge was abundant. The first liberation was recorded on May 13 and the last on July 28, a period of two and a half months. During that year the heaviest discharge coincided with the advanced pink stage. Heavy discharge occurred during periods of heavy precipitation and high air humidity but low temperature.

Seasonal development of apple scab in Ontario

G. C. Chamberlain, St. Catharines, Ont.

In the years 1935-37 scab infection in the Niagara peninsula was of relatively little importance except in 1935. Observations concerning ascospore development and discharge showed that in all three years the ascospores were mature early in April. In 1935 the initial discharge on April 30 followed the early leaf development of the host, while in 1936 and 1937 it preceded the bursting of the buds, on April 28 and April 16 respectively. The period of major discharge in 1935, occurring between the pre-pink and pink stage of bud development, was critical for infection, and primary infection was well established (May 27) before the calyx period. In both 1936 and 1937 primary infection was light and was not observed until June 8 and 10 respectively, well after the calyx period. Perithecial production was limited in 1937 and it proved difficult to find leaves with numerous fruiting bodies.

Spraying and dusting for control of apple scab

G. C. Chamberlain, St. Catharines, Ont.

For two years spraying experiments have been conducted to determine the relative values of "Coposil," bentonite sulphur with and without lime, and Bordeaux 1-4-80 and 1-2-80, for the first and second cover sprays and their compatability with one per cent white oil emulsion when added to the second cover spray. Scab infection proved unimportant in both years and there was no significant difference in the prevalence of infection in the various blocks. In 1937 foliage injury, though not extensive, followed the application of Coposil and bentonite sulphur-oil sprays, particularly where lime was omitted.

New materials used for spraying apples were, "Ferrox Flotation" sulphur (paste), "Copper-Hydro 40," and "Qua-sul." From one year's experiments, Ferrox Flotation sulphur proved highly satisfactory. Copper-Hydro 40 gave good fungicidal protection but also produced some foliage injury in the form of spotting, particularly on summer varieties. Qua-sul failed to control scab satisfactorily.

The comparative values of different fungicides in the control of apple scab in British Columbia

G. E. Woolliams, Summerland, B.C.

In co-operation with A. A. Dennys of the Dominion Entomological Laboratory, Vernon, B.C., a number of combinations of fungicidal and insecticidal sprays have been used for apple scab and insect control in the northern parts of the Okanagan district. Their effectiveness and toxicity were compared with those of the standard lime sulphur—lead arsenate spray. The sprays tested were: (1) lime sulphur, in various strengths, with and without, (*a*) bentonite clay and hydrated lime, (*b*) calcium arsenate, and (*c*) lead arsenate; (2) basic copper sulphate and calcium arsenate (3) copper phosphate and calcium arsenate, and (4) the colloidal sulphurs—"Koloform," "Kolofog," "Wettex," and "Koppers Flotation Sulphur." On the whole the lime sulphur has been the most efficient spray, but the injury to the foliage was objectionable. Equal parts of standard lime sulphur and standard colloidal sulphur, used in the pink, calyx, and cover sprays, or standard lime sulphur in the pink spray followed by standard colloidal sulphur in the calyx and cover sprays, gave control nearly as satisfactory as that provided by the standard lime sulphur sprays and caused very little spray injury.

B. 60.03. CONTROL OF POWDERY MILDEW OF APPLE

J. C. Roger,[1] Summerland, B.C.

In 1935 the efficacy of one, two, and three, lime sulphur—ferrous sulphate sprays was tested in the control of powdery mildew on McIntosh. The results were, one spray 11·4 per cent of fruit marked, two sprays, 4·9 per cent, three sprays 3·9 per cent, and the check 45·1 per cent.

Pink and calyx sprays with each of four spray materials gave the following results in percentage of marked fruit; Koloform, one-half strength, 24·9; Kolofog, full strength, 24·6; Kolofog, one-half strength, 16·8; and lime sulphate—ferrous sulphate, 9·6.

The seasonal dissemination of wind-borne spores was determined by exposing glycerine-covered microscope slides within the framework of severely affected Jonathan trees. The period covered was from May 14 to August 20, 1935. It was found that over 95 per cent of the dissemination took place before June 26, with the heaviest period occurring from May 29 to June 19.

[1] **Formerly Assistant Plant Pathologist. Obit. Nov. 11, 1935.**

B. 60.04. PHYSIOLOGICAL DISORDERS OF APPLES

Investigations in Nova Scotia

K. A. Harrison, Kentville, N.S.

During 1935 and 1936 sixteen orchards containing the variety Stark were selected in the fruit-growing area for the purpose of securing data in connection with bitter pit.

During the past three years soil samples from the first nine inches of soil were collected at least twice a month, during July and August, and moisture determinations made. Samples were secured before rains, if possible, when soil moisture would be lowest. It was found that the soil moisture dropped to a relatively low point during the early part of July and fluctuated around this during the summer, depending on the rainfall. Rains during the latter part of August and September brought the soil moisture back to the spring level.

In 1935 bitter pit in the observational orchards ranged from 0·8 to 43·3 per cent and three of the fifteen orchards examined showed over 10 per cent of the disease. In 1936 the range was from 1·2 to 83·4 per cent, with five of the nine orchards showing over 35 per cent bitter pit. In 1937 the range was from 0·5 to 10·7 per cent and only one orchard out of twelve had more than 4 per cent of the trouble.

Rootlet studies were made during 1935 and 1936 to determine the percentage of dead rootlets. A comparison with the percentage of bitter pit on the same trees did not show a correlation. This phase of the work was discontinued in 1937.

An annual survey of the condition of individual trees in each orchard has been carried out.

Investigations in New Brunswick

J. L. Howatt and S. F. Clarkson, Fredericton, N.B.

A preliminary investigation of bitter pit was undertaken in 1934. In view of the deficiency of boron in most of the soils of the province, tests were conducted to determine the value of certain boron compounds in the control of this disease. The compounds tested included, glyceryl borate, glycol bori-borate, sodium borate, boracic acid, ammonium borate, copper borate, magnesium borate, and manganese borate. Boracic acid and sodium borate were used in solution, and applied in spray form on the foliage, while the remaining salts were used as dry or wet injections into the trunks or limbs of Baxter apple trees known to have been affected with bitter pit. The tests involved 67 trees. No control was effected by any of the boron compounds.

Drought spot, corky core and die back[1]

H. R. McLarty, J. C. Wilcox, C. G. Woodbridge, R. E. Fitzpatrick, and T. B. Lott, Summerland, B.C.

McLarty, H. R. Tree injections with boron and other materials as a control for drought spot and corky core of apple. Sci. Agric. 16: 625-633. 1936.

This is a tabulated report of the preliminary results of experiments from 1932 to 1935 in British Columbia on the control of drought spot and corky core of apples, two physiological disorders that cause serious economic losses in the Okanagan and Kootenay valleys. Injections into the trunk and main limbs of 30 different chemicals (which are listed), either alone or in combination with one

[1]Organized under the Physiological Disorders Committee—R. C. Palmer, Chairman

another, gave significant control of both conditions only when boron was used (either as manganous borate or boric acid), at doses over 0·48 gm. boric acid per 100 sq. cm. of trunk cross-sectional area for drought spot, and over 1·83 gm. for corky core. In the 1934-35 season, the average yield of saleable fruit of boron-treated trees was increased from 3·61 to 10·6 boxes per tree whereas on control trees it fell on the average from 3·8 to 2·5 boxes. The amounts of boric acid used (up to 5·92 gm.) did not cause injury to the foliage, but slight injury was noticed at the points of injection.

McLarty, H. R., J. C. Wilcox, and C. G. Woodbridge. The control of drought spot and corky core of the apple in British Columbia. Better Fruit. 31 (10): 12-13. 1937.

The authors describe the symptoms of drought spot, corky core, rosette, and die-back disorders which have affected apple trees in British Columbia for some years. The history of the investigations on the disease are briefly traced but not until 1934 was the discovery made that the disease is curable by feeding with boron. The treatment was recommended to growers in 1935 and was uniformly successful. Tests in 1936 confirmed the earlier results in so far as concerned the injection method; spraying gave excellent control but caused some injury to the foliage. Soil applications of boric acid and borax gave perfect control of drought spot and corky core with no ill effects so far. None of the Okanagan valley soils tested was high in boron, and it was also found that the smaller the boron content of McIntosh apple leaves, fruit, or twigs the more drought spot there was. The authors recommend autumn applications of boric acid evenly to the soil around affected trees, and others in proximity to them at the rate of 30 pounds per acre, starting two or three feet away from the trunk and continuing to the extreme limit of the limbs. The treatment is also of benefit in cases of pear and apricot drought spot and plum gum spot.

McLarty, H. R., J. C. Wilcox, and C. G. Woodbridge. The control of drought spot and corky core of the apple in British Columbia. Proceedings of the Thirty-second Annual Meeting of the Washington State Horticultural Association, 1936.

Covers practically the same material as that reported in the article in Better Fruit—see above extract.

McLarty, H. R., and J. C. Wilcox. From death valley to fertile fruit lands of B.C. comes invigoration for trees. Country Life in British Columbia. 20: 7 and 18. Dec. 1936.

An article for fruit growers in the Okanagan and Kootenay districts of British Columbia. The material is presented through a series of questions and answers, and covers the general recommendations for the control of drought spot and corky core of apple with soil applications of boric acid. Eight ounces per mature tree is the amount recommended.

McLarty, H. R. Boric acid treatments for the season 1937. Country Life in British Columbia. 21: 2. Sept. 1937.

The experimental evidence obtained in 1937 indicates that all orchard soils in the Okanagan and Kootenay districts in British Columbia have a very low boron content. The recommendations are that all soils in orchards should be given an application of boric acid at the rate of 30 pounds per acre. The time of treatment suggested is August or early September rather than in the fall. Experiments have shown that the earlier treatment not only controls drought spot and corky core in the following season's crop, but also prevents the die-back condition which is associated with a boron deficiency.

Woodbridge, C. G. The boron content of apple tissues as related to drought spot and corky core. Sci. Agric. 18: 41-48. 1937.

The author describes the methods used in sampling and analysing soils and apple tree tissues for their boron content, and presents the results of various analyses. These indicate (1) that a low boron content of apple tissues can be correlated with a high incidence of disease, (2) that there is no apparent correlation between low concentrations of boron in the soil and incidence of disease, and (3) that high soil concentrations are associated with a general freedom from drought spot and corky core.

B. 60.09. RESISTANCE TO APPLE SCAB

J. F. Hockey, Kentville, N.S.

Observations on the foliage reaction of thousands of apple seedlings from known parents have been made. A few hundred of these have borne fruit on which similar records have been taken. A larger percentage of seedlings from triploid female parents have shown resistance to scab than those from diploids. However, seedling vigour among triploid progeny has been poor. Seedlings from Cox Orange and Golden Russet, resulting from pollination by diploid varieties, have shown less resistance than seedlings resulting from triploid pollination or selfing. McIntosh, either as a female parent or a male parent, on other diploids gave a high percentage of susceptible progeny. Red Winter Reinette has given the largest proportion of resistant progeny among the diploids as a female parent.

Due to less vigour, there is a greater loss from winter killing, heaving, etc., among triploid seedlings than among diploids.

B. 60.12. CO-OPERATIVE INVESTIGATIONS OF FUNGICIDES[1]

J. F. Hockey and J. A. Boyle, Kentville, N.S.

Kelsall, A., J. F. Hockey and A. D. Pickett. General spray practices. N.S. Fruit Growers Ass. Report 73: 112-116. 1937.

Comparisons under orchard conditions have shown that the iron sulphate–lime sulphur mixture (iron sulphate 6 pounds, lime sulphur 1½ gallon, calcium arsenate 4 pounds, water 100 gallons) as recommended for use in Nova Scotia was the least expensive and safest sulphur fungicide. Among other materials compared were Magnetic and Aero wettable sulphurs, Ferrox Flotation sulphur, lime sulphur, and sulphur dust. Flotation sulphur of the Ferrox type (20 pounds per 100 gallons water) was a good safe fungicide and superior to blend Flotation sulphur.

Hockey, J. F. Comparisons of spray materials in 1937. N.S. Fruit Growers' Ass. Report 74: 73-78. 1938.

The iron sulphate–lime sulphur mixture as above gave the most economical control of apple diseases. Ferrox Flotation sulphur and Magnetic catalytic sulphur–lime sulphur gave excellent scab control as well as a schedule made up of "Z-O" and Magnetic wettable sulphur. Other materials used included Copper Hydro, Fungicide 66A, Microsul, Quasul, Magnetic Cryolite sulphur as a spray and a dust, Aero wettable sulphur, and standard Bordeaux and sulphur dusts.

Bordeaux mixture 3-10-100 applied on the second and third cover sprays has given good control of late scab infections and prevented storage scab.

Borax at rates of 3 to 5 pounds per 100 gallons has been used in Bordeaux mixtures with safety.

[1]In co-operation with the Dom. Entomological Laboratory, Annapolis Royal, N.S.

B. 60.15. FIRE BLIGHT INVESTIGATIONS IN WESTERN QUEBEC[1]

H. N. Racicot, Ottawa, Ont.

Persistence of fire blight on certain varieties

Since very little fire blight occurred in the commercial orchards of western Quebec in 1936, a survey was made to ascertain the varieties of apple trees on which fire blight persists during unfavourable seasons. It was observed only on Alexander, Winter Arabka, and Canada Baldwin trees, and on some crab apple trees. Where these were absent from the orchards, they were free from fire blight.

Spraying and dusting during full bloom to control blossom blight

Some of the blossoms of apple trees were atomized the same day with a suspension of *Bacillus amylovorus* after the trees had been sprayed or dusted during full bloom with Bordeaux mixture, lime sulphur, and sulphur dust. The results are summarized in table 1. Bordeaux mixture apparently reduced the number of blossom clusters blighted, but lime sulphur and sulphur dust did not.

TABLE 1.—NUMBER OF BLOSSOM CLUSTERS ATOMIZED AND SUBSEQUENTLY BLIGHTED

Treatment	No. of blossom clusters atomized	No. of blossom clusters blighted	Percentage of blossom clusters blighted
Bordeaux mixture	66	32	49
Sulphur dust	105	82	76
Lime sulphur	56	46	82
Untreated	89	68	76

Dissemination of fire blight

A tree under an insect-proof cage with a "Windolite" roof that shed rain was hand pollinated with pollen that had been atomized with a suspension of *Bacillus amylovorus*. In 1935, eight blossom clusters became infected out of approximately 200 clusters pollinated, while in 1936 all remained healthy. A similar tree under an identical cage pollinated with an untreated portion of some pollen remained healthy both years.

Two trees under insect-proof cages, but with screen roofs that admitted rain, were artificially inoculated, and the infections resulted in cankers that exuded during blossom time. Rain spread fire blight slightly in these trees both in 1935 and 1936. In a similar tree in a cage with a "Windolite" roof that shed rain, no new infection occurred.

Bees placed under two insect-proof cages over trees in full bloom, did not spread fire blight from exuding cankers to blossoms, although they spread the blight to a slight extent from inoculated blossoms to healthy blossoms.

Two hives of bees were heavily infested each fall by atomizing with a suspension of *Bacillus amylovorus* both comb and bees, and by pouring some of the suspension into liquid honey just before it was fed to the bees in these hives.

[1] A co-operative experiment on fire blight (*Bacillus amylovorus* (Burr.) Trev.) between the Divisions of Botany, Chemistry and Horticulture, and the Entomological Branch. Those co-operating are M. B. Davis, H. Hill, and F. S. Browne, Division of Horticulture; F. A. Herman, Division of Chemistry, Ottawa; and C. E. Petch, Dominion Entomological Laboratory, Hemmingford, Que.

The fire blight organism did not overwinter in these hives judging from the fact that it was not possible to recover it by making isolations from comb, brood or bees, and that bees from these hives placed under insect-proof cages with trees in full bloom did not inoculate any of the blossoms.

Aphids were allowed to develop in large numbers on trees with exuding cankers under insect-proof cages, and with "Windolite" roofs that shed rain, but they did not spread fire blight from the exuding cankers to either the blossoms or the twigs. In other cages ants were also introduced, but the two insects together failed to spread the blight.

In 1935, Petri dishes with potato dextrose agar were placed under shelters designed to shed rain drops and particles too heavy to be borne laterally by air, and to prevent insects contaminating the agar. These plates were thus exposed during different climatic conditions, such as fair weather, rainy or misty periods, and rain with high winds, under and at various distances from apple trees with fire blight. Colonies resembling those of *Bacillus amylovorus* were transferred to slants, and verified by inoculating into green pears, but no culture of this organism was obtained.

In 1935, air was drawn through tubes of sterilized tap water by using an atomizer bulb, while the operator stood under or near a tree or shrub with fire blight. Then the water was plated out, and colonies resembling those of *Bacillus amylovorus* were transferred to slants, and verified by inoculating into green pears. This organism was never isolated from the air in this manner.

In 1935, over 60 insects, representing various genera and species, were caught near or on fire blight cankers, and made to crawl over agar plates, or were killed, crushed and embedded into the agar, but no culture of the fire blight organism was obtained from these insects.

Aphids did not, when placed on twigs that had been atomized with a suspension of *Bacillus amylovorus*, then transferred 36 hours later to healthy twigs, inoculate these, although the atomized twigs became blighted. Even aphids that were atomized while feeding on healthy twigs, and later transferred to other healthy twigs, did not inoculate the latter, although the former became blighted. Aphids did not inoculate healthy shoots when transferred to these from a naturally infected shoot upon which they had been feeding.

Conditions favouring exudation from cankers

In order to determine whether or not the internal pressure of the sap of a tree influenced the exudation from fire blight cankers, mercury manometers were placed in holes in the bark of the trunk or large limbs of trees on June 13 and on June 27, 1935. In 1936, manometers were placed on the cut ends on water sprouts on June 10. A negative pressure was observed both years during both day and night, and during both fair and rainy weather.

The breaking off of infected fruit spurs to prevent blight from descending into the branches

On June 21, 1934, 50 fruit spurs with blighted blossoms were broken off, and these places marked with white tags. On a similar and adjacent tree, 50 fruit spurs with blighted blossoms were marked with green tags, but not broken off. These were examined on July 3, 1935. Of the 50 places marked with white tags where blighted spurs had been broken off, 35 were healthy, 6 were diseased, and 9 tags were missing, making 14·6 per cent of cases where blight had gone down into the branch. Of 50 similar blighted spurs that were not broken off, but only marked with green tags, in 44 cases the blight did not go down into the branch, in 5 cases the blight had descended into the branch, and 1 tag was missing, making 10·2 per cent of cases where blight had gone into the branch.

Disinfectants for treating fire blight cankers

A solution composed of 2 gms. mercuric chloride, 0·5 gm. mercuric iodide, 500 cc. 95 per cent ethyl alcohol, 500 cc. distilled water, and 16 cc. concentrated hydrochloric acid, when painted over fire blight cankers, did not penetrate sufficiently to kill the bacteria in the tissues.

The effect of saprophytes on the pathogenicity of Bacillus amylovorus

Ten inoculations were made with hypodermic needle and a pure suspension of *Bacillus amylovorus*. Separate suspensions of three saprophytic bacteria commonly isolated from fire blight cankers were prepared and a portion of each suspension was mixed with a part of the original suspension of *Bacillus amylovorus*. Ten inoculations were then made with each of the three mixed suspensions. All the inoculations were successful, and there was no appreciable difference in the size of necrotic areas at the end of six weeks, by which time, increase in size had ceased.

Longevity of Bacillus amylovorus in honey

In 1935, experiments were carried out with two samples of honey, both produced in Ottawa and supplied by the Bee Division, C.E.F., but one lot was from the 1934 crop, and the other from the 1935 crop. No difference was found in the longevity of the fire blight organism in these two lots of honey. In 1936, samples were obtained from various parts of Canada to see if there would be any difference in the longevity of the fire blight organism in these. A summary of the results obtained is given in table 2.

TABLE 2.—LONGEVITY OF *BACILLUS AMYLOVORUS* IN HONEY

Origin of honey	Comb	Extracted	Check
	days	days	days
Kentville, N.S.	3–6	5–10	0
Ste. Anne de la Pocatiere, Que.	4–7	5–7	0
Ottawa, Ont.	6–8	9	0
Brandon, Man.	2–5	9–12	0
Lethbridge, Alta.	2–3	11–12	0
Agassiz, B.C.	–	3–6	0

Hosts of Bacillus amylovorus

Blossoms of various rosaceous plants were atomized with a suspension of the organism, and when the blossoms, or blossoms and twigs, became blighted, isolations were made from these. Only when the isolations were positive were the plants considered susceptible. Twenty-nine species and varieties of rosaceous plants were added to the list of susceptible plants previously reported in the literature.

B. 60.16. STUDIES IN APPLE STORAGE

Packing and transportation co-operative project

Hockey, J. F. Packing and transportation project. N.S. Fruit Growers' Ass. Report 72: 55-57. 1935.

Anon. The packing and transportation of Nova Scotia apples. Dom. Dept. Agr. Pub. 543 1936.

A comprehensive project on apple packing and handling during transport was conducted with fruit from the 1934 and 1935 crops. Comparisons were made of several types of barrels, the methods of shaking, racking, and handling

at warehouses and docks, and the effect of these practices on the condition of the fruit. Eight hundred barrels of fruit in the first year and 520 barrels in the second year were critically examined for bruises, rots, and other blemishes. A summary of the mechanical injuries is given in the above references. Rots were more prevalent in the tails of barrels, where bruising was most severe. The commonest rots were caused by *Penicillium* spp. A condition known as "lenticel spot" was present in the varieties Gravenstein, Cox Orange, Ribston, Wagener, King, and Northern Spy when approaching full maturity. Oiled paper did not affect the prevalence of this condition.

Bruise discoloration tests in apples

J. S. Leefe,[1] Kentville, N.S.

By the use of a multiple temperature incubator, apples which had been bruised uniformly were stored at temperatures varying from 0° to 18° C. Periodical observations indicated that bruise discoloration disappeared in from 6 to 12 days, depending on the variety, in fruit stored at a temperature of 10° C. (50° F.) or higher. Fruits stored in the cold chambers retained their bruise discoloration for one month, the period of the test.

Storage rots of apples

J. A. Boyle and K. A. Harrison, Kentville, N.S.

Work in this field during the winter of 1936-37 consisted of culturing organisms causing rot of apples in common, cold, and gas storage at the experimental station.

Isolations were made from 213 apples. From these, 193 uncontaminated cultures were obtained. In this total, *Penicillium expansum* was the cause of decay on 44 per cent of the fruit; *Botrytis cinerea* accounted for 27 per cent of the rots; *Rhizopus nigricans*, 23 per cent; others, 6 per cent, which included *Mucor* sp., *Alternaria* sp., and a few unidentified fungi.

Apple storage diseases in New Brunswick

S. F. Clarkson and J. L. Howatt, Fredericton, N.B.

A new apple storage disease was discovered in the winter of 1934-35. The disease became evident after a storage period of 65 days and manifested itself in the form of firm, yellowish-brown, circular areas of rotted tissue, on the surface of which white fruiting pustules or acervuli appeared, either scattered, or in whole or partial concentric rings. Median sections through the centre of the rotted area revealed a mass of sharply delimited, brown, moist, rubbery tissue, often conical in shape, with the apex directed towards the core.

Taxonomic studies in collaboration with Dr. John Dearness, London, Ont., resulted in the erection of a new genus, *Dasycarpoma* for the pathogen. The binomial, *Dasycarpoma allantoideum* (Peck) Dearn., was established for the fungus. However, further taxonomic studies by E. W. Mason, of the Imperial Mycological Institute, indicated that the organism was identical with that known in Great Britain as *Gloeosporium album* Ostern. The nomenclature problem is not yet settled.

[1] Formerly Plant Disease Investigator.

Extensive nutritional studies involving a large number of media showed potato-dextrose agar to be an excellent substratum for both growth and development. On this medium the fungus showed a minimum of —0·5° C., a miximum of 38° C., and an optimum extending from 18° to 22° C. for development.

The greatest percentage germination of spores occurred in saturated atmospheres. Germination was poor at 91 per cent humidity with suppression at 84 per cent humidity. At room temperature, on potato-dextrose agar, the organism developed over a pH range extending from 4·0 to 8·0. Growth and sporulation were best between pH 6·0 and 7·0. A high degree of correlation was established between rot development and heavy nitrogenous fertilization of apple trees.

All the common varieties of apples, as well as peaches, plums, and pears, were susceptible to the rot.

Apple storage diseases at Ottawa

H. N. Racicot, Ottawa, Ont.

At the request of the Division of Horticulture, and in co-operation with them in their apple storage experiments, the fungi responsible for the decay of apples in storage in 1934-35 were determined by examining all the decayed apples found amongst those used in these experiments. The apples in these experiments came from all parts of Eastern Canada, and in many cases from trees in plots receiving different fertilizer treatments, and they had been stored at temperatures from 32° to 40° F. The number of cases in which various genera of fungi were the cause of decay, is as follows: *Penicillium* 135, *Alternaria* 40, *Coniothyrium* 9, *Botrytis cinerea* 8, *Cephalosporium* 6, *Fusarium* 3, *Haplosporella* 1, *Myxosporium* 1, *Sphaeropsis* 1, undertermined 12, making a total of 216 examinations.

Stone Fruits: Project Group No. 61.00

B. 61.02. FALL SPRAYING FOR PEACH LEAF CURL

R. S. Willison, St. Catharines, Ont.

As in former years, spraying with lime sulphur one to seven in November and February when temperatures were above 37° F., besides being without harmful results, controlled peach leaf curl as effectively as applications in early spring. On the basis of counts of a thousand leaves each, leaf curl ranged from a trace to 5 per cent in sprayed trees and from 40 to 72 per cent in check trees. Qua-sul, also used in February and April, was found to be unreliable in its control of leaf curl in the experimental orchard.

There was some evidence that summer sprays were of considerable value in reducing the incidence of this disease.

B. 61.06. PEACH CANKER INVESTIGATIONS

R. S. Willison, St. Catharines, Ont.

Willison, R. S. Peach canker investigations, II. Infection studies. Can. Jour. Res. 14 (Sec. C): 27-44. 1936.

In Ontario, peach canker is caused mainly by the wound parasite, *Valsa cincta* Fr. As there appears to be a delicate balance in the relation between host and parasite, infection occurs only when conditions operate in favour of the fungus, that is, in the fall and winter and sometimes in the spring.

Willison, R. S. Peach canker investigations, III. Further notes on incidence, contributing factors, and related phenomena. Can. Jour. Res. 15 (Sec. C): 324-339. 1937.

The conclusion mentioned above found corroboration in pruning experiments in which the percentage of cankers in pruning cuts of October and November, was ten times that in cuts made in January, and from 40 to 80 times that in cuts made in any other month.

The susceptibility of a variety to canker may be modified by cultural practices since, exclusive of pruning wound cankers, there were 60·2, 25·9 and 16·9 cankers per tree respectively where cultivation was continued till August 15, July 15 and June 15 annually. It is also significant that crotch cankers and trunk cankers following winter injury were distributed through the plots in similar proportions.

The study of surgical treatments, still in progress, indicates that best results are obtained when lesions are cleaned early in the growing season and disinfected with 1:500 corrosive sublimate before being coated with a protective water-proofing material.

B. 61.08. BROWN ROT AND OTHER WASTAGE IN PEACHES AND PLUMS[1]

R. S. Willison, St. Catharines, Ont.

In 1936, brown rot was not a serious factor, but it did appear in considerable quantity in harvested peaches in 1935 and in 1937. In these years, this disease was satisfactorily controlled by the use of either pre-pick sprays or dusts. The wettable sulphurs which had to be applied three weeks before harvest seemed to adhere well but the growth of the fruit in that period had the effect of reducing coverage.

Post-harvest dusting of plums was not so satisfactory a method of controlling brown rot of plums as pre-harvest spraying.

A greater incidence of rot was observed when the cooling of peaches was delayed for 24 hours, than when the fruit was cooled at once, in 1935, but not in 1937 when conditions during the holding period and the more gradual softening of the fruit at room temperature were less favourable for the early development of brown rot.

It was found that Rochester peaches could be kept at 45° F. or at 33-36° F. at least twice as long as Elberta, before breaking down. The former were also better from the point of view of flavour, texture, and firmness when held at these temperatures. The first visible stage of breakdown in both peaches and plums was usually the formation of minute bubbles in intercellular spaces, either as a halo around the pit or diffused through the flesh. This incipient breakdown was followed by discoloration of the tissues.

Some evidence was obtained that pre-harvest factors, probably soil conditions and cultural and spray practices, were capable of modifying not only the keeping qualities of plums of a given variety, but also their resistance to brown rot.

B. 61.09. INVESTIGATIONS OF PEACH YELLOWS AND KINDRED AILMENTS

R. S. Willison, St. Catharines, Ont.

Since 1935, the laboratory orchard has been carefully surveyed for symptoms of little peach, peach yellows, and other possible troubles. Little peach was diagnosed in 7 per cent of the trees in 1936, and in 3 per cent in 1937, while yellows occurred in only 0·9 per cent of the orchard in the whole period. Some of the affected trees, suspected plums and trees with abnormal symptoms, from commercial orchards have been used in infection studies from which there has been nothing to report so far.

[1]In co-operation with the Dominion Fruit Branch.

B. 61.10. CHERRY MOTTLE LEAF

H. R. McLarty, Summerland, B.C.

Studies on the natural spread of this disease indicate that in some orchards considerable new infection has occurred while in others there has been no increase during the 1935-37 period. Artificial spread has been accomplished only by grafting or budding. Limited tests in transferring black cherry aphis from diseased to healthy trees have failed to transmit the disease. General observation indicates that the disease is not of widespread occurrence in the Okanagan, but an accurate survey of all cherry orchards should be undertaken at once.

The properties of the cherry viruses of British Columbia

W. Newton and J. E. Bosher, Saanichton, B.C.

A highly infectious cherry virus was discovered in a local Royal Anne tree. The disease was transmitted by budding and by sap transfers to healthy cherry seedlings. Regardless of the point of inoculation, the characteristic mottle appeared first on the foliage at the branch extremities. The infectivity of virus infected cherry trees in the Kootenay district was established by patch grafting with bark and by the insertion of buds upon healthy seedling stock. The sap transmissible nature of the Kootenay form was established by rubbing healthy foliage with macerated diseased foliage. Attempts were made to prepare cherry virus antisera by inoculating rabbits with sap from infected foliage, but the antisera as prepared were inactive.

Small Fruits: Project Group No. 62.00

B. 62.01. RASPBERRY INSPECTION AND CERTIFICATION

R. R. Hurst, Charlottetown, P.E.I.

A total of 21,255 plants of raspberry stock were raised in Prince Edward Island and sold under certification in 1937. These sales comprised 28 shipments of the Viking variety, all consigned to Canadian purchasers, the individual orders varying from 25 to 18,000 plants each. This was an increase over 1936 production but less than that of 1935. The service has helped greatly in the improvement of the raspberry plantations in the province. All nursery stock produced and prepared for the market was a great credit to the growers.

Raspberry inspection and certification in Quebec

H. N. Racicot, Ottawa, Ont.

The results of the inspection and certification of raspberry nurseries in the province of Quebec are summarized below. Of the certified plants produced in Quebec in 1936, over 165,000 were sold.

Year	No. of Nurseries Inspected	Area Inspected (arpents)	No. of Nurseries Certified	Area Certified (arpents)
1935	100	55	59	33
1936	94	41·5	72	30
1937	104	51	71	28·4

Raspberry inspection and certification in Ontario

G. C. Chamberlain, St. Catharines, Ont.

The production of certified canes in Ontario reached its highest figure, 679,400, in 1935, declining to 607,500 in 1936, and to an estimate of 450,000 for 1937. This decline in production is principally economic and not due to any particular prevalence of virus diseases in the plantings. The leading variety in point of production has been Latham, followed by Viking and Cuthbert. Recently Newburgh and Chief varieties have been produced in increasing quantities, while production of Herbert and Lloyd George has declined. Viking, Cuthbert and, to less extent, Latham are varieties in which the virus diseases are more commonly encountered. In addition to the inspection service for certification, many inspections of fruiting plantations have been made annually on the request of growers.

B. 62.03. SUSCEPTIBILITY OF RASPBERRY VARIETIES TO MOSAIC AND OTHER DISEASES

G. C. Chamberlain, St. Catharines, Ont.

For the purpose of this project, a planting comprising eight varieties was set out with certified stock in the fall of 1932.

Mosaic first appeared in 1935, affecting two Latham stools, and has since spread, involving nine of this variety, two Brighton and one Viking. From one Cuthbert stool developing leaf curl in 1934, spread during the three-year period 1935-37 involved three additional Cuthbert, two Lloyd George, four Viking and one Chief. The Newburgh and Herbert varieties have remained free from virus infection.

A definite range of susceptibility to Verticilium wilt has been evident. Viking proved outstandingly susceptible and considerable loss of cane resulted. Chief, Cuthbert and Newburgh varieties have also been quite susceptible, Latham and Brighton to a lesser extent, and Herbert and Lloyd George slightly susceptible.

Other cane diseases have been of minor importance. Spur blight has been a factor on Herbert, Latham, Lloyd George and Brighton. Of these varieties Herbert and Lloyd George showed the most extensive bud killing. Anthracnose proved to be a serious disease of Lloyd George. Latham was outstandingly susceptible to powdery mildew, while Viking and Herbert were most seriously affected by leaf spot.

B. 62.04. STRAWBERRY ROOT-ROT STUDIES

A. A. Hildebrand, St. Catharines, Ont.

Hildebrand, A. A., and L. W. Koch. A microscopical study of infection of the roots of strawberry and tobacco seedlings by micro-organisms of the soil. Can. Jour. Res. 14 (Sec. C): 11-26. 1936.

Pathogenicity tests carried out in an attempt to evaluate the possible significance of fungi in the strawberry root-rot complex have yielded to date no convincing evidence that any of the many isolates obtained from typically diseased roots can be regarded as bearing an important primary causal relationship to the disease, but further tests being carried out at the present time under conditions of precise control of temperature and moisture of the soil may lead to a modification of the conclusions based on the results of earlier tests. That both temperature and moisture of the soil are closely correlated with incidence

and severity of the disease was demonstrated in a series of experiments involving the use of Wisconsin constant temperature tanks. When plants were examined after being grown for several weeks at 7-9°C. in *root-rot soil* that had been adjusted to and was maintained at 60 per cent of its water-holding capacity, they were found to possess well-developed, clean, healthy roots. However, by gradually increasing both temperature and moisture, the disease gradually became more severe until at 15°C. healthy plants set in wet root-rot soil (80 per cent water-holding capacity) died within a week. The experiments clearly demonstrated that under certain temperature and moisture conditions of even very "sick" soil, strawberries will grow and *can* escape root-rot. The importance of these and other uncontrollable variables in the soil leads to an appreciation of the difficulties involved in control of the disease. From additional data acquired during two years' extensive survey, it has not been possible to correlate incidence or severity of root-rot consistently with any particular (i) ratio of available nutrients, (ii) deficiency of essential elements, or (iii) pH of the soil.

B. 62.05. VIRUS INVESTIGATIONS OF THE STRAWBERRY

A. A. Hildebrand, St. Catharines, Ont.

Yellow-edge

Harris, R. V. and A. A. Hildebrand, An investigation of strawberry virus diseases in Ontario. Can. Jour. Res. 15 (Sec. C): 252-280. 1937.

Following identification in 1932 of the yellow-edge virus disease in England on the Royal Sovereign variety, "normal" plants of this variety from a clone minutely rogued for yellow-edge were used at St. Catharines as indicators in a further study of virus as relating to certain Ontario varieties. In a series of transmission experiments (by runner grafting), symptoms macroscopically indistinguishable from those of typical yellow-edge-infected plants in England were induced on Royal Sovereign from the local varieties Glen Mary, Parsons Beauty and Premier, which possess markedly the symptomless-carrier capacity.

Parallel experiments in England at the East Malling station demonstrated that of the two parent *Fragaria* species common to commercial varieties in North America and in England, *F. chiloensis* is a symptomless carrier of yellow-edge with a high order of resistance and *F. virginiana,* in complete contrast, exhibits symptoms with extreme readiness together with high susceptibility, thus providing some explanation of the observed wide range of varietal reaction to disease of the yellow-edge type.

June yellows

Attempts at transmission of June yellows from affected to presumably healthy Blakemore plants both by runner grafting and by insects using *Aphis forbesi* Weed, have given no convincing evidence that the disease is of the type that can be transmitted by the methods employed.

Strawberry virus diseases in Nova Scotia

J. F. Hockey and D. W. Creelman, Kentville, N.S.

Observations on some 53 varieties in trial and commercial plantings have shown the prevalence of yellows in Thomson, Catskill, John, Aroma, Jessie, Abbot, Blakemore, Dorsett, Meighen, Senator Dunlap, Tilley, and Walter. Yellow-edge was present in Beauty, Bliss, Belmar, Caledonia, Fruitland, and Marvel in amounts over ten per cent. One to ten per cent affected plants were

found in Aroma, Blakemore, Carl, Catskill, Dorsett, Edward, Glen Mary, Jessie, Jim, King, Lavergne, Minnehaha, Nichomas, Premier, Senator Dunlap, and Tilley. Less than one per cent of the plants of Aberdeen, Clare, Fairfax, John, Ralph, and Walter were affected with yellow-edge.

Preliminary trials with a selection of nursery stock from clone units have been very encouraging.

B. 62.10. CROWN GALL OF RASPBERRIES

G. C. Chamberlain, St. Catharines, Ont.

In a four-year-old Cuthbert plantation comprising three blocks, (1) canes heavily infected with gall when planted, (2) canes free from gall when planted, (3) canes heavily infected, with all visible galls removed before planting, there was no significant difference in the vigour of growth as measured by the height or diameter of cane. No correlation existed between the amount of gall infection and the presence or absence of galls when planted. The percentage of canes with gall infection reached a peak of 58 per cent in 1936 and 1937, when all blocks contained approximately the same percentage of infected canes. The crown type of gall was predominant in the first two years, while in 1936-37 root gall was more prevalent. Direct damage to the cane by breakage frequently results in severe gall at the crown. Generally, however, the presence of gall infection was not reflected on the cane in any noticeable manner.

In another similar experiment with Latham variety planted on three types of soil, (*a*) sandy, (*b*) black loam, (*c*) clay loam, the percentage of gall infection on the sandy soil was twice that on the heavy soil, though the galls were invariably larger on the heavier soil. In each soil type there was no appreciable difference in the height and diameter of cane, irrespective of the presence or absence of galls.

Crown gall of raspberries in British Columbia

Walter Jones, Saanichton, B.C.

The crown gall disease lowered the vitality of Cuthbert raspberry plants as judged by the relative growth, number, and character of the canes in alternate rows of healthy and infested raspberry plants. The healthy and diseased raspberry plants of corresponding size were planted in 1935, and the measurements were made in 1936 and 1937. Evidence of a field infection of the healthy plants was obtained in 1937.

B. 62.11. RASPBERRY VIRUS INVESTIGATIONS

G. C. Chamberlain, St. Catharines, Ont.

Chamberlain, G. C. Yellow blotch-curl: A new virus disease of the red raspberry in Ontario. Can. Jour. Res., 16 (Sec. C): 118-124. 1938.

A condition of the Cuthbert red raspberry distinct from any previously described disease has been investigated and determined to be due to virus infection. The disease, termed yellow blotch-curl, is characterized principally by a loose type of curling and pale chlorotic foliage which sometimes shows a yellow blotching and ring-spotting. The disease has been transmitted by patch-grafting to Cuthbert, Viking, Latham, Herbert, Chief and Lloyd George varieties, on which the different reactions have been noted and described.

In addition, a second new disease of the virus type, different from mosaic and leaf curl, has been repeatedly transmitted and is being investigated. Mosaic has been transmitted readily by patch-grafting, while little success has been obtained in the case of leaf curl.

B. 62.12. RASPBERRY DISEASE INVESTIGATIONS

Walter Jones, Saanichton, B.C.

Jones, Walter. *Armillaria mellea* Vahl. ex. Fr. on raspberries in British Columbia. Sci. Agric. 17: 752-753. 1937.
Jones, Walter. Raspberry decline investigations. *In* Appendix H. Rept. of the British Columbia Raspberry Committee. Dept. of Agric. Victoria. 1937. (Mimeographed.)

There was no significant difference between the chemical composition of soil samples taken from normal and subnormal plantations in the raspberry growing areas of the Fraser river valley. The soluble phosphates were low in the majority of the samples and there was a tendency towards a decrease in the phosphatic content of samples from subnormal areas.

The fungus *Armillaria mellea* has been found responsible for the decline and death of raspberry plants in many plantations. Sporophores of the wood-destroying fungus, *Hypholoma fasiculare* Fr., are quite general in raspberry plantations where symptoms of decline prevail. Decay of the wood of the crowns and roots is commonly associated with this fungus. A *Pholiota* sp. has also been found on a few living plants showing considerable decay of the wood of the crowns and roots.

Cylindrocladium scoparium Morgan and the nematode, *Pratylenchus pratensis*, were very prevalent in the root tissue of plants in one plantation in Hatzic where symptoms of decline were pronounced. The fungus proved pathogenic to raspberry seedlings.

The rust (*Phragmidium Rubi-idaei* (D.C.) (Karst.) is very prevalent in most plantations. The commonly grown Cuthbert and Viking varieties are very susceptible to this rust. Cane damage due to winter injury is also mostly confined to these two varieties.

Initial rust infection was not inhibited by dusting of the raspberry crowns and immediate soil area with copper lime dust in April.

Anthracnose, (*Elsinoe veneta* (Burkh.) Jenk.) has been found on several varieties but of those grown the variety Lloyd George is the most susceptible.

B. 62.—ROOT-ROTS OF THE RASPBERRY

G. H. Berkeley, St. Catharines, Ont.

Berkeley, G. H. Root-rots of the raspberry. Can. Jour. Res. 14 (Sec. C): 306-317. 1936.

The investigations reported here are concerned with isolations from diseased raspberry roots, preliminary inoculations with isolates, and microscopic examination of naturally and artificially infected roots.

The following fungi were isolated from naturally infected roots: *Coniothyrium Fuckelii* Sacc., *Cylindrocarpon radicicoca* Wr., *Fusarium* sp., possibly *F. orthoceras* App. and Wr., *Cylindrocladium* sp., *Pythium* spp., *Rhizoctoma Solani* Kühn, *Rhizoctonia* sp. (orchid type), and in preliminary inoculation experiments each of these fungi was found to have parasitic capabilities. Microscopic examination of roots artificially inoculated with pure cultures of the above fungi showed the presence of the fungus used for inoculation. In addition the "phycomycetous mycorrhizal" fungus already associated with root-rots of strawberries and tobacco was observed to be almost always present in roots of affected raspberry plants, and, to a lesser extent, in apparently healthy roots from normal plants. Nematodes, especially *Pratylenchus pratensis*, the meadow nematode, were present in and on roots from certain soils, while they were absent in roots from other soils. Strawberry and raspberry seeds were sown in sterilized and non-sterilized affected soil with the result that the roots in sterilized soil appeared to be healthy, while those in the non-sterilized soil became affected with necrotic lesions.

Evidence is given which shows not only that certain symptoms of raspberry root-rot are similar to the symptoms of strawberry root-rot, which is considered to be a major factor in the degeneration of strawberries in both Europe and America, but also that many of the fungi and nematodes generally conceded to be associated with root-rots of strawberry are likewise associated with root-rots of raspberry.

Other Fruit Disease Investigations: Project Group No. 63.00

B. 63.01. SPRAY SERVICE IN BRITISH COLUMBIA

G. E. Woolliams, Summerland, B.C.

An experiment conducted at Salmon Arm during 1933 and 1934 to control apple scab by spraying depending on weather conditions was continued during 1935 and 1936. Records of rainfall, relative humidity and air temperature were kept during the spring months. Satisfactory scab control was obtained when the trees were sprayed within 36 hours after a rainfall that caused the relative humidity of the air to remain at 70 per cent or higher for at least 24 hours. During the four years of experimentation it was found that such a humid period occurred each season at or before the trees were in full bloom and that a pink spray is always necessary. In 1933 and 1934 satisfactory scab control was obtained with only one spray, but in 1935 and 1936 two were required. The percentage of clean fruit on sprayed trees and on unsprayed trees was respectively: in 1933, 97·3 and 56·2; in 1934, 97·1 and 48·7; in 1935, 88·4 and 4·5; and in 1936, 99·6 and 3·2.

MYCOLOGICAL STUDIES: PROJECT GROUP No. 70.00

B. 70.01. EDIBLE AND POISONOUS FUNGI—A TAXONOMIC STUDY OF THE AGARICACEAE

J. W. Groves, Ottawa, Ont.

During the three years under review, a large number of collections of fleshy fungi have been submitted for identification. In order to know what species occur in this region and to permit greater accuracy in these determinations, a special study of the fleshy fungi of the Ottawa district was undertaken in 1936. The results of this survey have been summarized in the following paper:

Groves, J. W. Additions to the Agaricaceae of the Ottawa district. Can. Field Naturalist. 52: 57-60. 1938.

Seventy-nine species of Agaricaceae not previously reported from the Ottawa district are listed. This list is based chiefly on the collections of the last two years, with the addition of some unpublished records of the late Dr. John Macoun. In the latter, the specimens have been either determined or the identifications checked by Dr. John Dearness.

B. 70.02. SEXUALITY AND CULTURE STUDIES OF FOMES PINICOLA (SW.) COOKE

Irene Mounce and Ruth Macrae, Ottawa, Ont.

Recent studies of isolates of *Fomes pinicola* from various localities, combined with those on which results have been published (1929) show (1) that in North America the isolates may be divided into two groups, a large group A and a small group B. Monosporous mycelia of any culture in group A are compatible (mutually fertile) with monosporous mycelia of every other member of group A; similarly monosporous mycelia from any culture in group B are

compatible with all other monosporous mycelia of group B; but monosporous mycelia of group A are almost completely incompatible with those from group B. (2) This would seem to indicate the presence of two species were it not for the results obtained when monosporous mycelia from group A and from group B are paired with those from a large number of isolates of European origin. The latter form a third group C; they are almost completely compatible with group A, and only partially incompatible with group B. Interestingly enough group B includes cultures both from the so-called *Populus* form of *F. pinicola*, which has sometimes been designated as a separate species, *F. marginatus* Gill., and from the typical form on conferous hosts. It has not been found, however, east of the province of Manitoba or in Europe.

B. 70.05. MAINTENANCE OF NATIONAL MYCOLOGICAL HERBARIUM

I. L. Conners, Ottawa, Ont.

Conners, I. L. Additions to the fungus flora of Anticosti Island and Gaspe Peninsula. Can. Field Naturalist 51: 6-7. 1937.

A study of the fungi collected by Mr. J. Adams in 1935 revealed 35 species, of which 27 were not previously reported from this region.

Additions to the herbarium

In the three years, 1935 to 1937, 1,886 specimens have been added to the herbarium. Of these, 593 specimens were received in exchange for duplicate specimens distributed from the herbarium. The remainder were collectd by members of the division or were received from correspondents. During this period collections were made by the writer in Manitoba, Alberta, about Ithaca, N.Y., U.S.A., in Bonaventure county, Que., and near Kentville, N.S. Portions of this material still remain to be determined.

Agaricaceae

J. W. Groves, Ottawa, Ont.

The collections of Agaricaceae has been re-arranged, mounted, in some cases the determinations checked or corrected, and it has been made available for use as a reference collection. A large collection of photographs of members of this family has been checked and indexed, the prints mounted on herbarium sheets, and incorporated in the collection with their respective species. The combination of the dried specimens and the photographs will greatly facilitate the identification of new specimens. A special effort has been made to increase the collection and in 1936, 94 species were added of which 32 were new to the herbarium and in 1937, 144 species were added, of which 47 were new. The majority of the collections were made within 20 miles of Ottawa, but 23 species were obtained during a brief collecting trip to the forest experiment station at Chalk River, Ontario.

B. 70.06. REFERENCE COLLECTION OF PURE CULTURES OF PATHOGENIC FUNGI

Wood destroying fungi

Irene Mounce, Ruth Macrae, and Mildred K. Nobles, Ottawa, Ont.

During the years 1935-37, 186 cultures were added which include 59 species new to the collection. This makes a total of 250 species represented by 1,040 isolations from various sources. There were added, as well, 1,867 single spore isolations from 23 specimens, making a total of 47 species for which series

of such isolations are available. During that period 176 cultures were sent in answer to requests and 128 received. The division is much indebted to many correspondents and to members of the staff for cultures, or for specimens to be cultured and particularly to Dr. D. V. Baxter, who collected material in Alaska, Dr. Ross Davidson, Dr. G. Goidanich, Prof. Iwao Hino, Dr. E. P. Meinecke, Dr. L. O. Overholts, Dr. H. Robak, and Dr. R. C. Russell.

Fungi affecting ornamental plants and sclerotium-producing ascomycetes

F. L. Drayton, Ottawa, Ont.

This collection of pure cultures now includes 359 isolates in which 53 species are represented. In addition, there is a collection of 63 isolates of various forms of the *Botrytis cinerea* type collected from a variety of host plants and localities. The reason for maintaining a number of isolates of many of the species is that these cultures are being used for the sexuality studies described under Project B. 70.21. In these, the determination of the sterility and fertility relationships requires a number of isolates of monomycelial or monoascosporic origin. During the three years under review 32 species and strains have been added to this collection.

B. 70.08. CRITICAL STUDY OF CLOSELY RELATED FORMS OF WOOD-DESTROYING FUNGI

Irene Mounce and Ruth Macrae, Ottawa, Ont.

Mounce, Irene, and Ruth Macrae. The behaviour of paired monosporous mycelia of *Lenzites saepiaria* (Wulf.) Fr., *L. trabea* (Pers.) Fr., *L. thermophila* Falck, and *Trametes americana* Overh. Can. Jour. Res. 14 (Sec. C): 215-221. 1936.

Lenzites saepiaria, L. trabea, and *Trametes americana* are heterothallic and bipolar. In each species complete interfertility exists between haploid mycelia derived from different sources. *T. americana* is sometimes considered to be a pored form of *L. saepiaria.* The failure to obtain clamp connections in any pairing of a haploid mycelium of *L. saepiaria* with a haploid mycelium of *T. americana* seems significant and lends weight to the conclusion that these two forms are distinct. Haploid mycelia of *L. thermophila* are completely interfertile with those of *L. trabea.*

Mounce, Irene, and Ruth Macrae. The behaviour of paired monosporouus mycelia of *Fomes roseus* (Alb. and Schw.) Cooke and *Fomes subroseus* (Weir) Overh. Can. Jour. Res. 15 (Sec. C): 154-161. 1937.

Fomes roseus and *F. subroseus* are heterothallic and bipolar. With one exception, complete interfertility exists between haploid mycelia derived from different sources. The exception is of particular interest since it shows that two cultures of *F. roseus* from widely separated sources possess one interfertility factor in common. *F. roseus* and *F. subroseus* may be differentiated on the basis of their spore characters. The failure to obtain clamp connections in any of the many pairings of a haploid mycelium of *F. roseus* with a haploid mycelium of *F. subroseus* only serves to emphasize that these two fungi are distinct.

Polyporus abietinus (Dicks.) Fr. and *P. pargamenus* Fr. These two fungi are somwhat similar in appearance, the former usually growing on coniferous, the latter on deciduous hosts. Series of pairings of monosporous mycelia from single fruit-bodies from four different collections have shown that *P. pargamenus* is heterothallic and tetrapolar; similar series of pairings from four different collections have shown that *P. abietinus* is heterothallic and bipolar. Two hundred and seventeen pairings have been made between monosporous mycelia of *P. pargamenus* and *P. abietinus* but no clamp connections have developed in any pairing.

B. 70.13 SEXUALITY AND CULTURE STUDIES OF WOOD-DESTROYING FUNGI

Irene Mounce, Ruth Macrae and Mildred K. Nobles, Ottawa, Ont.

Macrae, Ruth. Interfertility phenomena of the American and European forms of *Panus stypticus* (Bull.) Fries. Nature 139: 674. 1937.

The American form of *Panus stypticus* is luminous, the European non-luminous. Isolates from Ontario and Quebec in Canada, and from Austria, Germany and Holland in Europe, were all heterothallic and tetrapolar. Both the American forms and the European forms are fertile among themselves and the American form is completely interfertile with the European form. In the F_1 generation luminosity is dominant.

In addition to the species reported previously *Polyporus obtusus* Berk. and *Peniophora heterocystidia* Burt are heterothallic and bipolar, and the latter has been shown to produce conidia in culture in the same way as *P. Allescheri* Bres.

Two cultures made from immature sporophores on *Quercus* one from Constance Bay and one from Petawawa, Ont., have been tentatively determined as *Polyporus compactus* Overh. The fungi are both heterothallic and tetrapolar and completely interfertile.

Single spore isolations from a second culture of *Fomes fraxinophilus* (Peck) Sacc., were paired and the results confirmed the statement made on page 60 in the Report of the Dominion Botantist for 1931 to 1934, i.e. that this species is heterothallic and tetrapolar.

Cultures of *Trametes serialis* Fries from various localities and collected by several mycologists have shown differences which make it questionable whether or not they all belong to the same species. Single spore cultures have been isolated from cultures from Norway, British Columbia, and from several places in the United States. Pairings of single spore cultures from each isolate have shown that all the isolates are bipolar. Pairings of single spore cultures from different isolates have shown so far: (*a*) that those from the United States are interfertile, but do not pair with those from Norway or British Columbia; (*b*) that those from Norway are interfertile among themselves but do not pair with any others; (*c*) that those from British Columbia are interfertile among themselves but do not pair with any others.

To facilitate the identification of fungi causing wood-rots work was begun on a key based on cultural characters. Detailed descriptions of the macroscopic and microscopic characters, accompanied by photographs and camera lucida drawings, have been completed for 35 species of *Fomes* and *Polyporus* and a key prepared for this group.

B. 70.16. CLASSIFICATION OF FUSARIUM SPECIES ASSOCIATED WITH FIELD CROP DISEASES

W. L. Gordon, Winnipeg, Man.

A study has been made of the species of *Fusarium* found to be associated with diseased roots and bases of wheat, oats, barley, and rye in Manitoba. Approximately 4,100 isolations of *Fusarium* spp. were obtained from the cereals mentioned. Study of these isolates has shown that twelve species and nine varieties of *Fusarium* representing seven sections of the genus were present.

Certain species were isolated much more frequently than others. *Fusarium* avenaceum (Fr.) Sacc., *F. Equiseti* (Cda.) Sacc., *F. oxysporum* Schlecht., *F.* ? *oxysporum* Schlecht, var. *aurantiacum* (Lk.) Wr., and *F. culmorum* (W.G.Sm.) Sacc., were most frequently isolated and accounted for approximately 96 per cent of the total number of isolations. The following species made up approximately 4 per cent of the isolations: *Fusarium sambucinum* Fuckel, *F. Poae*

(Peck) Wr., *F. sporotrichioides* Sherb., *F. avenaceum* (Fr.) Sacc. var. *volutum* Wr. and Rg., *F. Equiseti* (Cda.) Sacc. var. *bullatum* (Sherb.) Wr., *F. Scirpi* Lamb. and Fautr., *F. Scirpi* Lamb. and Fautr. var. *acuminatum* (Ell. and Ev.) Wr., *F. Scirpi* Lamb. and Fautr. var. *compactum* Wr., *F. Scirpi* Lamb. and Fautr. var. *filiferum* (Preuss) Wr., *F. moniliforme* Sheldon, *F. bulbigenum* Cke. and Mass., *F. bulbigenum* Cke. and Mass. var. *niveum* (E.F.Sm.) Wr., *F. bulbigenum* Cke. and Mass. var. *Lycopersici* (Brushi) Wr. and Rg., *F. Solani* (Mart.) App. and Wr., *F. Solani* (Mart.) App. and Wr. var. *Martii* (App. and Wr.) Wr.

B. 70.18. THE GROWTH OF RHIZOCTONIA SOLANI IN RELATION TO TEMPERATURE, ACID, ALKALI, AND OTHER FACTORS

H. I. Edwards and W. Newton, Saanichton, B.C.

Edwards, H. I. and W. Newton. The physiology of *Rhizoctonia Solani* Kühn. V. The activity of certain enzymes of *Rhizoctonia Solani* Kühn. Sci. Agric. 17: 544-549. 1937.

A number of strains of *Rhizoctonia* that could not be separated by morphological means were distinguished by their enzyme activities. The invertase activities of three strains isolated from Reward, Ceres, and a durum wheat were found to be distinct, indicating that several physiological forms may attack the same plant species. On the other hand, the invertase activities of two strains from aster and potato respectively, were similar, suggesting that strains on distinct species may be identical. It is suggested, therefore, that enzyme activity data may provide a possible basis for the classification of physiological strains of *Rhizoctonia Solani*.

The catalase, diastase, and invertase activities of culture filtrates were altered to a marked degree by the nature of the nitrogen compounds in the nutrient media. The enzyme activity was high when peptone was used as the sole source of nitrogen in the nutrient medium. The addition of nitrate and ammonium salts did not increase the activity over that obtained from peptone alone. In other media containing either gelatine, potassium nitrate, ammonium sulphate, or urea, the enzyme activity was low. It is suggested that the apparent stimulating effect of peptone may be due to its protective influence against hydrolysis of enzymes.

B. 70.19. THE CLASSIFICATION OF HELMINTHOSPORIUM SPECIES ASSOCIATED WITH FIELD CROP DISEASES IN CANADA

J. E. Machacek, Winnipeg, Man.

The number of species of *Helminthosporium* which attack field crops in Canada appears to be very limited. Only four of them, namely, *H. sativum* P.K. and B., *H. teres* Sacc., *H. gramineum* Rabenh., and *H. Avenae* Eidam, seem to be of economic importance. A number of other species, together with *H. sativum* and *H. teres*, have been isolated from discoloured kernels and diseased roots of various cereals, and from soil. Other related phragmosporous Dematiaceae have been obtained from the same sources. An effort has been made to establish a collection of different *Helminthosporium* species in order to make a detailed study of the genus.

In 1928 two collections of *Helminthosporium Tritici-repentis* Died., together with the ascigerous stage (*Pyrenophora Tritici-repentis* (Died.) Drechsler), were collected in two localities in Saskatchewan (Assiniboia and Indian Head) on wheat stubble. In 1933 the same fungus was isolated from leaf lesions of *Agropyron* sp. in Manitoba. In 1937 it was found causing a severe wilting and

spotting of durum wheat leaves in the vicinity of Melita, Manitoba. It is probable that this fungus is more wide-spread than hitherto believed, as it does not sporulate readily except on wilted or fallen leaves, and consequently it may escape notice.

Cultures of two *Helminthosporium* species, identified tentatively as *H. bicolor* Mitra and *H. Maydis* Nis. and Miy. were isolated from diseased roots of corn grown in Ontario.

B. 70.21. A STUDY OF THE SEXUAL MECHANISM AND LIFE HISTORY OF CERTAIN SPECIES OF DISCOMYCETES

F. L. Drayton and J. W. Groves, Ottawa, Ont.

The object of this study is twofold. Firstly, from a taxonomic point of view, great confusion exists in the Ciborioideae and other sclerotium-producing fungi of ascomycetous affinity, and it is hoped that a better understanding of the various types of sexual mechanism present in this group, will provide a basis for a more natural classification. Secondly, there is the problem of completing the knowledge of the life histories of many of the parasitic forms in which the vegetative phases alone are known. The recognition of the sexual phase supplies information that can be used in devising more effective control measures and in giving a better conception of the origin of physiologic races and of varying morphological characters.

The perfect stage of Botrytis convoluta

F. L. Drayton, Ottawa, Ont.

Drayton, F. L. The perfect stage of *Botrytis convoluta*. Mycologia 29: 305-318. 1937.

In the Dominion Botanist's report for the years 1931-1934 a summary is given of the paper by Whetzel and Drayton in which the Botrytis rhizome rot of the garden iris is described and the causal fungus named *Botrytis convoluta*. Further work has revealed that in this species another instance can be recorded of a genetic connection between species of the genera *Botrytis* and *Sclerotinia*.

Under carefully controlled conditions, combined with the use of microconidia for spermatization, the convoluted sclerotial masses of this fungus have developed apothecia of the *Sclerotinia* type. The connection of this ascigerous stage with the conidiophores and conidia of the imperfect stage is established. The new binomial *Sclerotinia convoluta* is proposed and a technical description is given.

The large scale-speck fungus or narcissus

F. L. Drayton and R. E. Fitzpatrick, Ottawa, Ont.

This fungus has been referred to in previous reports of the Dominion Botanist as a saprophyte, or at the most a weak parasite, on the outer scale of narcissus bulbs. McWhorter and Weiss have called it the large scale-speck fungus, because of the sclerotia, varying from 1 to 2 mm. in diameter, which it develops on the bulb scales. No spore form was known at that time except the microconidia of the *Sclerotinia* type, which develop in cultures on potato-dextrose agar.

By following the technique used in these studies, a few apothecia developed from a stroma formed with sclerotia on the surface of the wheat cultures. A large number of single ascospore cultures were made from these apothecia and further work revealed some points of great interest.

The single ascospore cultures are of two distinct types, differing in rate of growth, character of growth, and diameter of hyphae. One set produces

sclerotia and stromata, and the latter tissue forms receptive bodies which on spermatization develop into apothecia. The other set produces a pseudo-stroma and microconidia only. This type of segregation would appear to be a truly dioecious form of heterothallism, in other words heterothallism as originally defined by Blakeslee, a phenomenon never observed previously in this group of fungi.

A paper will appear shortly on this fungus and the binomial proposed will be *Sclerotinia Narcissi.*

Other species under investigation

F. L. Drayton and J. W. Groves, Ottawa, Ont.

Sclerotinia fructicola (Wint.) Rehm—The method of fertilization in the production of apothecia in this species has never been investigated. Microconidia are produced in great profusion in single ascospore cultures. A stroma is developed in wheat cultures and on this some apothecial fundaments have formed, but so far, satisfactory conditions for bringing these to maturity have not been found.

Septotinia podophyllina Whetz.—Apothecia were obtained from single ascospores and conidia of this fungus by means of the special procedure used in this work. The indications are that the single spore cultures are self-fertile and further proof was obtained of the genetic connection between the apothecial stage and the associated conidial form which Whetzel refers to the form-genus *Septoriopsis.*

Sclerotinia sp. on *Ranunculus septentrionalis*—This is an apothecial form with a *Botrytis* conidial stage that Whetzel has had under observation for several years. From single ascospore cultures, spermatized with microconidia, mature apothecia have been obtained. With the vegetative growth at 5° C, far better development of apothecia took place than at 14° or 10° C. The cultures appear to be self-sterile.

Botrytis spp. on a variety of host plants—In reporting the work done on a large number of isolates, it can be treated as four groups. The first is a form which has been known as *B. streptothrix* because of their twisted conidiophores. The second group was isolated from decayed areas in gladiolus corms, with the conidia of the usual type, but the sclerotia are convoluted. The third consists of isolates from pears and apples which had decayed in cold storage. The fourth group includes a large number of isolates of the *cinerea* type from a wide range of host plants and localities. In no case is the study on these forms completed, but in several instances apothecial fundaments have developed and there is every expectation that a better understanding of these perplexing forms will be obtained.

Considerable work has been done also on a number of named species including *Ciboria aestivalis* (Poll.) Whetz., *Sclerotinia Erythronii* Whetz., *Ciboria acerina* Whetz. and Buchw., *Ciboria pseudotuberosa* Rehm, *Botrytis galanthina* (B. and Br.) Sacc., *Botrytis Paeoniae* Oud., *Botrytis Tulipae* (Lib.) Lind, and *Sclerotium perniciosum* van Slog. and Sim. Thomas. Among the unnamed species of interest being studied at present are a *Sclerotium* sp. affecting tulips and sweet clover, two species of undescribed genera, one from fallen poplar leaves and the other on male catkins of *Acer rubrum,* a *Ciboria* sp. on *Carex,* and *Sclerotinia* spp. on *Asarum canadensis* and on poplar leaves.

Taxonomic studies of dermateaceae

J. W. Groves, Ottawa, Ont.

This is a continuation of studies begun at the University of Toronto, the purpose being to study the species of the family Dermateaceae with a view to eventual monographic treatment. The taxonomy of this group is at present in a state of confusion and a knowledge of relationships among the genera and species is essential to the clarifying of the problem. Since these species have more than one type of fructification in their life history, cultural studies are necessary in order to prove the genetic connections of the various stages. Preliminary work has indicated that when these connections have been established, the form of the conidial spore is likely to prove of great value in indicating fundamental relationships, while the form of the conidial fruiting body is useful in distinguishing between closely related species.

To a previous collection of cultures of 86 species, an additional 40 species have been added, representing 12 genera. Of these, 15 species have not been cultured previously, and four are apparently undescribed. The cultures were obtained from specimens collected in the Ottawa district and from specimens sent in by correspondents.

B. 70.24. STUDY OF THE STRAINS OF RHIZOCTONIA SOLANI IN PATHOGENICITY, IN FORMATION OF SCLEROTIA, AND THEIR REACTION TO OTHER SOIL MICRO-ORGANISMS

G. B. Sanford, Edmonton, Alta.

Tyner, L. E., and G. B. Sanford. On the production of sclerotia by *Rhizoctonia Solani* Kühn in pure culture. Sci. Agric. 16: 197-207. 1935.

The effect of phosphorus, potassium, nitrogen, magnesium, calcium and sulphur, and certain environmental factors, including the reaction of substrate, temperature, humidity, aeration and irradiation on sclerotia formation by *Rhizoctonia Solani* Kühn, was studied in pure culture, and, where possible, the optimal and minimal unit for each indicated.

Sclerotia were not produced when either phosphorus or nitrogen were absent from the medium. The optimal and minimal units for phosphorus were 31 p.p.m., and 7·5 p.p.m., and for nitrogen 560 p.p.m., and 50-60 p.p.m., respectively. The minimal for potassium was about 2 p.p.m, but the optimal point could not be determined, as sclerotia were produced almost equally well over a wide range of concentrations. Sclerotia were somewhat curtailed at concentrations of magnesium below 20 p.p.m. Small amounts appear beneficial for optimum growth of both sclerotia and mycelium. The omission of calcium from the medium did not affect sclerotia production nor mycelial growth. A concentration of 320 p.p.m. of sulphur completely suppressed sclerotia and reduced mycelial growth.

At pH values between 3 and 9, sclerotia were produced readily, with the optimum around pH 5·5. The optimum temperature for sclerotia appeared to lie between 18° and 21° C., and in this range of temperature the most favourable atmospheric humidity was above 60 per cent. Irradiations from pitchblende increased sclerotial formation.

Sanford, G. B. Studies on *Rhizoctonia Solani* Kühn. III. Racial differences in pathogenicity. Can. Jour. Res. 16 (Sec. C): 53-64. 1938.

Pathogenicity tests on potato stems were made of 133 isolates of *Rhizoctonia Solani* Kühn. Of these, 114 were from random sclerotia on random tubers from four fields, 13 from lesions on potato stems, and eight from single basidiospores. A number of tests were made in the laboratory at 17° and 23° C., in two contrasting types of artificially infested, unsterilized, virgin soil, which was maintained at optimum moisture content for disease expression.

More of the isolates were pathogenic in the infertile podsol soil than in the fertile black loam. Eighteen per cent of the isolates were of virulent rank in the latter soil, in contrast to 34 per cent of them in the former one.

Indications from the study were that, under average soil conditions, approximately 20 to 50 per cent of the isolates of *R. Solani* from sclerotia on random tubers may be assigned to the zero and marginal classes of pathogenic rank. The data also indicated that certain isolates were inherently very deficient in pathogenicity to potato stems, while others characteristically possess a high degree of virulence. Thus, with regard to the effect of soil type and racial differences in pathogenicity, it would appear that the results of this study help to explain why the stems of a high percentage of plants from sclerotia-infested sets often escape with little or no infection under field conditions.

POTATO DISEASE INVESTIGATIONS

Tuber Investigations: Project Group No. 80.00

B. 80.02. THE WILT OF POTATOES IN PRINCE EDWARD ISLAND

R. R. Hurst and G. W. Ayers, Charlottetown, P.E.I.

Potato wilt has become widespread during recent years and is now recognized as an important problem. Its occurrence in 1937 accounted for the disqualification of 40 fields throughout the province. It was present in amounts ranging from two to fourteen per cent and became a factor in Queens county for the first time in 1937. The symptoms were carefully studied under field conditions. Affected plants exhibit a flagging at the leaflet tips, followed by a definite wilting, the symptoms progressing inwards from the terminal leaflets and towards the main stem. The yellowing of the petiole and main stem was a characteristic feature, being accompanied also by a brownish discoloration of the vascular tissue. It was noted too that a single branch may be affected while others remain healthy; or one shoot only may escape the attack. In severely wilted plants the stem tissue below ground shows a deep brownish discoloration which is clearly evident in a cross-section of the tissue. A blackening of the lower stem and stolons may extend into the potato vascular system to form a darkened ring.

In the course of isolation studies *Verticillium* sp. has been isolated repeatedly. The generic identity of the organism has been based upon the diverse nature of spores, the verticillate arrangement of conidiophores and the darkened hyphae. Pathogenicity tests are in progress under greenhouse conditions.

B. 80.10. A STUDY OF THE RELATIVE VALUE OF THE PRESENT FORMALIN, CORROSIVE SUBLIMATE AND OTHER TREATMENTS AGAINST COMMON SCAB AND RHIZOCTONIA

G. B. Sanford, Edmonton, Alta.

Sanford, G. B. Studies on *Rhizoctonia Solani* Kühn. I. Effect of potato tuber treatment on stem infection six weeks after planting. Sci. Agric. 17: 225-234. 1936.

The effects of treating potato tubers with acidified mercuric chloride solution, and the development of *Rhizoctonia Solani* on the stems growing from clean treated tubers versus untreated tubers heavily infested with sclerotia was studied under a wide range of field conditions, which included different crop sequences, culture and soil types. The development, as indicated on the stems 42 days after planting, was recorded by a numerical rating for severity of lesions, and also by the percentage of plants without lesions. In 24 out of a total of 34 experiments (70 per cent) the severity of infection was significantly greater on the plants from untreated sets heavily infested with sclerotia than on those

from clean treated sets. On the basis of percentage of plants with clean stems, in 31 experiments, or 91 per cent of them, an effective treatment would have been valuable at this stage. There was a tendency for increased infection arising from apparently clean, untreated sets. All soils, whether the previous crop was summer-fallow, cereals, truck, or potatoes, or whether of glacial origin or of the black prairie loam type, carried a basic, although variable, infestation. In the 34 experiments mentioned above, an average of 28·7 per cent of the stems of plants from sets with a heavy infestation of sclerotia, had lesions attributable to the sclerotia, and if the amount for which the soil infestation was responsible is included, the average was only 42 per cent. Extreme variability, which could not be accounted for in the transfer of the pathogen to the stems from heavily infested sets, was common during the three years of the test. The treatment used apparently caused as many missing hills as the pathogen from the sclerotia, the average per experiment being approximately 2·5.

Sanford, G. B. Studies on *Rhizoctonia Solani* Kühn. II. Effect on yield and disease of planting potato sets infested with sclerotia. Sci. Agric. 17: 601-611. 1937.

The effect on yield and disease of planting potato sets infested with sclerotia of *Rhizoctonia Solani* Kühn was studied during four years in 36 experiments, under a wide range of soil types and crop sequences. In general, the use of yield of large-size tubers, or small-size tubers, or total yield, or yield of deformed tubers, or sclerotia on tubers at harvest proved to be undependable criteria to determine the relative value of tuber treatments. Although percentage of stem infection would be fairly reliable to indicate both soil infestation and control by a treatment during the early growth period, it is important, if not essential, to determine the effect of the disease on the stolons, if control of the disease is to be measured in terms of yield. The yield of large-size tubers was the most reliable of all criteria used. It gave expected results in about 40 per cent of the experiments. An average of approximately 58 per cent of the plants from the sclerotia-bearing sets had no disease lesions on the stems.

Laboratory methods of determining the relative lethal effect on sclerotia and general suitability of various tuber treatments are suggested in preference to ordinary field tests.

The influence of various seed potato treatments against rhizoctonia infection under field conditions

W. Jones and H. S. MacLeod, Saanichton, B.C.

Mercuric chloride and the organic mercury compounds as tuber dips proved the most effective treatments in the control of the rhizoctonia disease of potatoes as determined by freedom from stem lesions, total tuber yield, and percentage of off-grade tubers.

B. 80.11. DATE OF DIGGING AND ITS RELATION TO DEGREE OF INFECTION WITH RHIZOCTONIA

R. R. Hurst and S. G. Peppin, Charlottetown, P.E.I.

Peppin, S. G., and R. R. Hurst. Date of digging and its relation to the development of rhizoctonia on potato tubers. Am. Potato Jour. 13: 74-76. 1936.

The object of the experiment was to determine what influence, if any, the date of digging had in limiting the amount of black scurf on the crop of tubers. The normal digging dates in this section are about September 20 for Irish Cobbler, and October 1 for Green Mountain. In these experiments, the tubers were harvested from September 1 to October 13. The results of nine years experiments are shown in the accompanying table.

THE RELATION BETWEEN DATE OF DIGGING AND THE PER CENT OF RHIZOCTONIA (BLACK SCURF)

Varieties	Date harvested						
	September					October	
	1	8	15	22	29	6	13
Irish Cobblers..	2·33*	5·41	14·51	26·07	30·18	37·70	43·07
Green Mountains.. ..	0·20	1·67	8·31	16·96	27·78	34·14	39·55

* Nine year average of rhizoctonia estimated on a percentage basis.

From these results it will be seen that there is a considerable increase in the number of affected tubers from week to week.

The results also indicate clearly that on a heavily infested soil the normal digging date is actually too late. On the other hand it is reasonable to assume that on soil not so heavily infested, a considerable degree of safety exists on these dates, and that hastening the harvest date by one or two weeks will result in a comparatively clean crop even in years when conditions are favourable for the development of the fungus.

It must be borne in mind, however, that the practice of early harvesting must be conducted carefully since immature tubers are liable to injury at harvest time, and consequently are rendered more susceptible to storage losses.

From the certified seed grower's standpoint early harvesting is to be recommended. He should test his crop from time to time by digging a few hills here and there throughout the field as the regular harvest date approaches and should be prepared to harvest the entire crop on the first appearance of sclerotia on the tubers.

The procedure, therefore, of digging the potato crop at as early a date as possible, either just prior to or immediately after maturity is a practice to be recommended when the rhizoctonia disease is a factor to be considered.

B. 80.—A ROT OF POTATO SEED-PIECES

K. A. Harrison, Kentville, N.S.

Isolations from a rot in potato index tubers being grown in a greenhouse gave a sterile fungus capable of reproducing the disease at temperatures between 16° and 28° C. The maximum was not established because the growth of potatoes was poor at 28° C. The fungus became established in sterilized soil and at favourable temperatures rotted the sets planted therein. Sets planted in unsterilized soil, inoculated in the same manner and kept at the same temperatures, did not rot. This was taken as an indication that the organism had not become established in the soil and probably was not a soil parasite. Likewise it was considered most probable that the fungus was associated with the tubers from which the indices were taken.

Because of the high optimum temperature for this disease, it is considered that the rot will be of slight economic importance to the potato crop in Nova Scotia under field conditions.

Virus Diseases of Potato: Project Group No. 81.00

B 81.02. THE IDENTITY, TRANSMISSION, VARIATIONS, AND CONTROL OF VIRUS DISEASES

D. J. MacLeod and J. L. Howatt, Fredericton, N.B.

Field studies conducted in 1935 yielded some noteworthy results concerning the effect of high air temperatures, 90° to 102° F., during the month of August, on the symptomatology of mild mosaic, rugose mosaic, crinkle mosaic, leafrolling mosaic, leafroll, spindle tuber, giant hill, and witches' broom of the potato. With the exception of rugose mosaic, the typical symptoms of all the other mosaic diseases disappeared at 95° F. and did not reappear

except on the new growth developed after the cessation of the heat wave. No changes were effected in the foliage of leafroll plants developed prior to the heat wave, but subsequent growth was devoid of leafroll symptoms. The symptoms of the other virus diseases were not affected by the high temperatures.

Virus diseases included in the mosaic group were observed on varieties or forms of the following wild potato species: *S. demissum* Lindl., *S. curtilobum* Juz. and Buk., *S. Kesselbrenneri* Buk., *S. andigenum* Juz. and Buk., *S. araccpapa* Juz., *S. Molinae, S. Catarthum, S. chocclo* Buk., and Lechn., *S. tenuifilamentum* Juz. and Buk., *S. goniocalyx* Juz. and Buk., *S. stenotomum* Juz. and Buk., *S. mamilliferum* Juz. and Buk., *S. ajuscoense* Buk., *S. leptostigma* Juz.

The aphid survey begun in 1934, was continued for the past three years with the co-operation of the Dominion Entomological Laboratory at Fredericton. In 1935, 291 collections of aphides were made from potato fields located throughout the province. The collections comprised 83·4 per cent *Macrosiphum solanifolii* Ashm., 9·4 per cent *Myzus persicae* Sulz., 13·6 per cent *Aphis abbreviata* Patch, and 0·6 per cent *Myzus pseudosolani* Theob. In 1936, 228 lots of aphides were collected from 58 potato fields. Approximately 87 per cent of the collections were pure cultures of *Macrosiphum solanifolii* Ashm. *Myzus persicae* Sulz., and *Aphis abbreviata* Patch, the species held largely responsible for transmission of mild mosaic, comprised only 13 per cent of the collections. In 1937, collecting was restricted to Carleton county, the area of most intense potato production. In contrast to the results of previous years, 92 per cent of the collections contained *Myzus persicae* Sulz.

B. 81.08. THE RATE OF SPREAD OF VIRUS DISEASES

C. Perrault, Ste-Anne de la Pocatière, Que.

Potato plots planted in 1931 with certified seed and one to five per cent mosaic sets yielded, after the seventh consecutive year, a crop 96 to 100 per cent mosaic. Certain potato plants have never shown signs of mosaic although they have grown for several years in the neighbourhood of hills severely affected with mosaic. The yield of these apparently healthy hills is two to three times greater than that from plants affected with severe mosaic.

Regular spraying with nicotine sulphate under field conditions has not controlled sucking insects and consequently the rate of spread of virus diseases did not vary among sprayed and unsprayed plots.

B. 81.10. THE STUDY OF PHYSICAL METHODS FOR DETECTING VIRUS INFECTION

The specific gravity of potato tubers in relation to virus infection

E. R. Bewell, Saanichton, B.C.

Investigations conducted during 1936 and 1937 indicate that virus diseases decrease the dry-matter content of potatoes. The hills that were tested were collected at random throughout British Columbia.

Virus disease	1936		1937	
	Average per cent dry matter		Average per cent dry matter	
	Diseased hills	Adjacent healthy hills	Diseased hills	Adjacent healthy hills
Leaf roll	21·51	23·15	20·57	23·21
Mosaic	20·43	22·95	20·57	23·00

Tests were also made of hills affected with giant hill and although the average dry matter of diseased hills was less than that of adjacent healthy hills, the difference was not significant, and the tests indicate that giant hill is not a virus.

Secondly, the dry matter of seed potatoes was determined by the specific gravity method before planting, and the plants examined during the growing season. Practically all virus disease found in the plots occurred in plants from tubers that were below the mean for the sample tested.

The production of antisera in chickens by inoculation with potato virus X

W. Newton and H. I. Edwards, Saanichton, B.C.

Newton, W., and H. I. Edwards. Virus studies. I. The production of antisera in chickens by inoculation with potato "X." Can. Jour. Res. 14 (Sec. C): 412-414. 1936.

Chicken antiserum was produced by three wing vein inoculations with sap from *Datura meteloides* and *Datura Stramonium* plants infected with "potato virus X." Before injection, the saps were purified by the Bawden and Pirie method. This antiserum formed a conspicuous precipitate when incubated for three hours at 37° C. with similarly purified sap of these two plant species when they were infected with the X or healthy potato virus, but failed to form any precipitate when incubated in the same way with purified sap from virus-free plants. Two unknown viruses, one from spinach and the other from tomato were established as belonging to the X group by the precipitin reaction through the use of chicken antisera. The serological grouping was supported by the fact that the unknowns had similar, if not identical lethal temperatures, longevities in vitro, and host ranges as the ordinary potato virus X.

The potato viruses of British Columbia

W. Newton, Saanichton, B.C.

All the certified varieties of potatoes grown in British Columbia were found to carry *Solanum virus* 1 Orton with the single exception of the variety King Edward. No evidence was obtained to support the theory that the exceptional vigour of giant hill plants is due to the absence of virus infection. All giant hill plants investigated carried *Solanum virus* 1. The previous find was again confirmed that all giant hill plants have a lower dry matter content than corresponding normal plants. The uniformity of the difference in the dry matter suggests that giant hill is not a virus disease when coupled with the evidence that giant hill cannot be transmitted by grafting or by other means.

Evidence was obtained that *Solanum virus* 1 moved from potatoes to *Datura meteloides* and tobacco on the Lulu island potato plot in spite of the fact that transmission by insects has never been established for this virus.

Proof was obtained that the aphid populations on potatoes are increased by spraying with Bordeaux apparently due to the destruction of fungi parasitic upon these insects.

Serological investigations

H. I. Edwards and W. Newton, Saanichton, B.C.

Antisera prepared at this laboratory and secured from the Rockefeller Institute at Princeton, N.J. established the relationship of *Solanum virus* 1 Orton to the causal agents of a local disease of tomatoes, streak X; a local disease of spinach, spinach spot, and to a local disease of ivy-leaf and ordinary geraniums, *Pelargonium virus* 1 Pape; and also the relationship of *Nicotiana virus* 1 (Mayer) Allard to the causal agents of two local diseases of tomatoes,

tomato yellow or aucuba mosaic, and single virus streak. A tobacco disease distinct from ordinary tobacco mosaic from the Fraser river valley was also established as belonging to the *Nicotiana virus* 1 group. These investigations established the practical possibility of preparing plant virus antisera in quantity at a single point for distribution to plant pathologists all over the world. The serum samples prepared at Princeton, N.J. travelled through the ordinary mail at least 3,000 miles and they arrived in perfect condition and remained active for more than three months after arrival.

The properties of a geranium virus

W. Newton, Saanichton, B.C.

A local disease of geraniums was found to be caused by *Pelargonium virus* 1 Pape. The virus was transmitted as sap to *Nicotiana glutinosa*. The thermal death, host range, and other properties were similar to the X virus of potatoes. Serological proof was obtained that the local geranium virus belonged to the X group.

Foliage Diseases (Blights, etc.): Project Group No. 82.00

BB. 82·01. STUDIES OF POTATO VARIETIES AND STRAINS FOR RESISTANCE TO LATE BLIGHT AND VIRUS DISEASES

R. R. Hurst and S. G. Peppin. Charlottetown, P.E.I.

With the aid of greenhouse facilities new blight resistant potato strains have been propagated from seed-balls of blight resistant stock formerly in use but later discarded because of contamination by virus disease. Field tests of the material thus obtained are being continued, all unpromising strains being abandoned.

Seed strain studies

The Seed Potato Inspection Service has endeavoured to interest seed potato growers in the improvement of the most favoured varietal strains under certification in the province. A number of growers have undertaken to maintain the quality of seed stock by adopting the tuber-unit seed plot method. Yet in spite of this it appeared certain that the best possible results were not being realized generally, thus it has been necessary to reclaim and improve the original strains for purposes of purification with the intention of providing seed growers with small quantities of high class foundation stock. Five strains each of Irish Cobbler and Green Mountain, representing the choicest original sorts, have thus been reclaimed and the purification work has been done according to plan, the tuber unit method being practised throughout. The total mosaic content of the Green Mountain strains tested in 1937 was reduced below 1936 readings by approximately one per cent. The object of this effort, therefore, is being fulfilled. Thus the results to date are sufficiently encouraging to warrant at least the restricted distribution of small lots of foundation stock.

B. 82·02. DUSTING VERSUS SPRAYING IN THE CONTROL OF LATE BLIGHT OF POTATOES

R. R. Hurst, Charlottetown, P.E.I.

Tests conducted during 1936 were based upon a comparison of Bordeaux mixture (4-4-40) and a neutral copper dust known commercially under the trade name of Copper-Hydro "40". Employed in this way liquid Bordeaux

was superior to Copper-Hydro "40" as a control for late blight. A slightly higher total yield was produced from the plants to which this particluar fungicide had been applied.

The tests conducted in 1937 using Copper-Hydro 40 (viz. ready solubility, ease and convenience of handling, portability, vigour imparting nature, and splendid fungicidal character) place a high rating upon this product.

B. 82·03. THE VALUE OF BORDEAUX MIXTURE IN CONTROLLING LATE BLIGHT AND ITS EFFECTS UPON YIELD

C. Perrault, Ste-Anne de la Pocatière, Que.

In 1935 and 1936, when late blight was of no importance in the district, plots sprayed with Bordeaux yielded slightly more than plots sprayed with water only. Strangely enough plots sprayed with the solution weaker in copper sulphate yielded more than those sprayed with the 4-4-40 mixture. But in 1937 when late blight was severe in the district plots sprayed with the 4-4-40 solution yielded more heavily. Tubers harvested from plots sprayed with the 2-4-40 mixture showed more late blight infection and soft rot than plots sprayed with standard Bordeaux. Late blight infection on tubers was still more common among plots that did not receive any protection against the disease.

During this three-year period plots that received six applications of Bordeaux did not yield any more than those that received only four applications.

B. 82.04. LATE BLIGHT EPIDEMIOLOGY STUDIES

R. R. Hurst and E. H. Saunders, Charlottetown, P.E.I.

Maximum and minimum daily temperatures, inches of rainfall, and hours of sunshine have been recorded for five years ending 1937. Observations over such a short period do not justify the drawing of definite epidemiological conclusions yet striking comparisons are obvious. General blight conditions have been charted for each year and correlated with weather conditions corresponding to the respective growing season.

The suddenness of epiphytotics following periods of blight inactivity due to hot, dry weather has been traced to the survival of sporangia through the optimum conditions provided by soil temperature and moisture relationships at six-inch depth. It has been noted further that there is little or no indirect germination of sporangia above 24° C; the direct type of germination also decreases rapidly above this temperature. The temperature-humidity relationship has been held accountable for the interruption of blight outbreaks.

The general occurrence and severity of blight have been noted for each year as follows:—

1933. Late blight caused slight to severe damage in all three counties. This was one of the worst blight years on record.

1934. Late blight was less prevalent but many fields showed severe infection.

1935. This was a practically blightless year.

1936. Late blight was generally severe, having its beginning about mid-August, spreading rapidly and inflicting severe losses. Temperatures were low and humidity high throughout the growing season.

1937. Blight was of very little consequence until September when a widespread outbreak developed.

Investigations completed in 1936 have demonstrated the effectiveness of heavy soil coverings as a measure of prevention against blight.

Epidemiology studies in Quebec

C. Perrault, Ste-Anne de la Pocatière, Que.

In 1935 late blight was epidemic in the regions of Montreal, Trois-Rivières and Quebec. The disease made rapid progress in these districts due to heavy precipitation. It appeared two weeks earlier in the district of Quebec where total precipitation for July, August and September totalled 18·5 inches. In 1936 the disease was reported first from the regions of the Eastern Townships, Trois-Rivières and Montreal. Low temperature during the latter half of August checked the disease until September when again it made some progress. However, it was not considered serious. In 1937 late blight broke out in the region of Quebec about July 27 and favoured with high air humidity and temperature it became epidemic throughout the province. The lower St. Lawrence and even the Gaspé region where the disease had not been of any importance since 1930 were affected by the trouble. However, due to the cooler climate of these regions the disease, when it appears, is generally observed two to six weeks later than in the region of Quebec.

Experimental evidence was obtained in the greenhouse that potato seedlings may become infected with late blight when grown on the same soil that produced a potato crop seriously affected with the disease.

B. 82.07. LATE BLIGHT INVESTIGATIONS OF POTATOES IN BRITISH COLUMBIA

H. S. MacLeod and W. Jones, Saanichton, B.C.

Bordeaux, Burgundy, Micronized Burgundy, Bouisol, and Bordinette sprays as well as copper lime dust significantly reduced the infection of potato foliage by *Phytophthora infestans*. These treatments also significantly increased plot yields under field conditions. Evidence was obtained that the addition of stickers increased the efficiency of the sprays.

Spraying proved more effective than dusting.

Bacterial Diseases: Project Group No. 83.00

B. 83.04. BACTERIAL WILT AND ROT OF POTATOES

H. N. Racicot and D. B. O. Savile,[1] Ottawa, Ont.

Savile, D. B. O., and H. N. Racicot. Bacterial wilt and rot of potatoes. Sci. Agric. 17: 518-522. 1937.

Investigations of the bacterial wilt and rot of potatoes led to the discovery of the pathogen, a very slow growing, Gram-positive, small, short rod (0·3-0·5 x 0·6-0·9 μ), closely related to both *Phytomonas michiganensis* (E. F. Sm.) Bergey, *et al* (the cause of tomato bacterial canker) and *P. sepedonica* (Spiekerm.) (the cause of potato bacterial ring rot in Germany). The disease was reproduced by inoculation in the greenhouse, and the pathogen re-isolated.

In field experiments carried out after the above paper was published diseased sets gave 25 per cent misses, 66 per cent diseased and 9 per cent healthy plants; sets needle inoculated around the eyes with a suspension of the organism, gave 2 per cent misses, 97 per cent diseased and 1 per cent healthy plants; sets with cut surfaces waxed, then dipped into the suspension, gave no misses, 45 per cent diseased and 55 per cent healthy plants; sets cut with knife contaminated by cutting into diseased tubers, gave 3 per cent misses, 96 per cent diseased and 1

[1]Formerly Graduate Assistant.

per cent healthy plants; sets from tubers dipped into suspension, dried, then cut, gave 1 per cent misses, 59 per cent diseased and 40 per cent healthy plants; healthy, untreated sets gave no misses, 6 per cent diseased and 94 per cent healthy plants.

The outstanding information gained from the above results is that bacterial wilt and rot is a very infectious disease. It is easily transmitted by the knife used in cutting sets. Therefore, the disease could also be transmitted by the picker-type of planting machines, and especially by tuber-unit planting machines, which cut the tubers into sets while planting. Infection may also take place by the healthy sets coming into contact with freshly cut, diseased sets. A small amount of transmission by mechanical means (insects, rodents, cultivating implements, etc.) occurred in the field.

Twenty-eight out of thirty tomato plants inoculated, and four out of seven eggplants, became diseased, while only one out of six sweet pepper plants inoculated became slightly diseased.

From one to 17 of the following plants were inoculated, but none became diseased: *Petunia hybrida* Vilm., 17; *Solanum Dulcamara* L., 8; *Physalis pubescens* L. (husk tomato), 5; *P. heterophylla* Nees, 5; *Nicotiana tabacum* L., 2; and *Solanum capsicastrum* Link, 1.

Investigations in Quebec

C. Perrault, Ste-Anne de la Pocatière, Que.

The disease is carried over in tubers from one year to another. During winter a high percentage of rot may develop in storage from apparently healthy tubers of a diseased crop. It has been shown that from such apparently healthy tubers planted in the spring, more than 50 per cent of the plants may show the disease during summer. Soil types on account of their water holding capacity may influence the progress of the disease in the field. Contaminated or diseased sets will rot to a larger extent, without producing any seedlings, if planted in a wet soil. Diseased plants will be more easily diagnosed in a warm sandy soil; in a wet soil only a small percentage of diseased plants can be detected before harvest time. But there has not been much difference so far in the percentage of diseased plants with affected tubers between plots in various types of soils.

Contaminated knives have transmitted the disease to an extent of 86 per cent; cutting knives seem to be the main source of transmission of this disease. Disease transmission through soil appears to be insignificant under natural field conditions. The organism when inoculated into plants seven to eleven inches in height has produced wilt symptoms six weeks later; when inoculated into potato sets by means of a needle symptoms appeared on plants ten to thirteen weeks later.

Investigations in New Brunswick

J. L. Howatt and S. F. Clarkson, Fredericton, N.B.

An unusual potato disease, affecting a number of standard potato varieties made its appearance in 1935. Affected plants showed chlorosis, wilting and dying of the foliage, accompanied in many instances by a soft rot of one or more of the tubers. Four organisms were isolated from diseased material collected in several localities in the province and one lot received from the province of Quebec. Studies on the cultural, morphological, and physiological characteristics of these organisms revealed that they were similar in most respects to *Bacillus carotovorous* Jones. In 1937 a similar disease again made its appearance, which was confined largely to the Spaulding Rose, Chippewa, Warba, and Katahdin varieties, imported the current season from the state of Maine. However, a local strain of Green Mountain and a lot of the same variety imported from Quebec, were also found diseased. Further investigations revealed that

two distinct organisms, alone or in combination, were associated with the tuber disease. Primary infection apparently resulted from a Gram-positive, short rod, which had gained entrance through the stolon end and confined itself to the vascular ring. The secondary infection, resulting in a soft rot, was apparently due to *Bacillus carotovorous* Jones.

Other Potato Studies: Project Group No. 84.00

B. 84.01. DOMINION SEED POTATO CERTIFICATION SERVICE

John Tucker, Ottawa

The following is a concise report on the work of the Seed Potato Certification Service for the three years ending December 31st, 1937.

SUMMARY OF FIELD INSPECTIONS 1935-1937

Year	No. of Applicants	No. of fields entered	No. of fields passed	Per cent passed	No. of acres entered	No. of acres passed	Per cent passed
1935	5,920	7,549	5,894	78·1	20,374	16,751	82·2
1936	4,868	7,586	5,888	77·6	20,083	16,739	83·3
1937	6,659	9,444	7,541	79·8	30,378	25,711	84·6

SHIPMENTS—CERTIFIED SEED POTATOES

1935 crop	918,212 bushels
1936 crop	1,699,325 bushels
1937 crop (to Dec. 31, 1937)	2,009,016 bushels

The shipments shown above refer to seed which has actually been shipped under official tags and does not include seed sold bin-run for local use, direct, and for which official tags were not requisitioned.

For the ten-year period 1928-1937 the average acreage inspected was 29,708 acres, the average acreage passed was 23,600 and the shipments averaged 1,534,353 bushels, per annum.

ACREAGE WHICH PASSED FIELD INSPECTIONS, BY VARIETIES

Year	Green Mountain	Irish Cobbler	Bliss Triumph	Dooley	Netted Gem	Katahdin	Other Varieties
1935	4,388	9,507	1,144	886	293	93	440
1936	4,929	8,260	1,570	772	312	247	649
1937	11,032	9,602	2,562	501	402	790	822

FIELD REJECTIONS

PERCENTAGE OF THE FIELDS ENTERED

Year	Mosaic	Black Leg	Leaf Roll	Foreign Varieties	Adjacent to diseased	Miscellaneous	Total
	%	%	%	%	%	%	%
1935	9·5	1·7	0·9	1·2	2·4	6·2	21·9
1936	9·3	1·5	1·0	2·0	2·8	5·8	22·4
1937	6·9	1·1	0·5	2·0	2·6	7·1	20·2

Actual inspection work includes two field inspections of the growing crop, tuber inspections in the storage bins and at the shipping points, the preparation of official reports on each lot inspected, the issuance each year of approximately one million stamped and dated official tags and of several thousand health and special seed certificates (required by some foreign countries). Other seasonal activities undertaken by the inspectors are as follows: demonstration plots in every province each season for the study of potato diseases, the identification of varieties, and the testing of strains and seed treatments; field demonstrations and potato club tours to illustrate the value of disease-free seed; inspection of several hundred plots planted to certified seed by junior farmers in various competitions, thereby establishing practical co-operation with provincial agricultural authorities; potato judging at fall fairs and exhibitions; the preparation and arrangement of exhibits; and tuber-index work at some experimental or selected farms.

Lists of growers having seed for sale were prepared and distributed to prospective buyers, and extensive trade resulted from bringing producer and consumer together in this way. Copies of field reports were also issued, on request, to interested parties. These services appear to be much appreciated by the trade, and are in ever-increasing demand.

B. 84.02. THE ISOLATION IN TUBER LINES OF DISEASE-FREE AND HIGH-YIELDING POTATOES

W. K. McCulloch, Kentville, N.S.

The aim of this project was to test the control of virus diseases by means of tuber-unit seed plots and rogueing, and to make available for distribution small lots of foundation stock.

The following table shows the results of the work with staple varieties for three years:—

Variety	No. of tuber-lines		Number of sets planted	Number of plants rogued out	Per cent virus
	At Kentville	At North Mountain			
Bliss Triumph	19	–	1,577	538	34·1
Bliss Triumph	–	3	360	24	6·6
Green Mountain	26	–	2,900	1,219	42·0
Green Mountain	–	3	324	2	0·6
Irish Cobbler	43	–	2,920	398	13·6
Irish Cobbler	–	3	360	2	0·5
Early Rose	6	–	630	137	21·7
Early Ohio	6	–	386	263	68·1

The above table shows that the ordinary means of controlling virus, namely, tuber-unit seed plot and rogueing, are of little avail under conditions such as those at Kentville. On the other hand, these same practices are apparently successful under North Mountain conditions.

The latter conclusion is borne out in a practical way by the fact that during the three years under review upwards of 180,000 bushels of certified Bliss Triumph seed potatoes were exported from Nova Scotia, and that practically all of this seed had its origin in the tuber line plots at North Mountain, Kings Co., N.S.

During the period under review upwards of 200 other plots were under preliminary test. These consisted of named and unnamed varieties found under cultivation in the rural districts of the province, seedlings from British Columbia, Prince Edward Island, Russia, and Finland, and more or less staple varieties from the British Isles, Germany, and Holland.

B. 84.12. TESTING NEWLY DEVELOPED STRAINS AND VARIETIES OF POTATOES FOR RESISTANCE TO COMMON POTATO DISEASES

D. J. MacLeod and J. L. Howatt, Fredericton, N.B.

This project concerns the testing of seedlings, named varieties, and wild species of potatoes for their resistance to mild mosaic, late blight, or common scab. The mosaic and common scab resistance studies were confined to crosses between commercial varieties of potatoes while the blight resistance studies involved crosses between wild species, especially *Solanum demissum* Lindl., and commercial varieties.

Since 1935, 8,344 seedlings were tested for resistance to mild mosaic. Only 2,127 of these seedlings are now on hand, the remainder being discarded because of undesirable horticultural features or susceptibility to mild mosaic or leaf roll, Amongst the survivors are a number of productions which have remained healthy after two hand inoculations, four years' field exposure, and one year's greenhouse exposure to viruliferous aphides.

Eleven thousand four hundred and forty-seven potato productions have been tested for late blight resistance. Testing was effected by spraying the seedlings daily for seven consecutive days with a conidial suspension of *Phytophthora infestans* (Mont.) de Bary. All blight resistance studies were confined to a large inoculation chamber housed in the greenhouse. The reaction of the various plans to blight infection varied from absolute immunity to complete susceptibility. Crosses involving a susceptible and an immune parent yielded in the F_1 generation both immune and susceptible seedlings in approximately a 50 per cent ratio. Some seedlings remained immune to blight after the second backcross to a susceptible variety.

Six hundred and ninety-seven seedlings, the progeny of crosses between 17 smooth skinned varieties of potatoes all proved very susceptible to scab when planted on scab-infested soil. However, the varieties Hindenburg, Richter's Jubel, and Arnica proved almost immune under field conditions when the Green Mountain variety was severely scabbed.

B. 84.14. THE USE FOR SEED OF POTATOES PREVIOUSLY EXPOSED TO FREEZING TEMPERATURES

R. R. Hurst, Charlottetown, P.E.I.

Hurst, R. R. Low temperature injury to late harvested potatoes. Dom. Dept. Agric., Cir. 128. 1937.

A destructive soft rot due to low temperature injury has been encountered in Prince Edward Island. This condition results from freezing injury to portions of the crop not dug before the first killing frost. The crop dug and stored before frost comes through the winter in a sound condition. Many tubers dug after frost rot as a result of severe chilling. Chilling sets in when the soil next the tubers becomes frozen prior to digging or frozen soil comes into contact with the potatoes during digging operations. Moreover tubers already frozen and chilled earth carried into storage probably cause further injury of a similar nature. Tubers harvested late in the day, after the frost had left the ground, escaped injury.

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Heavy frosts being a menace at digging time, every effort should be made to gather the crop not later than early October. Cultivation practices ensuring a liberal covering of earth over the potatoes afford valuable protection against frost. When frost injury is evident or suspected it is necessary to sort out affected tubers shortly after digging, and also to avoid mixing this part of the crop with potatoes dug before frost occurs. Potatoes lifted after frost should not be used for seed unless there has been no evidence of low temperature injury, a requirement based upon the results of field tests which showed that the use of such seed tubers resulted in many misses as well as a high percentage of weak plants. From a revenue standpoint potato growers cannot afford to use seed-pieces from frost-injured tubers. The greatest detriment with respect to stand and tuber yield was associated with temperatures of 20° F. and lower. Temperatures higher than 20° F. were not detrimental up to exposures of 180 minutes.

B. 84.15. AN INVESTIGATION OF THE FUNGICIDAL VALUE OF SOIL DISINFECTANTS IN COMBINATION WITH FERTILIZERS

R. R. Hurst, Charlottetown, P.E.I.

Combined with commercial fertilizer (4-8-10), mercuric chloride and mercurous chloride controlled rhizoctonia to a satisfactory degree. The former was most effective in this respect, showing a total only of 9·58 per cent affected tubers as against 89·49 per cent infection in the crop from untreated soil.

VEGETABLE DISEASE INVESTIGATIONS

Tomato Diseases: Project Group No. 90.00

B. 90.03. TOMATO STREAK RESEARCH

G. H. Berkeley, St. Catharines, Ont.

Berkeley, G. H. A strain of the virus which causes streak in tomato. Can. Jour. Res. 14 (Sec. C): 419-424. 1936.

Following the results recorded in the 1931-34 progress report of the Dominion Botanist, the work under this project has centred around a comparison of streak material from different sources, and control.

A strain of tomato streak virus 1 was found in Ontario, which was different in several respects from tomato streak virus 1. Experimental evidence was obtained which suggested that tomato streak virus 1 and the Ontario strain of this virus, were strains of tobacco virus 1.

Berkeley, G. H. Prevention of virus diseases of greenhouse grown tomatoes. Dom. Dept. of Agric., Circ. 118. 1937.

In this paper 15 measures are outlined and recommended as a means of preventing spread under greenhouse conditions.

A disease of tomatoes caused by a virus of the potato X group

W. Newton and H. I. Edwards, Saanichton, B.C.

Newton, W. Virus studies. II. Streak X, a disease of tomatoes caused by a virus of the potato X group unassociated with tobacco mosaic. Can. Jour. Res. 14 (Sec. C): 415-418. 1936.

A streak disease of tomatoes was found to be caused by a virus of the potato X group unassociated with tobacco virus 1. The disease markedly reduced the yield of marketable fruit in several greenhouses near Victoria.

The symptoms resemble those induced by ordinary potato virus X in conjunction with tobacco mosaic. The host range, lethal temperature, longevity in vitro, and dilution extinction point of the virus resemble ordinary potato X. Streak X may be distinguished from ordinary potato X by the more pronounced symptoms it induces on tobacco, *Datura*, *Nicotiana glutinosa*, and tomato, and particularly by the streaking and necrosis of the stems and leaves of tomato. The virus causing this streak disease could not be recovered from Irish Cobbler potatoes after an incubation period of ten days, neither did the characteristic symptoms occur on tomatoes already infected with the ordinary potato virus X. The virus was recovered unchanged from X-free potato seedlings. The antigen reaction also proved that the streak virus belonged to the potato virus X group.

Virus diseases of tomato

W. Newton and H. I. Edwards, Saanichton, B.C.

Newton, W. and H. I. Edwards. Virus Studies. III. Tomato diseases. Can. Jour. Res. 15 (Sec. C): 162-167. 1937.

Single virus streak, potato virus X, streak virus X, and aucuba mosaic (tobacco virus 6) were found causing diseases of tomatoes in commercial glasshouses in British Columbia during 1936. Single virus streak was the commonest disease although greater losses were caused by streak virus X. Aucuba mosaic was found in one case only, but was highly pathogenic. Potato virus X was present mixed with single virus streak, giving rare cases of mixed virus streak. Tomato mosaic (tobacco virus 1) was not present as a tomato disease.

Single virus streak serum did not give a precipitate when mixed with aucuba antigen, thus indicating that the viruses are distinct. However, a slight precipitate with tobacco virus 1 antigen did indicate distant relationship with this form. Although three strains of single virus streak could be distinguished by symptoms produced on tomatoes when inoculated simultaneously, these strains proved to be serologically identical.

B. 90.06. THE INFLUENCE OF ENVIRONMENT UPON TOMATO DISEASES

J. E. Bosher, Saanichton, B.C.

Evidence was obtained that tomato growth under glass is favourable when peat and mineral fertilizers are applied after steaming the soils rather than before. The depression of growth was striking when peat was incorporated before steaming.

Other Vegetable Diseases: Project Group No. 91.00

B. 91.01. THE CONTROL OF CELERY BLIGHTS

J. K. Richardson, St. Catharines, Ont.

Richardson, J. K. Control of late blight of celery. Sci. Agric. 16: 358-364. 1936.

A paper on this subject was published in 1936 in which recommendations for the control of blight were given. Among these were, (1) use Burgundy or Bordeaux mixture as sprays or copper lime dust, (2) start spraying early, cover foliage thoroughly, (3) spray before, not after rains, and (4) apply dust while dew is on the plants.

In 1937 the fungicide Qua-sul was tested. Only early blight (*Cercospora Apii*) developed in the plots, and while Burgundy mixture gave almost perfect control, Qua-sul had little or no effect on checking the disease.

B. 91.03. EGGPLANT WILT

J. K. Richardson, St. Catharines, Ont.

Experiments have been continued in an effort to find some soil treatment capable of controlling this disease. Cyanamid in amounts varying from 500 to 2,000 pounds per acre applied in the fall and in the spring slightly delayed the appearance of the disease but had no definite controlling effect. In addition, the minor elements, boron, manganese, zinc, copper and sulphur and the soil disinfectant Qua-sul also gave negative results.

B. 91.04. CONTROL OF CUCUMBER SCAB

J. L. Howatt, Fredericton, N.B.

Spraying with Bordeaux or Burgundy mixture for the control of cucumber scab has proved to be costly and often ineffective. In order to alleviate this situation a co-operative experiment was initiated with the Fredericton experimental station with a view to developing, by selection and hybridization, strains of cucumbers resistant to the scab disease. In a test involving 16 varieties and strains of cucumbers, two apparently immune strains were found. The most susceptible variety showed 60·0 per cent of scab.

B. 91.06. CELERY BLACKHEART

J. K. Richardson, St. Catharines, Ont.

The interrelationship, as well as the individual effect of the three factors connected with the problem, namely physiological blackheart, bacterial soft rot and tarnished plant bugs (*Lygus pratensis* L.) have been determined. The physiological disease which affects the young heart tissues of the plant is the most important single factor, but under certain environmental conditions the pathogen *Erwinia carotovora* (Jones) Holland, is capable of infecting blackheart tissues and causing a decay of the heart. Tarnished plant bugs in addition to acting as vectors of bacterial soft rot, produce injuries which may under certain conditions be confused with the physiological disease. This damage, however, is confined primarily to the fleshy stalks, petioles and larger leaf veins and not the young heart tissues, as is the case in blackheart.

A variation in the susceptibility of different varieties to the physiological disease has been observed. Of the varieties commonly grown, Paris Golden is susceptible, while Golden Plume and Golden Phenomenal exhibit marked resistance. Since the early crops are the most severely affected, growers may curtail their losses by delaying planting.

B. 91.11. STUDIES IN CELERY STORAGE

H. N. Racicot, Ottawa, Ont.

In co-operation with the other members of the Quebec Refrigeration Committee and with the Division of Horticulture, the cause of decay of celery in cold storage was studied in 1934-35 and 1935-36.

Bacterial organisms causing soft rot, most of which belong to the *Bacillus carotovorus* group, were prevalent both on the 1934 celery and on that of 1935. Fungi, although not as prevalent as bacteria, were abundant, and those found associated with the decay of celery in 1934-35 and 1935-36, arranged in the order of the frequency with which they occurred, are as follows: *Botrytis*

cinera, Septoria Apii-graveolentis, Sclerotinia sclerotiorum, Hymenula affinis, Rhizopus sp., *Alternaria* sp., *Penicillium* sp., *Fusarium* sp., *Verticillium* sp., and others that appeared infrequently. A species of *Typhula*, a Basidiomycete that produces sclerotia, was frequently found associated with decayed celery, but it is believed that its association was purely saprophytic.

B. 91.—SPINACH WILT

T. B. Lott, Summerland, B.C.

In the Grand Forks district climatic conditions are exceptionally favourable for the growing of spinach for seed. Growers, however, have been seriously handicapped through the occurrence of a wilt that kills the plants at about the time the seed is setting. Isolation and inoculation experiments have shown that the wilt is caused by a species of *Fusarium*. Through the establishment of a series of test plots it has been shown that the causal organism is widely spread throughout the soils of this district and appears to be present in virgin soils.

B. 91.—TWIN SPOT OF PEAS

J. K. Richardson, St. Catharines, Ont.

An abnormal condition in pea seed of the Chancellor variety was observed at the Kapuskasing experimental station in the spring of 1934. The affected seeds have two circular brown spots approximately 1/32 of an inch in diameter, one on either side of the point of junction of the plumule and radicle with the cotyledons, but in all other respects they appear normal.

In experiments both in the field and under glass with first and second generation spotted and normal seed, there has been no significant difference in percentage germination and no spotted seeds have yet been produced. Similar tests in soil which produced spotted seed in Kapuskasing also produced negative results.

B. 91.—ONION ROOT-ROT

J. K. Richardson, St. Catharines, Ont.

During the early summer of 1936, many onion growers in Kent county reported that their crops came up unevenly, and many plants appeared unthrifty. Upon examination, a large percentage of seedlings were found to be suffering from a root trouble, for in addition to the presence of many withered roots, microscopic examination revealed the presence of numerous fungi within their tissues.

A field experiment on the farm of one of the growers showed that the condition was improved by treating the soil with a six per cent formaldehyde dust, thoroughly incorporated with the soil at the rate of 1·5 ounces to the square foot, several days before sowing the seed. Some benefit was also derived from the application of formalin solution 1-40, or 4½ per cent formaldehyde dust applied by means of an attachment to the seeder at the time of planting.

B. 91.—PHYSIOLOGICAL BREAKDOWN OF ONIONS

J. K. Richardson, St. Catharines, Ont.

A physiological breakdown of onions resembling frost injury was observed early in 1937. Affected specimens may appear quite normal or slightly discoloured externally, but upon cutting show a watersoaking of one or more of the inner scales. Affected scales may be close to the surface or not, and when more

than one is affected they may be either adjoining or separated by apparently normal ones. The condition was observed in stock kept in both natural and artificial storage and was most common in the larger specimens.

Onions grown under various conditions in 1937 on land which had produced the disease in 1936 are being kept in storage at various temperatures to determine any differences in breakdown which may develop.

B. 91. CORN ROOT-ROT

J. K. Richardson, St. Catharines, Ont.

In 1936 many fields of sweet corn in Essex and Kent counties were reported to be showing an uneven growth and unthrifty appearance. An examination of affected plants revealed considerable rotting of the roots, and a varied fungus flora within their tissues. Many species of organisms were isolated from diseased roots, and of these, members of the genera *Pythium*, *Helminthosporium* and *Fusarium* have been proved to be parasitic to varying degrees on corn, wheat, oats, rye, timothy, soybean, red clover, alfalfa, rape, buckwheat, sugar beet and tomato.

MISCELLANEA

Project Group No. 100.00

B. 100.01. SURVEY OF THE PLANT DISEASES IN CANADA

I. L. Conners, Ottawa, Ont.

Conners, I. L. Annual Report of the Canadian Plant Disease Survey 14 (1934): i-vii, 1-116. 1935. (mimeographed.)
Conners, I. L. Annual Report of the Canadian Plant Disease Survey 15 (1935): i-ix, 1-76. 1936. (mimeographed.)
Conners, I. L. Annual Report of the Canadian Plant Disease Survey 16 (1936): i-xi, 1-88. 1937. (mimeographed.)

Cereal rusts

The most destructive epidemic of stem rust (*Puccinia graminis* Pers.) ever experienced in Western Canada occurred in 1935. It was apparently no more severe than the epidemic of 1916, but the total damage was greater because of the larger acreage under cultivation. Rust severely affected wheat throughout Manitoba and over eastern Saskatchewan. It caused some damage over large sections of Saskatchewan. No damage occurred in Alberta, where a sprinkling of rust developed after most of the crop had been harvested. In Manitoba, east of the Red river, the crop was destroyed by the combined action of rust and drought. In the severely affected area in southern Manitoba and southeastern and eastern Saskatchewan there were prospects for a fine crop, but at some points less than five per cent of the bread wheat was threshed. Exclusive of heat damage, rust was estimated to have reduced the yield 20,000,000 bushels in Manitoba and 82,000,000 bushels in Saskatchewan, a loss for the two provinces of $85,000,000. Detailed figures are not available but stem rust was destructive to winter wheat in southern Ontario and on spring wheat in the Maritime Provinces.

Stem rust was relatively of little importance in 1934 or 1936 in the Prairie Provinces. In both years dry hot weather effectively checked rust development. However in 1936, the early development of rust was sufficient that a destructive epidemic would have developed given weather favourable for the continued spread of the rust. It also caused some damage to late fields of wheat in Prince Edward Island.

Cereal smuts

While bunt or stinking smut (*Tilletia caries* (D.C.) Tul and *T. laevis* Kühn) was several times more prevalent in durum wheat than in bread wheat for a period of years, since 1934 the percentage of cars of these two classes of wheat grading smutty has been essentially the same, or 0·8 per cent of the cars. A black loose smut (*Ustilago medians* Biedenkopf) was discovered by Dr. W. F. Hanna among diseased barley heads collected at Brandon, Man. in 1934. Since spores of this smut adhering to the seed cause infection in the young seedling, it, unlike the more common loose smut of barley, can be controlled by the use of chemical treatments.

Cereal root-rots

Common root-rot (*Helminthosporium sativum* P.K. and B. and *Fusarium* spp.) is probably the most important disease affecting the roots or the basal portions of wheat and other cereals. In 1934 the disease was present in 37 per cent of the wheat fields examined in Alberta, 93 per cent in Saskatchewan and 92 per cent in Manitoba.

In Saskatchewan common root-rot was found to become progressively more prevalent and destructive as the season advanced; the average damage was slight on June 1, moderate on July 4 and moderate to severe from August 1 onwards. It was also more severe in the drier areas of the province than elsewhere. In 1935 the percentage of fields found diseased was: Alberta, 24 per cent; Saskatchewan, 97 per cent; and Manitoba, 96 per cent. In contrast with the previous year the disease became only slightly more severe as the season advanced as a result of a cool, rainy spring with a resultant low soil temperature for much of the season. In 1936 common root-rot was present in 93 per cent of the fields examined in Saskatchewan and it caused moderate damage. No survey was made in the other provinces.

Take-all (*Ophiobolus graminis* Sacc.) is a disease of little importance. In 1934 it caused slight damage in 49 per cent of the fields examined in Alberta, a trace to slight damage in the Anaheim and St. Gregor districts, but no take-all was found in Manitoba. In 1935 it affected 12 per cent of the fields examined in Alberta, 2 per cent in Saskatchewan, and a single field in Manitoba. In 1936 take-all caused a trace of damage in five fields out of 277 examined in the Saskatchewan survey.

Browning root-rot (*Pythium* spp.) was widespread in Saskatchewan in 1935, when it was reported in 104 out of 196 fields examined. Several fields were severely damaged. It was also reported from two fields in Alberta. In 1934 the disease was also fairly prevalent, being reported from the three Prairie Provinces. In Saskatchewan it was confined to the northerly sections of the province, while the previous year it had been severe in central Saskatchewan. The disease was of little importance in 1936.

The new root-rot found by Sanford in 1933 was found to be due to *Colletotrichum graminicola* (Ces.) Wilson. As the cause of anthracnose on the above ground parts of the plant, this fungus has been reported from Alberta, Saskatchewan, and Prince Edward Island. Anthracnose was also found on wheat for the first time in Canada when it was collected in Alberta in 1934.

Oat nematode

The discovery of the nematode, *Heterodera schachtii* Schmidt, causing severe injury to oats in Ontario is a matter of considerable concern to Canadian agriculture. For several years a serious seedling disease of oats has been present in Simcoe county. In 1933 Dr. D. F. Putman found that the diseased plants were badly infected by root-rotting fungi, but in addition, a large number of nematode cysts were found adhering to the roots. The nematode was

identified as *Heterodera schachtii*. Oats was more severely affected than any of the other cereals. While the nematode has not been previously recorded in Canada or the United States, it has frequently been reported as a serious parasite in Europe. Since its discovery in 1934, the original infestation in Simcoe and Ontario counties has increased in intensity. In addition, another badly infested centre has been located in Waterloo county.

New diseases

Several diseases new to Canada have been found in the three-year period. The following may be mentioned:

In 1934: Mosaic (virus) on mangels being grown for seed on Lulu island, near Vancouver, B.C., and on Swiss chard at Saskatoon, Sask.; a mosaic (virus) on sweet cherries in the Nelson district, B.C.; two diseases of the cultivated mushroom, the truffle disease (*Pseudobalsamea microspora* Diehl and Lambert) at Winnipeg, Man., and white plaster mould (*Oospora fimicola* (Cast and Matr.) Cub. and Megl.) in Welland county, Ont,; smut (*Urocystis Colchici* (Schlechtd.) Rabh.) on the autumn crocus at Ottawa, Ont.; leaf spot (*Phyllosticta Lychnidis* Bondarzew) on Maltese cross at Lennoxville, Que.

In 1935: Beet rust (*Uromyces Betae* (Pers.) Lév.) on sugar beets, mangels and garden beets on Vancouver Island and Agassiz, B.C., garden beets being the most affected; downy mildew (*Peronospora manshurica* (Naoum.) Syd.) on soybeans at Harrow, Ont.; rust (*Uromyces Geranii* (D.C.) Fr.) on cultivated geranium at Ottawa; downy mildew (*Peronospora Cheiranthii* Gäum) on wallflower at Victoria, B.C.; grey bulb rot (*Sclerotium Tuliparum* Kleb.) a destructive but rare disease of tulips, was found once again in the Ottawa area, when it was observed at Rockcliffe, Ont.

In 1936: A newly described leaf spot (*Cladosporium pisicola* Snyder) of pea at Salmon Arm, B.C.; a leaf spot (*Ramularia Rhei* Allescher) on rhubarb at High River, Alta.; rust (*Coleosporium Campanulae* (Pers.) Lév.) on Campanula *persicifolia* at Vancouver, B.C.; leaf spot (*Marssonina Daphnes* (Desm. and Rob.) P. Magn. reported as *Gloeosporium mezereum* Cooke) on *Daphne mezereum* at Vancouver and Victoria, B.C.; wilt (*Dothiorella Ulmi* Verrall and May) on single trees at two places near Kentville, N.S.

Other Investigations

In 1936 and 1937 special cereal disease surveys were carried out in New Brunswick, Nova Scotia and Prince Edward Island.

In 1936 it was evident that stem rust (*Puccinia graminis*) was not as destructive as in 1935 and damage was confined to late fields in Prince Edward Island. Barley leaf rust (*Puccinia anomala* Rostr.) was prevalent at Fredericton, but was of no importance elsewhere. Net blotch (*Helminthosporium teres* Sacc.) of barley was usually abundant, while stripe (*H. gramineum* Rabh.) was practically absent.

A heavy infection of crown rust was found near Fredericton and subsequently it has been shown that buckthorns in the vicinity are responsible for the outbreak. Leaf blotch (*Helminthosporium Avenae* Eidam) was prevalent at Fredericton, N.B., Nappan, N.S., and Charlottetown, P.E.I. Smut was abundant in oats and to a less extent in barley.

In 1937 besides the varietal plots at the experimental stations, 329 farmers' fields were examined in the three provinces. Stem rust on oats was severe here and there throughout the provinces and destroyed 50 per cent or more of the crop in individual fields. These outbreaks, however, were definitely associated with plantings of barberries. The rust was absent or at most, slightly infected oats outside these areas. Heavy outbreaks of crown rust (*Puccinia coronata* Cda.)

were likewise associated with plantings of the alternate host, the buckthorn. Later in the season crown rust became prevalent everywhere and caused some damage to late fields.

The oat smuts (*Ustilago Kolleri* Wille and *U. Avenae* (Pers.) Jens.) were found in 107 out of 166 fields examined. Although smut was less prevalent than last year, 27 fields showed five per cent or more of smutty heads, the highest being 35 per cent. The fact that over a third of the fields showed one per cent or more of smut indicates that at least an equal number of farmers fail to treat their seed for smut or the treatment is very inadequately done. Another important disease of oats, leaf blotch (*Helminthosporium Avenae*), was recorded in 129 fields out of 159 examined. As a seedling blight the disease is important in cool seasons, but it can be controlled, as well as smut, by treating the seed with an organic mercury dust. Blast (non-parasitic) was also prevalent this year in contrast to last year.

Among the diseases of wheat, stem rust was the most important. Stem rust infection ranged from 40 to 90 per cent in the last two weeks in August in Prince Edward Island, while 10 to 40 per cent of rust was not uncommon in New Brunswick and Nova Scotia, especially near the Northumberland strait. Net blotch *(Helminthosporium teres)* of barley was present in 36 fields out of 55 examined and moderate to severe in 13. Seed treatment with organic mercury dusts would be beneficial. Head blight (*H. sativum* and *Fusarium* spp.) was observed causing some damage.

B. 100.02. DETERMINATION OF DISEASES OF INTERCEPTED PLANT IMPORTATIONS

A. J. Hicks, Ottawa, Ont.

During the years 1935-1937 inclusive, 2,705 shipments containing 5,667 varieties were intercepted because of the presence of disease. Of this number, 585 shipments containing 1,173 varieties were allowed entry only after sorting out and removal of diseased material. A total of 67 shipments containing 118 varieties were refused entry and destroyed. Most of the interceptions occurred in shipments of tulips, narcissi, gladioli, bulbous iris, crocuses, hyacinths and tuberous begonias. The most common disease of Dutch-grown gladioli was dry rot, whereas scab predominated in shipments of gladioli from the United States. Eelworm or ring disease was commonly found in shipments of narcissi from the Channel Islands, but was not frequently encountered in Dutch material. The main cause of interception of the latter was basal rot. As usual, Botrytis spot of tulips was much in evidence. Fusarium decay of crocuses and a Penicillium rot and eelworm of bulbous iris were frequently found in incoming shipments, the fungous decays being very destructive.

B. 100.15. FERMENTATION STUDIES

H. E. Edwards and W. Newton, Saanichton, B.C.

Experimental samples of wines were prepared from the Olympia berry, a new cane fruit. In spite of the low acidity of the fruit, the character of the samples was not superior to other wines of the loganberry class. The fruit closely approached the Young berry in composition.

Examination of the 1937 strawberry jam packs revealed abnormally low sugar-inversion values. This condition was probably the result of a low fruit acidity induced by heavy rains during the packing season.

Analyses of 150 soil samples revealed a general phosphate and calcium deficiency in both field and glasshouse soils. Excess quantities of potash and nitrates was characteristic of many glasshouse soils, especially those operated by Chinese. A magnesium deficiency was discovered in both the field and glasshouse soils of the Gordon Head district. Evidence was obtained that the lime requirements of a soil can be satisfactorily estimated only by coupling a calcium with a pH determination.

B. 100.17. SOIL TREATMENTS

D. J. MacLeod, Fredericton, N.B.

Further trials on the use of mercuric chloride as a soil treatment for disease control were conducted in New Brunswick, Nova Scotia, Prince Edward Island, and Quebec. The trials dealt with the club root disease of crucifers and the common scab, and rhizoctonia diseases of potatoes. The mercury salt was used in amounts varying from five to ten pounds an acre. All applications were made directly in the drill with diatomaceous earth as a dilutent.

The results on the whole indicated that soil treatment with mercuric chloride was of little value in the control of common scab or club root of turnips where susceptible crops had been grown for more than one year on the same soil. The results with rhizoctonia were inconclusive. The mercury treatment proved most effective against the club root disease of cabbage and cauliflower. While complete suppression of clubbing was not effected on the roots of these plants, yet sufficient protection was afforded to allow of satisfactory yields from an otherwise unproductive area.

B. 100.18. DISEASE OF ZOSTERA MARINA

Irene Mounce, Ottawa, Ont.

In March, 1935, a report on the disease of eelgrass (*Zostera marina* L.) was submitted to the Biological Board of Canada. It contained (*a*) summaries of reports on the condition of eelgrass in European and North American waters, and (*b*) a report on work carried out at the Biological Station, St. Andrews, N.B. during the summer of 1934, particularly on *Ophiobolus halimus* Diehl and Mounce. Since that time although there has been no active participation in the study of this problem the laboratory has kept in touch with the situation through Dr. A. H. Leim, Dr. W. A. Clemens, Dr. Harrison Lewis and other workers.

The most significant and disturbing development is the finding for the first time of *Labyrinthula* in the broad-leaved western *Zostera*. In September, 1936, Dr. H. T. Güssow inspected the eelgrass in the vicinity of Departure Bay Biological Station, Nanaimo, B.C., and collected specimens which were preserved and sent to Ottawa. Parts of the collection were forwarded to Mr. E. Lorraine Young III, who is particularly interested in *Labyrinthula* and who found that organism present in this collection and in a further collection obtained from the same station through the courtesy of Dr. W. A. Clemens, its director. So far no obvious diminution of the eelgrass beds has been observed by Dr. Clemens and what may happen remains, at present, a matter of conjecture.

B. 100.20. TOBACCO DISEASE INVESTIGATIONS*

Mosaic studies

G. H. Berkeley, St. Catharines, Ont.

Berkeley, G. H. Prevention of tobacco mosaic in Ontario. Dom. Dept. Agric. Circ. 110. 1937.

During the past three years field experiments with mosaic have been continued at Delhi and St. Catharines in Ontario, and L'Assomption and Farnham in Quebec. Surveys have indicated that (*a*) mosaic is by no means as general in Quebec as it is in Ontario; (*b*) in Ontario considerable mosaic carries over in the soil and infects tobacco in successive plantings, while in Quebec this means of infection does not appear to be so important and (*c*) though in Ontario one of the main agencies of spread is cultivation, this does not appear to be the case in Quebec. The main control measures recommended are (1) the seedbed soil should be sterilized; (2) only healthy seed free from chaff should be used; (3) if old boards or canvas are to be used again they should be disinfected; (4) the hands should be thoroughly washed before working with tobacco; (5) no smoking or chewing of tobacco should be permitted while working with tobacco; (6) hands should be washed after handling mosaic plants; (7) rotate tobacco with some other crop; (8) rogue mosaic plants before each cultivation, especially during the early part of the season; (9) do not cultivate or work amongst tobacco while the plants are wet; (10) it is not advisable to re-set tobacco plants in soil from which mosaic plants have been rogued; (11) in topping, suckering, etc., treat all healthy plants first, leaving mosaic plants till later; (12) the implements used in a badly-infected field should not be used in a healthy field unless they have been washed free from virus, or disinfected.

In addition, laboratory tests have demonstrated that the mosaic virus remains viable in dry leaf powder for at least eight to ten months when kept in wet or dry sand or clay under greenhouse conditions, but that in the same material under out-of-door conditions the mosaic virus remains viable for only five to eight months. On the other hand, the filtrate from a mosaic solution when added to wet or dry sand or clay remained infective indoors for only two to five months, while out-of-doors it was not recovered after the second month. Tests of soil and roots from 100 per cent mosaic plots have demonstrated that in Ontario the virus can be recovered after ten months, while in Quebec it was not recovered after three or four months. This evidence suggests at least one reason why rotation is apparently not so important in Quebec as it is in Ontario.

Black root-rot (Thielaviopsis basicola (Berk.) Ferr.

L. W. Koch, St. Catharines, Ont.

Koch, L. W. Recent investigations on tobacco root-rot in Canada. Can. Jour. Res. 13 (Sec. C): 173-186. 1935.

Hildebrand, A. A. and L. W. Koch, A microscopical study of infection of the roots of strawberry and tobacco seedlings by micro-organisms of the soil. Can. Jour. Res. 14 (Sec. C): 11-26. 1936.

Intensive microscopic examination of lesions on approximately 1,600 roots affected with typical black root-rot revealed the presence of many different organisms which were found to occur singly, and in various combinations with one another and, more especially, in frequent association with *T. basicola*. In addition to *T. basicola* the organisms observed included the following: the so-called phycomycetous type of "mycorrhizal" fungus, representatives of the genus *Rhizoctonia*, including *R. Solani* as well as several endophytic forms of the type familiar in orchids, different members of the genus *Pythium*, and nema-

* In co-operation with the Tobacco Division, and Dominion Experimental Farms at Delhi and Harrow in Ontario, and L'Assomption and Farnham in Quebec.

todes. Microscopic evidence of parasitism on the part of each of the above-mentioned organisms was revealed by necrosis involving single cells, groups of cells or entire rootlets. Isolations consistently yielded *T. basicola* as well as representatives of 21 genera of fungi, also bacteria and nematodes. Preliminary infection experiments have demonstrated that one *Rhizoctonia* of the *Solani* type and three endophytes from the same genus, four forms of *Pythium* as well as *T. basicola* possess parasitic capability in the roots of tobacco whereas two other forms of *Pythium*, three of *Rhizoctonia* and seven distinct members of the Fungi Imperfecti showed no capability of parasitism of the same host under identical conditions.

Field experiments have demonstrated the value of rotating tobacco with other crops to reduce damage from black root-rot. Some benefit has been noted by a single intervening crop of oats but considerably greater benefit has been been experienced by rotation with corn and oats.

Brown root-rot

L. W. Koch, St. Catharines, Ont.

On intensive microscopic study of brown root-rot of tobacco in different developmental stages has revealed a rhythmical and consistent sequence of events, During the first 24 to 48 hours single affected cells became discoloured and their contents, granular. At this stage neither fungi nor nematodes were present. Within the next few days, however, bacteria almost invariably appeared in large numbers in affected and adjacent tissues and were then followed by fungi, mostly Fungi Imperfecti and Phycomycetes. Water infusions of timothy and corn induced a brown root-rot of tobacco after short periods of root immersion. The presence of a toxin or toxins has been indicated in "brown root-rot" soils.

Koch, L. W. and R. J. Haslam. Varietal susceptibility of tobacco to brown root-rot in Canada. Sci. Agric. 18: 561-567. 1938.

Two years' experiments have indicated extreme susceptibility to brown root-rot in the flue-cured varieties Yellow Mammoth, White Stem Willow Leaf, etc., and considerable resistance in the varieties White Mammoth, Bonanza, White Stem Orinoco and Duquesne. Of the burley varieties, Harrow Velvet, Gays Yellow and Halley's Special proved highly susceptible while Judy's Pride, Kelley and others offered distinct resistance. In Canada, certain burley varieties which are most susceptible to black root-rot appear to be most resistant to brown root-rot, and *vice versa*.

Blackleg of seedlings (Bacillus aroideae Towns.)

L. W. Koch, St. Catharines, Ont.

Blackleg of tobacco was found for the first time in Canada during the summer of 1936 on seedlings of the Kelley variety in Kent county. Isolates from these and from other affected seedlings found during 1936 and 1937, and subsequent infection experiments demonstrated pathogenicity of two strains of bacteria, one strain consistently manifesting greater virulence than the other. Inoculations proved most successful when host plants were injured before inoculation. Both stems and leaves of seedlings were susceptible to infection by inoculation. A study of the pathological histology of affected host tissues revealed the presence of abundant bacteria in the mesophyll tissues of leaves and in the cortical tissues of stems. On certain occasions bacteria were also found within the tracheae of affected leaves and stems.

Some evidence was obtained of this disease attacking plants in the field and causing a black wet rot at the base of the stalks.

Tobacco leaf spot investigations

P. G. Newell, St. Catharines, Ont.

The work under this project during the past two seasons has consisted mainly in isolations of bacteria or fungi from suspected parasitic leaf spot material, and testing for the pathogenicity of the isolate thus obtained.

This work has shown that in addition to angular leaf spot and wildfire, there are other leaf spots, some of which appear to be physiological in origin, in that no organisms have as yet been associated with them.

B. 100.22. A STUDY OF THE NATURE AND CONTROL OF SEED-BORNE DISEASES

G. A. Scott, Ottawa, Ont.

Investigations were started on this project at the Central Laboratory, Ottawa, in the spring of 1936, paying particular attention to wheat. At the outset the need of a suitable surface sterilizing agent for seed was evident. By the use of ordinary commercial chloride of lime a safe and efficient method of surface sterilizing seed was devised. This method entailed the soaking of the seed in a standard solution, containing two per cent available chlorine for a period of time before planting. A quick and easy method of standardizing such a solution has been worked out.

Some 800 samples of grain were tested under laboratory and greenhouse conditions for the presence of parasitic seed-borne fungi and bacteria. In general the results clearly indicate that the majority of the best registered and commercial grains are carrying parasitic fungi to rather an alarming extent. There seems to be no correlation between fungus infection and germination. Of special interest and significance are the results obtained after testing 70 samples of Thatcher wheat, grown in the United States and imported into Canada for seeding purposes. Forty of these samples showed a fungus infection of more than 50 per cent and seven were 100 per cent infected. The results of all tests were summarized and detailed written reports issued on all samples.

Several seed disinfectants and seed-treating devices were tested. The organic mercury dusts were found to be satisfactory, especially New Improved Ceresan. Not only was this dust efficient in controlling certain seed-borne parasites but, by its use, a substantial increase in germination was evident on heavily infected grain.

Investigations were undertaken to test the efficiency of the automatic Kemp Seed Treater compared with the ordinary methods of dusting. The former method was not as efficient as the latter. Field observations were made and records taken of crops which were grown from seed treated with the Kemp treater in comparison with untreated seed. Beneficial results from treating the grain were noted in all cases.

An extension and educational program has been carried out during the last two years. Demonstration material was prepared on seed-borne diseases and exhibits of this material were featured at the Ottawa Valley Seed Fair, the Canadian National Exhibition, the Toronto Royal Winter Fair and at conferences of the Ontario Agricultural Representatives. The prevalence, importance, and control of seed-borne parasites were stressed in lectures delivered at meetings of farmers, registered and commercial seed growers, agricultural representatives and students attending Agricultural Schools.

B. 100.23. PHYSIOLOGICAL SPECIALIZATION IN SOME NON-CEREAL RUSTS

A. M. Brown, Winnipeg, Man.

Field observations made at Winnipeg for a number of years indicated that the strain of *Uromyces Fabae* (Pers.) de Bary affecting *Lathyrus* spp. is distinct from that affecting *Vicia americana* Muhl. Inoculation experiments in 1933 and 1936, with these two strains on the following hosts, *Vicia americana, V. Cracca* L., *V. Faba* L., *V. sativum* L., *Pisum sativum* L., *Phaseolus multifloris* Willd., *P. vulgaris* L., *Lathyrus ochroleucus* Hook., and *L. venosus* Muhl., showed that the former strain infected readily *V. Faba, P. sativum, L. ochroleucus,* and *L. venosus,* but did not affect *V. americana, V. Cracca, V. sativum, P. multiflorus,* and *P. vulgaris,* whereas the latter strain infected only *V. americana.* In 1936, one variety (name unknown) of *V. Faba* was found immune to the former as well as to the latter strain. The urediospores of the former strain, in comparison with those of the latter, are larger, more elipsoid, and more definitely verrucose. It is suggested that the former strains be designated as *Uromyces Fabae* var. *Lathyri* and the latter as *U. Fabae* var. *Viciae-americanae.*

A third strain of *U. Fabae* collected by Mr. I. L. Conners on *P. sativum* in Nova Scotia, infected this host, but only caused flecks on *L. ochroleucus* and *L. venosus,* and no external evidence of infection on the other of the above-mentioned hosts. None of these strains infect *V. Cracca.* The presence of telia on leaves of this host collected by I. L. Conners at Ottawa, indicates that a fourth strain of this rust is present in Canada.

B. 100. SNOW MOULD OF TURF

Broadfoot, W. C. Experiments on the chemical control of snow mould of turf in Alberta. Sci. Agric. 16: 615-618. 1936.

Broadfoot, W. C. Snow-mould of turf in Alberta. Jour. Board of Greenkeeping Res. 5: 182-183. 1938.

A *Fusarium* sp., a *Rhizoctonia* sp., and an unidentified basidiomycetous fungus with characteristic clamp connections, were isolated from turf infested with snow-mould, and were found pathogenic to *Festuca rubra* var. *fallax* at 6° C. The former two organisms grew best at 20° to 25° C., whereas the latter developed best between 6° and 15° C., and ceased growth at 20° C. As much as eight ounces per 1,000 square feet of either corrosive sublimate or calomel, or various proportions of these, did not cause noticeable injury, when the turf was lightly watered following application. Because of the possible incidence of snow mould in the fall, as well as in the spring, a suitable formula for Alberta should consist of equal parts of corrosive sublimate and calomel, applied in the fall at the rate of four ounces per 1,000 square feet of turf.