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DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS



REPORT

FROM THE

DIVISION OF ENTOMOLOGY

FOR THE

Year Ending March 31, 1914

PREPARED BY

The Dominion Entomologist. C. Gordon Hewitt, D.Sc.

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REPORT OF THE DIVISION OF ENTOMOLOGY.

BY C. GORDON HEWITT, D.Sc., DOMINION ENTOMOLOGIST.

OTTAWA, March 31, 1914.

J. H. GRISDALE, Esq., B.Agr.,
 Director, Dominion Experimental Farms,
 Department of Agriculture, Ottawa.

SIR,—I have the honour to submit herewith my fifth annual report of the work of the Division of Entomology covering the work beginning April 1, 1913, and ending March 31, 1914. In addition to a brief account of the progress and results of the investigations which have engaged the attention of the staff of the Division, both at headquarters and in the field, reference is also made, for the purposes of record and for the use of other workers, to the depredations of those insects which were unusually abundant and injurious during the year 1913.

The greater part of the investigation work is now carried out at the various field or regional laboratories located in different regions of Canada. Naturally, they are situated in the districts where the insects under investigation occur most abundantly. During the year, laboratories were established in three new regions, namely: Strathroy, Ont.; Treesbank, Man.; and Lethbridge, Alta. The following is a list of the field laboratories now established, together with the investigations which are being carried out at each station:—

BRIDGETOWN, N.S.—Mr. G. E. Sanders in charge. Investigations on the bionomics of the Brown-tail Moth and its control; introduction of parasites of the Brown-tail and Gipsy Moths; the Bud Moths and Green Fruit Worms of the apple.

FREDERICTON, N.B.—Mr. J. D. Tothill in charge. Control work and investigations on the Brown-tail Moth and the introduction and establishment of its parasites and predaceous beetles; investigation of the natural control by parasitic and predaceous insects of the Tent Caterpillar, the Fall Web-worm and Spruce Budworm.

COVEY HILL, QUE.—Mr. C. E. Petch in charge. Apple insects, especially the Apple Curculio (*Anthonomus quadrigibbus*); Grasshopper control by bacterial disease (*Coccobacillus acridiorum* d'Herelle).

JORDAN HARBOUR, ONT.—W. A. Ross in charge. Apple Maggot (*Rhagoletis pomonella*); Apple and other aphids; control of greenhouse pests; control of mill-infesting insects.

STRATHROY, ONT.—Mr. H. E. Hudson in charge. Investigation of White Grubs (*Lachnosterna* spp.); Wireworms and insects affecting field crops.

TREESBANK, MAN.—Mr. N. Criddle in charge. Investigation of White Grubs (*Lachnosterna* spp.); and chief insects affecting cereals; Hessian Fly, Wheat Stem Maggots (*Oscinis* spp.), Wheat Stem Sawfly (*Cephus occidentalis*) and Grasshoppers.

LETHBRIDGE, ALTA.—Mr. E. H. Strickland in charge. Cutworms affecting cereals and field crops; injury to winter wheat involving a study of Eelworms.

AGASSIZ, B.C.—Mr. R. C. Treherne in charge. Completion of investigation of Strawberry Root Weevil (*Otiorhynchus ovatus*); investigations on Lesser Apple Worm; Budmoths and other insects affecting apple; Wheat Midge (*Diplosis tritici?*) and Root Maggots.

Mr. L. S. McLaine, through the cordial co-operation of Dr. L. O. Howard, Chief of the Bureau of Entomology of the United States Department of Agriculture, and of Mr. A. F. Burgess, in charge of the Gipsy and Brown-tail Moth work, was located at the Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass., during the summer, for the purpose of collecting caterpillars and breeding out the parasites which were shipped to Fredericton, N.B., as will be described later.

Apart from the importance of the numerous lines of inquiry which are being followed at the various field stations, the value of this progressive policy has been experienced and appreciated in other directions. The officers in charge are able personally to visit and advise local agriculturists, to attend and address meetings and, not infrequently when an outbreak of an insect is reported to us, we are able to have the matter immediately investigated to the greater satisfaction of all concerned. A personal visit from an officer of the department gives far more satisfaction than the receipt of a letter of advice. In many cases the officer can give advice when the same could not be sent from this office owing to lack of definite information. A visit from a medical man is more valuable than a diagnosis and prescription obtained by the use of the mails.

As in previous reports, the work of the Division will be considered under the following sections:—

I. The administration of the Destructive Insect and Pest Act, including:—

- (a) Inspection and fumigation of imported nursery stock, etc.
- (b) Field work against the Brown-tail Moth and parasite work.

- II. Insects affecting cereals and field crops.
- III. Insects affecting fruit crops.
- IV. Insects affecting forest and shade trees.
- V. Insects affecting domestic animals and man.
- VI. Insects affecting garden and greenhouse.
- VII. Apiculture.
- VIII. Miscellaneous.

I. THE ADMINISTRATION OF THE DESTRUCTIVE INSECT AND PEST ACT.

AMENDMENTS TO REGULATIONS.

The following amendments to the regulations under the Act have been made by Order in Council during the past year:—

October 8, 1913.—North Portal, Sask. was declared a port of entry for imported nursery stock, the importation season being March 15 to May 15 and October 7 to December 7.

December 4, 1913.—The following new regulation prohibiting the importation of nursery stock through the mails was passed, to take effect on and after March 1, 1914. This was necessitated by the impracticability of intercepting mail shipments for the purposes of inspection and fumigation:—

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18. "The importation of all nursery stock, including trees, shrubs, plants, vines, grapes, scions, cuttings, or buds, through the mail is prohibited, excepting greenhouse-grown florists' stock, cut flowers, herbaceous perennials, and bedding plants, which will be admitted provided that a detailed statement of the contents is attached to such parcels." This regulation is to take effect on and after the 1st day of March, 1914. The words "Importations by mail shall be subject to the same regulations" in regulation 3, line 14, are struck out.

February 14, 1914.—In order to permit the entry of European nursery stock through the port of St. John, N.B., during the whole of the winter, as the regulations did not permit such entry during the period December 8 to March 14, section 6 was amended to read as follows—

6. "Nursery stock, not including such stock as is exempt under section 3 of these regulations, originating in Europe, shall be imported only through the ports and with the exception of St. John, N.B., during the periods specified under section 3 for stock requiring fumigation, with the addition of the ports of Halifax, N.S., Sherbrooke, Que., and Montreal, Que., through which ports and also the port of St. John, N.B., such European stock may enter from September 15 to May 15. Such European nursery stock, and such other imported vegetation as the minister may determine, entering Canada, shall be exempt from fumigation, but shall be inspected either at the port of entry or at its destination to which it may be allowed to proceed, but in the latter case it must not be unpacked except in the presence of an inspector."

March 7, 1914.—Owing to the repeated discovery of potatoes imported from California into British Columbia which were infested with the Potato Tuber Moth (*Phthorimaea operculella* Zett.), to which reference is made later in this report, this insect was scheduled under section 12 of the regulations, and section 13 was amended to include the state of California among those states and countries from which the importation of potatoes is prohibited.

NEW PLANT QUARANTINE OR FUMIGATION STATIONS.

The natural growth of the country results in an increase in the quantity of fruit and shade trees, ornamental and other shrubs and plants imported into Canada. To meet this increase and to facilitate the importation of such natural products, increased accommodation is being provided for the fumigation and inspection of imported nursery stock.

St. John, N.B.—At St. John, N.B., a new fumigation and inspection station has been constructed adjoining the Eastern Steamship Company's wharf. It consists of a large fumigation chamber measuring 25 feet long, 10 feet wide and 8 feet high, an inspection and packing room, a small fumigation chamber of 100 cubic feet capacity, and an office.

Niagara Falls, Ont.—In order to provide increased accommodation at Niagara Falls, Ont., through which port most of the nursery stock for Ontario enters, an additional station has recently been erected at Montrose, on the Michigan Central Railroad. This building, which measures about 45 feet square, contains two large fumigation chambers, each 20 feet long, 10 feet wide, and 8 feet high, a small fumigation chamber of 100 cubic feet capacity, and an office. In addition, provision is made to permit the inspection of plants.

North Portal, Sask.—Previous to 1913, all shipments of nursery stock destined to points in the prairie provinces entered *via* Winnipeg, which was the port of entry, and were fumigated there. The increase in the amount of nursery stock imported into the

provinces of Saskatchewan and Alberta, and the delay necessitated by the routing of shipments of stock from certain of the states exporting trees to Canada, made it desirable to establish an additional port of entry and plant quarantine station in the West. Accordingly, a new station has been erected at North Portal, Sask., on the Canadian Pacific railroad. This station consists of two fumigation houses, each measuring 20 feet long, 10 feet wide, and 8 feet high, a small fumigation chamber of 100 cubic feet capacity, and an office. The additional facilities so provided will prove a great advantage to importers of trees residing in the provinces of Saskatchewan and Alberta, by reducing the time taken in transit by shipments of nursery stock. It is hoped that it will encourage further tree planting in these western provinces.

INSPECTION AND FUMIGATION OF IMPORTED NURSERY STOCK.

The inspection of all nursery stock from Europe, Japan, and the New England States has been continued, and during the importation season of 1912-13, which closed in May, 1913, over four million trees and plants were inspected. The adjoining table shows the nature of the stock inspected and its destination, according to provinces. The figures given are taken from the reports of the inspectors.

NURSERY STOCK Inspected during the importation season 1912-13.

	Prince Edward Island.	Nova Scotia.	New Brunswick.	Quebec.	Ontario.	Manitoba.	Saskatchewan.	Alberta.	British Columbia.
Ornamentals		14,072	2,731	106,374	601,170	5,253		12	252,767
Fruit trees.....		9,6	900	373	51,975				1,081
Small fruits		3,916	12	3,660	82,099			100	5,477
Shade trees		836	616	9,613	78,408				1,093
Unclassified shrubs....	25	388		5,816	2,151	1,975	59,322	33,550	9,031
Seedlings.....		194,162		33,700	1,776,164				87,100
Conifers.....		2,720		2,835	421,222	200			552
Forest stock		2,475							
Grafting stock.....		6,600		1,225	189,100				12,000
Totals.....	25	226,145	4,259	163,596	3,202,289	7,428	59,322	33,662	369,101

The recent institution of inspection services by the respective Governments in various European countries, including Great Britain and Ireland, exporting nursery stock to Canada, and in the New England States and Japan, has resulted in our receiving a much better class of nursery stock, and a marked freedom from insect pests. The discovery of evidences of Brown-tail Moth infestation and the presence of Woolly Aphis and scale insects on imported stock necessitate a constant vigilance on the part of our inspectors. However carefully the inspection of foreign nurseries, or of exported shipments is carried on, those who have had any practical experience in the inspection of nurseries and trees will realize the importance of a careful second inspection of the plants on arrival.

The inspection of imported plants is carried on either at the port of entry, usually in the case of small shipments for distant points, or at the destination. During the past year Mr. J. Perrin was appointed an inspector to inspect shipments arriving at Halifax.

An approximate record only is kept of the amount of nursery stock fumigated. This exceeds very considerably the amount inspected, as it includes all the nursery stock imported from the United States, which constitutes our chief source of supply.

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It is most gratifying to observe the increasing quantity of nursery stock imported into the prairie provinces. The number of trees inspected has been given in the previous table. The following figures indicate the amount of nursery stock subject to fumigation that was imported into the prairie provinces alone; practically all of this stock originated in the United States:—

	Manitoba.	Saskatchewan.	Alberta.
Ornamental shrubs	60,684	29,506	14,462
Small fruits	13,618	7,840	1,657
Shade trees	98,693	116,732	14,235
Fruit trees.....	8,417	4,360	1,882
Cuttings.....	25,195	127,840	22,500
Conifers.....	8,549	3,339	5,865
	215,156	289,617	60,651

These figures not only indicate the proportion of nursery stock fumigated as compared with the quantity inspected (see previous table), but afford strong evidence of the efforts which are being made to make the prairie farms less treeless.

FIELD WORK AGAINST THE BROWN-TAIL MOTH, 1912-13.

NEW BRUNSWICK.

During the winter of 1911-12 seven counties were found to be lightly infested with the Brown-tail Moth. Owing to the unfavourable weather conditions prevailing in July, 1912, when the moths were flying in the adjoining states, which prevented any invasion of the female moths, and to the careful scouting work during the previous season, an unusually small number of winter webs was collected.

The scouting work commenced on November 22, 1912, and terminated on February 3, 1913. The field force consisted of eight men, the Dominion and Provincial Governments each employing four men. Mr. J. D. Tothill had charge of the work, assisted by Mr. A. B. Baird. The whole of the area infested in the previous year was scouted, but only eighty-one new winter webs were found and the remains of twenty-seven webs of 1911. Eighty of the new winter webs were found in Charlotte county, and a single nest occurred in Queens county.

The distribution of the Brown-tail Moth on the food plants in New Brunswick during the season 1912 was as follows:—

Apple.....	87	Elm.....	2
Amelanchier.....	6	Plum.....	1
Thorn.....	6	Oak.....	1
Choke Cherry.....	4	Maple.....	1

The fact that in Charlotte county 1,812 winter webs were collected in 1911, and only 80 were found in 1912 indicates the value of the thorough scouting work which was carried out, and that were counties in New Brunswick not subject to an annual invasion of moths from the adjoining states during the flying season any unusual increase in the infestation could be checked. In 1913, however, an immense flight of moths took place in July, and the inspection work of the present season (1913-14), of which Mr. L. S. McLaine, with the assistance of Mr. A. B. Baird, has charge, has disclosed a very heavy infestation and a great increase of the infested area. The results of the inspection work of the past winter 1913-14 now being brought to a close will be given in my next annual report.

NOVA SCOTIA.

Mr. G. E. Sanders had charge of the scouting work in this province during the winter of 1912-13. It was found that the infestation had spread in an easterly direction, single winter webs being found at Sheffield Mills, Kings county, and Falmouth, Hants county. The number of new infestations, however, was less than the previous season. There was an increase in the number of winter webs collected, 11,054 webs being found in an area which included portions of the five counties from Yarmouth to Hants.

The distribution of the winter webs according to food plants in Nova Scotia was as follows:—

Apple.....	9,755	White Birch.....	9
Pear.....	359	Beech.....	4
Thorn.....	338	Wild Cherry.....	2
Plum.....	327	Elder.....	1
Wild Pear.....	122	Poplar.....	1
Oak.....	80	Prune.....	1
Maple.....	16	Raspberry.....	1
Wild Rose.....	14	Alder.....	1
Elm.....	11	Quince.....	1
Sweet Cherry.....	11		

Mr. Sanders continued his investigations on the bionomics of the Brown-tail Moth under Nova Scotia conditions. One of the most serious problems is the dropping of the winter webs on to the ground, thus they escape collection. This "winter-drop" is being carefully studied in all its aspects. Winter webs were placed on the ground in different localities and left from December, 1912 to April, 1913. The greatest winter-kill in any of the lots of 25 webs was 7.57 per cent, practically a negligible quantity. Having demonstrated the ability of larvæ in dropped nests to survive the winter on the ground practically unharmed, experiments were carried out with a view to ascertaining whether such larvæ could find food on the ground, and whether or not they could successfully reach suitable trees. It was found that they would thrive on the ordinary herbage such as clover, timothy, dandelion, wild strawberry, etc., for forty-four days, which was a sufficient length of time to enable them to travel 300 feet or more on the ground and reach suitable trees. Altogether, 3,529 young caterpillars out of 5,365 used in the experiments, or 65.7 per cent., found the trees under conditions which unusually occur in the field.

This ability to survive in winter webs which drop to the ground before winter explains many cases of re-infection that are otherwise inexplicable. Field observations showed that the percentage of nests hanging by a single thread and ready to drop would sometimes be as high as 20 per cent. The results of our scouting work from year to year indicate that the successful control of the Brown-tail Moth is possible by our present methods of thorough scouting were it not for the re-infestations which take place by moths being carried over by the wind from the New England States, and our present inability to deal with the problem of the dropped nests to which we are giving our attention.

It is satisfactory to find from our scouting work that the infestation of the Brown-tail Moth in the orchards is least in those orchards where spraying is regularly practised. The occurrence of unsprayed orchards, thorn thickets and wild apple, etc., in various infested localities serves to supply a permanent breeding place where artificial control is difficult.

IMPORTATION OF PARASITES OF THE BROWN-TAIL AND GIPSY MOTHS.

The ultimate control of the Brown-tail Moth must necessarily be a natural one, and while we have, so far, successfully held the insect in check by thorough scouting work and the collection of the winter webs, the natural spread of the moth from the

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infected area in the New England States will render such methods less potent in dealing with the insect outside the orchard and cultivated areas. Our efforts are directed with a view to keeping the insect in check, so far as is practicable. In my last annual report the preliminary efforts to introduce the native parasites of the Brown-tail and Gipsy Moths into Canada were described. Through the continued courtesy and most welcome co-operation of Dr. L. O. Howard, Chief of the United States Bureau of Entomology, and of his assistant, Mr. A. F. Burgess, in charge of the Gipsy Moth Work, we were able to make more extensive importations of parasites during the summer of 1913. This was made possible by the very kind provision of accommodation at the Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass., for our officer, Mr. L. S. McLaine, who had charge of the work of obtaining the parasitized material.

COLLECTION OF PARASITES.

The parasites which we were desirous of obtaining were: *Apanteles lacteicolor* Vier., which infests the hibernating caterpillars of the Brown-tail Moth; and the Tachinid parasite *Compsilura concinnata* Meig., which we had successfully introduced into New Brunswick in 1912. These parasites will attack both the Gipsy and Brown-tail caterpillars, and the caterpillars of several of our native lepidoptera upon which fact the success of work in introducing and establishing them depended. We also desired to obtain further supplies of the predaceous beetle *Calosoma sycophanta*, which successfully withstood the winter of 1912-13 at Fredericton.

During the winter of 1912-13, 6,500 parasitized winter webs of the Brown-tail Moth were collected from six localities in Massachussetts, and placed in cold storage. On May 6, they were removed and the young larvæ were fed in Fiske trays. The first *Apanteles* cocoon appeared on June 1. The work of feeding and picking over the trays was an almost intolerable operation on account of the poisonous hairs and great heat. Mr. McLaine and his helpers deserve great credit for the admirable way in which this work was carried on under most trying circumstances. As the cocoons of *Apanteles* were collected they were put into an ice-box until a sufficient number had been obtained to ship to our laboratory at Fredericton, N.B. It was found that the best method of shipping the cocoons was in iced refrigerator boxes by express. The Tachinid parasite *C. concinnata* was reared from Gipsy Moth caterpillars in preference to Brown-tail Moth caterpillars to avoid the hairs of the latter. The caterpillars were collected as near the fifth stage as possible to reduce the labour of feeding. The first collection was made on June 25. In order to facilitate the collection of the caterpillars, trees were burlapped in four localities. The caterpillars were fed in Fiske trays and the first *Compsilura* puparium was noted on July 2. The following is a summary of the results:—

Caterpillars from 6,500 Brown-tail Moth winter webs reared, from which 46,548 cocoons of *Apanteles lacteicolor* were obtained and forwarded to Fredericton, N.B.; a total of 49,119 Gipsy Moth caterpillars from ten localities were fed, from them 5,738 puparia of *Compsilura concinnata* were obtained and shipped to New Brunswick. Early in June 200 adults of the predaceous beetle *Calosoma sycophanta* were collected and shipped to New Brunswick. In addition, 975 larvæ of *Calosoma* in all stages were collected in various localities and fed in the laboratory until they entered the ground for pupation; they will hibernate at Melrose Highlands and be shipped later to Fredericton, N.B.

There were also shipped to New Brunswick 475 cocoons of the parasite *Meteorus versicolor* Wesm., which is an imported parasite of the Brown-tail Moth, and also parasitizes the caterpillars of the White-marked Tussock Moth and the Fall Webworm.

COLONIZATION OF PARASITES.

The parasites and predaceous beetles were received and distributed in colonies in New Brunswick and Nova Scotia by Mr. J. D. Tothill. The following table gives the location and strength of each of the colonies distributed. All the colonies are strong ones with the exception of the single colony of *Meteorus*.

DISTRIBUTION OF IMPORTED PARASITES AND BEETLES IN 1913.

Species.	Location of Colony.	Size of Colony.
<i>Compsilura concinnata</i>	Fredericton, N. B.....	1,238 puparia.
".....	Nerepis, N. B.....	1,500 "
".....	St. Stephen, N. B.....	1,500 "
".....	Bear River, N. S.....	1,500 "
<i>Apanteles lacteicolor</i>	Whittier Ridge, N. B.....	4,499 adults.
".....	Basewood Ridge, N. B.....	7,000 cocoons.
".....	St. Stephen, N. B.....	7,000 "
".....	Nerepis, N. B.....	3,391 "
".....	Bear River, N. S.....	7,000 "
<i>Calosoma sycophanta</i>	St. Stephen, N. B.....	100 adults.
".....	Whittier Ridge, N. B.....	100 "
<i>Meteorus versicolor</i>	Whittier Ridge, N. B.....	475 cocoons.

It is gratifying to note that the larvæ of the beetle *Calosoma*, which were reared by Mr. Tothill in 1912 and allowed to go into hibernation at Fredericton, N.B., successfully withstood the winter of 1912-13, which was severe owing to the snowfall being less than usual and the occurrence of very low temperatures.

APANTELES IN NOVA SCOTIA.

Winter webs of the Brown-tail Moth collected in Nova Scotia during the season 1912-13 were kept and the larvæ emerging from them were fed in Fiske trays at the laboratory at Bridgetown, N.S., with a view to ascertaining whether any native parasitic insects were attacking the Brown-tail Moth caterpillars. Caterpillars from winter webs collected at Bear River, N.S., were found to be parasitized with a species of *Apanteles*. Specimens of the *Apanteles* were submitted to Mr. A. F. Burgess of the Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass., for determination, who reported on July 9, as follows: "The specimens of *Apanteles* have been examined by Mr. Summers and checked up with specimens which we have here and the description which was drawn up by Mr. Viereck for *Apanteles lacteicolor*. The description is somewhat vague, but the specimens tally very well with other specimens of *lacteicolor* which we have here at the laboratory, and we therefore believe it to be that species."

The pleasure of the discovery of the occurrence of this species of parasite in Nova Scotia created was only a little greater than the mystery surrounding the reason for such occurrence. It cannot have reached Nova Scotia by natural spread. Either it was introduced with winter webs of the Brown-tail Moth on plants carried from Massachusetts prior to 1910, after which dates such plants have been inspected, or *A. lacteicolor*, or a species of *Apanteles* most closely resembling *lacteicolor*, is native to Nova Scotia. In any case it augurs well for the future of the colonies of *A. lacteicolor* which we are introducing into the province.

PARASITES OF NATIVE INSECTS.

In addition to the work connected with the importation and colonization of the parasites of the Brown-tail and Gipsy Moths, Mr. J. D. Tothill continued at the

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Entomological Field Laboratory at Fredericton, N.B., the detailed study which he is making on the natural control of the Forest Tent Caterpillar (*Malacosoma disstria*) and the Fall Webworm (*Hyphantria cunea*). Observations were also made on the parasites of the Spruce Budworm (*Harmoloba fumiferana*) in New Brunswick. Such an intensive study as is being undertaken is necessary in order to ascertain the manner in which the natural control of certain of our more common insect pests is brought about and maintained, and the conditions governing the same. Until we have such information our attempts to imitate or assist the natural control of insect pests cannot be undertaken on the sound scientific basis which success demands. No one can foretell to what practical uses it may not be possible to put the results of knowledge so gained. Among the important questions involved is whether in all cases a complete sequence of parasites is required. No one species of parasite can secure the natural control of the insect. Natural control involves the destruction of a greater number of individuals of the species than are produced by unrestricted increase. This destruction is brought about by numerous causes, the chief of which are parasitic and predaceous insects. Other causes are diseases caused by micro-organisms of a bacterial and protozoal nature, fungi, or physiological troubles. Usually, the parasitic insects form a sequence, different species of parasites attacking the insects in the different stages of its development. Some attack the egg, others the young larvæ or older larvæ, and other species attack the pupating larvæ or pupæ. These facts will indicate, perhaps, the complexity of the problem and the nature of the information necessary for its solution or understanding.

Egg masses of *Malacosoma disstria* were collected in different localities in New Brunswick, Quebec, and Ontario, and four species of egg parasites were reared and studied. One of these species, known as No. 4, is evidently an important factor in the natural control of the insect. It is an obligate parasite; the highest percentage of parasitism for a locality was 9.85 per cent., but individual egg masses were parasitized sometimes to the extent of 50 per cent.

In the study of the parasitism of *Hyphantria*, many thousands of caterpillars collected from different localities were fed and dissected for larval parasites, and the percentages of parasites from different localities were obtained by dissection, and rearing. These parasites were mainly *Apanteles*, *Meteorus*, *Limnerium validum*, *L. pilosulum*, *Varichoeta aldrichi* Towns., and *Exochilum mundum* Say.

Mr. Tothill also studied the habits of the native ant *Formica ulkei* Emery, which, together with other ants, may exercise an appreciable influence in the natural control of certain species of lepidoptera upon which they prey.

II. INSECTS AFFECTING CEREALS AND FIELD CROPS.

CUTWORMS.

In view of the remarkable abundance of these caterpillars in southern Alberta, a brief account of which I included in my last report, much information has since been gathered on the life-history, habits, etc., of the species mainly responsible for the damage, viz., *Porosagrotis orthogonia* Morr. (referred to in previous publications of the Division as *Porosagrotis delorata* Sm.). In April last (1913) Mr. Arthur Gibson visited Alberta and made a thorough investigation of the infested districts. In company with Mr. E. H. Strickland, the resident Field Officer of the Division, he found the cutworms fairly numerous throughout the Lethbridge district. They were particularly present in fields of spring wheat, fall wheat, and oats. In some places, as for instance at Iron Springs, Alta., they were present in certain fields in numbers varying from three to eleven to the square foot. A series of control experiments was started early in May. Infested fields were divided into various sized plots (none smaller

than one-tenth of an acre). Upon such land moistened bran poisoned with various strengths of Paris green, London purple, and arsenate of lead, was broad-casted. Owing to the dull, cool, backward spring, however, the cutworms were not feeding ravenously and in many of the experimental plots not more than 20 per cent of the cutworms were killed. From observations made by Mr. Strickland, too, it would appear that the *Perosagrotis* cutworm feeds just below the surface of the soil. If this underground feeding habit should prove constant, we cannot, of course, expect applications of poisoned bran, shorts, etc., to prove a perfect remedy. Further experiments in control will be made whenever the cutworms again become active. The actual damage effected by the cutworms in southern Alberta during 1913 was not nearly so great as that of the preceding year. One correspondent living at Magrath estimated that he lost 50 per cent of his crop in 1912.

In Manitoba, Ontario, and Quebec, the Red-backed Cutworm (*Euxoa ochrogaster*) was reported to have been particularly abundant in fields of cabbage, etc. From New Brunswick reports were received of injury by the Greasy Cutworm (*Agrotis ypsilon*), especially in fields of potatoes, many of which were seriously injured.

THE ARMY WORM (*Leucania unipuncta*).

It is important to record the reappearance of the true Army-worm during 1913. In early August, Mr. Norman Criddle reported that the larvæ were in great abundance in a large field of oats near Treesbank, Man. An interesting observation was that the caterpillars were also readily devouring the Green Foxtail (*Setaria viridis*). Reporting later on the outbreak, Mr. Criddle estimated the greatest amount of damage would reach 50 per cent, and the average on infested fields about 20 per cent. Farmers in Manitoba should watch for the appearance of the Army-worm in 1914 and report occurrences at once to the Division. There are two annual broods of the Army-worm, the moths appearing in June and again in August and September. The moths which appear in June lay their eggs, and it is the caterpillars from this brood which appear in July and August which are the most destructive.

LOCUSTS.

In eastern Ontario, Quebec, and southern Manitoba, considerable loss was occasioned from the ravages of locusts, particularly in light, sandy areas. At Bowesville, near Ottawa, a serious outbreak occurred, which we investigated in July. Two species of destructive locusts were present, namely, the Lesser Migratory Locust (*Melanoplus atlanis* Riley) and the Pellucid Locust (*Camnula pellucida* Scudd.), the former particularly being present in very large numbers. Fields of oats, barley, timothy, rye, and corn were being devastated, large areas being entirely eaten; beans, potatoes, and carrots were also attacked.

At our Entomological Field Station at Covey Hill, Que., a series of experiments was begun by our Field Officer, Mr. C. E. Petch, on the destruction of locusts with the Grasshopper *Coccobacillus* (*Coccobacillus acridiorum* d'Herelle), the original culture of which was received through the kindness of the Director of the Pasteur Institute, Paris, France. Successful inoculations were made at Covey Hill and later a supply of infected bouillon was received at Ottawa, and this was sprayed directly over the grasshoppers at Bowesville, Ont. Unfortunately, however, owing to a delay of some hours in the arrival of the bouillon at Ottawa, together with unfavourable weather conditions, it was not expected that infection would take place in the field. We hope to receive further cultures from France and to continue the experiments during the spring and summer of 1914. At the Covey Hill Field Station over 400 locusts were inoculated in the laboratory, five of which died within three hours, indicating that the *Coccobacillus* was pathogenic in the case of our native species of locusts.

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In Manitoba, wherever applications of the Criddle Mixture were made, little damage was caused by the locusts.

WHITE GRUBS (*Lachnosterna* spp.).

An extended investigation into life-history, control, etc. of these insects is now being undertaken by the Division in co-operation with the United States Bureau of Entomology.

At several of the field stations, important studies have been made of the various species of White Grubs destructive to field and garden crops. Large collections of the adults have been made from various plants in Ontario and Manitoba, and the life-histories of the different species are being investigated. Mr. Norman Criddle, of Aweme, Man., was appointed a Field Officer of the Division to study particularly the Manitoba species of White Grubs. Six species were under observation at this station, and much data were obtained as to their habits, food plants, etc. Mr. H. F. Hudson, Field Officer at Strathroy, Ont., has found three species of common occurrence and at Vineland, Ont., Mr. W. A. Ross has noted two species.

As these insects require from two to four years to complete their life-cycle, the investigations now under way will not be completed until 1917 or 1918.

During 1913 many reports were received of injury by White Grubs. These were chiefly from British Columbia, Manitoba, Ontario, Quebec, and in mostly all instances the destruction was to potatoes.

MISCELLANEOUS.

WIREWORMS.—These insects were reported as injurious from various parts of the Dominion. At Ottawa, in the comparative tests of Indian Corn on the Central Experimental Farm, the injuries of the larvæ of the Elaterid, *Cryptohypnus abbreviatus* Say, were discovered.

THE HESSIAN FLY (*Mayetiola destructor* Say.).—A few complaints of damage by this insect were received from Manitoba, and a thorough study was begun of the life-history in that province. It was found to be plentiful at Reston, Man.

THE LESSER WHEAT-STEM MAGGOT (*Oscinis carbonaria* Loew.).—This insect, which in Manitoba ranks in importance next to the Hessian Fly in injury to spring wheat, was also fairly abundant in some districts. At Treesbank, Man., Mr. Criddle estimated that the injury to spring wheat in June by this insect and the Hessian Fly averaged 5 per cent.; in some fields the damage was as high as 15 per cent.

THE PEA WEEVIL (*Bruchus pisorum* L.).—From reports received, this insect is undoubtedly on the increase again. Samples of infested seed peas have been forwarded to the Division from localities in Ontario. No such infested seed, of course, should be used, either for food or planting, unless the same is fumigated with bisulphide of carbon to kill the beetles, many of which remain in the seed during the winter. If peas which have been injured by the Pea Weevil are used in spring for seed purposes, a very much larger amount per acre will be required. It is, of course, inadvisable to use injured peas for seed; such should be fed to stock.

THE CLOVER-SEED CHALCID (*Bruchophagus fovealis* Howard).—During the winter of 1912-13 and that of 1913-14, seeds of Red Clover (*Trifolium pratense* L.) and strains from this and Mammoth Red, were found to be heavily infested with the larvæ and pupæ of the Clover-seed Chalcid. Fourteen samples of seed, each sample containing 500 seeds, were counted at random and it was found that the highest percentage of infestation was 21 per cent., and the lowest 9 per cent.; the average per-

centage of destroyed seed in the fourteen samples was 16 per cent. As far as we know, these are the first records of the insect having been found in clover seed grown in Canada.

THE CARROT RUST FLY (*Psyla rosae* Fab.).—In the Maritime Provinces the carrot and parsnip crops were considerably reduced by the larvæ of this destructive insect. In some districts in Prince Edward Island and New Brunswick, whole plantations were affected and the crops practically ruined. Correspondents who applied kerosene emulsion to the rows of young carrots reported that little loss was occasioned by the maggots.

THRIPS.—The occurrence of "white-eared" oats in Saskatchewan and Alberta was again reported. It is evident that this injury, which my investigations have shown to be most frequently due, in eastern Canada at least, to the Common Grass Thrips (*Anaphothrips striatus* Osborn), is fairly widespread. In Alberta, Banner oats were particularly affected; it is usually found that the late-flowering varieties suffer most from Thrips injury.¹

ROOT MAGGOTS.—From all parts of the Dominion, reports have been received of the destruction of cabbages, cauliflowers, onions, turnips, radishes, beans, etc., by the different species of Root Maggots (*Phorbia* spp.). Experiments on their control have been continued at Ottawa, and Mr. R. C. Treherne has carried on experiments at Agassiz, B.C. As the experimental studies on the control of *Phorbia brassicæ* and *P. ceparum* have been continued each year since 1910, it is hoped that it will be possible to issue a bulletin on the subject during the next twelve months, after another season's work.

WHEAT MIDGE (*Diplosis tritici*?).—Mr. Treherne studied this insect, which was very prevalent at Agassiz, B.C. Particular attention was paid to the occurrence of the larvæ in the different varieties of wheat and barley. In 1905 and 1906 the crops of spring wheat were seriously affected by the midge in the Lower Fraser valley, and in spite of discontinuing the growing of spring wheat for a year at Agassiz and in the valley in 1907, the insect was again present in 1908.

INJURIES TO WINTER WHEAT IN ALBERTA.

In my last annual report (p. 507) reference was made to the discovery of Eelworms in injured wheat plants from southern Alberta. This matter was more fully investigated by Mr. E. H. Strickland, our Field Officer in Alberta, during the past summer, and in September I visited the districts where the injuries occurred. The extent of the injuries may be gathered from the following facts which I obtained in certain of the localities visited, which were typical of many others. Mr. W. J. Glass, of Macleod, Alta., one of the best growers of winter wheat, usually obtains an average yield in good seasons of 33 bushels per acre. In the fall of 1912 (August) he seeded 220 acres to winter wheat; cutworms destroyed a portion of the crop, but the greater portion died as a result of the injuries that we are investigating. Accordingly, he reseeded 100 acres to oats, and from 97 acres of winter wheat which was left he thrashed out only 162 bushels. Mr. Becker, of Pincher Station, had 400 acres sown to winter wheat, and in 1913 it averaged about 7 bushels to the acre instead of about 30 bushels. In one section of the infested land, only 150 bushels were thrashed off 100 acres. Similar losses were reported from this and other districts in southern Alberta.

The constant association of Eelworms with young injured plants led us to conclude in 1912 that they were responsible for the injuries. A further detailed study

¹See C. Gordon Hewitt, "Sterility in Oats caused by Thrips." Journ. Econ Ent., vol. 7, pp. 211-218, 1 fig., 1 pl., 1914.

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during 1913, however, indicated that Eelworms might not be the sole cause of this serious and extensive trouble, and with a view to ascertaining what relation the Eelworms bear to the destruction of the winter wheat, Mr. Strickland is conducting as exhaustive an inquiry as possible into the whole matter. The comparative absence of information concerning the soil-infesting Nematodes of North America increases the difficulties surrounding this study. Dr. Ritzema Bos, Director of the Phytopathological Institute, Wageningen, Holland, and the leading European authority on Nematodes affecting plants, has very kindly examined living and preserved material which I sent to him. In dead portions of young winter wheat plants he found Eelworms of the genera *Cephalobus*, *Rhabditis* and living Anguillidæ, but he could not find any Nematode worm known as a plant parasite. Dr. J. G. de Man of Ierseke (Zeeland), a well-known specialist in Nematode worms, also kindly examined some of our material. He found neither in the fresh plants nor in the alcoholic material any forms known to be parasitic on plants; a species of *Tylenchus* allied to *T. dubius* Butschli, one *Dorylaimus* allied to the European *D. bryophilus* de Man, and a number of worms belonging to the genera *Cephalobus* and *Rhabditis* were found by him. Dr. Ritzema Bos believes that *Cephalobus* feeds saprophytically on plants destroyed by other Nematode worms or disease. The occurrence of three kinds of Nematode worms in the soil, namely, non-parasitic which normally live in the soil and on the humus it contains, saprophytic which feed on dying decaying vegetation, and truly parasitic, which enter and feed upon the tissue of the living plant, makes the determination of the relationships of the various forms found a matter of unusual difficulty.

In addition, a fungus (*Fusarium* sp.) has been found which may have some relation to the trouble. It is not unlikely that climatic conditions are also concerned in the production of the injuries. These factors may also affect the young wheat plants conjointly. Whether the injury is caused by one factor or several factors working together can only be discovered by further study, and we shall continue our investigations during the coming season on the relations of the various species of Nematode worms to the injured plants.

III.—INSECTS AFFECTING FRUIT CROPS.

Considerable progress was made in the investigations which are being carried on at the Entomological Field Stations. I have indicated earlier in this report (pp. 2-3) at what stations the different insects are being studied, and a brief statement of the progress of our studies will now be given.

BUDMOTHS OF APPLE IN NOVA SCOTIA.

In the spring of 1913 a large amount of the damage to young fruit attributed to frost was due to Budmoth. In the Annapolis valley, Mr. Sanders has found two species of true Budmoths, the common Eye-spotted Budmoth (*Spilonota ocellana*), and a large species, *Olethreutes consanguinana*, was recorded for the first time feeding in apple. The life-histories of both these species have been studied, and the spraying experiments in the orchard of Mr. R. S. Eaton at Kentville, N.S., have been continued. The results of last year's (1913) spraying experiments cannot be obtained until May (1914), but the 1912 experiments indicated that the spray applied before the blossoms opened gave the greatest benefit of any single spray, killing from 50 to 60 per cent of the Budmoths. This spray, together with the spray applied after the falling of the blossoms, gave the best results; an increased set of 20 per cent more fruit was secured over that in the check plots.

FRUIT-WORMS IN NOVA SCOTIA.

For a number of years fruit-growers have complained of the damage caused by fruit-worms and their inability to control them owing largely to ignorance of their habits. During 1913, Mr. Sanders continued his studies which were commenced in 1912, and found that instead of one species there were probably about twelve injurious species belonging to the genera *Xylina*, *Calocampa*, and *Scopelosoma*. By far the commonest species is *Xylina bethunei*. Their injury to the fruit is responsible for converting a large proportion of apples of grades Nos. 1 and 2 to grade No. 3.

The winter is passed in the adult state, the moths hibernating under rubbish, grass, etc. In the early spring the adults emerge and deposit their eggs on the apple twigs. The eggs hatch in about a fortnight and the caterpillars feed on the leaves and fruit until about midsummer when they drop to the ground and pupate in the soil. About two months later the moths emerge. In the spraying experiments the most valuable spray for Green Fruit-worm appeared to be that applied after the falling of the blossoms, the usual codling moth spray. Clean cultivation and destruction of rubbish is also an important factor in controlling this pest. The spraying experiments and observations are being continued during the coming season.

There is no doubt that when it is realized how the production and the proportion of high grade fruit may be increased, that systematic spraying along the lines of Mr. Sander's results will be more generally carried out, and for this reason the demonstration work he is doing will prove of inestimable value to the fruit-growers of the province. Already there are signs of a greater inclination and desire not only to spray but to spray systematically and with knowledge of the objects of spraying.

THE CURCULIOS OF PLUM AND APPLE IN QUEBEC.

At Covey Hill, Que., Mr. C. E. Petch continued his studies of the Plum Curculio (*Conotrachelus nemophar*) and the Apple Curculio (*Anthonomus quadrigibbus*) which were commended in 1912. The complete failure of the fruit crop in the district severely handicapped the work. In the orchards in which the work was being carried on, 1,800 trees produced only a peck of apples, and very few plums were gathered from 200 trees. Nevertheless, progress was made in a study of the life-histories of these species, susceptibilities of varieties to attack and control measures.

APPLE MAGGOT IN ONTARIO.

A third season's work on the Apple Maggot (*Rhagoletis pomonella*) was carried on by Mr. W. A. Ross. The insect was remarkably scarce, however, and in orchards which had been previously badly infested, considerable difficulty was experienced in securing adults. Most of the work was carried on at Bowmanville, Ont. In addition to further studies on the life-history and habits of the insect the experiments on control measures were continued. These included the testing of a number of soil insecticides, cultivation, the use of poultry, and spraying with sweetened arsenicals. It was found that the insect may remain in the soil in the pupal stage for two years. In July, 1913, flies emerged from 1911 pupæ. Healthy 1912 pupæ were found which will no doubt emerge in the coming season (1914).

Mr. Ross commenced a study of the Aphides affecting fruit in western Ontario where the aphids on apple are particularly injurious to the foliage of young nursery stock and to young apples. The four commonest species on apple are the Apple Aphis (*A. pomi*); the Grain Aphis [*Hydaphis (Siphocoryne) avenæ*]; the Rosy Apple Aphis (*A. sorbi*); and the Woolly Apple Aphis (*Schizoneura lanigera*). The Green Peach Aphis (*Myzus persicae*) was particularly abundant in the fall of 1913.

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FRUIT INSECT INVESTIGATIONS IN BRITISH COLUMBIA.

Mr. R. C. Treherne concluded his study on the Strawberry Root Weevil (*Otiorynchus ovatus*) commenced in 1912, and a bulletin on the subject is now in the press. Mr. Treherne's investigations have shown that the control of the Weevil is dependent upon cultural methods and the system of cropping.

In addition to making observations on miscellaneous insects affecting fruit, Mr. Treherne commenced a study of the Bulmoth (probably *Tmetocera ocellana*), in the Lower Fraser valley, where this species affects both nursery stock and the flower-buds of older apple trees.

IV. INSECTS AFFECTING FOREST AND SHADE TREES.

FOREST INSECT INVESTIGATIONS IN BRITISH COLUMBIA.

As frequent reports of serious forest insect deprecations in British Columbia had been received during the last few years, and in view of the high commercial value of the merchantable timber in the province, it had been decided that Mr. J. M. Swaine, Assistant Entomologist in charge of Forest Insect Investigations, should make a preliminary survey of the forest insect conditions in 1913. A request from the Minister of Lands of British Columbia that such an investigation should take place was received and coincided with our own wishes. Accordingly, we were able to arrange for the work to be carried out in co-operation with the Provincial Forestry Branch, which contributed to the investigation by defraying Mr. Swaine's expenses while in the province. The investigation was confined to regions in the southern portion of the province and Vancouver Island. It was found that an immense amount of valuable timber is being destroyed by various injurious insects. Several outbreaks of Bark-beetles were located and studied, and reports were received of extensive Bark-beetle outbreaks in spruce and pine in regions which could not then be visited.

The most extensive injury examined during this summer's work was to bull pine by the Western Pine Bark-beetle (*Dendroctonus brevicomis*) and the Western White Pine Bark-beetle (*D. monticolæ*); and to Western White pine by the Western White Pine Bark-beetle. Many hundreds of trees have been killed by these beetles, and the infestations are still spreading. The Douglas Fir Bark-beetle (*D. pseudotsugæ*) was found killing Douglas fir both in the interior and on Vancouver island. The Sitka Spruce Bark-beetle (*Dendroctonus obesus*) was found killing the Sitka spruce on Vancouver Island. The Engelmann's spruce and lodgepole pine were also suffering severely in the Kootenays from Bark-beetle attack.

The practical results of this preliminary survey and suggested control measures are embodied in a bulletin now in the press.

The destructive bark-beetles are the most serious enemies of British Columbia forests. They can be controlled, fortunately, by modification of lumbering methods, which often involve little expense if applied during the earlier stages of the infestation.

In addition to the foregoing work, Mr. Swaine investigated the cause of the dying timber in Stanley Park, Vancouver, B.C., with a view to advising the Parks Board who are naturally alarmed at the destruction of the trees in this fine park of virgin forest. It was found that the Sitka Spruce Gall Aphid (*Chermes* sp.) and the Western Hemlock Looper (*Therina* sp.) have caused the death of a number of large trees in the park and in the environs of Vancouver. It is hoped that the investigations which we have commenced on these insects will result in checking this most unfortunate destruction. It is proposed to have a field officer stationed in Stanley park during the coming season to make a complete study of the insects responsible for the damage.

MISCELLANEOUS FOREST AND SHADE TREE INSECTS.

THE FOREST TENT CATERPILLAR (*Malacosoma disstria*) again defoliated large areas of poplar, birch, maple, and other deciduous trees, in parts of Eastern Canada, particularly in Quebec and New Brunswick, and in the Fraser River valley of British Columbia. A bacterial disease destroyed large numbers of the caterpillars in eastern Ontario last summer, and is expected to play an important part in their control, which is being studied by Mr. Tothill in New Brunswick. A circular on the Tent Caterpillars was published.

THE LARCH SAWFLY (*Nematus erichsonii*) is travelling steadily westward across Manitoba and northern Saskatchewan. It has already killed large numbers of larches in Manitoba forests. A further importation of parasitized cocoons of this sawfly was made from Great Britain, the cocoons having been collected at Ambleside, in the English Lake district. The cocoons were all placed in a tamarack swamp near Aweme, in southern Manitoba. In a check lot of the cocoons retained at Ottawa, it was found that 68 per cent were parasitized with *Mesoleius tenthredinis*, *Hygamblys albopictus*, *Microcryptus labralis*, and certain Tachinid parasites.

THE SPRUCE BUD-WORM (*Harmoloba fumiferana*) has been reported from Ontario and Quebec woods less frequently than in the previous three years. It is apparent that its parasites have obtained control in many places and have saved the trees from further injury. An extensive outbreak appears to be spreading in the New Brunswick forests.

For several years the Eastern Fir Bark-beetle (*Ips balsameus*) has killed a large number of isolated balsam firs in Ontario, Quebec, and New Brunswick forests.

The Elm Bark-louse (*Gossyparia spuria*) is still a serious enemy to elms in Quebec and Ontario. Badly infested trees become unthrifty and gradually die. The Locust Borer (*Cyrtene robiniae*) is killing locust and acacia trees in parts of Ontario. The larvæ excavate tunnels through the wood of living trees and prove a most destructive enemy. The Oak-twig Pruner (*Elaphidion villosum*) has been reported in injurious numbers in southern Quebec. The infested twigs die and fall to the ground; and when the insects are very numerous the appearance of the trees is considerably affected. The Bronze Birch-borer (*Agrilus anxius*) continues to be the most serious enemy of ornamental birches in eastern Ontario. The Poplar Borer (*Saperda calcarata*) has been very injurious to poplar shade trees.

V.—INSECTS AFFECTING DOMESTIC ANIMALS AND MAN.

THE CONTROL OF HOUSE FLIES.

The campaign against the house fly has been continued with unremitting zeal, and throughout Canada health authorities are convinced of the danger to health involved in the presence of flies. The requests for our circular on "How to deal with the Fly Nuisance" from medical officers of health and teachers are numerous and encouraging.

While the control of flies under city conditions is important and necessary in the interests of health, the control of flies under rural conditions is also very important, especially on account of its intimate connection with the problem of pure milk. The treatment of stable manure which constitutes the chief breeding place of the house fly is a serious question from the point of view of the farmer. Accordingly, a series of experiments were carried out in August and September, 1913, with a view to discovering an insecticide which is not only cheap and efficient, but does not decrease the fertilizing properties of the manure. A cubic yard of manure was used as a standard

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and the number of flies emerging from each heap of manure treated or untreated was counted. A full description of the experiments has been published (*Journ. Economic Entomology*, vol. 7, pp. 281-289). The results were as follows:—

Treatment. -	Number of flies emerged from manure.
Untreated	13,332
Zenoleum	8,042
Iron sulphate	7,859
Chloride of lime (surface application)	5,943
Chloride of lime (mixed)	4,627
Kerosene emulsion	3,481

While kerosene emulsion appeared to give the best results, this may have been due to the greater amount of straw in the experiment and I should prefer the chloride of lime. The treated manure will be tested during the coming season in regard to its fertilizing properties.

It may be added that a similar series of experiments was carried out by the Bureau of Entomology of the United States Department of Agriculture. Their experiments conclusively demonstrated the superiority of borax (crude sodium borate) or colemanite (calcium borate) over all other larvicides. This chemical was not tried in our experiments at Ottawa. It was found that 0.62 pound of borax was sufficient to kill all the larvæ in 10 cubic feet (8 bushels of manure); the dry borax is sprinkled on the manure and washed in with 2 or 3 gallons of water.

TREATMENT OF INSECT-INFESTED FLOUR MILLS.

In many parts of Ontario the Mediterranean Flour Moth (*Ephestia kuehniella*) is responsible for heavy losses in flour and feed mills. Mr. Ross carried on experiments on superheating as a method of ridding mills or stores of these insects in preference to fumigation. A mill in Dundas, Ont., in which the meal and flour was found to be alive with the caterpillars, and the moths were flying around in the bins, was selected. It was found that a temperature of 120° F., maintained for at least ten hours, would prove fatal to all eggs, caterpillars, and adults of *Ephestia*.

MISCELLANEOUS.

Our inquiries in regard to the distribution of ticks in British Columbia, and especially of *Dermacentor venustus* on account of its relation to the obscure disease termed "tick paralysis" in children, have been continued, and additional data have been secured.

Following the discovery by Dr. S. Hadwen of the occurrence of the Warble Fly, *Hypoderma bovis*, in Canada in addition to *H. lineata*, which had always been regarded as the common North American species, our studies of the Canadian warble flies have been continued, and it has been found that *Hypoderma bovis* is commonly distributed throughout Canada, in some parts of which warble flies appear to be increasing in number; their control, therefore, demands careful attention, and especially is it necessary to secure co-operative effort among farmers in destroying the warbles in the spring.

VI.—INSECTS AFFECTING GARDEN AND GREENHOUSE.

As opportunities occurred, investigations on greenhouse insects have been carried on by Mr. Gibson at Ottawa, and by Mr. W. A. Ross in Toronto and other places in Ontario. Reference was made in my last report to the injuries of sowbugs. In greenhouses in London, Ont., they attacked the seedlings of sweet peas, *Asparagus*

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pinus, *Primulas*, petunias, and other plants; tender cuttings such as *Begonia* and *Coleus* were injured. Three species of these Isopods were found, namely, *Oniscus asellus*, *Armadillidum vulgare* and *A. quadrifrons*. Mr. Ross has discovered an effective poisoned bait, and finds that one of the most important preventive measures is cleanliness and the cleaning away of rubbish around the greenhouses. The Bulb Mite (*Rhizoglyphus hyacinthi*) was found seriously damaging the bulbs of Easter lilies in London, Ont. At Eglinton the Cattleya Fly (*Isosoma orchidearum*) was found injuring orchids. In greenhouses, and especially in gardens, the Tarnished Plant-bug (*Lygus pratensis*) continues to be injurious in Ontario. It is notably destructive to asters and chrysanthemums; one Ontario florist estimated the season's loss on chrysanthemums at \$2,000, and on asters at \$500. The Chrysanthemum Fly (*Phytomyza chrysanthemi*) was injurious in Toronto greenhouses. Mr. Gibson discovered an interesting case of the Variegated Cutworm (*Peridroma saucia*) destroying carnations by eating out the interiors of the buds.

Garden asters in different localities, including Ottawa, have been attacked and in many cases destroyed by root aphids (*Aphis maidi-radidis*), which are cultivated by ants. The occurrence of root-maggots has been mentioned in a previous section.

VII.—APICULTURE.

APICULTURAL WORK AT OTTAWA.

On November 8, 1912, thirty-five colonies in the apiary were weighed and put into the bee cellar under the farm foreman's house. Their weights varied from 37 pounds to 66 pounds, average 52½ pounds. Average temperature of the cellar in November 49° F.; in December, 45° F.; in January, 42½° F.; in February, 43½° F.; in March, 47½° F.; in April, 48½° F. The bees were brought out of the cellar and weighed on April 9. The loss in weight during the winter varied from 7 to 29 pounds per colony, average 15½ pounds. Four colonies died in the cellar, one shortly before March 15, the others shortly before April 5. All were foodless, and starvation was the immediate cause of death. Their weights were as follows:—

Size of Hive.	Weight Nov. 8.	Weight after death April 5.	Loss.
	Lb.	Lb.	Lb.
8-frame.....	37	24	13
8-frame.....	47	28	19
10-frame.....	56	27	29
10-frame.....	58	29	29

Twelve colonies were wintered out of doors in special wintering cases. These cases were each made to hold four hives, with a space of 2 inches to 3 inches of packing material around the sides and underneath, and 10 inches on top, with a 2 inch air space above, ventilated by holes under the cover. The entrances were 9 inches long and 1½ inches deep, the lengths being reduced during winter by means of a strip of wool revolving on a screw. One of these cases was packed with clover chaff, another with cut straw and the third with shavings. As colonies wintered out-of-doors consume more food than those wintered indoors, extra heavy colonies were selected to place in these cases. All survived the winter which, however, was unusually mild. Loss due to bees dying in the snow was not serious. The colonies in the case packed

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with shavings came out stronger than those in other cases. The case containing shavings was, however, slightly better protected from wind. In April, each of the twelve colonies had an average of about 10 pounds of stores. In the middle of April breeding was in a more advanced stage than in the colonies wintered in the cellar, and two of the colonies in the case packed with shavings were the strongest in the apiary. The bees were left in the wintering cases until the beginning of June, and during April and early May increased faster than the unprotected colonies that had been taken from the cellar. One of the colonies in the case packed with shavings swarmed on May 26. Several weak colonies that were found to be queenless or to contain unsatisfactory queens were united to others, the total number being thus reduced from 43 to 39.

The bees made a good start during April and the first six days of May, collecting nectar from willows and maples. From May 7 till May 30 the weather was cool and often cloudy and dry. Dandelion and fruit bloom yielded very little food, and breeding received a check from the 13th to the 20th.

Towards the end of May, widespread preparations for swarming, which could only be attributed to the abundance of the melliferous shrubs and trees in bloom on the farm, combined with uncertain weather for gathering, were made, and on May 27 about 80 per cent of the colonies were found to have queen-cells containing eggs and larvæ. The swarming fever was checked when, the weather improving, the bees discovered that little nectar could be got. June was a warm and fine month. The first flowers of alsike and white clover were seen on June 6. Unfortunately, a severe drought dried up these plants which are the chief source of honey in this region, and reduced their yield to a fraction of the usual quantity. A serious deficiency of rain continued until August 22. However, the weather for gathering was, on the whole, excellent, and for a period of seventy-six days, from the opening of the clover flow on June 24 until frost cut off the supply from aster and golden rod on September 8, the hives on scales gained steadily in weight.

Summary of gain in weight of a moderately strong colony, compiled from daily readings obtained from hives on scales:—

Period.	Gain during period	Average gain per day.	Source.
June 25-30.	14 pounds.	About 3 pounds.	Mainly alsike and white clover.
July 1-31.....	32 pound.	" 1 pound.	" " white clover and sweet clover.
Aug. 1-30.....	17 "	" $\frac{1}{2}$ "	" buckwheat and sweet clover.
Sept. 1-8....	7 "	" 1 "	Aster and golden rod.
	70		

The above figures are necessarily only approximate, for the records were influenced by several varying factors which it was impossible to control.

The total honey crop for 1913 was 1,965 pounds of extracted honey, of which 695 pounds were graded white honey and 1,270 pounds amber or dark honey, and 533 sections, of which 233 were white and 300 amber or dark honey. The average yield per hive from 43 colonies spring count, was therefore 70½ pounds, reckoning, as is usually done, a section as equivalent to two pounds of extracted honey. The largest amount of honey taken from a single colony was 163 pounds of extracted honey. This colony consisted of evenly-marked three-banded bees, too excitable to be regarded as pure Italians in the strict sense.

The number of colonies was increased during the year from thirty-nine to fifty-three. The bees in the apiary, with the exception of four colonies of Pure Italians,

containing queens obtained last year from Bologna, Italy, were three-banded and Golden Italians, crossed more or less with Blacks. Eight of the queens produced small proportions of black bees. The queens imported from Italy gave somewhat disappointing results, which may have been due in some measure to injury caused by the long journey.

European Foul Brood reappeared in several colonies on May 23. Between that date and the end of July diseased larvæ were observed in sixteen out of the original thirty-nine colonies. The six worst cases, in which more than about 100 larvæ were seen to be affected, were treated by the well-known method of shaking the bees into a clean hive, the combs being boiled down. Every colony that manifested definite disease was re-queened with a selected Italian. July brought a reduction in the number of affected larvæ, and in August only very few could be found.

European Foul Brood Summary.

	Extensively diseased.	Slightly diseased.	Remained Healthy.
Colonies consisting entirely of bees showing yellow bands often of varying widths, not including Italians from Italy or pure Golden	3	6	17
Colonies in which bees showing yellow bands were mixed with black bees.....	3	1	4
Italians (from Italy).....	1	1	2
Pure Golden (queen obtained from Texas).....	1		

The testing of different strains of Italians and hybrids for resistance to European Foul Brood was begun by Mr. Sladen, Assistant Entomologist in charge of Apiculture, and many queens of selected parentage were reared. A temporary bee-mating station was established on the Kazabazua plains, about 50 miles north of Ottawa. Although no colonies of bees could be discovered within 3 miles of this station, the Italian queens brought there were mated by local black drones, and the colour of the resulting hybrids was found to be, as expected, darker than that of pure Italians.

Queens of several varieties and strains of Italians and two pure Carniolan queens were obtained from Europe and introduced.

In September, all weak colonies were united, only selected queens of choice parentage being saved, and the bees were fed with sugar syrup to bring up the weight of the eight-frame colonies to about 60 pounds and the ten-frame colonies to about 70 pounds. The work of uniting and feeding was begun on September 13, and completed, with the exception of a few details, by October 1. On October 29, 30, and 31, sixteen colonies were weighed and packed in shavings in wintering cases for out-door wintering. Three of these cases were situated in a portion of the apiary that has been surrounded with a board fence 6 to 7 feet high to protect them from wind.

On November 10 the remaining thirty-seven colonies were weighed and placed in the bee cellar.

At the time of writing, March 28, all the colonies out-of-doors and indoors, seem to be wintering satisfactorily.

Mr. J. I. Beaulne rendered valuable assistance in the Apiary.

APICULTURAL WORK ON THE BRANCH FARMS.

During the past year steps were taken to organize the apicultural work on the Experimental Farms. In some cases apiaries already existed, in others bees were purchased and apiaries were started.

The following is a summary of reports of apicultural work that have been received from the branch Farms.

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Charlottetown, P.E.I.—Two colonies of Italians and three colonies of Black bees were purchased early in the season, and produced 75 pounds of surplus honey. The bees were placed in a room in the cellar of the Superintendent's residence on December 18. The temperature of the bee cellar was kept as near to 45° F. as possible. All the colonies came out in good condition in the spring of 1914.

Kentville, N.S.—Five colonies of Black bees were purchased locally early in July. They were so badly damaged in transit that only four weak colonies resulted. About 30 pounds of honey was extracted. A wintering case was made for each colony and the colonies were placed in these, packed in planer shavings on December 13.

Nappan, N.S.—From ten colonies, spring count, were obtained 1,170 pounds of extracted honey, valued at \$140.40, 80 pounds of comb honey, valued at \$20, and nine swarms, valued at \$72. The greatest yield of extracted honey from a single colony was 205 pounds. White clover and Alsike clover are the principle nectar-yielding plants. Unfortunately, the bees went into the cellar a little short of stores and mice got into the hives, with the result that several colonies were found to be dead in the spring.

Ste. Anne de la Pocatière, Que.—Six colonies were purchased and arrived on June 28. They produced 208 pounds of honey and eight swarms.

Cap Rouge, Que.—The apiary was established on June 20 with ten colonies of Black bees. The yield of honey amounted to 267 pounds of extracted honey and 52 sections. The honey flow from White clover, the chief honey plant, was of short duration, and interrupted by frequent rainy days. Eleven colonies were wintered in the cellar under the superintendent's house, and seem to be in good condition.

Brandon, Man.—Eight colonies gathered an average of 30½ pounds of honey each and gave twelve swarms. The best colony gathered 68 pounds of honey and threw two swarms on July 4 and 14. Twenty colonies were placed in the basement of the Superintendent's residence on November 10.

Indian Head, Sask.—A fresh start with bees was made in June with two small swarms. These were shipped from Ottawa, a distance of over 1,600 miles, in "combless" wire cages, provided with water and candy. Both colonies swarmed, and an attempt made to winter the four weak and poorly provisioned colonies ended in the loss of two, and the reduction of the others to extreme weakness.

Lacombe, Alta.—Two colonies came through the winter satisfactorily and swarmed during the summer of 1913, but the swarms were lost. These colonies were wintered in a root cellar which proved too damp, causing death of both colonies.

Invermere, B.C.—Six colonies obtained from Salmon Arm in June produced an average of about 40 pounds each of excellent honey, for which there was a ready local demand.

Agassiz, B.C.—In the autumn of 1913, 13 pounds of mixed honey were extracted. In the spring of 1914 there were eight colonies in good condition. Two died, probably from starvation, during the winter, which, though comparatively mild, was very wet. The hives in use are of the Langstroth ten-frame pattern.

Sidney, B.C.—Ten colonies of bees were purchased from a neighbouring bee-keeper in the autumn of 1913, and were removed to the Farm in the early spring. This is a good region for honey production and good results are hoped for.

VIII.—MISCELLANEOUS.

COLLECTIONS.

The collection of insects which now constitutes the National Collection has increased materially during the past year owing to the increase in the staff of the Division, and the greater opportunities which are now afforded to secure insects of all orders by the presence of field officers in the various provinces. Mr. Germain Beaulieu has worked most zealously in dealing with new material and in arranging the collections generally, excellent progress having been made in the arrangement of the Coleoptera. We have continued to name collections of insects for individuals and teaching institutions.

In the determination of new material we have again enjoyed the assistance of Dr. L. O. Howard, Chief of the United States Bureau of Entomology, and his scientific assistants in the Bureau and in the National Museum at Washington, for which assistance we are most grateful, and we would also express our gratitude and indebtedness to other specialists who have assisted us during the year.

An exhibition of injurious and useful insects was made at the Central Canada Exhibition held at Ottawa in September last.

PROTECTION OF BIRDS.

As the protection of insectivorous birds has a very direct bearing on the natural control of insect pests, and as such birds are both thoughtlessly and wantonly destroyed in Canada, thereby reducing the numbers of our allies in the control of insect pests, every effort is being made to impress upon farmers, teachers, and others, the importance of protecting our native birds. A proposal which I made to the Ottawa Field Naturalists' Club for the institution of a practical example of bird protection in Ottawa has been adopted and will be put into effect during the coming spring. The Ottawa Improvement Commission have agreed to constitute Rockliffe Park a bird sanctuary and to make and distribute 250 nesting boxes of the Berlepsch pattern in the park. On our part, you have kindly agreed to have 160 Berlepsch nesting boxes distributed on the grounds and in the Botanical Gardens of the Central Experimental Farm. We hope that this will prove a valuable example of the methods to be taken to attract birds to the farm.

CORRESPONDENCE.

The growth of the work has naturally resulted in an increase in the correspondence. The number of letters received from April 1, 1913, to March 31, 1914, was 6,384, and the number of letters sent out during the same period was 7,814, compared with 5,165 letters received and 6,938 letters sent out during the previous fiscal year.

TRAVELLING.

The direction and supervision of the work has necessitated, as usual, visits to the different provinces during the year. All the fumigation stations have been visited. In June and July a visit was made to New Brunswick, Nova Scotia and Massachusetts. The Fiftieth Annual Meeting of the Entomological Society of Ontario was held at Guelph, Ont., in August, and was attended by all the members of the scientific staff who were able to be present. On September 8, I left Ottawa to visit the field laboratories in Ontario and Western Canada. In British Columbia I also visited a number of the Indian reserves in order to inspect the progress of our work in the orchards of the Indians which is being carried on by Mr. Tom Wilson. I left Victoria, B.C., on October 11 for the United States; the Oregon Agricultural College, Corvallis, Ore. was visited on the way to California, where I wished to examine their quarantine

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methods, etc., and to inquire into the occurrence of the Potato Tuber Moth (*Phthorimæa operculella* Zett.). The Universities of California and Leland Stanford were also visited. On the return journey two days were spent at Salt Lake City, Utah, for the purpose of looking into the question of the Alfalfa Weevil (*Phytonomus murinus* Fab.). From December 30 to January 2 the meetings of the American Association for the Advancement of Science, the Entomological Society of America and the Association of Economic Entomologists were attended at Atlanta, Ga. The various officers of the Division have attended meetings throughout the year for the purpose of giving addresses and demonstrations.

PUBLICATIONS.

During the year the officers of the Division, both at headquarters and in the field, have contributed scientific papers to entomological and other journals, embodying results of too technical character for publication in bulletin form. More popular articles on the control of various insect pests have been contributed from time to time to agricultural journals and papers.

In addition to two bulletins which have been prepared and are now in the press, the following circulars have been published during the year:—

“Tent Caterpillars,” by J. M. Swaine, 14 pp., 8 figs. (*Entomological Circular No. 1.*)

“Flea-beetles and their Control,” by Arthur Gibson, 12 pp., 14 figs. (*Entomological Circular No. 2.*)

“The Chinch Bug in Ontario,” by H. F. Hudson, 13 pp., 3 figs. (*Entomological Circular No. 3.*)

STAFF.

With the increase in our work, and its expansion in various directions, an increase in the staff of the Division has been necessary, and the following officers have been appointed during the past year:—

Mr. L. S. McLaine, M. Sc., was appointed a field officer in April, 1913. He graduated at the Massachusetts Agricultural College, Amherst, Mass., in 1910, and received his master's degree in 1912 for research in entomology. Prior to his appointment Mr. McLaine was acting as Deputy State Nursery Inspector of Massachusetts, and he has therefore had excellent experience in field work in addition to a thorough laboratory training. During the summer of 1913 he was responsible for the work of securing parasites of the Brown-tail and Gipsy Moths in Massachusetts, and throughout the past winter he has had charge of the field work against the Brown-tail Moth in New Brunswick.

Mr. A. E. Kellett was appointed an Artist Assistant in August, 1913. Mr. Kellett studied art for three years in the Armstrong Academy of Arts, Newcastle-on-Tyne, England, and subsequently he served five years' apprenticeship to process engraving and illustrating. He has, therefore, had an excellent training both in the artistic and technical aspects of illustrating work. After coming to Canada in 1910 Mr. Kellett was employed in Winnipeg as artist and designer.

Mr. Joseph Perrin was appointed inspector of imported nursery stock at Halifax, N.S. Mr. Perrin has always been a keen entomologist, and has added materially to the knowledge of the lepidoptera of Nova Scotia.

The progress and success of our work has been due to the zealous and enthusiastic manner in which all the officers of the Division, both at headquarters and in the field, have carried on their work, of which I cannot sufficiently express my appreciation. My especial thanks and acknowledgments are due to my Chief Assistant, Mr.

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Arthur Gibson, who has had charge of the work during my absence. Grateful acknowledgment is also due to the conscientious and satisfactory manner in which the clerical duties have been carried on by Miss J. McInnes, Messrs. J. A. Letourneau and M. J. Moloughney, with temporary assistance. It is now felt that we are in a better position to render the assistance which is desired by the agriculturists, foresters, and others who suffer from the depredations of insect pests, and that the lines upon which the work is being developed are such as to bring us more directly and readily into contact with those whom it is our privilege to assist in developing the resources of the country.

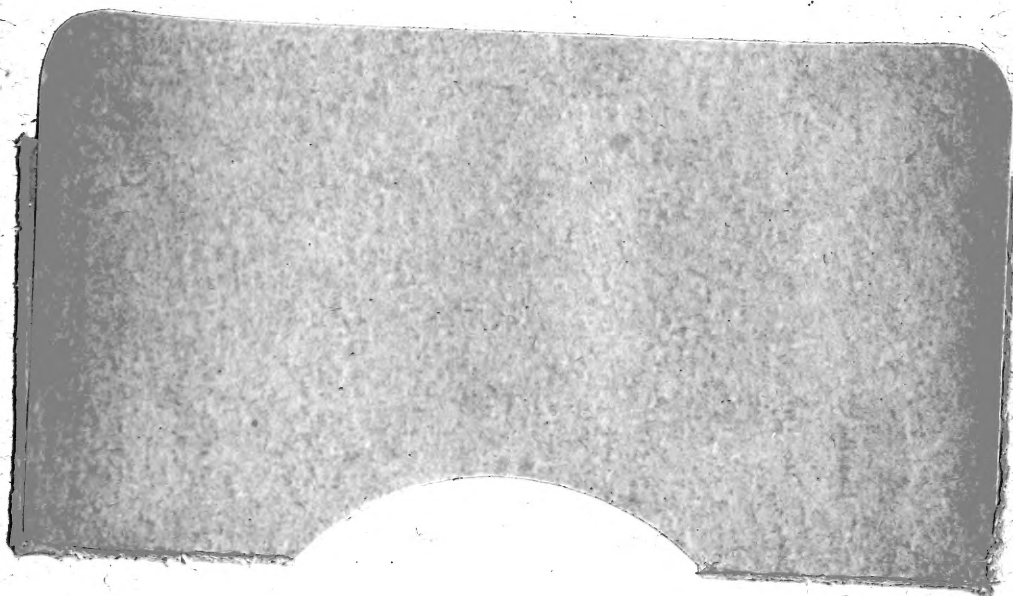
I have the honour to be, sir,
Your obedient servant,

C. GORDON HEWITT,
Dominion Entomologist.

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