1946
ANNUAL TECHNICAL REPORT

WINNIPEG LABORATORY
FOREST INSECT INVESTIGATIONS

SUBJECT INDEX

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I. INTRODUCTION

Activities of the Forest Insect Laboratory, Winnipeg, during 1946, were highlighted by the continued expansion of the Forest Insect Survey. The force of insect rangers was increased to seven and four transportation units were provided for their work. A corresponding increase in student help and extra labour to aid in the Survey rearings accompanied the growth of the insect ranger staff. Further additional student assistants enabled the laboratory to increase the scope and number of field investigations undertaken.

A result of the larger Survey staff was a marked improvement in our knowledge of the distribution of the more important forest insect pests. The distribution and intensity of such insects as the larch sawfly, jack pine budworm, spruce budworm, forest tent caterpillar, bark beetles, bronze birch borer, aspen tortrix, american poplar leaf beetle, black headed budworm and the yellow headed spruce sawfly were thoroughly recorded.

Greater emphasis was placed on larch sawfly investigations due to the continued serious nature of this pest. A new project designed to study the effect of water levels on larch sawfly populations was initiated, and is to be expanded. Chemical control studies with DDT and 666 were also conducted and parasite surveys were intensified.

Another new project to study the importance of biological control of the spruce budworm was undertaken in the Spruce Woods Forest Reserve, Manitoba. The ultimate objective is to determine the value of the present factors and the influence of new parasite, predator and disease introductions on the budworm population in the area.

The work on the jack pine budworm and related studies carried on at Hawk Lake, Ontario, since 1937 was transferred to a new permanent site in the Whiteshell Forest Reserve, Manitoba. At the new site investigations on the effect of jack pine pollen on the epidemiology of the jack pine budworm were continued as well as studies on host selection and hybridization with the spruce budworm.

The most important results and conclusions on the aforementioned projects are presented in this report. A shortage of trained staff during the winter months prevented analysis of all data obtained during the summer, but time was found to summarize those results essential for the intelligent planning of projects to be continued in 1947.

At the present time and for the next few years, the lack of a sufficient number of trained and experienced personnel is bound to be a serious handicap in the development of a full scale research program. Much of the work is being performed by undergraduate students who will require several years to obtain the necessary minimum academic qualifications for research in entomology. When, however, this objective is achieved, we can look forward confidently to significant results. In the meantime it is hoped that this report will be regarded with due recognition of the difficulties inherent in a rapid staff expansion.

Respectfully submitted,

R.R.LEJEUNE
Officer-in-Charge

II ORGANIZATION

R.F.Lejeune	Officer-in-Charge, SSE-3208 - Agricultural Scientist Grade 2 (April 1, 1946 to January 1, 1947), Agricultural Scientist grade 3 (January 1, 1947 to March 31, 1947)
W.C.McGuffin	SSE-254 - Agricultural Assistant Grade 11, (April 1, 1946 to May 31, 1946) SSE-3341 - Agricultural Scientist Grade 2, (June 1, 1946 to March 31, 1947)
R.J.Heron	SSE-3038 - Senior Agricultural Assistant (April 1, 1946 to May 3, 1946) SSE-3308 - Senior Agricultural Assistant (May 4, 1946 to March 31, 1947) On leave of absence Sept. 19, 1946 to March 31, 1947.
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H.R. Wong	SSE-3321-Student (Agriculture) Grade 3, (May 14, 1946 to September 28, 1946)
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L.L. Mc Dowall	SSE 3256 - Insect Ranger Grade 1, (May 14, 1946 to March 31, 1947)
J.A.Drouin	SSE-3255 - Insect Ranger Grade 1, (May 15, 1946 to March 31, 1947)
T. Cook	SSE-3257 - Insect Ranger Grade 1, (May 31, 1946 to August 5, 1946)
E.F.Bridgman	SSE-3257 - Insect Ranger Grade 1, (August 26, 1946 to March 31, 1947)
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S.I.Dougall	SSE-3297 - Stenographer Grade 1, (June 24, 1946 to March 31, 1947)
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SUMMARY REPORT OF THE FOREST INSECT SURVEY, CENTRAL CANADA

By W. C. McGuffin and R. B. Barker,
Forest Insect Laboratory, Winnipeg, Manitoba.

INTRODUCTION

A great part of the boreal regions of Central Canada was sampled in 1946. This was made possible both by the fine work of the co-operators of Alberta, Saskatchewan and Manitoba, and by the active co-operation of officers of the Hudson's Bay Company. Increases, both in personnel and means of transportation, enabled the Winnipeg Laboratory to intensify greatly this reconnaissance in the three provinces during the 1946 season.

A total of 1,108 collections and 120 negative reports was received in 1946, representing an increase in the number of collections of 461 or 76 per cent over the number received in 1945. The collections were distributed among the provinces as follows: Manitoba, 643, Saskatchewan 235, Alberta 224, Ontario 1, Yukon 1, British Columbia 1, Northwest Territories 3. There were 46 co-operators in Manitoba, 30 in Saskatchewan and 29 in Alberta. The personnel from this laboratory (not included as co-operators) made 410 collections in Manitoba, 150 in Saskatchewan and 153 in Alberta.

The number of collections made from each of the more important tree species was as follows:--

Coniferous Host	Collections	Deciduous Host	Collections
White spruce	193	Poplar (all species)	143
Black spruce	33	Willow	107
Spruce (species not mentioned)	41	White birch	69
Balsam fir	47	Others	162
Tamarack	157		
Jack pine	109		
Lodgepole pine	46		
Red pine	1		
	627		481

GRAND TOTAL--1,108

A large number of poplar trees was sampled in the early part of the season. As a result, information was obtained on the following: the distribution of the tent caterpillar; the prevalence of the American poplar leaf beetle; and on parasitism of the aspen tortrix by parasites known to have as a host the spruce budworm. The results of the last study are to be published in the future in a separate paper.

The assistance provided by co-operators throughout Alberta, Saskatchewan and Manitoba and by officers of the Hudson's Bay Company, is gratefully acknowledged. R. R. Lejeune, Officer-in-Charge of the Winnipeg Laboratory, contributed the articles on the spruce budworm and the jack pine budworm and assisted greatly in the preparation of this report.

SPECIES CAUSING SERIOUS INJURY AT THE PRESENT TIME

Larch Sawfly (__Pristiphora erichsonii__ Htg.).--Although it maintained its position as one of the most important forest insects in the Prairie Provinces, the larch sawfly extended its range very little in Manitoba, but did appear in some new localities in Saskatchewan (see map). The forested areas of Alberta were not affected. → Forest Insect Survey (1946) P. 65

This sawfly was generally distributed throughout southern Manitoba wherever tamarack occurs. It was found in the Whiteshell Forest Reserve as light infestations at the following points: White Lake, Star Lake, Falcon Lake, Caddy Lake, Red Rock Lake, and Rennie. In the extreme south, the larch sawfly occurred at Piney, where it was heavy, and at Middlebro, where it was light. No reports were received on last year's infestation near the Dawson Cabin in the Sandilands Forest Reserve. In the vicinity of Seddon's Corner, near Whitemouth, the outbreak was heavier and more extensive than in 1945. Forest Ranger H. L. Kendrick mapped and reported this infestation. From tp. 17, rge. 8, E.P. mer., near Beaconia, Man., Forest Ranger B. Gilmore reported and submitted collections taken in a medium infestation. East of Lake Winnipeg, light infestations occurred at least as far north as Berens River. Near Bissett, there is an area of severe defoliation. Small populations of this sawfly occur near Norway House and on Elk Island in God's Lake. Although the tamarack of the Interlake area was in a greatly weakened state it still continued to sustain an attack of the larch sawfly. In 1946, it occurred at Riverton, Shorncliffe and Hodgson. One area near Shorncliffe suffered 80 per cent defoliation. In western Manitoba, the old outbreak in the Spruce Woods Forest Reserve has almost subsided. It is over-shadowed by that of Riding Mountain National Park. The most seriously affected areas in the Park were along the Norgate Road and near Lake Audy. Defoliation was approximately the same as last year near Moon Lake and near the P.O.W. Camp. Moderate to severe defoliation occurred in all tamarack stands in the Bird-tail Valley, around Gunn Lake, Tilson Lake, Kay's Lake and Crescent Lake in the western part of the Park. Park Warden John Hyska contributed important information regarding sawfly damage in this region. In 1946, the sawfly was very active in the Duck Mountain Forest Reserve, particularly in the northern part and in tamarack stands outside the Reserve between Renwer and Sclater. The tamarack in the Porcupine Forest near Mafeking is lightly defoliated. Just south of Overflowing River on The Pas highway, there is an infestation of the larch sawfly. The average defoliation throughout a strip 25 miles wide was approximately 45 per cent.

In Saskatchewan, the sawfly infestation contiguous with the Manitoba outbreak in the Duck Mountain area, i.e., around Madge Lake, Pelly, Ushta and north to Hudson Bay Junction, is still flourishing. Larch sawfly has also been found near Carrot River (tp. 50, rge. 11, W. 2nd mer.) where a light infestation was reported by Field Officer W. A. MacNeill. Just north of this outbreak, the sawfly occurred in tp. 53, rge. 11, W. 2nd mer. In Fort a la Corne Forest Reserve, this insect was found near English Cabin and in tp. 51, rge. 22, W. 2nd mer. Field Officer W. A. MacNeill made two collections of the sawfly, one in the Nisbet Forest Reserve, tp. 49, rge. 26, W. 2nd mer. and the other in tp. 50, rge. 24, W. 2nd mer. Two small collections were taken in the southern part of Prince Albert National Park.

	Collections
Manitoba..............................	60
Saskatchewan..........................	10

Jack Pine Budworm (Archips fumiferana Clem.).--Apart from a medium to heavy infestation in the Sandilands Forest Reserve and a small medium infestation in the Whiteshell Forest Reserve, Manitoba, this insect is either on the wane or absent (see map). The Sandilands infestation, however, covers practically the entire reserve with very heavy defoliation in the central portion north of Headquarters. Indeed, defoliation was so severe that some mortality or heavy terminal dying is anticipated. The Whiteshell infestation fringes the trans-Canada Highway from Rennie to the Manitoba-Ontario border, while a small outbreak at Seddon's Corner near Whitemouth continued at reduced intensity. A light population covering a small area was again present at Cowan, northeast of the Duck Mountain Forest Reserve. One larva of this insect was found near the Elk House Administration site of the Fort à la Corne Forest Reserve in Saskatchewan. One small collection was taken on lodgepole pine in Alberta, near the Clearwater Ranger Stations, 45 miles south of Rocky Mountain House.

	Collections
Manitoba..............................	12
Saskatchewan..........................	1
Alberta...............................	1

Spruce Budworm (Archips fumiferana Clem.).--The spruce budworm (see map) continued at its usual moderate to heavy intensity in the Spruce Woods Forest Reserve, Manitoba. Practically all white spruce stands throughout the area contained some budworm larvae with heavy defoliation being restricted to several widely scattered "islands". By far the heaviest feeding occurred in stands west of Carberry, south of the trans-Canada highway. Scotch and jack pine plantations in the midst of this heavy budworm area showed no defoliation. Several white spruce permanent sample plots were established in this locality to study the effects of defoliation and investigations were begun on the possibility of using biological control methods. A small infestation with a larval population of moderate numbers was discovered at Pine Ridge, about fifteen miles northeast of Winnipeg. Four collections were taken in and around Wasagaming. The expected increase in the spruce budworm population in eastern Manitoba failed to materialize, but continued vigilance to detect its presence is necessary. No collections of budworm were received nor was there any evidence of budworm feeding noted on spruce or balsam anywhere in eastern Manitoba between Lake Winnipeg and the Manitoba-Ontario border. No collections were received or signs of feeding reported from Alberta or Saskatchewan.

The threat of the spruce budworm in northwestern Ontario to the spruce and balsam forests of eastern Manitoba is still present. For that reason, foresters and fire rangers, whose duties take them through the country between Lake Winnipeg and the Ontario boundary, are urged to make collections from spruce, balsam and jack pine in that area, particularly in late June and early July.

	Collections
Manitoba............................	27

American Poplar Leaf Beetle (*Phytodecta americana* Schffr.).--While generally distributed throughout the southern part of the Prairie Provinces, this insect usually occurred in small numbers. However, in some areas, poplar was heavily defoliated by these beetles. In Manitoba, the only infestation of note was in the Duck Mountain Forest Reserve. Here the beetle population was heavier in the western part of the Reserve than it was in the eastern part. A population count (the number of adult beetles per square foot of "beating sheet") was as follows: 14 beetles per square foot of sheet in the southwest, 5 in the northwest, 4.5 in the northeast, and 8 in the southeast portion of the Reserve. The Duck Mountain infestation extended into Saskatchewan west to Pelly and Endeavour and north to within 10 miles of Hudson Bay Junction. At Endeavour, the trembling aspen trees were three-quarters defoliated. Near Rabbit Cabin in Prince Albert National Park, Warden E. L. Millard reported this pest in a small area of poplar. A heavy infestation was reported near Jackfish Lake, north of North Battleford. Field Officer J. H. Hodgins sent a collection accompanied by a report from Cypress Hills Park. Large areas of poplar in tp. 8, rge. 26, W. 3rd mer. were infested. Across the boundary in Alberta there was a sprinkling of this insect in the Cypress Hills area. Alberta had another small infestation near Crimson Lake, west of Rocky Mountain House.

	Collections
Manitoba............................	4
Saskatchewan........................	6
Alberta.............................	2

Forest Tent Caterpillar (*Malacosoma disstria* Hbn.).--In 1946, this tent caterpillar continued its advance eastward; it is now centred around the Narrows of Lake Winnipeg. Heavy defoliation occurred within a strip running northwest and southeast from Rosenburg. Surrounding this centre of heavy defoliation, there was an area of medium defoliation which became lighter on its outer boundaries. Little or no defoliation was noted west and northwest from Hodgson. On the peninsula between Washow and Fisher Bays, there was a "spotty" but heavy infestation. Poplar was heavily attacked around Lake St. George, on Moose Island and throughout a strip 20 miles long by 1½ miles wide, along the eastern shore of Lake Winnipeg, south of the Narrows. Since there was a light infestation at Berens River, it seems probable that the tent caterpillar was present along the shore line from Berens River to the Narrows. One larva was found at Little Grand Rapids, about 70 miles up the Berens River east of Lake Winnipeg.

Collections without reports of damage were received from Red Rock Lake in the Whiteshell Forest Reserve and from Whitemouth.

No collections were received from Saskatchewan and only one was sent in from Alberta (Coleman, Alta.).

	Collections
Manitoba..............................	3
Alberta...............................	1

SPECIES NOT CAUSING SERIOUS INJURY AT THE PRESENT TIME
BUT KNOWN TO BE CAPABLE OF DOING SO

Bark Beetles--Several localized infestations of bark beetles were reported from the plains region of Alberta. Timber Inspector T. R. Hammer sent in a sample of Ips sp. collected from dying white spruce at Grand Prairie. A beetle, Dendroctonus simplex Lec., was found in Siberian larch at the Oliver Nursery near Edmonton, but the infestation is believed to be of a secondary nature. At Embarras Portage in tp. 107, rge. 9, W. 4th mer., a large percentage of the timber was reported dead or dying. A sample of spruce from the area contained both bark beetles (Ips nr. perturbatus Eichh., Dryocoetes affaber Mann.) and ambrosia beetles (Trypodendron sp.). An investigation of this outbreak is planned for 1947. Both of the foregoing infestations were reported by the Director of Forestry for Alberta, T. F. Blefgen. In Saskatchewan, the only bark beetles received were removed from spruce windfalls at Prairie River. A large number of beetles, Dendroctonus sp., were found at Red Rock Lake in the Whiteshell Forest Reserve of Manitoba, but no signs of damage were detected.

	Collections
Manitoba..............................	1
Saskatchewan	1
Alberta................................	3

Black-headed Budworm (<u>Acleris variana</u> Fern.).--This insect was scattered lightly over Manitoba and eastern Saskatchewan. In Manitoba, three collections were made in the Spruce Woods Forest Reserve, one in the Turtle Mountain Forest Reserve, three in the Riding Mountain National Park and one near The Pas. One collection was sent in from each of the following places in Saskatchewan: Hudson Bay Junction, Prairie River and Amisk Lake.

	Collections
Manitoba..............................	8
Saskatchewan...........................	3

Large Aspen Tortrix (<u>Archips conflictana</u> Wlk.).--This pest of poplar was noticed in several areas during the season. The worst damage occurred in the Duck Mountain Forest Reserve and in the area between this reserve and Madge Lake in Saskatchewan. This leaf roller caused heavier damage in the western part of the reserve than in the eastern part, a marked degree of defoliation being present in the former. Field Officer A. J. Feusi submitted collections from poplar east of Madge Lake, Sask., and reported that some areas in this vicinity were completely stripped of foliage. He further reported that the larvae were feeding on willow and even on the new growth of white spruce. In addition, one collection was made in the Turtle Mountain Forest Reserve of Manitoba and another near Usherville, Sask. Two small infestations were sampled and reported in Alberta. One of these was in Waterton Lakes Park, along the Big Chief Highway in the vicinity of Waterton Lakes. Here, the trees were from an eighth to a quarter defoliated. The other infestation was in the Castle River District near Coleman. Situated in tp. 6, rge. 2, W. 5th mer., this infestation extended along both sides of the Burmis Road and the Castle River. Average defoliation was about a sixteenth of the total foliage.

	Collections
Manitoba..............................	7
Saskatchewan...........................	6
Alberta................................	3

White Pine Weevil (<u>Pissodes</u> <u>strobi</u> Peck).--Light damage from localized infestations of this weevil was observed near the Prisoner of War camp in Riding Mountain National Park. In Saskatchewan, weevil damage was observed just north of Waskesiu on the Hanging Heart Road of Prince Albert National Park, at Amisk Lake, at MacDowall, and in the southern half of the Meadow Lake Forest Reserve. In Alberta, an infestation of the Engelmann spruce weevil (<u>Pissodes</u> <u>engelmanni</u> Hopk.) was found on Engelmann spruce in Waterton Lakes National Park.

	Collections
Manitoba................................	1
Saskatchewan............................	4
Alberta.................................	1

Bronze Birch Borer (<u>Agrilus</u> <u>anxius</u> Gory).--An initial survey of the damage by the bronze birch borer was made in Saskatchewan and Alberta. In Prince Albert National Park, 30 per cent of the white birch trees along the road between Waskesiu and Hanging Heart Lakes were dead or dying. In Alberta, damage damage from this insect was noted all along the road from Kinuso (south of Lesser Slave Lake) to Westlock (northwest of Edmonton). Since it is prevalent in these two areas, this borer is probably present in infestation proportions in other parts of these provinces, and in Manitoba as well.

	Collections
Saskatchewan............................	1
Alberta.................................	1

Poplar Borer (<u>Saperda</u> <u>calcarata</u> Say).--Two infestations of this insect were found in Alberta. One of these was near Kananaskis (tp. 24, rge. 8, W. 5th mer.) and the other was on Deadman's Flats, near Canmore. The latter infestation, reported by Forest Ranger J. Kovach, bore a heavy population of borers; many trees were already dead.

	Collections
Alberta.................................	2

Balsam Fir Sawfly (<u>Neodiprion</u> <u>abietis</u> Harr.).--Although 24 collections of this insect were obtained in 1946, no reports of damage were received. In Manitoba, this pest was found at Grandview, Bield, Garland, Moose Lake, Stupart Lake, Riverton, Ashern, Hodgson, Bissett, Red Rock Lake, Basaginnigak Lake, Wasagaming, Thicket Portage and Cross Lake. The six Saskatchewan collections were sent from the Fort à la Corne Forest Reserve, Nipawin, Waskesiu, Amisk Lake and Loon Lake. One collection only was taken in Alberta, at Waterton Lakes.

	Collections
Manitoba..............................	17
Saskatchewan..........................	6
Alberta...............................	1

Cankerworms (*Alsophila pometaria* Harr. and *Paleacrita vernata* Peck).--The damage from cankerworms to trees in the city of Winnipeg, although severe, in places, was not so heavy in 1946 as it was in 1945.

	Collections
Manitoba..............................	8

Hemlock Looper (*Lambdina fiscellaria* Guen.).--Only 7 collections of this insect were received in 1946; all of these came from Manitoba (Bield, Wasagaming, Moose Lake near The Pas, Berens River and Falcon Lake).

	Collections
Manitoba..............................	7

Spotless Fall Webworm (*Hyphantria textor* Harr.).--Collections of this insect were made in Manitoba at Riverton, Ashern and Hodgson in the Interlake country and at Whitemouth and Red Rock Lake in the area of the Whiteshell Forest Reserve. The Ashern collection was taken on willow, the others on Manitoba maple.

	Collections
Manitoba..............................	5

Spiny Elm Caterpillar (*Nymphalis antiopa* L.).--No reports or collections of this insect were received in 1946.

Poplar Vagabond Aphid (*Mordwilkoja vagabunda* Walsh). --Three collections were received from Manitoba (Duck Mountain Forest Reserve and Hodgson), one from Saskatchewan (Prince Albert National Park) and one from Alberta (Rocky Mountain House).

	Collections
Manitoba	3
Saskatchewan	1
Alberta	1

Pine Tortoise Scale (Toumeyella sp.).--This scale appears to have killed a large number of jack pine seedlings in the southern part of the Sandilands Forest Reserve of Manitoba. The main area of infestation is in townships 4 and 5, flanking the line between ranges 9 and 10. Small, scattered infestations exist in tp. 6, rge. 10, E.P. mer. A small outbreak was found near Piney, Man., on the Red Pine Reserve. In Saskatchewan, a collection was taken near Prince Albert in the Nisbet Forest Reserve; in this area the scale population was below normal.

	Collections
Manitoba	3
Saskatchewan	1

MINOR FOREST AND SHADE TREE INSECT PESTS

Ugly-nest Caterpillar (Archips cerasivorana Fitch).--This insect was distributed generally throughout southern Manitoba, but in no instance was it reported in infestation proportions. Collections were received from Bird's Hill, Turtle Mountain Forest Reserve, Spruce Woods Forest Reserve, Porcupine Forest Reserve, Riding Mountain National Park, The Pas, Bissett and Riverton. One collection, made at Crutwell, Saskatchewan, was from a light and localized outbreak. Several nests of the caterpillar were reported near Nipawin.

	Collections
Manitoba	14
Saskatchewan	1

Pitch Nodule Maker (Petrova albicapitana Busck).--Collections of this pest were received from Piney, Sandilands Forest Reserve (where a light infestation exists), Rennie and from Gypsumville in Manitoba. In Saskatchewan, two collections were received from the Nisbet Forest Reserve, one from Prince Albert National Park and one from Fox Lake, near Amisk Lake. All Manitoba and Saskatchewan collections were from jack pine. The Alberta collections, all from lodgepole pine, were made in the Oliver Nursery near Edmonton, at Edson, and at Coleman.

	Collections
Manitoba............................	5
Saskatchewan........................	4
Alberta.............................	3

Pine Needle Scale (<u>Chionaspis</u> <u>pinifoliae</u> Fitch).--Two infestations of this insect were reported in 1946, both in Manitoba. One of these was at Swan River, where four spruce trees were infested; the other was on a golf course near Winnipeg, where all the white spruce trees were severely attacked.

	Collections
Manitoba............................	2

Spruce Gall Aphid (<u>Adelges</u> <u>abietis</u> L.).--Fifteen collections of this insect were received in 1946 without any reports of severe damage. In Manitoba, the collections were received from Wasagaming, Gypsumville and Fort Garry. Those from Saskatchewan came from Emma Lake, Waskesiu, Fort à la Corne Forest Reserve, Dorintosh, Amisk Lake, Mosher Lake, Hudson Bay Junction and Battle Heights. In Alberta, this pest was found at Entrance, Cooking Lake and Slave Lake.

	Collections
Manitoba............................	3
Saskatchewan........................	9
Alberta.............................	3

Yellow-headed Spruce Sawfly (<u>Pikonema</u> <u>alaskensis</u> Roh.).--In many parts of the Prairie Provinces this insect caused severe defoliation of cultivated spruce. It was generally distributed also throughout the forested areas although not in significant numbers.

In Manitoba, collections were received from Riding Mountain National Park, Grandview, Deepdale, Sasaginnigak Lake, Bield, Whitemouth, Ethelbert, Garland, Bird's Hill, The Pas, Riverton and Moose Lake. The Saskatchewan collections came from Loon Lake, Amisk Lake, Green Lake, Nipawin, Glaslyn, Love, Battle Heights, Prince Albert National Park and the following Forest Reserves: Nisbet, Fort à la Corne, Keppel, Meadow Lake and Big River. Only two collections were taken in Alberta; one at the Clearwater Station, south of Rocky Mountain House and the other at Edson.

	Collections
Manitoba.........................	25
Saskatchewan.....................	37
Alberta..........................	2

Western Willow Leaf Beetle (Galerucella decora Say).--The beaked willow, Salix bebbiana, of central Saskatchewan, was attacked by this beetle in 1946. In great areas of townships 40 to 60, the willow foliage was skeletonized to a burned-over appearance. Field Officer T. A. Shannon reported it in townships 42 and 43, ranges 8 and 9 W. 2nd mer. Field Officers O. Otterbein and W. MacNeill made collections and reported that the leaves were skeletonized and brown in areas east of Carrot River. There were heavy attacks north of Waskesiu in Prince Albert National Park. Field Officer A. Hansen noticed heavy damage in the Glaslyn area and Field Officer A. A. B. Benson indicated that this infestation extended north to township 54 and south to Jackfish Lake between Glaslyn and North Battleford.

In Manitoba, one adult was found in the Duck Mountain Forest Reserve. A few "browned" areas were seen in Alberta; one of these was near Chip Lake, between Edson and Edmonton and the others were between Sylvan Lake and Calgary.

	Collections
Manitoba.........................	1
Saskatchewan.....................	6

Pitch Midge (Retinodiplosis sp.).--Only one collection of this insect was received in 1946; it occurred on jack pine near Piney, Manitoba (tp. 1, rge. 12, E.P. mer.).

	Collections
Manitoba.........................	1

BENEFICIAL INSECTS

In 1946, shipments of a fly, Sturmia sp., which is parasitic on the yellow-headed spruce sawfly, were released at Pine Ridge, Sasaginnigak Lake, Rennie, Whitemouth, Fort Garry, Sandilands Forest Reserve and Riding Mountain National Park. It is hoped that this parasite will become established and, in time, exercise some measure of control on this pest of planted spruce.

A survey of the parasites of the European larch sawfly initiated in 1945, was expanded in 1946 to include several more infestation areas in Manitoba. Parasitism by the European species, <u>Mesoleius aulicus</u> Grav., was determined by dissection of sawfly larvae. In Riding Mountain National Park, where tamarack is currently undergoing a heavy sawfly attack, the rate of parasitism was 16 per cent. However, the parasitism varied greatly in different areas, ranging from 2 to 55 per cent. <u>Mesoleius</u> was widely distributed through other areas of Manitoba, but parasitized less than 4 per cent of the cocoons examined. The effectiveness of this parasite in controlling the sawfly is placed in doubt by recent studies which indicate that only about 10 per cent of the parasites survive to kill their hosts. Larvae of a parasitic fly, <u>Bessa harveyi</u> Tns., were encountered during the survey in sawfly larvae from Riding Mountain National Park and Riverton.

Two species of spruce budworm parasites were released during the season in the Spruce Woods Forest Reserve. One was the parasitic fly, <u>Ceromasia auricaudata</u> Tns., and the other was <u>Phytodietus fumiferanae</u> Roh., a parasite successfully used in British Columbia.

Studies now in progress show that parasitism of the spruce budworm (<u>Archips fumiferana</u> Clem.) in the Spruce Woods Forest Reserve was high both in the larval and pupal stages. Thirty-one per cent of larvae were parasitized by the two hymenopterous species, <u>Apanteles fumiferanae</u> Vier. and <u>Glypta fumiferanae</u> Vier. No evidence of parasitism by Diptera was found in the larval stage of the budworm. Forty-one per cent of the pupae collected in the area were parasitized, the principal agent being <u>Itoplectis conquisitor</u> Say.

Also noteworthy in the Spruce Woods Forest Reserve was the activity of a predator on the budworm. Large numbers of larvae of the spruce foliage worm, Dioryctria reniculella Grt., were observed feeding on both larvae and pupae of the budworm, and many pupae, partially eaten, were seen on the foliage.

Parasitism of jack pine budworm pupae at Red Rock Lake in the Whiteshell Forest Reserve was only 14 per cent, of which the hymenopterous parasite, Phaeogenes hariolus Cress., caused 9 per cent. In the Sandilands Forest Reserve, pupal parasitism by all agents amounted to 19 per cent, mainly attributable to Itoplectis conquisitor Say and to several species of parasitic flies.

LIST OF CO-OPERATORS IN THE FOREST INSECT SURVEY
CENTRAL CANADA - 1946

NAME	COLLECTIONS
Abra, H.	2
Anderson, A.	157
Anderson, O.	2
Arlidge, A.	2
Bainbridge, A.	3
Balchen, B.	1
Barker, R.	13
Bates, G.	5
Bayson, L.	2
Beaudoin, F.	3
Bennett, R.	4
Benson, A.	2
Berck, B.	1
Berens, B.	3
Binkley, D.	4
Black, W.	25
Blefgen, T. F.	6
Boulton, J. H.	1
Bowman, A.	1
Bradshaw, F.	1
Brandt, A.	1
Bridgman, E. F.	39
Brown, R.	2
Buck, D.	6
Campbell, E.	1
Campbell, F.	2
Champion, J.	1
Chapman, G.	4
Cherrett, M.	7
Clark, J.	25
Clee, J.	25
Coats, J.	18
Cook, T.	150
Cooper, D. E.	9
Coupland, A.	3
Cox, S. P.	1
Criddle, S.	1
Davies, G.	13
Dobie, J. L.	1
Dougall, S.	2
Drouin, J. A.	157
Dunlop, C.	4
Dunn, C.	1
Durant, P.	3
Eley, G. M.	2
Ellison, D.	2
Emes, B.	1
Enwright, C.	12
Evans, G.	3
Feusi, A.	4
Filuk, B.	15
Frew, B.	3
Fyfe, H.	34
Gilmore, B.	1
Goodison, J.	6
Hackett, J.	1
Hammer, T.	1
Hanson, A.	2
Harrison, L.	1
Hensley, C. A. E.	1
Heron, R. J.	36
Hildahl, V.	155
Hodgins, J.	2
Hogan, P. C.	36
Holden, G.	1
Horne, L. S.	5
Hyska, J.	4
Janssen, J.	5
Jervis, F.	2
Jewesson, R.	2
Johnson, A.	1

A. Status 1946

1. Jack pine budworm (*Archips fumiferana* Clem.) (Fyfe)

Apart from a medium to heavy infestation in the Sandilands Forest Reserve, and a small medium infestation in the Whiteshell Forest Reserve, Manitoba, this insect is either on the wane or absent. The Sandilands infestation, however, covers practically the entire reserve with very heavy defoliation in evidence in the central portion north of Headquarters. Indeed, defoliation was so severe that some mortality or heavy stagging is anticipated. The Whiteshell infestation fringes the trans-Canada Highway from Rennie to the Manitoba-Ontario border, while a small outbreak at Seddon's Corner continued at reduced intensity. A light population covering a small area was again present at Cowan, northeast of the Duck Mountain Forest Reserve. One larva of this insect was found near the Elk House Administration site of the Fort a la Corne Forest Reserve in Saskatchewan. One small sample was found on lodgepole pine in Alberta, near the Clearwater Ranger Station, 45 miles south of Rocky Mountain House.

2. Spruce budworm (*Archips fumiferana* Clem.) (Filuk)

The spruce budworm continued at its usual moderate to heavy intensity in the Spruce Woods Forest Reserve, Manitoba. Practically all white spruce stands throughout the area contained some budworm larvae with heavy defoliation being restricted to several widely scattered "islands". By far the heaviest feeding occurred in stands west of Carberry, south of the trans-Canada highway. Scotch and jack pine plantations in the midst of this heavy budworm area were completely free of defoliation. Several white spruce permanent sample plots were established in this locality to study the effect of defoliation, and investigations on the possibility of using biological control methods were begun. A small infestation in moderate numbers was discovered at Pine Ridge, about 15 miles northeast of Winnipeg. Four samples were found in and around Wasagaming. The expected increase in the spruce budworm population in eastern Manitoba failed to materialize, but continued vigilance to detect its presence is necessary. No samples of budworm were received, nor was any evidence of budworm feeding noted on spruce or balsam anywhere in eastern Manitoba between Lake Winnipeg and the Manitoba-Ontario border. No samples or signs of feeding were reported for Alberta or Saskatchewan.

B. Biological Control of Archips Fumiferana Clem.

1. Budworm Pupal Survey

(a) Introduction.

In 1946 collections of budworm pupae for this survey were confined to Manitoba areas of infestation. The East Hawk Lake infestation which had been sampled every year since the inception of the survey could not be included this year owing to the scarcity of pupae in the region. All pupae were collected by the staff of the Winnipeg laboratory.

(b) Areas Contributing:

The number of study areas was reduced to three in 1946. Collections were continued from Sandilands Forest Reserve and from Spruce Woods Forest Reserve. A collection was made for the first time near the new field station of the Winnipeg Laboratory at Red Rock Lake in the Whiteshell Forest Reserve. Pupae from Sandilands and Whiteshell Forest Reserves were of the jack pine form.

Spruce budworm were collected in four separate regions of the Spruce Woods Forest Reserve where a moderate to heavy infestation is present. Separate records were kept for each region and the information about parasites of the budworm thus obtained will be incorporated in a biological survey of the Reserve commenced in 1946. The four regions which were sampled were located in the Reserve as follows:

Area A_1 - in the north-western part of the Reserve, near Onah
Area A_2 - in the north-western part of the Reserve, near Onah
Area B_2 - on the northern boundary of the Reserve, near Carberry
Area C_1 - centrally located in the western part of the Reserve

Areas B_2 and C_1, furthest separated of the areas, were approximately 10 miles apart.

For purposes of comparison with the results of former years, it should be noted at Area C_1, known as the site of original infestation, was the approximate source of all former collections of pupae made in Spruce Woods.

Table I indicates the source and number of pupae received in 1946.

TABLE I

Source and Number of Pupae Received in the 1946 Budworm Parasite Survey

Locality	Collector	Service or Company	No. of Collections	No. of Pupae
SPRUCE BUDWORM				
Spruce Woods Forest Reserve		Forest Insect Investigations		
Area A_1	R.J.Heron, B.Filuk		1	223
Area A_2	R.R.Lejeune, H.R.Wong	"	1	218
Area B_2	R.B.Barker	"	1	1614
Area C_1		"	1	188
Total for Reserve				2,243
JACK PINE BUDWORM				
Sandilands Forest Reserve	W.C.McGuffin, B.Filuk	"	1	561
Whiteshell Forest Reserve, Red Rock Lake	R.R.Lejeune, H.R.Wong R.B.Barker, W.F.Black H.Fyfe, J. Coats	"	1	653
Totals				3,457

(c) Organization:

The revised "Directions for the Budworm Pupal Survey" which was included in the 1944 Annual Report, Pages 39 to 49, was followed for procedure in 1946.

(d) Analysis of Data:-

(i) Parasites reared

The following parasites were reared from budworm pupae in 1946. The species are listed in order of abundance.

HYMENOPTERA

Itoplectis conquisitor (Say)
Phaeogenes hariolus Cress.
Amblymerus verditer Nort.
Psychophagus tortricis Br.
Tetrastichus sp.
Brachymeria compsilurae (Cwfd.)

In addition there were several specimens of an unidentified chalcid.

DIPTERA

Phryxe pecosensis (Tns.)
Zenillia caesar Ald.
Madremyia saundersii (Will.)
Nemorilla pyste Wlk.

The areas in which each species of dipterous parasite was recovered are listed below. All adult Diptera have been identified but there still remains a number of unidentified puparia which, after being placed in cold storage last October, are now being incubated for emergence.

Species	Sandilands For. Res.	Spruce Woods Forest Res.	Whiteshell For. Res.
Phryxe pecosensis (Tns.)	-	x	x
Zenillia caesar Ald.	X	x	x
Madremyia saundersii (Will.)	x	x	-
Nemorilla pyste Wlk.	-	-	x

(ii) Pupal parasitism for 1946:

Table 2, which follows, shows the relative parasitism according to area. Only the mortality caused by parasites is taken into consideration, and parasitism percentages are based on the total number of pupae received * minus those dead from other causes. Methods used in the calcuation of parasitism and natural mortality follow those used in 1942 which are set forth in the 1942 Annual Report, page 26.

Table 2 shows the percentage of pupae parasitized by chalcids, but not the actual numbers which emerged from the pupae. These figures are given in Table 3, which shows in addition the occurrence of species in each area.

* For Spruce Woods Forest Reserve the number of pupae received was reduced by the number of pupae damaged by a predator *Dioryctria reniculella* Grt. Predation by this species was not seen in other areas.

TABLE 2

PERCENTAGE MORTALITY OF PUPAE FROM THE 1946 BUDWORM SURVEY

Area of Manitoba	*Itoplectis conquisitor*	*Phaeogenes hariolus*	Diptera	Chalcids	Miscellaneous Hym.	Total
SPRUCE BUDWORM						
Spruce Woods For.Res.						
Area A_1	42.16	5.42	12.04	1.20	--	60.84
Area A_2	39.22	3.26	19.60	3.92	--	66.01
Area B_2	40.54	.82	8.18	1.57	--	51.11
Area C_1	27.68	2.68	13.39	10.71	--	54.46
All areas combined	39.71	1.64	9.99	2.37	--	53.71
JACK PINE BUDWORM						
Sandilands Forest Res.	15.81	3.44	9.62	1.03	--	29.90
Whiteshell For.Res. Red Rock Lake	2.09	9.39	2.78	0.70	--	14.96

TABLE 3

Chalcids Reared From 1946 Budworm Pupal Survey

Species	Area	No. of Chalcids	Average No. per parasitized pupa
Amblymerus verditer Nort.	Spruce Woods Forest Res.		
	Area A_1	14	7
	Area A_2	15	3
	Area B_2	82	-*
	Area C_1	143	13
	Sandilands Forest Res.	12	4
	Whiteshell Forest Res. Red Rock Lake	24	24
Psychophagus tortricis Br.	Spruce Woods For. Res.		
	Area A_2	11	11
	Area B_2	16	-*
Brachymeria compsilurae Cwfd.	Whiteshell Forest Res. Red Rock Lake	3	-*
Tetrastichus sp.	Spruce Woods For.Res. Area C_1	4	4
Unidentified Chalcid	Whiteshell Forest Res. Red Rock Lake	3	-*

* Average number of chalcids per parasitized pupa could not be determined.

Spruce budworm pupae in Spruce Woods Forest Reserve suffered mortality due to parasites to the extent of 53.71% over the entire area with individual regions ranging from a 51.11% to a 66.01% mortality. (These percentages are based on the total number of pupae received minus those dead from other causes as 100%.) Comparison with mortality in 1945 is possible in only one area. Known as the original area of infestation, C_1, it had a pupal parasitism in 1945 of 18.62% and in 1946, 54.46%. Itoplectis conquisitor Say was the principal parasitic species in the reserve, and dipterous parasites of several species were next in importance. Phaeogenes hariolus Cress remained at a low level, but shows evidence of increased abundance compared to former years. The chalcids, Amblymerus verditer Nort, Psychophagus tortricis Br. and Tetrastichus sp. caused little mortality except in area C_1 (10.71%).

The parasite complex was similar in each of the four areas in the Spruce Woods with the exception of the "original" area C_1 where Itoplectis parasitism was lower than average, and Chalcid parasitism (chiefly due to Amblymerus) was higher. The ichneumons, Itoplectis and Phaeogenes, and the chalcid Amblymerus were common to all areas. Two other chalcids occurred only in certain areas, Psychophagus was confined to Areas A2 and B_2 and Tetrastichus to Area C_1. Since only a small percentage of the dipterous parasites matured to be identified, a statement of distribution of species in each area would be of doubtful value. Zenillia caesar Ald., Phryxe pecosensis (Tns.) and Madremyia saundersii (Will.) were identified from Spruce Woods.

Jack pine budworm pupae from Sandilands Forest Reserve were 29.90% parasitized, according to Table 2. Parasitism here was chiefly by Itoplectis. Next in importance were diptera of which Zenillia and Madremyia were identified. Phaeogenes and Amblymerus caused only a low mortality rate. Pupae from Red Rock Lake in the Whiteshell Forest Reserve were parasitized to the extent of 14.96%, principally by Phaeogenes. Mortality due to Itoplectis and to diptera of several species was about equal. The chalcid parasites, Amblymerus, Brachymeria compsilurae Cwfd., and an unidentified species caused less than 1% mortality.

(iii) Natural Mortality of pupae: A number of dead pupae from which no emergence of moths or parasites had taken place remained in the rearing cages after emergence was completed. The number and percentage of unemerged pupae in each area is shown in Table 4.

TABLE 4

Natural Mortality of Pupae Received in 1946

Area	No. of pupae in sample	No. of unemerged pupae	% Unemerged pupae
*Spruce Woods Forest Reserve			
Area A_1	204	38	18.63
Area A_2	199	46	23.12
Area B_2	1573	360	22.92
Area C_1	174	62	35.63
Sandilands Forest Reserve	561	270	48.13
Whiteshell Forest Reserve Red Rock Lake	653	78	11.94

* In Spruce Woods Forest Reserve, the number of pupae in the sample does not include pupae damaged by the predator, *Dioryctria reniculella* Grt.

An examination was made of the pupae referred to in Table 4. The condition of the pupae is recorded in Table 5. Here "parasitized" refers to pupae containing dead parasites which were identified as shown. Those containing unknown hymenopterous parasites could not be identified specifically because of the immature condition of the parasites. (They were probably *Itoplectis* or *Phaeogenes*. Only one unemerged pupa contained dead chalcids.) "Injured" refers to a small number of pupae which showed mechanical injury. "Containing moths" refers to pupae containing fully-formed moths. "Shrivelled" pupae were small and dry. "Diseased" pupae, recovered from the Red Rock area only, showed pink coloring inside. (Identification of the organism responsible was not made.) "Empty" pupae were hollow but normal in size and shape. "Fungus" refers to pupae supporting a fungus growth. (Only one such pupa was observed.)

TABLE 5

Condition of all Unemerged Pupae *

AREA	% Parasitised						Injured	Containing Moths	Shrivelled	Diseased	Empty	Fungus
	By Itoplectis	By Phaeogenes	By Unknown Hym.	By Diptera	By Chalcids	By TOTAL						
SPRUCE WOODS Forest Reserve												
Area A_1	0.00	0.00	2.63	10.53	0.00	13.16	0.00	7.89	65.79	0.00	13.16	0.00
Area A_2	0.00	0.00	2.17	23.91	0.00	26.08	2.17	2.17	63.04	0.00	6.52	0.00
Area B_2	0.28	0.00	0.55	5.00	0.00	5.83	0.00	4.17	73.89	0.00	16.11	0.00
Area C_1	1.61	0.00	1.61	11.29	1.61	16.13	0.00	9.68	67.74	0.00	6.45	0.00
SANDILANDS Forest Reserve	0.37	0.00	0.37	4.07	0.00	4.81	2.59	42.22	47.78	0.00	2.22	0.37
WHITESHELL Forest Reserve RED ROCK LAKE	0.00	6.41	2.56	7.69	0.00	16.67	1.28	2.56	71.79	5.13	2.56	0.00
AVERAGE *						8.66	1.05	16.51	64.05		9.13	

* Not including pupae killed by <u>Dioryctria reniculella</u> Grt.

A considerable percentage (5% to 26%) of the unemerged pupae in each area were parasitized. Although the parasites failed to emerge, their presence was undoubtedly a factor in mortality of these pupae. Table 6 shows the percentage of pupae in each area which were parasitized. The percentages are based on the number of pupae from which parasites emerged plus the number of dead pupae which contained unemerged parasites.

When percentages of Table 6 and Table 10 (given later) are compared, it is observed that the greatest difference in percentage of parasitism occurred with the Diptera. This indicates that rearing conditions employed have a more pronounced effect on the mortality of dipterous parasites than on the other kinds which were present. Table 10 thus presents a somewhat distorted picture of relative parasitism by Ichneumonoidea, Chalcidoidea and Diptera.

TABLE 6

Percentage Parasitism of all Pupae in 1946

Area	*Itoplectis conquisitor*	*Phaeogenes hariolus*	Unidentifiable Hymenoptera	Diptera	Chalcids	Total Parasitized
SPRUCE WOODS For. Res.						
Area A_1	34.31	4.41	0.49	11.76	0.98	51.96
Area A_2	30.15	2.51	0.50	20.60	3.02	56.78
Area B_2	31.32	0.64	0.13	7.44	1.21	40.74
Area C_1	18.39	1.72	0.57	12.64	7.47	40.80
All areas combined	30.44	1.26	0.24	9.49	1.86	43.30
SANDILANDS Forest Res.	8.38	1.78	0.18	6.95	0.53	17.82
WHITESHELL Forest Res. Red Rock Lake	1.84	9.03	0.31	3.36	0.61	15.16

(iv) Other host-parasite relations of the budworm pupal survey: A number of tables follow which deal with other host-parasite relations. Similar data are tabulated in all annual reports since the inception of the survey, and the methods followed in compiling the tables remain the same as those outlined in the 1941 Annual Report, Page 69. It should be noted, however, that for the Spruce Woods Forest Reserve, the total number of pupae on which the tables are based does not include those pupae which were killed by the predator, Dioryctria reniculella Grt. (Tables 8, 9 and 10).

Table 11 shows the sex ratios of Archips fumiferana pupae, Phaeogenes hariolus and Itoplectis conquisitor in 1946. Natural dead pupae were excluded from the computations. Table 12 shows the sex ratios of Itoplectis conquisitor and Phaeogenes hariolus which emerged from male and female pupae of Archips fumiferana.

TABLE 8

Percentage Mortality of Male Pupae in 1946

Area	Itoplectis conquisitor	Phaeogenes hariolus	Diptera	Chalcids	Miscell.	Total parasitized	Natural Dead	Total Mortality
SPRUCE WOODS Forest Reserve								
Area A_1	34.69	7.14	11.22	1.02	---	54.08	18.37	72.45
Area A_2	37.89	0.00	11.58	5.26	---	54.74	21.05	75.79
Area B_2	32.50	0.36	7.12	2.14	---	42.11	22.66	64.77
Area C_1	19.32	2 .27	6.82	9.09	---	37.50	37.50	75.00
All areas combined	32.12	1.07	7.83	2.84	---	43.86	23.31	67.17
SANDILANDS Forest Reserve	7.19	2.94	5.88	0.65	---	16.66	43.46	60.12
WHITESHELL Forest Reserve RED ROCK LAKE	2.82	12.54	3.13	0.62	---	19.12	14.73	33.85

TABLE 9

Percentage Mortality of Female Pupae in 1946.

Area	*Itoplectis conquisitor*	*Phaeogenes hariolus*	Diptera	Chalcids	Miscell. Hym.	Total parasitized	Natural Dead	Total mortality
SPRUCE WOODS Forest Reserve								
Area A_1	33.96	1.89	8.49	.93	----	45.28	18.87	64.15
Area A_2	23.08	4.81	18.27	.96	---	47.11	24.99	72.11
Area B_2	29.81	.96	5.36	.14	---	36.26	23.21	59.47
Area C_1	16.27	1.17	10.46	4.65	---	32.55	33.71	66.27
All areas combined	28.41	1.46	7.42	.68	---	37.99	23.83	61.82
SANDILANDS Forest Reserve	9.41	.39	3.92	.39	---	14.11	53.72	67.83
WHITESHELL Forest Reserve RED ROCK LAKE	.90	4.19	1.80	.60	---	7.48	9.28	16.76

TABLE 10

Percentage Mortality of All Pupae in 1946

Area	*Itoplectis conquisitor*	*Phaeogenes hariolus*	Diptera	Chalcids	Miscell. Hym.	Total parasitized	Natural Dead	Total mortality
SPRUCE WOODS Forest Reserve								
Area A_1	34.31	4.41	9.80	0.98	---	49.50	18.63	68.14
Area A_2	30.15	2.51	15.07	3.02	---	50.75	23.12	73.86
Area B_2	31.25	0.64	6.30	1.21	---	39.40	22.92	62.32
Area C_1	17.81	1.72	8.62	6.89	---	35.06	35.63	70.69
All areas combined	30.35	1.26	7.63	1.82	---	41.06	23.56	64.62
SANDILANDS Forest Reserve	8.19	1.78	4.99	0.53	---	15.50	48.13	63.63
WHITESHELL Forest Reserve RED ROCK LAKE	1.84	8.27	2.45	0.61	---	13.17	11.94	25.11

TABLE 11

Sex Ratios of *Archips fumiferana*, *Itoplectis conquisitor* and *Phaeogenes hariolus* for the 1946 Pupal Survey

Area	Sex Ratio of *Archips fumiferanae*	Sex Ratio of *Itoplectis conquisitor*	Sex Ratio of *Phaeogenes hariolus*
SPRUCE WOODS Forest Reserve			
Area A_1	.503	.543	.222
Area A_2	.541	.583	.800
Area B_2	.458	.407	.600
Area C_1	.500	.613	1.000
All areas combined	.474	.448	.555
SANDILANDS Forest Reserve	.405	.739	.200
WHITESHELL Forest Reserve Red Rock Lake	.527	.250	.407
TOTAL	.478	.463	.428

Table 12

Sex Ratios of *Itoplectis conquisitor* and *Phaeogenes hariolus* reared from male and female pupae of *Archips fumiferana*.

Area	Male Pupae		Female Pupae	
	Itoplectis conquisitor	*Phaeogenes hariolus*	*Itoplectis conquisitor*	*Phaeogenes hariolus*
SPRUCE WOODS Forest Reserve				
Area A_1	.294	.286	.777	.000
Area A_2	.417	.000	.833	.800
Area B_2	.321	.000	.516	.857
Area C_1	.353	1.000	.928	1.000
All areas combined	.330	.333	.594	.733
SANDILANDS Forest Reserve	.636	.111	.800	1.000
WHITESHELL Forest Reserve RED ROCK LAKE	.222	.250	.333	.857
TOTAL	.344	.246	.610	.800

(v) Pupae killed by a predator: Notable in the Spruce Woods Forest Reserve was the activity of the larvae of the Spruce foliage worm, *Dioryctria reniculella* Grt. as a predator of spruce budworm larvae and pupae. When the collections of pupae were made for this survey, large numbers of these pyralid larvae were seen on the foliage engaged in feeding on the budworm. No quantitative sampling to determine the extent of their predation was done at this time, but a number of pupae damaged by *Dioryctria* were later found among the pupae collected for rearing. Percentages of such pupae in each area are given below:

Area A_1	8.5%
Area A_2	8.7%
Area B_2	2.7%
Area C_1	7.4%

These percentages cannot be taken as indices of predation in these areas. In area B_2, damaged pupae were avoided in the collecting but in the other areas, collections were made with less prejudice to include both damaged and undamaged pupae as they occurred.

Observations on populations and food preferences of *Dioryctria reniculella* Grt. are contained under "Biological Control Studies in Spruce Woods," (Page 128) of this report.

A late spring frost, which occurred in the Spruce Woods area, resulted in damage to foliage of the terminal shoots of spruce. The consequent reduction of food available to the larva of *Dioryctria* may have been a factor in diverting the larva from its usual phytophagous habits to entomophagous habits. A combination of a shortage of its usual food and a high concentration of budworm on the foliage, or the latter condition alone, may have been responsible for the predation.

(e) Summary:

2,243 spruce budworm pupae and 1,214 jack pine budworm pupae were collected for parasite emergence. The following parasites were reared from this material:

HYMENOPTERA

- *Itoplectis conquisitor* (Say)
- *Phaeogenes hariolus* Cress.
- *Amblymerus verditer* Nort.
- *Psychophagus tortricis* Br.
- *Tetrastichus* sp.
- *Brachymeria compsilurae* (Cwfd.)
- An unknown chalcid species.

DIPTERA

- *Phryxe pecosensis* (Tns.)
- *Zenillia caesar* Ald.
- *Madremyia saundersii* (Will.)
- *Nemorilla pyste.* Wlk.

Parasitism in each area is shown in a number of tables which are included in this report.

Pupal mortality from both parasitism and other causes in the three study areas is given below:

Area	% Parasitism	% Natural Mortality	% Total Mortality
SPRUCE WOODS Forest Reserve			
Area A_1	49.50	18.63	68.14
Area A_2	50.75	23.12	73.86
Area B_2	39.40	22.92	62.32
Area C_1	35.06	35.63	70.69
All areas	41.06	23.56	64.62
SANDILANDS Forest Reserve	15.50	48.13	63.63
WHITESHELL Forest Reserve	13.17	11.94	25.11

Of the hymenopterous parasites, Itoplectis, Phaeogenes and Amblymerus were recovered from all study areas. Itoplectis caused the greatest mortality of any parasite in Spruce Woods and Sandilands Forest Reserve. In the Whiteshell Forest Reserve, Phaeogenes surpassed Itoplectis as a mortality factor. Of the four species of diptera recovered and identified, only Zenillia was common to all study areas. Diptera of several species were next in importance to Itoplectis in Spruce Woods and Sandilands Forest Reserve.

Mortality from parasites was much lower in the two jack pine budworm areas than in the spruce budworm area. The difference in degree of parasitism by Itoplectis was the main factor.

Pupae classed as "natural dead" made up 25% of the total pupae. On examination, 64% of these pupae were shrivelled, 16% contained recognizable moths, 9% were empty and 1% showed mechanical injury. Evidence of a disease was seen only in pupae from the Whiteshell Forest Reserve, and a fungus growth was found in a pupa from Sandilands Forest Reserve. Pupae containing dead parasites constituted 9% of the "natural dead". 77% of these pupae contained dead dipterous larvae.

It should be noted that "natural mortality" in Sandilands Forest Reserve was considerably higher than in other study areas. When the pupae from this area were collected, they were observed to be generally under-sized, and many appeared somewhat shrivelled. When these pupae were examined after emergence was completed in the sample, the majority either contained recognizable moths (42%) or were shrivelled (48%).

Table 6, showing percentage parasitism of all pupae in 1946, was compiled to include the parasitized element of the "natural dead" pupae. This table gives a more accurate picture of the actual frequency of parasites than that obtained from Table 2 or Table 10. If failure of the parasites to emerge was due to a factor present under artificial rearing conditions, but not present in the field, then table 6 also gives a more accurate picture of mortality due to parasites, since the presence of parasites, even without their emergence, would have been sufficient to cause the death of the pupae inhabited.

A predator of spruce budworm larvae and pupae was common in Spruce Woods Forest Reserve. The spruce foliage worm *Dioryctria reniculella*, Grt., which is usually a foliage feeder, killed 4% of the pupae collected in the area. Quantitative sampling for predation was not done, but actual predation, estimated by field workers in the area, was much higher.

2. Larval Parasites

Determination of larval parasitism in 1946 was again established by dissection of random field collected larvae.

Larval collections were made in four areas, namely: Red Rock Lake Experimental Area, Red Rock Lake Campsite, Jessica Lake area (all in the Whiteshell Forest Reserve), and Hawk Lake, Ontario.

Reference to the papers by H. R. Browne*, now published, on the description of *Glypta fumiferanae* Vier., and *Apanteles fumiferanae* Vier. larvae enabled the separation of parasites into these two species, whereas they had previously been classed as "Hymenoptera".

The results of these dissections are as follows:

TABLE I

Larval Parasitism, Hawk Lake, Ont.

	Date of Collection	No. of larvae dissected	Apanteles	Glypta	Diptera	%
1	June 21	48	16	3	3	46
2	June 21	72	21	0	0	29
	TOTAL	120	37	3	3	

% Parasitism 35.8%

The very low population density limited the number of samples and the size of the collections.

Sample 1 was not specific in area, but a random collection from Hawk Lake.

Sample 2 was taken from the campsite at Hawk Lake. These larvae were collected in the population count area where there was a similar collection made in 1945. Comparison of the results of the two years is noteworthy.

* Brown - Studies on Parasites of the Spruce Budworm, *Archips fumiferana* (Clem.)
1. Life History of *Apanteles fumiferanae* Viereck Can. Ent. 78:121-129, 1946.
2. Life History of *Glypta fumiferanae* Viereck Can. Ent. 78:138-147, 1946.

TABLE II

Year	Date	No. of trees examined	Terminals examined	No. of larvae found	No. of larvae dissected	Hymenoptera	Diptera	Percentage parasitism.
1945	June 28	10	2000	76	55	8	17	45.4%
1946	June 21	10	2000	67	48	19	3	45.8%

At such low population densities as indicated here, 3.1 and 3.8 larvae per 100 terminals, the parasites are still able to maintain themselves at a fairly high level. The main shift has been a change from Diptera to Apanteles, the latter being the major parasite in this specific area now.

TABLE III

Larval Parasitism, Jessica Lake Area, Manitoba

Date of Collection	No. of larvae dissected	Apanteles	Glypta	Diptera	% Parasitism
1 June 18	25	9	0	0	36%
2 June 19	35	12	2	0	40%
3 June 19	24	4	1	0	20.8%
TOTAL	84	25	3	0	

% Parasitism 33.3%

TABLE IV

Larval Parasitism ,Red Rock Lake Experimental Area,Manit

1 June 18	58	7	3	0	17.2%
2 June 19	69	5	1	0	8.7%
3 June 19	67	6	4	0	14.9%
TOTAL	194	18	8	0	

% Parasitism 13.4%

TABLE V

Larval Parasitism, Red Rock Lake Campsite, Manitoba

Date of Collection	No. of larvae dissected	Apanteles	Glypta	Diptera	% Parasitism
1 June 14	59	10	0	1	18.6%
2 June 17	94	21	1	0	23.4%
3 June 19	91	13	1	0	15.4%
4 June 19	48	1	0	0	2.1%
5 June 26	139	12	9	1	15.8%
TOTAL	431	57	11	2	

% Parasitism 16.0%

C. Population Studies

1. Population Counts

In 1946 larval counts were again conducted at East Hawk Lake, Ontario. A study of distribution of staminate trees and degree of parasitism was made in an attempt to determine their effect on interannual fluctuations in larval population. Similar studies were carried on at Red Rock Lake, Manitoba, but on a very limited scale. Data in this report is indicative of population trends in only the "campsite" area at Red Rock, and is not necessarily representative of the true population in this general area. At the time when pupal and egg counts could have been conducted at East Hawk Lake, work was in progress at Red Rock Lake on the Host Selection and Pollen Studies. Due to considerable distances and shortage of trained personnel, pupal and egg counts were impractical at East Hawk Lake.

2. Larval Counts

(a) Hawk Lake, Ontario.

The method of making larval counts is identical with that of the two preceding years (1944 Annual Technical Report, Winnipeg Laboratory). At "Post Office Point", the system employed in previous years in making pupal counts was again used, i.e. 200 terminals examined for each replicate. However, larval development at Hawk Lake was approximately two weeks behind that of Red Rock Lake, and although work on Post Office Point at this time was primarily intended to be a pupal count, it ultimately resulted in a larval count. In all other larval counts at East Hawk, 100 terminals per replicate were used, and, in order to be consistent in working up the final data, the units used in making the pupal counts were translated to those of the larval counts, and hence the resulting fractions in the columns "No. of Larvae", and "Empty Webs", under the heading of Post Office Point in Table I.

In the three areas at East Hawk Lake, Ontario, (namely Campsite, Post Office Point and Dead Horse Point) a total of 556 trees were examined in an attempt to determine the percentage distribution of staminate trees. These percentages, together with the figures from preceding years, are contained in the following table:

TABLE I

Hawk Lake, Ont. Larval & Pupal Counts June & July, 1946

Tree No.	Area in which counts made	Distribution of staminate trees	Location of sample	No. of staminate cones	No. of larvae	No. of empty webs	No. of terminals	No. of larvae	No. of empty webs	Total larvae per 100 terminals	Total webs per 100 terminals
1	Campsite	None	Top	0	0	0	100	4	7	4	7
			Bottom	10	1	0	90	4	2	5	2
2	Campsite	Light	Top	10	1	0	90	1	2	2	2
			Bottom	6	1	0	94	1	0	2	0
3	Campsite	Heavy	Top	44	9	13	56	4	2	13	15
			Bottom	44	15	2	56	2	1	17	3
4	Campsite	None	Top	0	0	0	100	0	1	0	1
			Bottom	7	2	0	93	0	1	2	1
5	Campsite	None	Top	0	0	0	100	0	1	0	0
			Bottom	0	0	0	100	3	3	3	3
6	Campsite	None	Top	0	0	0	100	0	2	0	2
			Bottom	0	0	0	100	0	0	0	0
7	Campsite	Heavy	Top	6	0	0	94	1	1	1	1
			Bottom	0	0	0	100	3	0	3	0
8	Campsite	Light	Top	9	2	0	91	3	1	5	1
			Bottom	0	0	0	100	1	0	1	0
9	Campsite	None	Top	0	0	0	100	1	2	1	2
			Bottom	2	0	0	98	0	2	0	2
10	Campsite	None	Top	0	0	0	100	1	0	1	0
			Bottom	0	0	0	100	1	1	1	1
1*	Post Office Point	None	Top	0	0	0	100	0	.5	0	.5
			Bottom	0	0	0	100	0	0	0	0
2	"	None	Top	0	0	0	100	.5	1.5	.5	1.5
			Bottom	0	0	0	100	0	2	0	2
3	"	None	Top	0	0	0	100	0	.5	0	.5
			Bottom	0	0	0	100	0	4	0	4
4	"	None	Top	0	0	0	100	0	3.5	0	3.5
			Bottom	0	0	0	100	0	0	0	0
5	"	None	Top	0	0	0	100	0	4	0	4
			Bottom	0	0	0	100	0	4	0	4
6	"	None	Top	0	0	0	100	.5	0	.5	0
			Bottom	0	0	0	100	0	1	0	1
7	"	None	Top	0	0	0	100	0	1.5	0	1.5
			Bottom	0	0	0	100	0	0	0	0

*200 terminals per replicate ∴ decimal

Table I (cont.)

Tree No.	Area in which counts made	Distribution of staminate trees	Location of Sample	No. of staminate cones	No. of Larvae	No. of empty webs	No. of terminals	No. of larvae	No. of empty webs	Total larvae per 100 terminals	Total webs per 100 terminals
8	Post Office Point	None	Top	0	0	0	100	0	0	0	0
			Bottom	0	0	0	100	0	1.5	0	1.5
9	"	"	Top	0	0	0	100	.5	0	.5	0
			Bottom	0	0	0	100	0	.5	0	.5
10	"	"	Top	0	0	0	100	0	.5	0	.5
			Bottom	0	0	0	100	0	0	0	0
11	"	"	Top	0	0	0	100	0	2.5	0	2.5
			Bottom	0	0	0	100	0	1.5	0	1.5
12	"	"	Top	0	0	0	100	0	.5	0	.5
			Bottom	0	0	0	100	0	0	0	0
13	"	"	Top	0	0	0	100	0	3	0	3
			Bottom	0	0	0	100	0	1.5	0	1.5
14	"	"	Top	0	0	0	100	0	.5	0	.5
			Bottom	0	0	0	100	0	1	0	1
15	"	"	Top	0	0	0	100	.5	4.5	.5	4.5
			Bottom	0	0	0	100	0	2.5	0	2.5
16	"	"	Top	0	0	0	100	0	.5	0	.5
			Bottom	0	0	0	100	0	2	0	2
17	"	"	Top	0	0	0	100	0	1.5	0	1.5
			Bottom	0	0	0	100	0	0	0	0
18	"	"	Top	0	0	0	100	0	.5	0	.5
			Bottom	0	0	0	100	.5	1	.5	1
19	" "	"	Top	0	0	0	100	0	2	0	2
			Bottom	0	0	0	100	0	1.5	0	1.5
20	"	"	Top	0	0	0	100	0	1	0	1
			Bottom	0	0	0	100	0	1	0	1
1	Dead Horse Point	Heavy	Top	0	0	0	100	1	16	1	16
			Bottom	0	0	0	100	0	10	0	10
2	"	Heavy	Top	0	0	0	100	0	12	0	12
			Bottom	0	0	0	100	0	4	0	4
3	"	None	Top	0	0	0	100	0	2	0	2
			Bottom	0	0	0	100	1	0	1	0
4	"	Heavy	Top	0	0	0	100	0	7	0	7
			Bottom	0	0	0	100	0	0	0	0
5	"	None	Top	0	0	0	100	0	4	0	4
			Bottom	0	0	0	100	0	0	0	0
6	"	None	Top	0	0	0	100	0	8	0	8
			Bottom	0	0	0	100	0	7	0	7

Table I (cont.)

Tree No.	Area in which counts made	Distribution of staminate trees	Location of Sample	No. of staminate cones	No. of Larvae	No. of Empty Webs	No. of Terminals	No. of Larvae	No. of Empty Webs	Total larvae per 100 terminals	Total webs per 100 terminals
1	Campsite	None	Top	0	0	0	100	0	6	0	6
			Bottom	0	0	0	100	0	1	0	1
2	Campsite	None	Top	0	0	0	100	1	3	1	3
			Bottom	0	0	0	100	0	7	0	7
3	Campsite	None	Top	0	0	0	100	1 pupa	10	1	10
			Bottom	0	0	0	100	1	3	1	3
4	Campsite	None	Top	0	0	0	100	0	1	0	1
			Bottom	0	0	0	100	0	0	0	0
5	Campsite	None	Top	0	0	0	100	0	1	0	1
			Bottom	0	0	0	100	1 pupa	3	1	3
6	Campsite	Heavy	Top	0	0	0	100	0	3	0	3
			Bottom	0	0	0	100	0	4	0	4

Red Rock Lake, Man. Larval Counts, June, 1946

1	Red Rock	Light	Top	25	23	5	75	13	2	36	7
			Bottom	10	12	0	90	19	1	31	1
2	Red Rock	Light	Top	21	36	2	79	10	6	46	8
			Bottom	11	11	2	89	6	0	17	2
3	Red Rock	Heavy	Top	25	55	2	75	12	5	67	7
			Bottom	41	61	3	59	11	3	72	6
4	Red Rock	None	Top	1	1	1	99	6	1	7	2
			Bottom	0	0	0	100	9	1	9	1

	Non-staminate	Lightly staminate	Heavily Staminate
1942	70.81	16.34	12.86
1944	1.27	8.28	90.45
1945	14.31	16.70	68.99
1946	70.51	8.45	21.04

A total of four larval counts were made, two at the Campsite area, and one at each of the two other areas. The mean number of larvae per hundred terminals for the three classes of staminate trees in the four areas at East Hawk Lake are found in the following table:

Non-staminate	.33%
Lightly staminate	2.5%
Heavily staminate	2.9%

As in previous years a final figure was obtained for the larval population of Hawk Lake, using the equation as given on page 44 (Annual Technical Report, 1942). By means of this formula, the larval population at Hawk Lake, Ontario, was calculated as follows:

Larvae per 100 terminals:

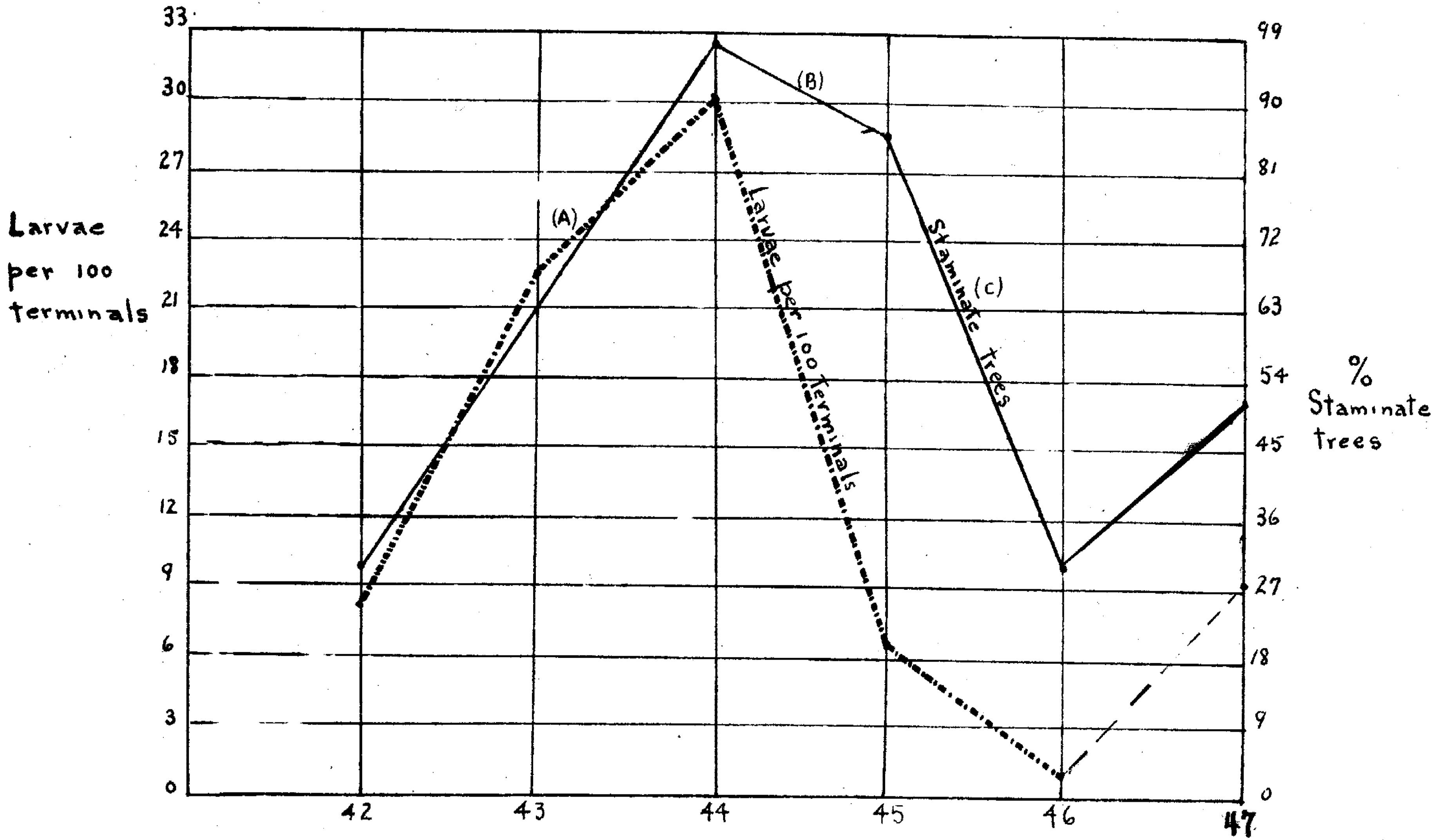
$$\frac{(70.51 \times .33) + (8.45 \times 2.5) + (21.04 \times 2.9)}{100} = 1.05$$

(b) Influence of pollen on Inter-Annual Fluctuations in Larval Populations.

Extensive research has been conducted by this laboratory to ascertain the influence of parasites and pollen production on fluctuations in population. However, further studies will be necessary to determine the bearing which factors such as overwintering mortality, disease and activities of predators, have on interannual fluctuations in budworm population.

The following table illustrates the variations which have taken place since larval population counts were first conducted in this area in 1941.

	1941	1942	1943	1944	1945	1946
Average number of larvae per 100 terminals	6.28	8.22	22.85	30.18	6.91	1.05



HAWK LAKE AREA

Graph illustrating corresponding fluctuations in larval population and pollen production.

This graph illustrates the relation which pollen has on fluctuations in larval population. Ratios of "pollen distribution to larvae/100 terminals" have been established in order to reveal the irregularities in the graph.

Table 2 was compiled in an endeavour to combine all factors upon which studies have been made, and which might have a possible bearing on the relation of pollen production to fluctuations in larval population.

Table 2

Year	Eggs /100 terminals	Larvae / 100 terminals	%(heavily (lightly staminate trees	% survival ratio: larvae/100 / eggs oviposited	fecundity ratio: eggs/100 / larvae/100 term.	Ratio pollen dist. / larvae/100 terminals
1941	30.6	6.28	---	---	4.9	---
1942	214	8.22	29.20	26.8	26	3.55
1943	148	22.85	---	10.7	6.5	---
1944	34.2	30.18	98.73	20.4	1.1	3.27
1945	7.48	6.91	85.69	20.2	1.1	12.40
1946	---	1.05	29.49	14.0	---	28.8

In 1942 and 1944 the ratios are 3.55 and 3.27 respectively, and hence a close correlation will be observed on the graph. Unfortunately, no record was kept on the distribution of staminate trees in 1943, and hence the straight line joining 42 and 44 is theoretical. It will be observed that after 1944, when the larval population and pollen production were at their maximum, the graph appears to exhibit no regularity with the ratios being no longer proportionate. However, it is evident that the variations in larval population follow the general trends of the variations in pollen production, and that the lack of direct proportion for 1945 and 1946 may be attributed to a number of complex factors, which have, as yet, not been considered.

Judging by the foregoing data in Table 2, it would seem that pollen production has little influence on oviposition. The year of peak egg production was in 1942, and it would be expected that the larval population would assume its maximum the following year. However, % survival was found to be 10.7%, (the lowest recorded in this report). It would appear logical that there would be a high mortality when egg production is at its peak, but the factors which contributed to such a heavy mortality have not yet been ascertained.

Fecundity was examined in a similar manner, with a view to correlating it with other factors which might have revealed something on the inadequacy of results obtained for 1945 and 1946 on the graph. However, there was no more success in this case than with the other factors considered in the foregoing table.

It appears from studies on the budworm itself, that pollen is definitely a preferred food, and does influence growth and development. Nevertheless, when attempts are made to correlate pollen production with field data as above, no regularly consistent trends are apparent save in the matter of larval populations, and even there the correlation is disproportionate. One conclusion which naturally follows is that the influence of pollen on the field populations is masked by variations in factors such as parasitism, weather, disease and other agents which are perhaps incompletely or inadequately estimated, due to their complexity.

(c) Red Rock Lake, Manitoba.

Population studies at Red Rock Lake were initiated this year. Distribution of staminate trees amongst a survey of 409 trees at the campsite are listed below:

Non-staminate	40.58%
Lightly staminate	11.24%
Heavily staminate	48.16%

Mean number of larvae per 100 terminals for the three classes of trees are listed here:

Non-staminate	~~1.6~~	8.5
Lightly staminate	~~6.26~~	32.5
Heavily staminate	~~[illegible]~~	70.0

The final figures for determining the larval population was calculated by using the same formula as that used in obtaining the final figure for East Hawk Lake:

$$\frac{(40.58 \times \sout{1.5}\ 8.5) + (11.24 \times \sout{6.25}\ 32.5) + (48.16 \times \sout{6.5}\ 70.0)}{100} = \sout{[illegible]}\ 40.8 \text{ larvae}/100$$

Table 3 shows the average number of larvae per 100 terminals in each of the five areas in which larval counts were made in 1946.

3. Analysis of Larval Population Data.

(a) Hawk Lake, Ontario.

The replicate larval counts were examined statistically by the use of correlation coefficients to determine the relation of replicate samples to one another. The formula used is identical with that used in the preceding year (see Annual Technical Report, Wpg. Lab. 1945, page 47). An inspection of the larval count revealed that the majority of replicate pairs yielded no larvae. The following table has been devised to illustrate the frequency with which the various classes (identical replicate pairs) occur in the four areas under consideration at Hawk Lake.

Frequency	Class
29	(0) (0)
6	(1) (0)
4	(.5) (0)
1	(2) (2)
1	(1) (3)
1	(4) (1)

It will be observed that the correlation between replicate pairs is very good, with the majority of pairs falling into the class (0)(0), but the numbers of larvae recorded in the sample were obviously too small to permit the calculations of normal correlation coefficients, and for this reason data in this regard has been omitted. In other words, it may be stated unequivocally that, regardless of the number of trees sampled, it is impossible to obtain a statistically accurate sample of budworm population according to the usual methods, when this population is below a certain minimum level.

TABLE III

Hawk Lake, Ont. & Red Rock Lake, Man. LARVAL COUNTS

June & July

General Area	Area	No. of Trees	Distribution of staminate trees	AVERAGE per replicate of 100 terminals: No. of staminate cones	No. of larvae	No. of terminals	No. of Larvae	Average No. of Larvae / 100 term.
Hawk Lake	Camp-site	10	5 non-stamin. 3 light " 2 heavy "	6.9	1.5	93.1	1.5	3.05
"	Post Office Point	20	20 Non-staminate	0	0	100	.06	.06
"	Dead Horse Point	6	3 heavy stam. 3 Non-stamin.	0	0	100	.17	.17
"	Camp-site	6	5 Non-stamin. 1 Heavy "	0	0	100	.33	.33
Red Rock Lake	Red Rock Lake	4	1 Non-stamin. 2 light Stamin. 1 Heavy stamin.	16.7	24.8	83.3	10.7	35.6

Dr. C. H. Goulden, Dominion Cereal Breeding Laboratory, inspected the Hawk Lake counts, and concluded that the number of larvae recorded was so small as to render ordinary statistical analysis useless. He is of the opinion that the presence of so many zero counts, and the extreme skewness of the population curve invalidates the analysis.

(b) Red Rock Lake.

This year replicate larval counts were initiated at Red Rock Lake, and the resulting data was subjected to statistical analysis. The formula used is identical with that mentioned in the "Analysis of Larval Population Data" for East Hawk Lake. Correlation coefficients were employed to determine the relation of replicate larval counts to one another, for the four trees under examination.

The correlation coefficients of the larval counts and their significance are indicated here:-

Location	Correlation Coefficient	"t" value	5% point	1% point	Significance
Upper ½	.863	2.41	4.30	9.92	nil
Lower ½	.933	3.67	4.30	9.92	nil

Taking the "5% point" as the minimum level of significance, it will be noticed that in each case the "t" value falls below the minimum required level of significance. This may be attributed to the small number of trees sampled. For a more adequate explanation of a similar situation, see (1944 Annual Technical Report, Wpg. Lab. Forest Insect Investigations, page 48)

4. Summary

Larval counts were conducted for the sixth consecutive year at East Hawk Lake, Ontario, and for the first time at Red Rock Lake, Manitoba. The numbers obtained averaged 1.05 and 4.44 larvae /100 terminals respectively for the two areas under examination. Egg and pupal counts were omitted this year for reasons previously stated in this report.

When examined graphically, it will be observed that larva population trends and pollen production trends follow the same general pattern from year to year. It is thought that a number of complex factors which, up to this point, have been completely or partially neglected, are responsible for the disproportionate correlation between these two factors, and hence the inability to show more conclusively the relationship in its true perspective.

Upon subjecting the data from Hawk Lake to statistical analysis for adequate sampling, it was found that the numbers of larvae recorded in the sample were obviously too small to permit the calculations of normal correlation coefficients. Upon examining Red Rock Lake data, it was found that there was no significance of correlation between the replicate samples of the larva count. This may be explained by the fact that only four trees were examined, which is far below the minimum number which has been found to give a statistically reliable picture.

D. Host Transfer Study

Transfers of the jack pine and spruce budworm to various hosts were first undertaken in 1942, to determine the ease with which one strain might adapt itself to the food type of the other strain. Transfers have been made each successive year since the study was initiated, with the exception of 1946. An arbitrary limit of five generations on the new host has been selected as the terminating point for any one transfer, and with this in mind, it was thought that there would be considerable information available with the conclusion of the remaining transfers.

The present report includes a summary of this year's data, observations during the course of rearings, and analysis of accumulated data from those cages where the budworm have failed to survive up to the beginning of the overwintering period in 1946. The remaining transfers from both strains are currently overwintering, and an attempt has been made in this report to analyze the data obtained from these cages, but it is thought this can be more satisfactorily carried out upon completion of the 5 year period, or at such time as the remaining transfers are extinct.

1. Observations During the Course of Rearings

This year the work on the transfer study was transferred from the site at Hawk Lake to the new field station at Red Rock Lake, Manitoba. The various food types for this study are available at Red Rock, and thus the study may be carried on in its entirety at the new location. Most of these cages were transferred while larval development was still in progress. Other cages were left until the first pupa was observed. An attempt was made to show relative dates of pupation at Red Rock as compared to East Hawk Lake, as it would seem that temperatures in the latter area are much lower than at Red Rock. Of the jack pine budworm transfers, the two cages from which pupae were obtained were both at East Hawk Lake, where the first pupa appeared; and, with the spruce budworm transfers, the cages were removed to Red Rock Lake while larval development was still in progress. Hence there is no record of relative dates of pupation of the two strains in the areas mentioned.

(a) Cannibalism

An incident of noteworthy mention was observed on June 3 in Cage 45A, where cannibalism was taking place. Prior to this date, the larvae from this cage had been feeding on balsam. On June 3 they were transferred to the substituted host, jack pine, where, due to the early shedding of pollen, the larvae had to be placed on jack pine terminals. The larvae probably were unable to adapt themselves to the food change and due to starvation had to resort to cannibalism. It was noticed that in most cases 3rd instar larvae were usually the victims of 4th, 5th and 6th instar larvae, and in one specific case, when viewed with the aid of a hand lens, all but the head capsule of a 3rd instar larva was devoured by larvae of the more advanced stages. There were several other attacks but the smaller larvae in the majority of cases were able to escape.

(b) Needle Mining Activities of Spruce Budworm Larvae

It was observed that spruce budworm larvae were actively mining the needles of the various overwintering hosts on May 11. Unfortunately, no record of needle mining was obtained prior to this date, so comparable dates from the various transfers are not available. The extent of needle mining by larvae from the various cages will be found in Tables I and II.

In cages 45A and 69 of the Ab-Pj transfer needle mining activities are reported as "light". Spruce budworm larvae remained on balsam for most of their developmental period before being transferred to jack pine. Hence the recording of "light" is in reference to the needle mining activities of spruce budworm larvae feeding on balsam.

With one exception, no mined needles were found in cages harboring jack pine budworm larvae. In cage 49 of the Pj-Ab transfer, 2 mined needles were observed in this cage in the spring of 1946. It is debatable whether these are due to the activities of Pj budworm larvae, as it is generally supposed that jack pine budworm are incapable of mining needles. Upon subsequent examination of this cage, no larvae were found, and it is possible that these mined

TABLE I

1946 Rearings of 1943 and 1944 Host Transfers

	1946 Rearings of 1943 Transfers		1946 Rearings of 1944 Host Transfers							
1946 Cage No.	35	33	53	51	49	45A	43	43A	41	39
Original Source of Budworm	Pj	Sw	Pj. stam.	Pj	Pj	Ab	Ab	Ab	Ab	Ab
Host in 1945	Sw	Ab	Pj. stam.	Sb	Ab	Pj	Sb	Sb	Ab	Sw
Extent of needle mining	-	Heavy	nil	nil	nil	Light	Medium	Medium	Heavy	nil
Pupae matured in 1946										
Males	-	45	-	-	-	1	8	10	41	5
Females	-	18	-	-	-	5	6	7	36	3
Total	-	63	-	-	-	6	14	17	77	8
Dates of pupation										
Males										
1st pupa	-	June 19	-	-	-	July 6	June 30	June 28	June 26	July 3(moth)
50% pupation	-	June 23	-	-	-	July 6	July 2	June 28	June 30	July 3
Females										
1st pupa	-	June 23	-	-	-	July 6	July 2	June 28	June 27	July 3(moth)
50% pupation	-	June 26	-	-	-	July 8	July 3	June 28	July 2	July 3
Average widths										
Males	-	.36	-	-	-	.38	.37	.38	.38	.40
Females	-	.38	-	-	-	.37	.42	.43	.39	.40
♀ caged for oviposition	-	13	-	-	-	-	5	5	25	3
Egg clusters/♀	-	5.2	-	-	-	-	7.8	5	6.6	8
Total eggs/♀	-	52.3	-	-	-	-	100.2	102.6	98.6	202.6
Hatched eggs/♀	-	66.1	-	-	-	-	73.6	81	85.4	160.3
Unhatched eggs/♀	-	2.5	-	-	-	-	3	3.4	5.1	23.7

TABLE II

	1946 Rearings of 1945 Host Transfers								
1946 Cage No.	73	76	79	81	83	69	71	67	65
Original Source of budworm	Pj-stam.	Pj	Pj	Pj	Pj	Ab	Ab	Ab	Ab
Host in 1946	Pj.stam.	Pj	Sb	Ab	Sw	Pj	Sb	Ab	Sw
Extent of needle mining	nil	nil	nil	nil	nil	light	medium	heavy	medium
Pupae matured in 1946									
Males	-	-	-	16	13	2	24	42	15
Females	-	-	-	14	10	3	25	36	12
Total	-	-	-	30	23	5	49	78	27
Dates of pupation									
~~Males~~									
1st pupa	-	-	-	July 11	July 11	July 5	June 25	June 26	June 26
50% pupation	-	-	-	July 13	July 16	July 6	June 27	June 30	June 29
Females									
1st pupa	-	-	-	July 11	July 10(m[illegible]th)	Jul.8	June 27	June 26	June 27
50% pupation	-	-	-	July 16	July 16	July 11	June 29	July 3	July 4
Average widths									
Males	-	-	-	.32	.30	.31	.38	.34	.35
Females	-	-	-	.34	.32	.37	.40	.37	.36
♀ Caged for oviposition	-	-	-	9	5	3	17	25	10
Egg clusters/♀	-	-	-	.55	.6	1.6	8.6	3.8	3.6
Total eggs /♀	-	-	-	30.1	24	16.6	119.2	55.8	38.8
Hatched eggs/♀	-	-	-	18.1	17.6	9.3	99.4	40.3	30
Unhatched eggs/♀	-	-	-	11.4	3.2	0	6	2.6	1.6

needles may have been from the previous year. Then again, there is a chance that spruce budworm larvae may have been present due to the incomplete disinfestation of the overwintering seedling.

For information regarding the needle mining habits of spruce budworm larvae, the reader is referred to (P.51;1945 Annual Technical Report, Winnipeg Laboratory)

(c) Cage 45A Balsam - Jack pine

In the spring of 1946, when larvae were being transferred from balsam to jack pine, it was observed that many of the larvae were in the 5th and 6th stadia before the transfer was made. Under these circumstances, the larvae would have fed for most of their developmental period on balsam, and hence it is doubtful that the information from this cage is of any value in showing the reaction of spruce budworm on jack pine. Due to the early shedding of pollen, larvae could not be fed on staminate flowers and this necessitated the immediate transfer of larvae to terminal growth. As stated previously, cannibalism was prevalent in this cage, due perhaps, to the inability of the larvae to adapt themselves to the jack pine diet, after having fed for most of the larval developmental period on balsam.

165 hatched eggs were recorded in the fall of 1945 and upon examination for pupae in July, 1946, only 6 were found, of which 5 were ♀ and 1 ♂ (i.e. % survival of 3.63%). An oviposition cage was attempted, but unfortunately the ♂ moth had succumbed before any of the ♀ moths had emerged from the pupae, and thus the cage was brought to completion.

(d) Cages 51, 79 Jack pine - Black spruce

Both these cages failed to yield any pupae upon examination in the summer of 1946. Bud development was characteristically slow with terminal development being even more retarded than uncaged black spruce seedlings in the same vicinity. Cage 51 survived one complete generation, while Cage 79 was a transfer of 1945 and the 1st generation failed to overwinter. Cages 51 and 79 yielded a total of 336 and 192.5 hatched eggs respectively in the fall of 1945. Starvation probably was responsible for a large percentage of the mortality due to the inability of jack pine budworm larvae to mine needles, together with improper synchronization of bud development with larval appearance on the substituted host. The larvae of Cage 49 of the Pj-Ab transfer and Cage 35 of the Pj-Sw transfer failed to appear in the spring of 1946, and starvation would again seem to be the major reason.

(e) Cages 53, 73 Jack pine stam. - Jack pine stam.

Cage 53: In the fall of 1945, 320 hatched eggs were recorded for this cage and 31 larvae were counted on the overwintering seedling the following spring. However, this cage was discontinued as larvae were feeding on terminals and not on staminate cones.

Cage 73: 3700 hatched eggs were recorded for this cage. Upon examination of the seedling in the spring it was found to be in extremely poor condition, and this necessitated this cage being discontinued because the larvae had been feeding on terminals, and were not pollen fed as was the original intention. It is suggested that many of the larvae may have migrated in the spring when the seedling was still uncaged, because the seedlings were in such poor condition that adequate food would not be available for large numbers of larvae.

Table III shows the general location of the overwintering seedlings of the remaining transfers of this study, in relation to the experimental area at Red Rock Lake.

Table III Overwintering Material From Host Transfer Study (Winter 1946-47)

Original Cage Designation	Present Designation	Transfer	Year of Go Generation	1947 Generation	Overwintering Seedling	Location
14,15	33	Sw-Ab	1943	Go4	Sw	Sb & Sw plot in exptl area
39,40	39	Ab-Sw	1944	Go3	Sw	"
41,42	41	Ab-Ab	1944	Go3	Ab	Across rd. from Pj plot ex.area
43,44	43	Ab-Sb	1944	Go3	Sb	"
43,44	43A	Ab-Sb	1944	Go3	Sb	Sb & Sw plot in exptl. area
65,66	65	Ab-Sw	1945	Go2	Sw	"
67,68	67	Ab-Ab	1945	Go2	Ab	Across rd. from Pj plot ex.area
69,70	69	Ab-Pj	1945	Go2	Ab	"
71,72	71	Ab-Sb	1945	Go2	Sb	Sb & Sw plot in exptl. area
81, 82	81	Pj-Ab	1945	Go2	Ab	Across rd. from Pj plot ex area.
83,84	83	Pj-Sw	1945	Go2	Sw	Sb & Sw plot in exptl. area

2. Analysis of Data

All transfers which have been made since and including 1943 are included in this section. The analysis deals primarily with those transfers which have failed to survive up to the beginning of the overwintering period in 1946, but in some instances data has been compiled for those transfers which are currently overwintering and, in such an event this information will be included. Data shown in the following table is not to be regarded as final as larvae from both jack pine and spruce budworm strains are currently overwintering and further information is expected from future rearings until the time when the study is complete. This data is intended to show the manner in which the new host has affected the jack pine and spruce budworm strains, and to give some indication as to the adaptability of the two strains to the new food type.

(a) Adaptability of Spruce and Jack pine Budworm to Various Hosts.

Many difficulties are inevitable in compiling data from the various rearings. For instance, where cages show a sharp population increase, the tendency seems to be towards overcrowding as cages of standard size are not sufficiently large to contain enough fresh terminal growth to sustain vast increases in population. Overcrowding inevitably leads to starvation with a resulting decrease in the size of female pupae, which would in turn produce moths with a decreased egg laying capacity, and finally a decline in the cage population. The factor of overcrowding would obviously not affect population trends to the same extent under natural conditions.

The increase or decrease in any particular cage population may be said to be apparent, and not real. For instance all jack pine budworm moths for the crosses were removed from 1944 host transfer cages 53, 54, 55 and 60 while spruce budworm moths originated from 1944 host transfer cage 33. Then again, similar numbers of larvae were not placed in the cages the year of the original transfer. For example, rearings in Cage 35 are the result of 150 original larvae, while Cage 36 contained 100 larvae at the outset. Inconsistencies of this nature should be considered when placing various transfers on a comparative basis.

(1) Spruce Budworm

Table Iv is a complete record of all spruce budworm transfers upon which work has been done up to the beginning of the overwintering period in 1946. The purpose of this table is to reveal the ability of this strain to oviposit and survive on the various hosts considered.

G_o refers to year when original transfer made.
G_1 refers to the following year, and so forth.

Balsam-Balsam Transfers:-

The larvae from both cages of this transfer are currently overwintering with Cage 41 and Cage 67 having survived two and one generations respectively.

Cage 41: The year of the original transfer 5236.1 hatched eggs were recorded for this cage. 2135 hatched eggs were recorded from the second generation, and hence a decided decline in the potential population. Percentage survival has shown no great variations, and it is still too early to predict the outcome of this cage.

Cage 67: Has overwintered only once and the 1st generation showed a decline of more than 50% in the total hatched eggs from that of the previous year.

Balsam-Black spruce:

The budworm populations in all three cages of this transfer are still surviving.

Cages 43 and 43A: In 1944, Cages 43 and 44 were combined for oviposition, with a total of 2833.6 hatched eggs being recorded. The following spring 41 larvae from Cage 43 were transferred to another seedling, and this was designated Cage 43A. The number of larvae remaining in Cage 43 was not recorded so that the proportion of the 2833.6 hatched eggs which went to each of the two cages is not known.

Cage 71: A total of 666 hatched eggs were reported for this cage from the original generation. The first generation had a large percentage survival (i.e. 7.36%) with an increased number of hatched eggs.

Balsam-White Spruce

Cage 19: 1143.9 hatched eggs were recorded in the fall of the original transfer. A percentage survival of 10.66% was obtained, but due to the low fertility, only 65 hatched eggs were obtained from 122pupae of the same year. Only 3 pupae were recorded for the second generation, and hence the cage was discontinued.

Cage 39: 3270 hatched eggs were reported for the original transfer with a percentage survival of .15% for the first generation. There was a percentage survival of 22.22% for the second generation, which would seem to indicate that the population in this cage is on the increase.

Cage 65: The population in this cage has been reared through only one complete generation, so more information is expected from future rearings.

Balsam-Jack pine

The method used in the rearings of this transfer is somewhat different from other rearings, with both hosts being involved. During the summer the larvae were reared on jack pine, while balsam seedlings were used for overwintering purposes. This method did not prove altogether satisfactory as illustrated by the 1946 rearings in Cage 45A. In this instance, larvae fed for most of their developmental period on balsam. When transferred to jack pine, the larvae were unable to adapt themselves to the change in food type, and starvation resulted. However, it is unlikely that spruce budworm would have been able to overwinter on jack pine, as it is generally agreed that spruce budworm are unable to mine jack pine needles. Then again, the emergence of spruce budworm larvae from their hibernaculae is not synchronized with jack pine terminal growth, and hence the young larvae are subject to starvation. It is significant that two of the three cages of this transfer are now extinct.

Cage 34: No pupae were obtained from 402.3 eggs recorded the year of the original transfer, the larvae apparently having failed to overwinter.

Cage 45A: The population in this cage declined rapidly from 1069.5 hatched eggs from the original generation, to 165 from the 1st generation. Only 6 pupae were matured from the 165 hatched eggs, so the cage was brought to completion.

Cage 69: The budworm population has overwintered successfully for the 1st generation, but there has been a sharp decline in the number of hatched eggs with 1487.5 for the year of the original transfer, and only 27.9 reported for the 1st generation. On the basis of the other two cages of the balsam-jack pine transfer, it would not be unreasonable to predict that the spruce budworm strain in this cage will not survive another complete generation.

White Spruce - Balsam

Cage 33: This is the only cage of the 1943 transfers which is not extinct, making it the only cage containing larvae of the spruce budworm strain which has overwintered three consecutive years. 3300 eggs were recorded in the fall of 1943, and there has been a steady decline in the numbers of hatched eggs reported on each succeeding year, with there being very little fluctuation in the percentage survival.

This transfer provides a preferred host upon which spruce budworm should thrive. It would seem that this population decline is only apparent, and may be attributed in part to overcrowding with a resulting decrease in the egg laying capacity of females.

White Spruce - Black Spruce and White Spruce - White Spruce

1650 and 456 eggs were reported for cages 31 and 32 respectively. However, the young larvae failed to overwinter in both cases. The absence of larvae in cage 32 may be due to the activity of predators as two ant hills were located beside the overwintering seedling. No information is available on the failure of the larvae in cage 32 to overwinter, but there is a possibility that the eggs recorded for these two cages in 1943 may have been infertile as only total eggs and not total hatched eggs were recorded in that year.

(ii) Jack pine Budworm

Table V is a resume of the ability of the jack pine budworm strain to survive on a substituted host, and this table includes all transfers upon which work has been done in this study. Percentage survivals are compiled on the basis of the number of pupae matured in any cage for any single year divided by the number of hatched eggs recorded the previous year x 100 (i.e. for Cage 37 $\frac{4}{1248} \times 100 = .32\%$)

The outstanding feature of this study is the apparent inability of any one transfer to overwinter for more than two consecutive years. The larvae from Cage 79 of the jack pine-black spruce transfer failed to survive the first winter while in Cage 73 of the jack pine staminate- jack pine staminate, and Cage 76 of the jack pine - jack pine transfer, no pupae are listed as having been matured for the first generation. Cage 73 was discontinued prior to pupation as larvae had been feeding on jack pine terminals and were not pollen fed. The larvae from the original generation in Cages 37, 49, 36, 51, 47, 38, 56 and 53 successfully overwintered. Successful mating was accomplished in Cages 49, 51 53, but the larvae obtained from the eggs subsequently disappeared between the beginning of the overwintering period of the 1st generation and pupation the following year, while the remainder of these cages became extinct because of the shortage of moths for oviposition in the course of rearing the first generation. It will be interesting to observe the results in Cages 81 and 83 where 162.9 and 88 hatched eggs respectively were placed on overwintering seedlings in the fall of 1946. On the basis of the other jack pine budworm transfers, it seems probable that few, if any, pupae will be found on these seedlings next summer. Cage 35 of the jack pine - white spruce transfer is the only cage where 2nd generation larvae are recorded, but these larvae failed to overwinter for the third time, and this cage is also complete.

All cages in this study have shown a very sharp decline in population, this being most pronounced in the jack pine-jack pine transfers, where 3545 hatched eggs in Cage 56 yielded only 17 pupae the following year, with a percentage survival of .48%; and 3830 eggs in Cage 38 yielded only 16 pupae for a percentage survival of .42%. Faulty technique appears to be the only plausible explanation for the inability of jack pine budworm to survive on its natural host under controlled conditions.

(b) Effect of Host on Size of Pupae.

Pupal measurements have been made each year since the beginning of this study, to determine the effect that larval feeding has on the relative sizes of pupae reared on the various hosts. As stated previously, the majority of the spruce budworm transfers are overwintering, but the present report embodies all pupal widths recorded for the various transfers up to the present time. This data must be regarded as incomplete, as more information in this regard is expected from future rearings. This report is intended to give some indication of the trends in pupal size as affected by larval feeding on the various hosts.

(1) <u>Spruce budworm pupal widths</u>

A complete resume of the mean pupal widths for all rearings of transfers of the spruce budworm strain will be found in the following table.

Table VI Mean Pupal Widths of Spruce Budworm Rearings

Year of Transfer		Ab-Ab		Ab-Sb			Ab-Sw			Ab-PJ			Sw-Ab	Sw-Sb	Sw-Sw
Year of Transfer		44	45	44	45	44	43	44	45	43	44	45	43	43	43
Cage Designation		41	67	43	71	43A	19	39	65	34	45A	69	33	32	31
Mean Pupal Widths for Each Cage	♂	.391	.38	.363	.39	.403	-	.396	.39	-	.353	.33	.371	--	--
	♀	.427	.43	.410	.41	.457	-	.442	.42	-	.377	.38	.405	--	--
Mean Pupal Widths for All Cages In Each Transfer	♂	.385		.385			.393			.341			.371		
	♀	.428		.426			.431			.378			.405		

(All measurements are in cms.)

Considerable variations in pupal widths are shown in the various cages of any one transfer. For example, mean pupal widths for cages 43, 71, 43A of the balsam-black spruce transfer were found to be .363, .39 and .403 respectively, while ♀ widths were .410, .41 and .457.

From Table VI it may be observed that balsam - white spruce yielded the largest pupae. Black spruce and balsam gave very similar results with ♂ pupae being the same size in both transfers, and ♀ pupae being .002 cms. larger for black spruce than for balsam. Spruce budworm obtained from white spruce and reared on balsam yielded the next largest pupae, while larvae reared on jack pine provided the smallest pupae of any transfer in this study. The smallness of the pupae may be attributed, in part, to starvation. In 1946, it was observed that larvae from Cage 45A which had been feeding on balsam were unable to adapt themselves to the new food types when transferred to jack pine, and starvation resulted. No record was kept for pupal widths in 1943, so data is not available for Cages 19, 34, 32 and 31.

(ii) <u>Jack pine budworm pupal widths.</u>

In this section, the jack pine budworm pupal widths of all rearings up to the fall of 1946 are included, and information in this regard will be found in Table VII.

TABLE VII Mean Pupal Widths of Jackpine Budworm Rearings

Transfer		Pj - Ab			Pj - Sb			Pj - Sw			Pj - Pj			Pj stam -Pj stam.	
Year of Transfer		43	44	45	43	44	45	43	44	45	43	44	45	44	45
Cage designation		37	49	81	36	51	79	35	47	83	38	56	76	53	73
Mean pupal widths for each cage	♂	.283	.297	.31	.32	.322	.335	.286	.294	.30	.313	.331	.325	.324	.323
	♀	.280	.31	.335	.347	.348	.33	.297	.312	.32	.362	.363	.356	.364	.37
Mean pupal widths for all cages in each transfer	♂	.300			.326			.298			.327			.323	
	♀	.320			.342			.312			.360			.367	

(All measurements are in Cms.)

The mean ♂ and ♀ pupal widths for each of the above transfers were obtained from the mean pupal widths of all cages in any particular transfer. This table indicates that larvae fed on its natural host yielded the largest pupae with little difference in widths between staminate and terminal

TABLE VIII RATE OF DEVELOPMENT OF SPRUCE BUDWORM LARVAE FED ON VARIOUS HOSTS

Transfer	Ab - Ab		Ab - Sb			Ab - Sw			Ab - Pj			Sw-Ab	Sw-Sb	Sw-Sw
Year of Transfer	44	45	44	45	44	43	44	45	43	44	45	43	43	43
Cage designation	41	67	43	71	43A	19	39	65	34	45A	69	33	32	31
Mean date of 50% pupation per cage	July 5	July 6	July 5	July 6	July4	July5	July3	July3	-	July 9	July13	Jul.1	-	-
Mean date of 50% pupation per transfer	July 5		July 5			July 4			July 11			Jul.1	-	-

TABLE IX RATE OF DEVELOPMENT OF JACK PINE BUDWORM LARVAE FED ON VARIOUS HOSTS

Transfer	Pj - Ab			Pj - Sb			Pj - Sw			Pj - Pj			Pj stam - Pj stam.	
Year of transfer	43	44	45	43	44	45	43	44	45	43	44	45	44	45
Cage designation	37	49	81	36	51	79	35	47	83	38	56	76	53	73
Mean date of 50% pupation per cage	July19	July22	July22	July11	July 18	July26	July16	July5	July23	July 7	July19	July26	July16	July24
Mean date of 50% pupation per transfer	July 21			July 18			July 15			July 17			July 20	

TABLE X EFFECT OF HOST ON OVIPOSITION (Spruce Budworm Strain)

Transfer	Ab - Ab		Ab - Sb			Ab - Sw			Ab - Pj			Sw-Ab	Sw-Sb	Sw-Sw
Cage Designation	41	67	43	71	43A	19	39	65	34	45A	69	33	32	31
CAGES														
Mean no. of ♀ caged for oviposition	24	22.5	16	9	11	11.6	10.7	13.5	9	10	14	24.5	10	25
Mean: Egg clusters per ♀	6.94	6.4	6.75	4.8	5.61	4.85	7.74	4.1	3	43.8	3.3	6.46	3	5.5
Mean: Hatched eggs per ♀	102.7	80.6	81.3	57.8	87.1	92.7	100	43	44.7	52.1	34.4	88.8	45.6	66
TRANSFERS														
Mean no. of ♀ caged for oviposition	23.25		12			11.9			11			24.5	10	25
Mean: Egg cluster per ♀	6.67		5.72			5.56			16.7			6.46	3	5.5
Mean: Hatched eggs per ♀	91.65		75.4			78.6			43.7			88.8	45.6	66.

TABLE XI EFFECT OF HOST ON OVIPOSITION (Jackpine Budworm Strain)

Transfer	Pj - Ab			Pj - Sb			Pj - Sw			Pj - Pj			Pjstem-Pj stem	
Cage designation	37	49	81	36	51	79	35	47	83	38	56	76	53	73
CAGES														
Mean no. of ♀ caged for oviposition	13	8	9	20	11.5	25	18.3	20	15	14	14	19	16	25
Mean: Egg clusters per ♀	2.9	1.29	1.27	.8	1.82	.88	1.77	.35	8.9	3.57	3.52	2.6	2.46	4.2
Mean: Hatched eggs per ♀	96	28.4	31.6	22.4	27.65	7.7	39.1	10	15.4	191.5	141.8	86.7	107.2	148
TRANSFERS														
Mean: no. of ♀ caged for oviposition	10			18.8			17.8			16			20	
Mean: Egg clusters per ♀	1.82			1.17			3.67			3.23			3.33	
Mean: Hatched eggs per ♀	52			19.25			21.5			139.7			127.6	

fed larvae. Black spruce appears to provide the next best food type with widths comparing favorably with those obtained from larvae reared on the natural host. Balsam and white spruce produced the poorest results with mean widths of .300 and .295 for ♂'s and .320 and .312 for ♀'s.

(c) Effect of Host on Rate of Growth.

Records of the first date of pupation have been kept every year since the original transfers were made, with the exception of the 1943 jack pine budworm transfers. The practice of recording the date of 50% pupation in any one cage was initiated in 1944. This method is probably more accurate for obtaining relative rates of development of the various transfers as the recording of first appearance of pupae in any cage is not necessarily indicative of the rate at which remaining larvae in this cage will pupate.

(1) Rate of growth of spruce budworm fed on various hosts.

Table VIII includes all cages containing the spruce budworm strain and gives a complete record of the average date of 50% pupation since 1944. The column "Mean Date of 50% Pupation per cage" was derived by finding the mean date of 50% pupation of all rearings in any one cage, i.e. for cage 41 - 50% pupation was found to have occurred on June 26, July 18 and July 1 in 1944, 1945 and 1946 respectively. The mean of these three dates is July 5, as recorded in Table VIII.

"Mean Date of 50% Pupation per Transfer" was derived by taking the mean date of the total number of cages in any one transfer, i.e. the mean dates in the balsam - black spruce transfer were found to be July 5, July 6 and July 4 for cages 43, 71 and 43A respectively, giving July 5 as the mean date for this transfer.

In all transfers of white spruce to other hosts, the larvae were obtained from the Spruce Woods Forest Reserve whereas in transfers of balsam to other hosts the larvae were obtained from Hudson, Ontario.

Larvae obtained from white spruce and reared on balsam appear to have the most satisfactory food type necessary for an early development. The transfers where larvae were obtained from balsam and reared on balsam, black spruce, and white spruce, revealed very similar rates of development, while the balsam to jack pine transfer was approximately a week later in reaching the 50% pupation date than any of the other transfers where larvae were obtained from balsam. The populations in cages 34, 32, and 31 became extinct prior to the pupation period in 1944 and hence there is no record of the date of 50% pupation in these cages.

(ii) <u>Rate of growth of jack pine budworm fed on various hosts.</u>

As with the spruce budworm study, the relative rates of development of jack pine budworm, feeding on the various hosts has been determined by recording the 50% pupation date for the population in each cage every year with the exception of 1943. A complete resume of the findings are given in Table IX.

White spruce appears to provide the most satisfactory food type conducive to an early development, while larvae fed on jack pine terminals, black spruce, and balsam were two, three and six days later than white spruce in reaching the 50% point in pupation. The supposedly preferred food type of jack pine budworm (i.e. jack pine staminate cones) produced one of the slowest rates of development with the 50% point in pupation not being reached until July 20.

(d) Effect of Host on Oviposition.

The object of this study is to determine the relative fecundity of the same budworm strain when larvae have been reared on various hosts.

The results of oviposition from rearings on various hosts for both spruce and jack pine budworm strains are contained in Tables X and XI respectively.

(i) <u>Oviposition of the spruce budworm strain.</u>

The recordings of "Mean number of ♀ caged for oviposition" in Tables X and XI were obtained by finding the average number of ♀'s caged for oviposition from all rearings in any specific instance. In cage 41, for example, 23, 25 and 25 ♀'s were caged for oviposition for the years 1944, 1945 and 1946 respectively, giving an average of 24 as shown in Table X. A final figure for "Mean egg clusters/♀" and "Mean hatched eggs/♀" were obtained in a similar manner.

"Mean no. of ♀'s caged for oviposition" for the transfer were derived by t aking the mean number of caged females for all cages in any one transfer, i.e. 24 and 22.5 females were caged for oviposition in cages 41 and 67, giving a mean of 23.25 for the balsam to balsam transfer. Mean "egg clusters" and"hatched eggs" for all transfers were derived in a similar manner.

Prior to 1944 fertility was not recorded. Cages 31, 32 and 34 became extinct before the oviposition period in 1944 so fecundity and not fertility are reported for these cages in Table X. The fecundity reported for cages 33 and 19 in 1943 was 110 and 127.1 eggs per ♀ respectively. These figures have been used in the compiling of the final figure for "Hatched eggs/per ♀" in their respective transfers, but it will be observed that both numbers are considerably larger than the means recorded for these transfers.

Balsam appears to provide the most suitable conditions for oviposition, with balsam to balsam being more preferable than white spruce to balsam. Larvae obtained from balsam and reared on black and white spruce produced very similar results with the latter revealing a slightly larger number of hatched eggs per ♀. Jack pine appeared least adaptable for purposes of oviposition, while white spruce - black spruce and white spruce - white spruce cannot be compared as fecundity and not fertility is listed for these cages.

(ii) <u>Oviposition of the jack pine budworm strain.</u>

Fertility was not reported in 1943, and the figures obtained for the fecundity of females in cages 37, 36, 35 and 38 have been included with the number of hatched eggs recorded since 1943. Budworm fed on jack pine terminals yielded the largest number of fertile eggs followed by larvae which had been fed on pollen. Balsam fed larvae produced the next largest number of hatched eggs, while black and white spruce produced the poorest results with regard to oviposition.

(e) Relation Between Pupal Size and Fecundity.

The purpose of Figure I is to give some idea of how larval feeding on various hosts affects ♀ pupal size and hence the egg laying capacity and fertility.

The fluctuations in the numbers of hatched eggs per female for the various transfers appears to be more or less proportional to the increase or decrease in pupal size for these same transfers. This is best illustrated with the balsam - jack pine transfer, where a sharp decline in the female pupal widths shows a correspondingly sharp decline in the number of hatched eggs per female. The relation between pupal size and the total egg laying capacity of female moths showed a similar proportion with the exception of the Ab- Sw transfer where the mean female pupal width was larger than that of black spruce, while the egg laying capacity was less.

Figure II serves to show the effect of different hosts on jack pine budworm pupal widths, and the resulting number of hatched eggs per female. The total egg laying capacity per female was very much similar to the total hatched eggs per female, and is not shown in Figure II.

With the exception of the jack pine - black spruce transfer, there appears to be a close relation between pupal widths and the total number of hatched eggs per female. Black spruce appears to provide the necessary diet constituents essential to the production of large healthy pupae, but on the other hand, jack pine budworm reared on black spruce appears to be subject to some nutritional deficiency which apparently reduces egg production.

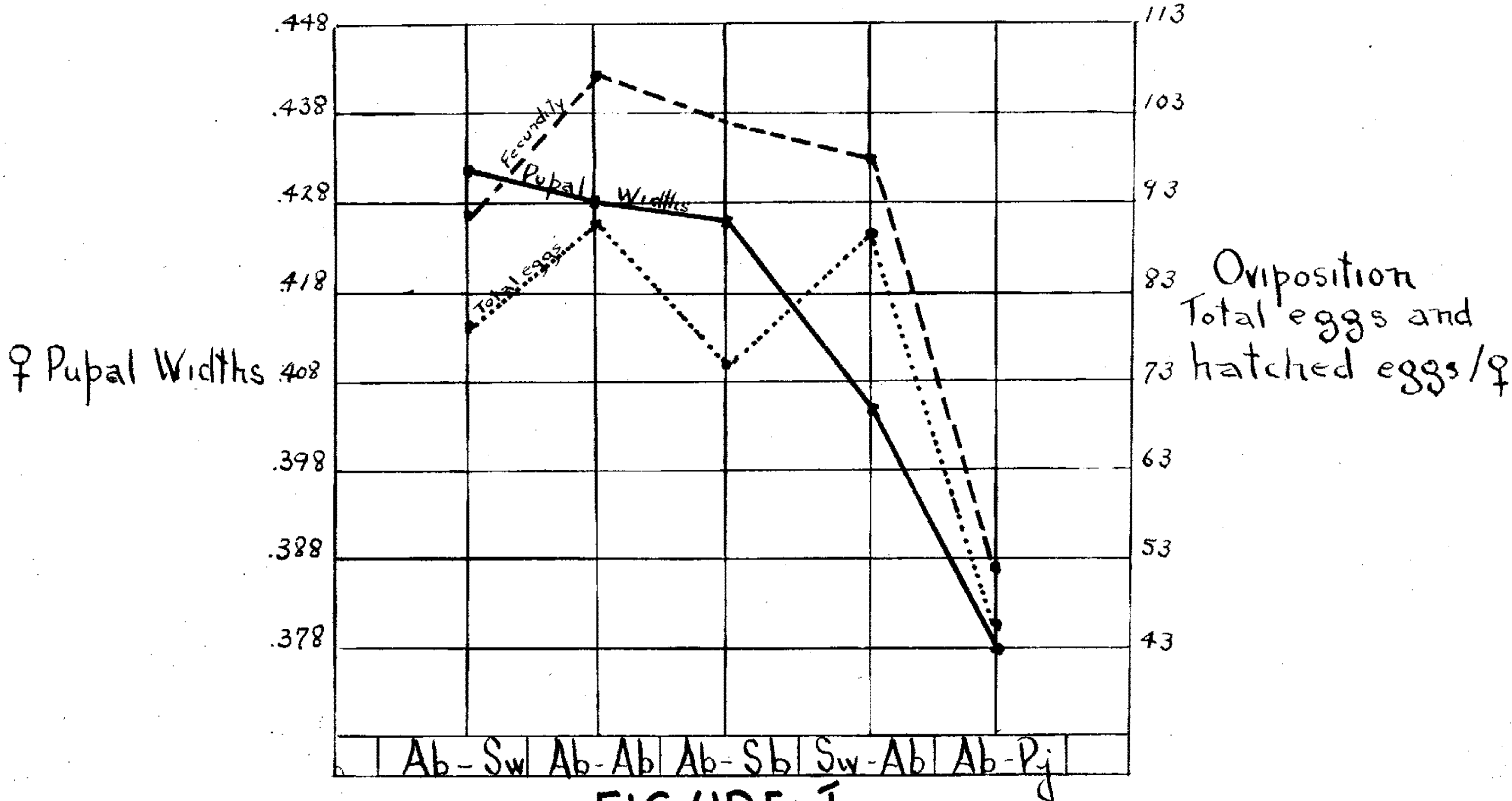


FIGURE I

Graph illustrating relation of ♀ pupal widths to oviposition when reared on various hosts – (Spruce budworm strain)

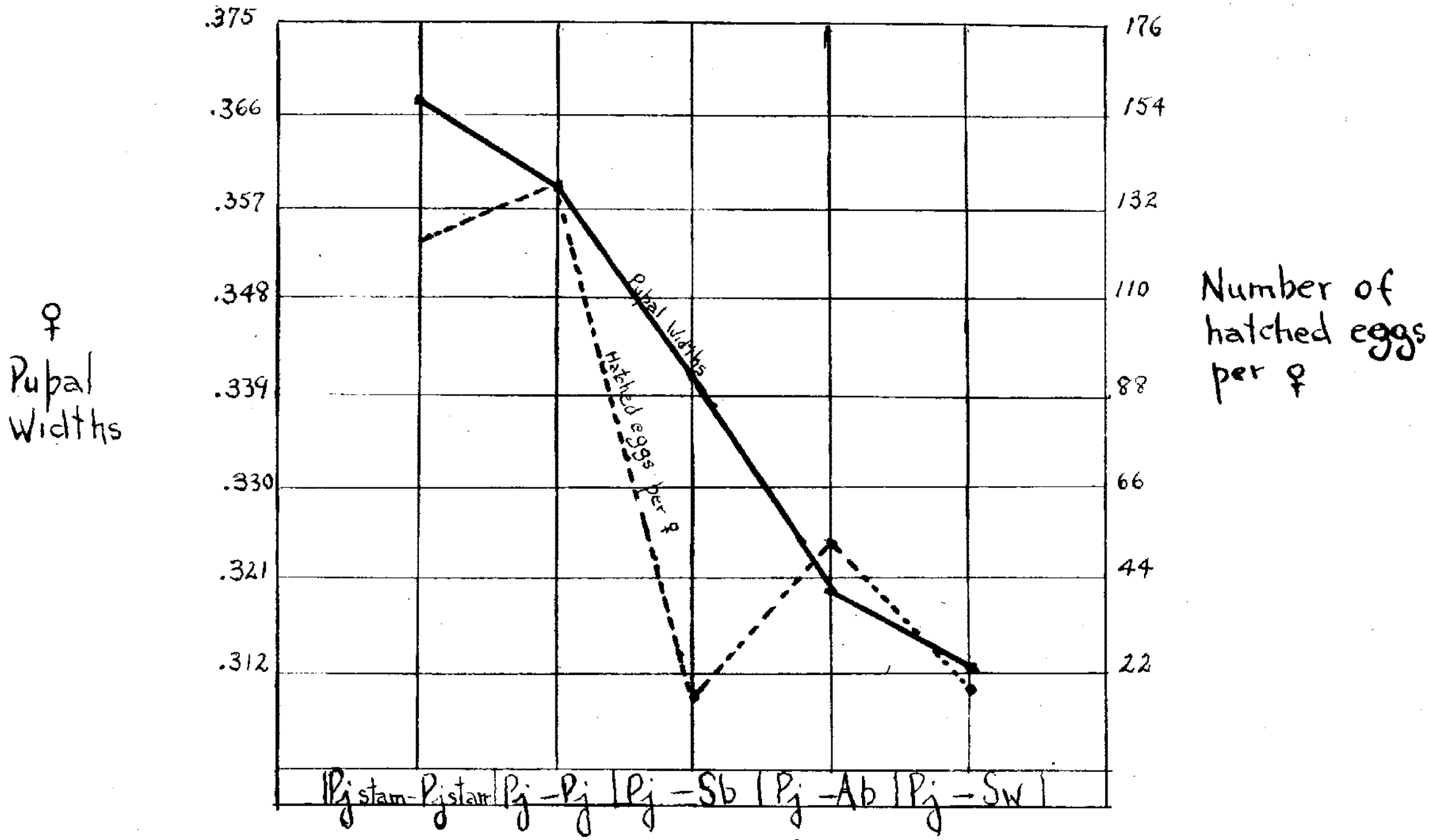


FIGURE II

Graph illustrating relation of ♀ pupal widths to oviposition when reared on various hosts (Jackpine budworm strain)

E. Crossing Studies

This experiment was initiated in 1944 with the experimental basis being outlined in the 1944 Annual Technical Report, page 70. As with the Host Selection Study, all cages containing hybrids were transferred from East Hawk Lake, Ontario to the new field station at Red Rock Lake, Manitoba.

No attempt has been made to analyze this year's data as it is thought that this can be more satisfactorily done when future investigations are concluded.

1. Rearing (Methods used in 1946 re 1944 and 1945 Crosses)

The methods employed in 1946 regarding the 1944 and 1945 crosses were identical with the methods described on page 65 of the 1945 Annual Technical Report.

(a) Observations on 1944 Crosses During Summer 1946

(i) Cage 1 - Jack pine ♂ X white spruce ♀: F2 1946. The first signs of activity in this cage were observed on May 23 when one second instar larva was seen. There were no mined needles on this date with general bud development being slightly retarded as compared with other balsam seedlings in the same vicinity. On June 1, this cage was examined for larvae and only 8 second and third stadia larvae were removed for rearing in F.I.S. jars. The results obtained in this cage were very disappointing with overwintering mortality being a possible explanation for this low survival. Four mined needles were removed from this cage on June 1. No larvae were found in these needles so most of the larvae should have left the needles by this date. Of the 8 larvae transferred to the F.I.S. jars, only one ♂ and one ♀ reached pupation.

Colour notes on F2 hybrids pupae and moths.

Cage I - Jack pine ♂ X white spruce ♀: F2 1946 (Reared on Balsam)

		Color	Shape
Pupae	♂	Pj budworm	Spruce budworm
	♀	Spruce budworm	Pj budworm
Moths	♂	Spruce budworm (tinged with copper)	
	♀	Pj budworm	

Table I contains a summary of data for 1946 rearings of Cage I on balsam. Only one successful mating was accomplished in this cage. Two egg clusters resulted from this mating and when viewed with a hand lens only 8 eggs were observed. These eggs proved to be 100% infertile so this cage was necessarily discontinued.

The jack pine fed larvae of this cage produced even more unsatisfactory results, a possible explanation being the exceedingly poor condition of the overwintering seedling. This seedling had only 12 terminals capable of providing food for larvae, when examined in the spring. One larvae was found on June 2 and one on June 6. However, one of these was discarded due to retarded development. This cage was examined again on June 27, but the remaining larva was not found so the cage was discontinued.

A great deal of significance cannot be attached to the 1946 rearings in Cage I as the populations in both the balsam and jack pine fed cages were obviously too small to draw a comparison with Cage IV or with the homozygote strains available in the Host Selection Study.

(ii) Cage 4 - Balsam ♂ X Jack pine ♀: F2 1946. The first sign of activity was noted in this cage on May 11 when several webs were observed. However, it was not until May 30 that larvae were actually observed crawling about in this cage. Bud development, at this time, compared favourably with balsam terminals in the field. Transfer of the larvae to F.I.S. rearing jars was undertaken on June 1 when 49 larvae, mostly third and fourth stadia, were placed in these jars. Only 2 mined needles were obtained from the overwintering seedling, so it is doubtful that the needle mining habit is practised extensively by this hybrid.

The survival of this cross, as shown in Table I, was high with 38 pupae matured from the 49 transferred larvae. The sex ratio for the pupae of this cage was .605, which figure is somewhat higher than the sex ratio of .493 established in the Hawk Lake, Ontario area for the jack pine budworm strain between the years 1938 to 1945 inclusive.

A mean percentage fertility of 51.98% was recorded for the eggs of these hybrids this year as compared to 1945 recordings of 93.3% fertility for homozygous jack pine budworm eggs from cage 73 and 74.7% fertility for homozygous spruce budworm eggs from cage 65.

A comparison of the Reciprocal Crosses (i.e. Cages I and IV) was not undertaken this year due to the low overwintering survival in Cage I. With only 2 pupae matured in Cage I, there was not sufficient data available for a comparison with Cage IV.

Table I

Survival and Fecundity F2 1946

Cage 1: Jack pine ♂ X White spruce ♀
Cage 4: Jack pine ♀ X Balsam ♂ Fo 1944

Cage Designation		Cage 1: Jack pine ♂ X White spruce ♀		Cage 4: Jack pine ♀ X Balsam ♂	
Larval Host Plant		Balsam		Balsam	
No. of Larvae Transferred in 1946		8		49	
No. of Pupae	♂	1		15	
	♀	1		23	
Date of first ♂ Pupa		July 6		June 16	
Date of first ♀ Pupae		July 8		June 23	
Sex Ratio of Pupa		.50		.605	
Emergence Dates of Moths	♂	July 17		July 3	
	♀	July 17		July 5	
No. of Pairs of Moths		1		13	
No. of Egg Clusters		2		54	
Total No. of Eggs		8	Cage div.	A 134	
				B 336	
				C 231	
No. of Fertile Eggs		0	Cage div.	A 66	
				B 145	
				C 147	
% Fertility		0	Cage div.	A 49.2	51.96
				B 43.1	
				C 63.6	

Complete Tabular Summary of Colour Notes
on F2 Hybrid Moths Released in
Oviposition Cages at Red
Rock Lake, Manitoba

Cage 4 - Balsam ♂ X Jack Pine ♀: F2 1946

Oviposition Cage	Date Released into Ovip.Cage	Sex	Colour Note
A	July 3	♂	typical spruce budworm type
A	" 3	♂	" " " "
A	" 4	♂	reddish tinge-not typical sp. type
A	" 4	♂	" " " "
A	" 4	♂	" " " "
A	" 5	♂	typical spruce budworm type
A	" 5	♀	Sp.type--brown tinge
A	" 5	♀	" " "
A	" 5	♀	" " "
A	" 6	♀	" " "
A	" 6	♀	" " "
B	" 4	♂	" " "
B	" 4	♂	" " "
B	" 5	♂	typical jack pine budworm type
B	" 7	♂	typical spruce budworm type
B	" 7	♂	Sp. type-Heavily tinged with copper
B	" 7	♀	" " "
B	" 7	♀	typical spruce budworm type
B	" 7	♀	" " "
B	" 8	♀	Sp.type-Lightly tinged with copper
B	" 8	♀	" " "
C	" 11	♂	Sp. type - copper tinge
C	" 11	♂	Sp. budworm type
C	" 11	♂	Typical jack pine budworm type
C	" 11	♀	" " " "
C	" 11	♀	" " " "
C	" 11	♀	" " " "
C	" 11	♀	" " " "

(b) 1946 Rearings of 1945 Crosses of Jack Pine and Spruce Forms of <u>Archips fumiferana</u> Clem.

(i) Cage 5--Jack pine ♂ X Balsam ♀:F1 1946. The first signs of activity were observed in this cage on May 23 when 2 larvae were observed in webs, but no sign of needle mining was evidenced. Bud development on the top half of the overwintering seedling was very much retarded with the buds not having started to expand by this date. Bud development on the lower half of the seedling was only slightly retarded as compared to free seedlings in the same vicinity. Upon re-examination on May 30, one mined needle was found. Several buds at the top of the seedling were infested and one third instar larva was observed.

Three pupae were removed from the seedling on July 3. On the same date, 6 larvae and pre-pupae were placed in a F.I.S. rearing jar for further development.

In Table II it will be observed that 3♂ and 3♀ moths emerged from pupae. However, all male moths were dead by July 17 and, with the first ♀ moth having emerged the previous day, no successful matings were accomplished and the cage was discontinued.

Table II

Data: re: 1945 Crosses

Cage Designation	Cage 5: Pj ♂ X Ab ♀ Fo 1945		Cage 7: Pj ♂ X Ab ♀ Fo 1945	Cage 9: Ab ♂ X Pj ♀ Fo 1945
Larval Host Plant	Balsam		Balsam	Balsam
No. of Larvae Transferred	3 pupae 6 larvae & Pre-pupae		58	57
Date of Transfer	July 3		June 13	June 14
No. of Pupae	♂	3	38	10
	♀	5	15	16
Date of first ♂ Pupa	July 3		July 29	July2
Date of first ♀ Pupa	July 11		July 8	July 2
Sex Ratio	.62		.28	.61
Emergence of Moths	♂	July 3	July 7	July 6
	♀	July 16	July 16	July 6
No. of ♂ Moths	3		35	10
No. of ♀ Moths	3		15	16
No. of Egg Clusters	-		10	17
No. of Eggs Laid	-		89	233
No. of Fertile Heterozygotes	-		36	140
% Fertility	-		40.4%	60.1%

(ii) Cage 7 - Jack pine ♂ X Balsam ♀: F1 1946. Two webs were noted in this cage on May 11. This cage was examined again on May 23, but no mined needles were found and bud development appeared to be slightly retarded. One third and one fourth instar larva were observed in this cage on May 30. On June 13, a balsam seedling was disinfested and 58 larvae, mostly of the fourth and fifth stadia, were transferred to this seedling for further development. Only 3 mined needles were obtained from this cage, so it is doubtful that the larvae of this cross practise the needle mining habit extensively.

The survival in this cage was very high, as shown in Table II, where 53 pupae were matured from the 58 transferred larvae. The sex ratio of .28 appears undully low while the percentage fertility of 40.4% is an improvement over the 34.61% fertility reported for the heterozygotes in 1945.

(iii) Cage 9 - Balsam ♂ X Jack pine ♀: F1 1946. Four mined needles and 1 second instar larva were observed in the examination of this cage on May 11. On May 23, 11 mined needles were observed. The buds were in poor condition at this time, averaging 1/8" - 1/4" in length, and still in possession of scales, whereas free seedlings have shed their scales and buds average 1/2" - 3/4" in length. On June 13, a balsam seedling was disinfested and 37 larvae were transferred to it from the overwintering seedling. A total of 89 mined needles were obtained upon examination of the contents of the old cage.

A fairly high survival was obtained in this cage with 26 pupae being matured from the 37 larvae transferred. A percentage fertility of 60.1% was obtained this year as compared to the 63.1% for the 1945 heterozygotes.

(iv) Pupal widths. Table III is a summary of the average male and femal pupal widths for 1946 rearings of 1945 crosses.

Table III

	♂	♀
Cage 5 Pj ♂ X Ab ♀	.35*	.36
Cage 7 Pj ♂ X Ab ♀	.34	.35
Cage 9 Ab ♂ X pj ♀	.33	.36

* All measurements are in cms.

Data on the pupal widths of spruce budworm reared on balsam and jack pine budworm reared on jack pine terminals and staminate cones was taken from Tables VIII and IX, p. 81, of the 1945 Annual Technical Report. These figures are contained in Table IV, the purpose being to determine to which strain the heterozygous pupae may show an affinity.

Table IV

	Spruce budworm	Jack pine budworm	
Host	Balsam	Jack pine terminals	Jack pine cones
♂	.38*	.33	.30
♀	.43	.36	.35

* All measurements in cms.

The ♀ heterozygous pupae in all 3 cages show pupal widths which are identical with the homozygote jack pine budworm strain reared on terminals and cones. In no instance did the ♀ pupal widths shown in Table III approximate spruce budworm ♀'s in size. ♂ heterozygous pupae in all 3 gages are approximately the same size as terminal fed jack pine budworm, while jack pine budworm fed on staminate cones and spruce budworm fed on balsam show pupal widths which are too small and too large respectively.

Table V

Complete Tabular Summary of Colour Notes on F1 Hybrid Moths Released in Oviposition Cages at Red Rock Lake, Manitoba, Summer 1946

Cage 5 - Jack pine ♂ X Balsam ♀: F1 1946 (Reared on Balsam)

Oviposition Cage	Date Released into Ovip. Cage	Sex	Colour Note
A	July 7	♂	typical spruce budworm type
A	" 11	♂	deeply tinged with copper-typical S.
A	" 11	♂	" " " " /type

No colour note given for ♀ moths

Cage 7 - Jack pine ♂ X Balsam ♀: F1 1946 (Reared on Balsam)

Oviposition Cage	Date Released into Ovip. Cage	Sex	Colour Note
A	July 7	2♂	deeply tinged with copper-spruce budworm type
A	" 8	3♂	deeply tinged with copper-colour was midway between F1 and sp types
A	" 10	♂	deeply tinged with copper-spruce budworm type
A	" 16	2♀	typical jack pine budworm type
A	" 17	4♂	typical spruce budworm type
A	" 17	♀	typical jack pine budworm type
A	" 18	♀	" " " "
A	" 19	2♀	" " " "
B	" 10	4♂	typical jack pine budworm type
B	" 10	♂	tinged with copper-spruce budworm type
C	" 10	5♂	typical jack pine budworm colour

Cage 9 - Balsam ♂ X Jack pine ♀: F1 1946 (Reared on Balsam)

Oviposition Cage	Date Released	Sex	Colour Note
A	July 11	3♂	typical jack pine budworm type
A	" 11	4♀	typical spruce budworm type
A	" 11	♀	tinged with copper-spruce budworm type
A	" 13	2♂	darker than typical jack pine budworm color
B	" 11	5♀	typical spruce budworm type
B	" 13	3♂	tinged with grey-jack pine budworm type
B	" 18	♂	typical jack pine budworm type

(c) Comparative Notes on the Reciprocal Crosses
Cage 7: Jack pine ♂ X Balsam ♀: F1 1946
Cage 9: Balsam ♂ X Jack pine ♀: F1 1946

(i) Needle mining. Both these crosses were overwintered on balsam and considerable difference was noted in the needle mining habit of the overwintered progeny . For instance, when the larvae from cage 7 (Jack pine ♂ X Balsam ♀) were transferred on June 13, only 3 mined needles were found. On the other hand, 89 mined needles were obtained from the reciprocal cross (cage 9: Balsam ♂ X Jack pine ♀) at the time of transfer. The phylogeny of the hybrids in cage 9 appear to resemble the homozygote spruce budworm strain as far as the needle mining habit is concerned, while the larvae in cage 7 were relatively inactive with regard to needle mining and in this manner resemble the jack pine budworm strain.

(ii) Rates of development. The rates of development of progeny from the reciprocal crosses showed very similar rates of development with the first pupa appearing in cage 7 on June 29, while July 2 was the date of the first pupal appearance in cage 9. As a means of comparing these results with the rates of development of the individual strains, it was noted that the first pupal appearance in cage 65 of the Host Selection Study (balsam - white spruce) occurred on June 26, while jack pine budworm reared in cages 81 and 83 showed no sign of pupa until July 11.

(iii) Survival. In both cages 7 and 9, the larvae were fed on balsam throughout their developmental period. Survival was extremely high in cage 7 where 53 pupae were obtained from 58 transferred larvae. However, survival in cage 9 proved to be not quite so satisfactory with only 26 pupae being matured from 37 transferred larvae.

(iv) Sex-Ratio. The sex ratio of the pupae of the jack pine ♂ X balsam ♀ cross was exceedingly low as only 15♀ pupae were matured as compared to 38♂ pupae. The sex ratio of .61 for balsam ♂ X jack pine ♀ in cage 9, although rather high, is considerably closer to the normal.

(v) Fertility. The heterozygotes in cage 7 were 40.4% fertile as compared to 87.9% in 1945, while a figure of 60.1% was obtained for cage 9 as compared to the percentage fertility of 83.1% in 1945.

(vi) Summary showing the shape and colour of pupae for 1946 rearings of the 1945 reciprocal crosses (Cages 7 and 9)

		Spruce Budworm		Jackpine Budworm	
		Shape	Color	Shape	Color
Cage 7: Pj ♂ X Ab ♀	♂	16	13	8	11
	♀	13	0	1	14
Cage 9: Ab ♂ X Pj ♀	♂	9	1	1	9
	♀	16	9	0	7

Overwintering Material
(1946-1947) Budworm Crosses

Cage Designation	Cage 4: Pj ♀ X Ab ♂	Cage 7: Pj ♂ X Ab ♀	Cage 9: Ab♂ X Pj ♀
Year of Fo Generation	1944	1945	1945
1947 Generation	F3	F2	F2
Host seedling	Balsam	Balsam	Balsam
Location	Across road from Pj plot in experimental area	Across road from Ab plot in experimental area	Across road from from Ab plot in experimental area

F. Influence of Pollen on Jack Pine Budworm

The 1946 field investigations of this problem carried on at Red Rock Lake, in the Whiteshell Forest Reserve in Manitoba, yielded no new conclusions on either of the major phases investigated, larval survival and fecundity.

Certain modifications in the method recommended in the 1945 Annual Technical Report, page 56, were made which resulted in increased reliability of the results.

1. Larval Survival

The basic procedure involves the controlled rearing of a supposedly known number of larvae on host branches of jack pine, either terminal, (green foliage), or staminate, (pollen). Larvae are introduced on to the caged branches early in development, second or third stage, and removed as pupae. In this manner, it is hoped to determine the influence of pollen on larval survival.

The following changes were incorporated into the 1946 procedure:

(a) The number of replicates (cages) was increased from 3 to 10.

(b) The cage size was reduced by about one-half.

(c) The number of larvae in each cage was reduced from 50 to 20.

(d) A check cage was set up for each treated cage and adjacent to it. The check cages were for the purpose of determining the error of disinfestation (see 1945 Annual Technical Report, pp. 55, 56).

By these changes it was hoped to reduce the variability, provide greater control and generally increase the reliability of the results.

The following, in Tables I and II, summarizes the data of pollen fed (staminate) and foliage fed (terminal, non-staminate) larvae respectively.

Table I

Survival of Pollen Fed Larvae 1946

Cage No.	No. Larvae Set Out	Pupae Recovered	Para-sites	Total	Check	Cage-Check
100	20	20	2	22	5	17
102	20	14	5	19	1	18
104	20	13	1	14	1	13
106	20	10	3	13	1	12
108	20	9	4	13	1	12
110	20	12	5	17	0	17
112	20	10	6	16	0	16
114	20	10	1	12	1	11
116	20	13	2	15	0	15
118	20	12	2	15	0	15
Totals	200	123	31	156	10	146

Table II

Survival of Terminal Fed larvae 1946

Cage No.	No. Larvae Set Out	Pupae Recovered	Para-sites	Total	Check	Cage-Check
120	20	5	5	10	0	10
122	20	9	7	16	1	15
124	20	12	1	13	0	13
126	20	12	3	15	0	15
128	20	6	0	6	0	6
130	20	7	0	7	1	6
132	20	10	1	11	0	11
134	20	8	0	8	0	8
136	20	8	3	11	0	11
138	20	6	1	7	0	7
Totals	200	83	21	104	2	102

(a) Discussion

The "Total" figure in column 5 is obtained by adding together the number of pupae recovered and the parasites recovered. In all but one case, these were emerged parasites. The arguments in favour of treating the data in this manner are as follows:

(i) The parasites generally emerge when larvae are in the fifth stadium. Larvae at this time have a high chance of survival and, were they not parasitized, most would probably survive.

(ii) Parasitism may not be considered discriminatory and should, therefore, be cancelled from both sides. The simplest method of doing this is to consider parasitized larvae as having survived and compute the survival figure accordingly.

The figures in column six ("check") represents the total contents of the cage at the time of pupation, including larvae, pupae and parasites; since no larvae were introduced into these cages, this figure is intended to represent the error in disinfestation. In all but one case, cage 100, the error is of no significance. It is interesting to note that disinfestation was begun with cage 100 and that following cage 102 the disinfestation appears to have been very thorough. The reason for the attainment of this high accuracy is probably for the most part due to the low budworm population in the area of experimental studies.

The survival figure for each cage has been obtained by subtracting the figure in column six, entitled "check", from that of column five, entitled "total". In other words, the total contents of the check cage at time of pupation has been subtracted from the figure representing the total reaching pupation in the cage to arrive at the final survival figure.

Uncertainty exists as to the validity of the above procedure. A possible better method would be to subtract the figure representing the number reaching the pupal stage in the check cage from the similar figure for the treated cage. However, since such differences as might arise by different methods of calculation are small, they may be disregarded for all practical purposes.

The percentage survival of larvae to the pupal stage on the two food types is as follows:

Pollen fed larvae : 73%
Terminal fed larvae: 51%

The 1946 rearings, therefore, reveal that survival of pollen fed larvae is considerably higher than that of terminal fed larvae.

While the survival for either type is not constant from cage to cage, the survival is more or less consistently higher in the staminate cages.

At least one further series of rearings is required before a definite conclusion may be stated.

The procedure followed in 1946 appears to be quite satisfactory on the whole, and no modifications are recommended. However, two additions could be made if circumstances allow:

(i) The individual rearing of larvae, for the purpose of providing greater control.
(ii) The rearing of a series of larvae on caged branches of foliage on staminate trees. This would be for the purpose of determining the effect of such a food type on the budworm as opposed to terminals on non-staminate trees. Pollen fed larvae merely have access to pollen, but they also have access to the foliage on staminate trees and it is, therefore, thought to be necessary to determine what benefits, if any, are derived by the budworm from staminate foliage.
(iii) Studies should be undertaken on the extent to which larvae with access to pollen actually fed on pollen.

2. <u>The Influence of Pollen on Fecundity.</u>

(a) Oviposition.

The mating of moths and their subsequent oviposition, the method by which fecundity has been determined in previous years, was unsuccessful in 1946, so that no data is included. Failure was due to shipping difficulties and the small number of moths available.

Recommendations for 1947 investigations of this phase are as follows:

(i) If matings are to be made in Winnipeg, the practice followed in 1945 and 1946, care should be exercised to see that pupae are shipped early to avoid emergence enroute.

(ii) The matings of a series of moths should be made at the field station. Either, only one pair should be placed in each oviposition cage and/or only mated moths should be placed in oviposition cages. As the procedure stands now, five males and five females are placed in an oviposition cage. They are placed there daily as moths emerge, no regard being given to age; no information is thus gained as to the actual number of matings which occur. This is probably small due to the random method of grouping the moths. The figure on the number of eggs laid per female represents the figure for fecundity and, at present, it is computed on the basis of five females laying the eggs from any one oviposition cage. This is undoubtedly not true as not all five females are probably never mated.

(iii) In the same manner, a record should be made of the actual number of matings which occur for each type. The percentage matings could thus be compared to determine whether food is a factor affecting this phase.

(b) Potential fecundity

A series of gravid moths of both staminate and terminal types were preserved in the summer of 1946 and later examined for ovarial contents.

The purpose of this experiment was to provide information on the relationship, if any, between:

(i) the food type and the number of ova
(ii) the number of ova and the number of zygotes deposited

The results are dependent upon the assumption that all oocytes are preformed when the moth emerges and do not continue to form as the zygotes are deposited.

The results of these dissections, giving the number of recorded oocytes for each female, are outlined on the next pages in Tables III and IV for staminate and terminal moths respectively.

TABLE III

Ovarial Content Gravid Staminate Moths

No.	Oocytes*		Total
	Mature	Rudimentary	
1	82	**	82
2	150	**	150
3	157	**	157
4	82	**	82
5	72	86	158
6	117	313	430
7	75	**	75
8	136	205	341
9	97	163	260
10	136	255	391
11	146	222	368
12	157	181	338
13	106	148	254
14	68	185	253
15	87	173	260
16	114	196	310
17	112	226	338
18	180	165	345
19	117	233	350
20	103	216	319
21	155	190	345
22	44	60	104
23	98	143	241
24	79	217	296
25	108	238	346
	2778	3815	6593

TABLE IV

Ovarial Content Gravid Terminal Moths

No.	Oocytes*		Total
	Mature	Rudimentary	
1	81	213	294
2	121	188	309
3	68	154	222
4	104	235	339
5	88	198	286
6*	129	301	430
7*	113	298	411
8*	125	259	384
9*	85	198	283
10*	85	192	277
11	109	250	359
12	63	244	307
13	85	277	362
14	144	147	291
15	61	219	280
16	125	212	337
	1596	3585	5181

* Arbitrary separation.
** Not counted.

The moths used were retained in stoppered vials before killing so that they had no chance of being fertilized or laying eggs.

The final figures for the number of contained oocytes in each case are as follows:

Staminate moths (25) - 302 oocytes per female
Terminal moths (16) - 324 oocytes per female

The figures in Tables III and IV show very little consistency since there is an extremely wide variation. The fact that different preservatives were used,and inexperience in technique, probably accounts for the extremely low contents in certain cases, and for the extreme variability in numbers. Dissection of staminate moths was completed first so that there should naturally be greater efficiency recorded in dissections of terminal moths.

The ovarioles diminish to an extremely small size at the free distal end so that oocytes found here are extmmely hard to count. A certain error is, therefore, to be expected in these counts.

The moths marked with an asterisk (*) are believed to represent the highest accuracy in counting. The type of preservative used and possibly other unknown factors caused the ovarioles and oocytes to be in a most satisfactory condition.

The results obtained are rather valueless as far as figures are concerned; the difference in the number of oocytes according to food type is insignificant when considering the various difficulties met within a preliminary investigation of this nature. The difference appears not to be one of great quantity so that experimental error such as counting would probably tend to make negligible any difference which exists.

As no work of a similar nature had been attempted previously, the 1946 results must be regarded merely as preliminary. However, certain valuable information regarding techniques, fixatives, preservatives and general interanl abdominal anatomy has been obtained so that further investigation into this subject, contemplated for 1947, should be somewhat simplified.

V. SPRUCE BUDWORM BIOLOGICAL CONTROL PROJECT (Filuk, Fyfe)

A. Introduction

In 1946 an extensive program was carried out on *Archips fumiferana* (Clem) in the Spruce Woods Forest Reserve, Manitoba. The biological control factor throughout the budworm phases was under study. An attempt was made to determine numerical relationship of other larvae to the budworm larvae to investigate any endemic stages of other spruce parasites. Three specific areas were chosen for their accessibility, moderate to heavy defoliation and having good trees for population counts. These areas will be referred to as A_1, A_2 and B_1 in the future, and will be designated on the map as such. Larval counts and later pupal counts were taken at weekly intervals, to determine population fluctuations and the role played by parasites in these fluctuations.

Though specific work was done in areas of heavier defoliation, a general survey was made throughout the reserve. Spruce stands extend north from the Assiniboine river up to and slightly beyond the Epinette swamp. The heaviest stands were found bordering this swamp, and consequently were areas of heaviest infestation. Terrain is very uneven, consisting mainly of sand hills tied down by shrubbery and grass. Deciduous trees, mainly aspen, are found among the conifers. Until the land becomes suitable for other vegetation, it would be well to protect the growth of spruce in this reserve. Surrounding country is quite void of trees, and in time this reserve may well be a convenient reservoir for lumber and fuel. At present the timber is too scattered to be used commercially, but some timber is being used from the Epinette swamp.

B. Status of Infestation

The budworm outbreak was first reported in 1939. This area is unique in that no balsam trees are found among the spruce, yet budworm flourish here. Only one similar occurrence was reported in Canada, in the Maritimes. During the war, little work was done here because of the army training areas being nearby. With the cessation of hostilities and the use of the area as a training ground, work was resumed here in the Spring of 1946. A general reconnaissance showed that area of original infestation (C_1) has been reduced from heavy to light. No visible effects of a previous heavy infestation were noticed. The area of heavy infestation has moved in a north-north-westerly direction, bordering the Epinette Swamp. Other points of the reserve are from light to traces of infestation. No increment borings have been taken for study of the effect of heavy defoliation on growth of the spruce.

An over-all picture of the present state of infestation can best be shown on the map following. Photographs which reveal degree of defoliation were taken but, unfortunately, were not clear enough to be of much assistance. A severe late spring frost killed many exposed spruce bud terminals. This gave an appearance of heavy infestation, but was actually a natural check on the budworm growth, forcing the larvae to feed on old needles. Defoliation of each study area is indicated in Table I.

The severe frost on May 13 killed all exposed buds which had grown rapidly in ideal spring weather. Those buds protected by scales were unharmed. This shortage of new terminals would tend to cause more mining of needles. However it was shown by Table II that this was not the case for Area C_1. A few days after the frost, the frozen terminals turned red, giving an appearance of heavy defoliation. It would be inaccurate to estimate defoliation of a spruce stand by distant scrutiny. All areas noted on this map were closely examined. Lack of sufficient roads and trails prevented a complete reconnaissance of the reserve.

C. Phenology

1. Budworm development.

After the slight upset caused by the late frost, budworm development progressed normally. Lack of sufficient healthy terminals tended to increase the number of mined needles. A record was kept of the number of frozen terminals per 100 terminals examined, and also the number of mined needles per 100 terminals examined. It was previously supposed that more frozen terminals increased the number of mined needles. As illustrated in the chart, this was not the case. (Table II)

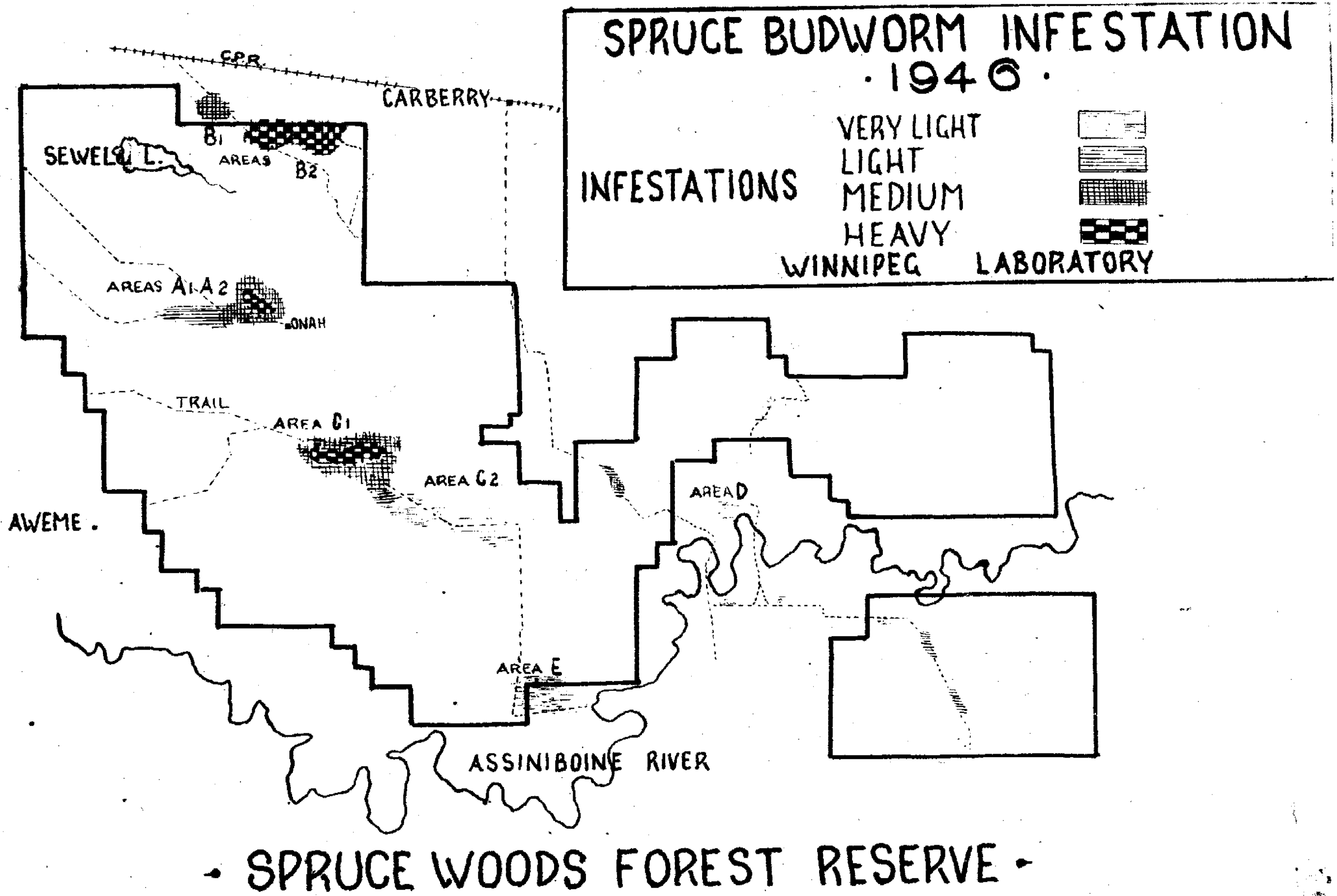

SPRUCE BUDWORM INFESTATION
·1946·
INFESTATIONS
VERY LIGHT
LIGHT
MEDIUM
HEAVY
WINNIPEG LABORATORY
C.P.R.
CARBERRY
SEWELL L.
B1
AREAS
B2
AREAS A1 A2
ONAH
TRAIL
AREA C1
AREA C2
AWEME
AREA D
AREA E
ASSINIBOINE RIVER
SPRUCE WOODS FOREST RESERVE

TABLE I

DEFOLIATION DATA OF AREAS IN POPULATION STUDY Taken August, 1946

Area A_1			Area A_2			Area A_2			Area B_1		
Tree Number	Defoliation Total	Defoliation Current	Tree Number	Defoliation Total	Defoliation Current	Tree Number	Defoliation Total	Defoliation Current	Tree Number	Defoliation Total	Defoliation Current
1601	8/16	7/16	1607*	0	0	1613	7/16	5/16	1619	2/16	2/16
1602	4/16	3/16	1608*	0	0	1614	5/16	4/16	1620	2/16	2/16
1603	2/16	2/16	1609*	0+	0	1615	2/16	1/16	1621	2/16	2/16
1604	2/16	2/16	1610*	0+	0	1616	5/16	4/16	1622	2/16	2/16
1605	3/16	2/16	1611*	0	0	1617	4/16	3/16	1623	1/16	1/16
1606	1/16	1/16	1612*	1	0	1618	4/16	3/16	1624	2/16	2/16

* Black spruce

TABLE II

COMPARISON: Frozen Terminals with Mined Needles: First Count

Area A_1			Area A_2						Area B_1		
Tree Number	No. of frozen terminals	No. of mined needles	Tree Number	No. of frozen terminals	No. of mined needles	Tree Number	No. of frozen terminals	No. of mined needles	Tree Number	No. of frozen terminals	No. of mined needles
1601	25	?	1607	1	38	1613	19	2	1619	4	18
1602	22	?	1608	0	39	1614	10	3	1620	15	5
1603	0	55	1609	0	21	1615	2	21	1621	11	1
1604	0	123	1610	0	44	1616	16	6	1622	33	6
1605	18	10	1611	0	18	1617	10	1	1623	8	5
1606	1	25	1612	0	41	1618	5	1	1624	6	0

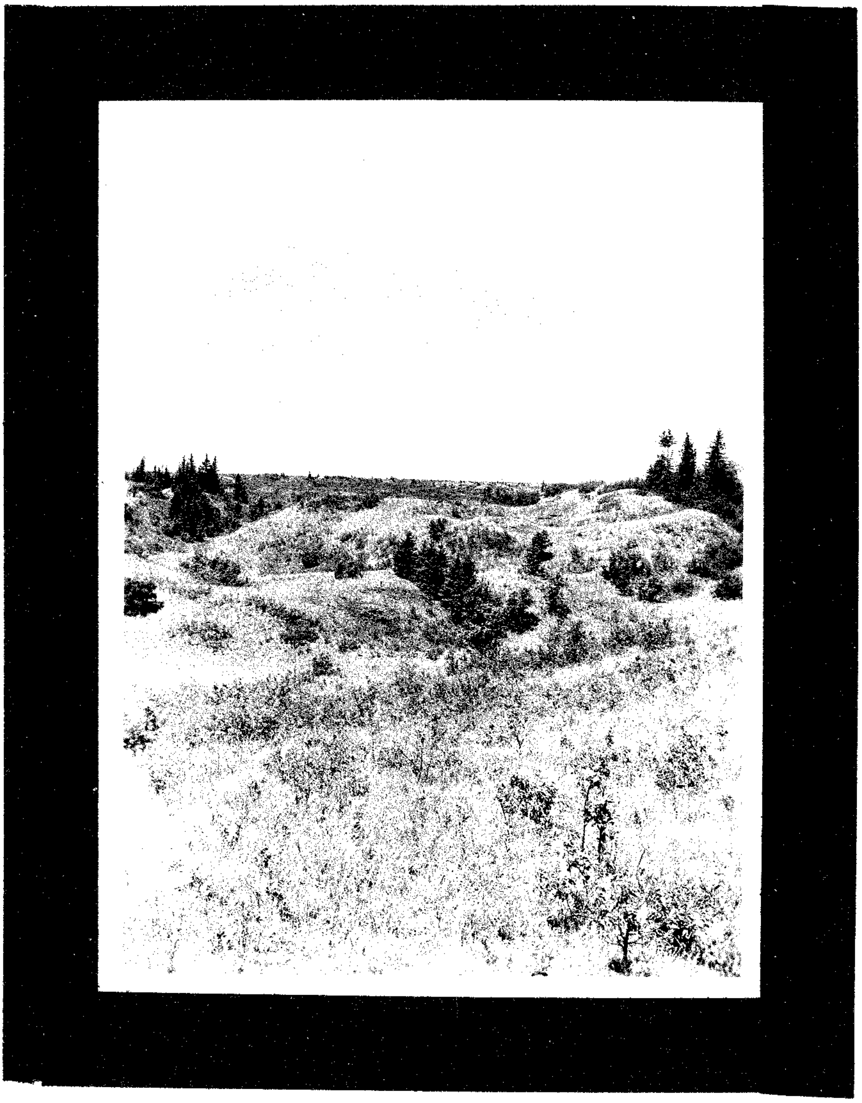
* This tree is not indicative of the statement made above.

Panoramic View

Typical Terrain in

Spruce Woods Forest Reserve

1/50 @ F20

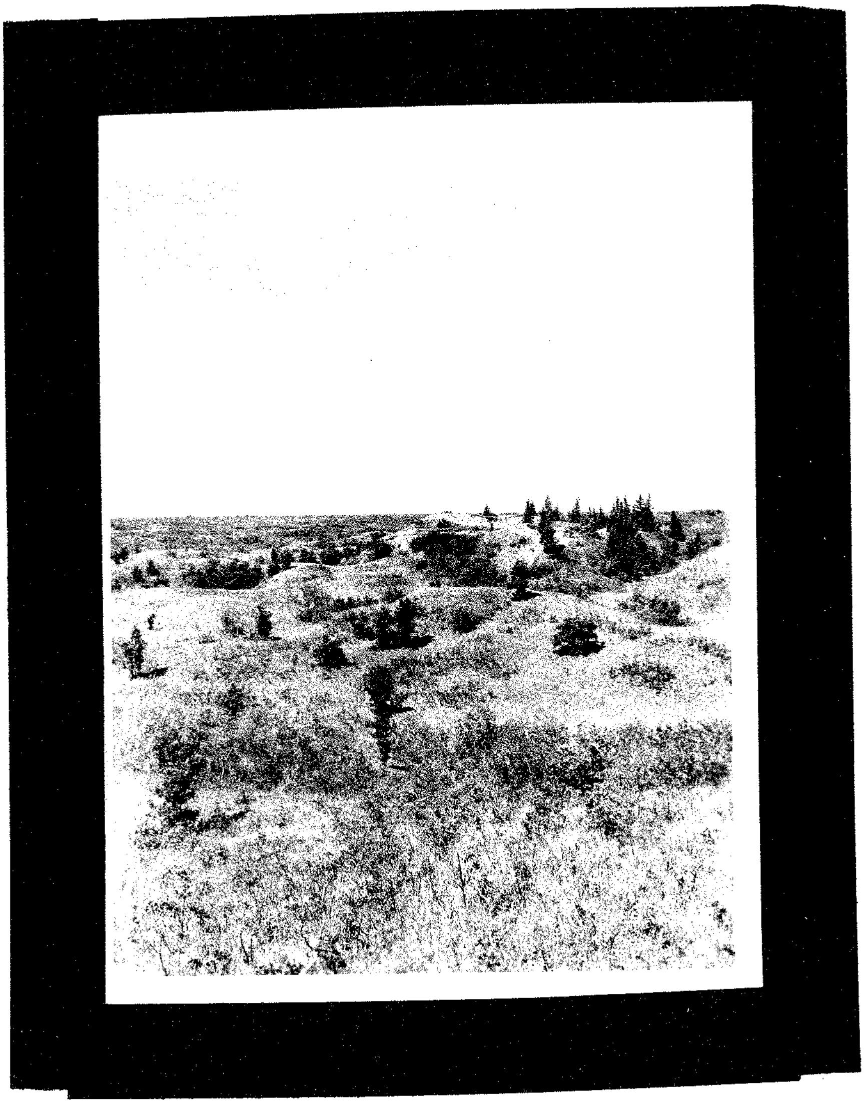


Panoramic View

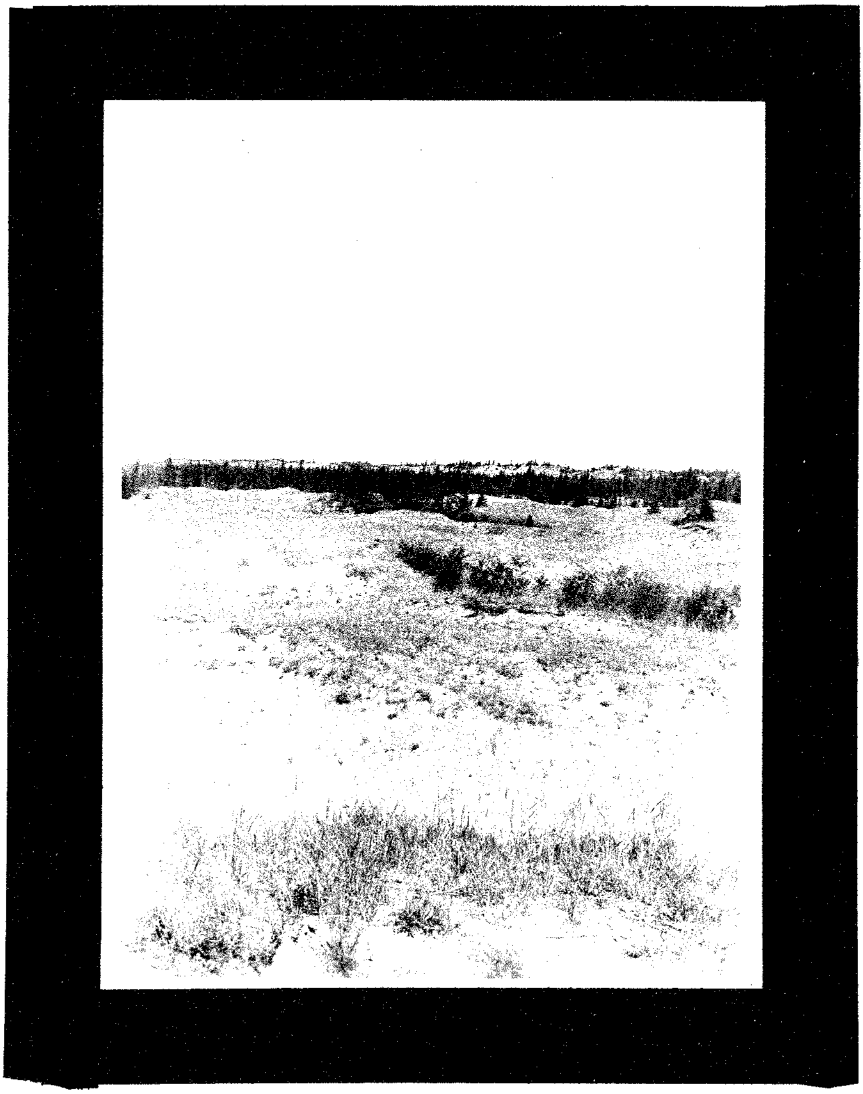
Typical Terrain in

Spruce Woods Forest Reserve

1/50 @ F20



The "Fairy Desert"
Spruce Woods Forest Reserve
Looking NNW. Illustration of
moving sand stopped by trees.



White Spruce Seedling

[illegible], Man.

Taken A.M. May 11,1946.
Showing snow covered
seedling after night
snowfall of 2½".

View of white spruce seedling beside Dominion Laboratory at Aweme, Manitoba. Taken on May 11, 1946.

Close-up of buds covered with snow.

From population counts it was noted that the majority of the budworm larvae were in the 2nd stadium on May 24. A few were already in the 3rd stadium. Ideal weather conditions prevailed for budworm growth. The first pupa was observed on June 12, and the first moth emerged on June 21. Budworm egg clusters were seen on July 1, and first hatching of these eggs were recorded on July 6. It should be noted that all the above mentioned observations were in B_1 which is the slightly more advanced of the three areas under observation.

2. Parasites and Predators.

Closely interwoven with the host development was that of parasites and predators. Large numbers of Tachinid flies were observed on May 24, possibly in search of budworm larvae. The first, *Itoplectis conquisitor* (Say) was seen on June 5, reaching large number by June 11. From laboratory rearings, it was noted that the first *Itoplectis* emerged from a budworm pupa on June 29. From parasite cocoons collected throughout the reserve and reared in the laboratory, it was determined that the larval parasites, *Apanteles fumiferana* (Vier) and *Glypta fumiferanae* (Vier), emerged from their cocoons in distinct peaks. The former's peak emergence date was June 21, while the latter three were June 26, 30 and July 3. Predators consisted of a few coccinelid beetles, *Anotis* sp., reduviids and ants preying on fallen larvae about June 5. *Dioryctria reniculella*, though quite numerous, did not prey on budworm unless foliage was scarce. A good illustration of this is in Area B2 where defoliation was near completion, and much predation by the *Dioryctria* was in evidence. A useful point of this facultative predator is its parallelism with budworm life cycles. They grow, pupate and emerge as adults within close range in time of each other.

3. Plant indicators

To make possible predictions as to time of occurrence of phases in budworm development, records were kept of surrounding plants. Many species were recorded as to time of flowering and withering. Two interesting records were noted. A very pretty cactus bloom, probably *Opuntia*, coincided with commencement of budworm pupation. Widespread blooming of a common plant *Gaillardia* sp. coincides with the commencement of budworm pupation, and the first withering of flowers comes just as pupation of budworm is complete and moths begin to emerge. It is a well distributed plant in this reserve, is easily spotted because of its large brilliant flowers, and is a convenient plant for phenological purposes.

D. Budworm Population Study

To determine population fluctuations through the summer, sampling at regular intervals was carried out. These results were recorded and final figures compiled as indicated in table below, numbered III.

Three distinct areas were selected for their degree of defoliation. They are marked on the map and are known as A_1, A_2 and B_1. The former area was most heavily defoliated while B_1 has moderate defoliation. Areas A_1 and A_2 are adjacent and situated near Onah Station. They border the Epinette swamp and some trees are on top of the ridge while some are at the bottom of the ridge, bordering this swamp. Area B_1 is situated almost due north of this swamp on the Carberry side. Area A_1 had six trees, all white spruce, well developed and averaging forty feet in height. Area A_2 had 12 trees, 6 of which were black spruce, averaging 25 feet high, and the other 6 trees white spruce averaging 30 feet high. Area B_1 has 6 white spruce trees, all healthy and averaging 35 feet in height. Each tree was identified with a metal tag and also painted with a white band for easier spotting.

By using a pruner with extension and a cloth net below the blade, branches containing approximately 100 terminals were cut from the middle third of the tree. Two such branches were cut each time. The branch was then taken and 100 terminals on it were counted and separated, discarding the remainder of the branch. Now these 100 terminals were carefully examined for larvae and pupae. Frozen and healthy terminals were considered. All records were entered in field books in the field. Other supporting data such as predators, mined needles, frozen terminals and other larvae were recorded. Each tree in each area was examined thusly, approximately every eight days. The use of the net greatly reduced error due to loss in handling.

All larvae and pupae found on the 100 terminals and in the net were preserved in Frehling's solution, each branch having a separate vial. One half of these larvae which dropped into the net while the branch was being cut were included in population count. It was decided on the average, that a branch has 200 terminals on it, therefore one-half the larvae in the net can be presumed to come from the 100 terminals that were under examination.

Other larvae were also found on the examined terminals. These were recorded and identified as closely as possible. These larvae were also dissected in the laboratory to determine if they act as an alternate host for the budworm parasite such as Apanteles and Glypta. No such indications were noted. The numerical relations of these larvae were closely checked in the case that they may be in endemic numbers possibly waiting for an upset in the biotic balance to come to the fore. Some of these other larvae found were D. renicullela, Z. fortunana, P. variana, Pikonema alaskensis and some unidentified Tortricids. Table III for other larvae indicates numerical comparison.

The reader will no doubt wish to ask the question, "How accurately are budworm fluctuations represented by these larval counts?" Larval migration is constantly in progress, particularly in the 4th and 5th stadia when search for food is intensified. Therefore it is quite possible that there are population shifts from one stratum to another on a tree, and also from tree to tree. However, the theory involved in the method of sampling employed was that if larvae migrated away from the sample tree or area, others also migrated to them. Originally it was proposed to take duplicate samples from the top and bottom half of each tree, but due to the time involved this was finally reduced to a set of duplicate samples from the centre of each sample tree.

The latter method gave some concern in relation to pupal counts. At that time it was observed that pupae appeared more numerous on the lower branches, many even pupating on bare branches at the base of the trees and on low shrubs beneath these trees. If this movement is very pronounced, counts taken from the middle third, would tend to underestimate the true population. In migrating on their webs, many larvae were also observed to fall freely, many to the ground. These, if they escape predators may eventually congregate on the lower branches with the result that the pupal population may be concentrated towards the

TABLE III

NUMERICAL COMPARISON WITH "Other Larvae"

AREAS	A_1					A_2					B_1					Percentage Total
Larvae found in	Number					Number					Number					"Other"
Population Counts	1st	2nd	3rd	4th	total	1st	2nd	3rd	4th	Total	1st	2nd	3rd	4th	Total	BUDWORM
Archips fumiferana	143	273	220	76	712	310	255	114	52	733	295	303	105	26	729	=2175
Peronea variana	3	1	0	0	4	5	2	0	0	7	3	1	1	0	5	0.73%
Zeiraphera fortunna	2	20	11	0	33	28	28	2	0	58	12	13	7	0	32	5.6%
Dioryctria reni-culella	0	14	20	25	59	3	35	23	19	80	22	21	23	6	72	9.7%
"Unidentifieds" *	3	7	5	3	18	2	12	18	4	36	0	1	7	3	11	3.0%

* includes unidentified Tortricids, 3 yellow-headed spruce sawflies, one *Pikonema alaskensis*, and others.

base of the tree. On the other hand, loss of budworm from the sampling areas (middle portions) by dropping may be compensated by larvae dropping into the sampling area from the top. In any case, it would seem that this phase of population movement within trees should be further investigated to determine its reliability.

Since trees in the Reserve are generally quite scattered, it would probably be fairly safe to assume that comparatively little inter-tree migration occurs, once the larvae have commenced feeding in the spring. If this is the case, then the problem resolves itself into developing a technique for taking reliable estimates of population changes on individual trees.

Trees outside the areas concerned were picked as observation trees. Branches were selected on them, and at each observation any new find or occurrence was recorded. This was to note any unusual biological factors which may not be found in the study areas. From these trees, supplementary information was sought for, but nothing encouraging was found. It was disappointing to discover nothing that was not already noted on the trees under population study. Perhaps these observation trees should be more widespread, and so may give some required data on the biological control study.

Table IV POPULATION COUNT DATA

Sample Area A_1, S.W.F.R., Manitoba, 1946

Tree No.	Host Tree		No. Larvae and Pupae per 200 terminals*			
		Count No.	1	2	3	4
		Avg. Stadium	2 & 3	4 & 5	6 & 7	Late larvae & pupae
		Date	V-2[illegible]-46	VI-4-46	VI-14-46	
1	White Spruce		57	73	18	13
2	"		31	25	20	3
3	"		17	44	29	8
4	"		38	43	31	20
5	"		36	43	17	8
6	"		23	27	36	30
Mean			33.7	42.5	25.2	13.6

TABLE IV POPULATION COUNT DATA

Sample Area A_2, S.W.F.R., Manitoba, 1946.

Tree No.	Host Tree		No. Larvae and Pupae per 200 terminals *			
		Count No.	1	2	3	4
		Avg.stadium	2 & 3	4 & 5	6 & 7	late larvae & pupae
		Date	V-28-46	VI-7-46	VI-15-46	VI-27-46
7	Black Spruce		9	6	8	7
8	"		10	7	8	7
9	"		4	0	0	0
10	"		24	5	8	6
11	"		12	3	7	0
12	"		14	5	3	0
Mean			12.2	4.3	5.1	3.3

* Included in these figures are 50% of the larvae that fell free in the net of the pruner - an approximate number.

Sample Area A_2, S.W.F.R.,Manitoba,1946

Tree No.	Host Tree		No. Larvae & Pupae per 200 terminals *			
		Count No.	1	2	3	4
		Avg.stadim	3 & 4	5	6 & 7	late larvae & pupae
		Date	V-28-46	VI-7-46	VI-17-46	VI-27-46
13	White Spruce		29	39	6	4
14	"		66	31	5	10
15	"		15	51	26	3
16	"		30	26	4	6
17	"		58	17	7	12
18	"		57	22	20	9
Mean			42.5	31	11.3	7.3

Table IV POPULATION COUNT DATA

Sample Area B_1, S.W.F.R. Manitoba, 1946.

Tree No.	Host Tree	No. of larvae, pupae & egg clusters per 200 terminals*				
		Count No.	1	2	3	4
		Avg. stadium	4 & 5	6	Late larvae & pupae	Egg clusters
		Date	VI-3-46	VI-11-46	VI-20-46	VII-5-46
19	White Spruce		73	41	14	10
20	"		78	37	19	9
21	"		43	16	17	15
22	"		54	56	12	22
23	"		40	23	24	14
24	"		51	21	6	7
Mean			56.5	32.3	15.3	12.8 clusters

E. Parasitism

Parasites are the chief factor in biological control of spruce budworm, and hence much work must be done to determine the extent of parasitism. These parasites attack the host in three phases of its life cycle, namely - egg, larva and pupa. Apparent mortality is the mortality of that particular phase of the life cycle. Actual mortality is the mortality over the whole life cycle.

(1) Larval parasitism

To determine extent of parasitism in the larval stage of the budworm, rearings and dissections were carried on in the laboratory. As indicated in chart below, approximately 770 larvae were sent in from different areas of the reserve to be reared. These rearings were for the purpose of identifying species present.

* Included in these figures are 50% of the larvae that fell free in net of the pruner - an approximate number.

Table 5

Larval Dissections from Population Study

Area	Tree Number	1st count Stadia 3	4	5	6	Parasites Apant.	Glypta	Dipt.	2nd count Stadia 4	5	6	7	Parasites Apant.	Glypta	Dipt.	3rd count Stadia 4	5	6	7	Parasites Apant.	Glypta	Dipt.	4th count Stadia 4	5	6	7	Parasites Apant.	Glypta	Dipt.
White spruce A1	1601	12							25	18	11		2	10	1		7	7	11		7					3			
	1602	11					1		15	9	1		2	8			7	10	7		7					2			
	1603	1							35	6			5	7		2	7	2	12	3	5	1		1	1	4		1	
	1604								21	13	4		6	6		3	11	9	17	4	9			3	1	3	2	1	1
	1605	3							18	23	9		10	18			5	11	18		5				1				
	1606								14	9	6		2	5		3	16	10	14	6	13					2			
Black spruce	1607	2					1		3	4				1			3	3	3	1	1			1		1		1	
	1608	3				1			5	1	1						2	2	1	1									
	1609	1																						1			1		
	1610								5					2			2	4		1						3			1
	1611	1							1	2							1	1	3		1								
	1612								5	1	1			2		1	1	1	1	1						1			
White spruce A2	1613		2	16	5		[illegible]		2	17	26		1	9			2	2	3		2								
	1614	22	27	7		1	9		12	15	6		[illegible]	13			3	2	2		3			3	1	2	1	2	
	1615	3							11	20	16		8	7			3	5	9	1	3								
	1616	9	13	4		[illegible]	2		2	17	24		4	16			1		2		1					2			
	1617	11	25	17	2	3	7			8	17		2	8			7	2	1	1	4								
	1618	9	23	23	1	7	9		4	12	13		4	6			7	3	5		7					4			
White spruce B1	1619	5	39	24		6	16		10	19	21		6	14			2	2	2	1	1								
	1620	1	37	17	13	15	10		7	36	44	1	9	19			8	3	5	1	7								
	1621		14	12	10	10	6		6	11	5	1	4	10			2			1					Egg				
	1622		27	20	2	8	10		5	30	29	6	11	14			4	2	4		4								
	1623	1	12	14	10	9	9		2	5	17	7	2	8			4	2	2		4				clusters				
	1624		25	13	3	3	3		4	3	13		5	5				3											
B2		6	32	56	16	9	21																						
C1			35	13	85	8	62																						

Number of larvae per 200 terminals

A total of 1950 budworm larvae were dissected, from different parts of the reserve. The chief purpose was to obtain a definite percentage parasitism, and also the variation between areas. In these dissections all stadia of the larvae were used, but for record purposes only those in 4th and 5th stadia were counted. From experience it was found difficult to discern very small parasite larvae that would be found in the 2nd and 3rd stadia. It was also found that no parasite larvae were found in 6th and 7th stadia. From the known history of Apanteles and Glypta, it was shown that these parasites leave the host in its 5th stadium. On the basis of these dissections, it was found that mortality caused by Apanteles and Glypta averaged 46.5% throughout the Reserve. See Table V.

Parasite cocoons were collected from the study areas during the course of population sampling. These were reared in the field laboratory to determine peak emergence dates. As previously mentioned, peak emergence date was June 21, for Apanteles. This coincided with first budworm moth recorded. As the first new budworm eggs hatched on July 7, it appears that the parasite has 16 days in which to make and prepare to parasitize the young budworm larvae. Glypta emerges on 3 different peak dates, namely June 26, 30 and July 3. It is present soon enough to parasitize the young larvae as they hatch. Prevalence in areas, and parasite emergence are shown in Table 7 and 8.

2. Pupal parasitism.

Pupal parasitism compared favourably with larval parasitism. It was found that 43.3% of pupae reared in the laboratory were parasitised. Budworm pupae, male and female were collected from all parts of the reserve for rearing. A total of 2543 were submitted. It was determined that Itoplectis conquisitor (Say) accounted for 28% out of 43.3% of the parasitism. Dipterous parasitism was 11% out of 43.3%. In larval dissections only 2 dipterous larvae were found. No explanation can be advanced to explain this deficiency in the larvae since emergence of dipterous parasites from pupae was comparatively much higher. See Table IX.

TABLE VII

Genus and Species	No.	Sex Ratio	Adult Emergence 194 Range
Area A_1 Total no. cocoons reared - 7 Number of adults obtained- 5 Number dead - - - - - - - 2			
Apanteles fumiferanae	4	3:4	Jun 20-Jul 2
Glypta fumiferanae	1	1:1	Jun 26
Area A_2 Total no. cocoons reared - 23 Number of adults obtained- 15 Number dead - - - - - - - 8			
Apanteles fumiferanae	5	2:5	Jun 20-Jun 27
Glypta fumiferanae	9	5:9	Jun 27-Jul 7
Meteorus trachynotus	1	♂	Jul 4
Area B_1 Total no. cocoons reared - 54 Number of adults obtained- 29 Number dead - - - - - - - 25			
Apanteles fumiferanae	20	12:20	Jun 10-Jun 30
Glypta fumiferanae	9	6:9	Jun 26-Jul 3
Area B_2 Total no. cocoons reared - 36 Number of adults obtained- 27 Number dead - - - - - - - 9			
Apanteles fumiferanae	23	22:23	Jun 15-July 1
Glypta fumiferanae	4	4:4	Jun 23-Jul 30
Area C_1 Total no. cocoons reared - 10 Number of adults obtained- 4 Number dead - - - - - - - 6			
Apanteles fumiferanae	4	3:4	Jun 20-June 23
Glypta fumiferanae	0	0	0

Table VIII

Parasite Cocoon Emergence *

Data		Area A_1	Area A_2	Area B_1	Area B_2	Area C_1
Apanteles fumiferanae (Vier.)	No.	4	5	20	23	4
	Sex ratio	3	2	12	22	3
Peak emergence date		June 26	June 23	June 20	June 22	June 22
Glypta fumiferanae (Vier)	No.	1	9	9	4	0
	Sex ratio	1	5	6	4	0
Peak emergence date		June 26	July 2	June 27	June 26	
Meteorys trachynotus	No.		1			
	Sex ratio		♂			
Peak emergence date			July 4			

* Hyperparasitism was found in all areas from which collections were taken. Highest percentage hyperparasitism was found in Area B_1.

Altogether there were 130 parasite cocoons reared. Fifty of these were counted as dead, 33 of which did not emerge. Seventeen remaining cocoons contained hyperparasites as follows:

10 cocoons - *tetrastichus* sp.
4 cocoons - *Psysophagus tortricis*
1 cocoon - 14 *Amblymerus verditer*
2 cocoons - unidentified chalcids.

All cocoons were those of *Apanteles* sp. except in case where *Amblymerus* emerged - was a Glypta cocoons.

The first pupal parasite, Itoplectis, was observed on June 5, as compared with first budworm pupa recorded on June 12. It is evident Itoplectis was present well ahead of budworm pupation. Pupae collected during population counts were also reared in the laboratory. This was to determine prevalence of parasites in the area concerned.

Several adult Itoplectis emerging from miscellaneous budworm pupae were used in a small experiment to determine if new Itoplectis females lay eggs immediately. They were given a chance to mate in jelly jars, and then were put singly in vials and fed syrup for a few days. Here they were given a chance for their ova to develop, but no chance to oviposit. Dissections of these specimens which were preserved in Frehlings revealed no ova developed and overioles were immature. It was not possible to count the ova for any future reference. As their life cycle is not completely known, it is doubtful where the Itoplectis spends the rest of the year. As a check on this finding, a few of these newly emerged Itoplectis were let free in jelly jars containing budworm pupae. They were seen to pierce the pupa with their ovipositor and often turn about to feed from the wound. Later, budworm moths emerged from these pupae. It appears that the new Itoplectis were incapable of laying eggs, and attacked the host only in process of feeding. See Table IX.

3. Egg Parasitism.

Lack of sufficient specimens prevented a thorough study of the egg parasitism. Time and army manoeuvres prevented the obtaining of many egg collections from all areas under study. Only area B_1 was accessible. From samples on hand it was noticed that each egg cluster averaged 21.1 eggs. On the basis of 6.4 clusters per 100 terminals, this allows for a potential spring population for 1947 of 135.04 larvae per 100 terminals. Overwintering mortality is high, but it can be assumed that egg parasitism helps partly in bringing down the population from potential to initial spring count.

TABLE IX

Pupal Parasitism

Areas	Total Pupae*	% Parasitism	% Natural Dead **	% Total Mortality
A_1	204	51.4	16.6	68.0
A_2	199	46.7	17.6	64.3
B_2	1571	40.8	21.8	62.6
C_1	174	40.8	29.8	70.6

* This total does not include those pupae that were predatorized.

** "Natural dead" are not figures from the field, but after they had been handled by the laboratory.

Predation was not accurate enought to be considered. When collections of pupae were made, prejudice and selection were unfortunately shown and hence a general picture could not be obtained. It is hoped that next year all pupae encountered will be collected, and so a "run of the mill" collection will be obtained.

4. Parasite Introduction.

Two species of budworm parasites were liberated in Spruce Woods this summer. One parasite, Phytodietus fumiferanae, was received on June 19 and liberated on June 20. These were in excellent condition when liberated. Out of 300 received 250 were living when liberated. They were seen attacking budworm larvae ten minutes after their liberation. The other species Ceromasia auricaudata, came in two lots. The first arrived on July 13 and were liberated on July 14. Their condition was poor, with 69% of the shipment dead. The second lot arrived July 22 and were liberated on July 23, in the same spot. Their condition was good. A total of 640 C. auricaudata were liberated.

It is unfortunate that the latter species arrived much too late to find its host, and thus its chances for re-establishment that summer were very poor. With more shipments coming, experience in handling reduces preliberation mortality of these parasites shipped from Belleville, Ontario.

Special care will be taken to observe any increased budworm control when these parasites become established.

F. Predation

Predators played a secondary role in control during 1946. No particular predator could be picked out as outstanding. As was mentioned previously, ants, coccinellid beetles and robber flies were present in moderate numbers. The latter were seen to attack budworm moths. The former two preyed on budworm larvae.

Dioryctria reniculllela is ordinarily phytophagous, but it has been observed to be predaceous at various times in the Spruce Woods Forest Reserve. In an effort to determine how effective it was in destroying budworm larvae and pupae, the following experiment was conducted in the field.

Three jelly jars were set up, one containing budworm pupae alone, one containing white spruce terminals alone, and the third jar having both budworm pupae and with white spruce terminals in it. Into each of these jars were placed four Dioryctria larvae. Periodically these jars were examined, and after seven days the following observations had been made:

Jar 1. Five of the seven budworm pupae supplied had been preyed upon and killed. One of the Dioryctria had pupated and later emerged.
Jar 2. Terminals have been partially eaten. None of the Dioryctria had pupated.

Parasite Release

in Area P_2

Spruce Woods Forest Reserve

Parasite Release

in Area E_2,

Spruce Woods Forest Reserve.

Jar 3. None of the five budworm pupae had been preyed upon. The white spruce terminals had been partially eaten. One Dioryctria had pupated.

It appears evident that Dioryctria are entomaphagous by circumstance and phytophagous by nature. As was indicated in the "other larvae" chart, Dioryctria was found in fair numbers. Dissecting them revealed no parasitism.

G. Disease

A collection of budworm larvae, which appeared diseased, was sent to Dr. K. Graham, at Saulte Ste. Mare, for examination. The following resume is based on a letter received from Dr. Graham, pertaining to this collection.

It seems fairly certain, from microscopic and electron microscopic studies, that a virus is an important factor in death of larvae and pupae from this collection.

One species of bacteria found in these larvae is a Gram positive diplococcus; another species also found is a Gram negative pleomorphic tapered rod. These species sometimes occur in great numbers concurrently with the virus. Though the two kinds of bacteria may occur together, they do not both occur together in great abundance - either one or the other predominates.

A species of yeast was abundant in a few dead and dying specimens.

It is planned to send more such larval collections this year, to continue the virus investigations.

H. Summary of Natural Control Factors.

Unusual weather conditions may have had a decided influence on population fluctuations. In early spring, favourable weather caused terminals on trees to expand, and the young budworm larvae to go out in search of these terminals. The sudden frost caught them unawares. There is no way of telling how many were killed by the low temperatures. It is almost as difficult to say how many died because of the freezing of the terminals and hence shortage of food. However, weather continued very favourable. No appreciable moisture fell, and temperatures were quite high, to hasten budworm development as if to make up for lost time. It seems that nature is fair to all. The slight starvation in the spring was overshadowed by the more serious food shortage created later. Larvae becoming larger, though less numerous, required more food. Parasites killed off many, but still some trees heavily infested did not have enough foliage for the budworm. Where defoliation was heaviest, pupation occurred sooner, perhaps speeded up by this created starvation.

The parasite complex has been somewhat mentioned before. All those encountered have been referred to. Listed below are the parasites found in order of their numerical superiority.

Hymenoptera:

Itoplectis conquisitor (Say)
Glypta fumiferana (Vier)
Apanteles fumiferana (Vier)
Phaeogenes hariolus (Cress)
Psycophagus tortricis Br.

Diptera:

Madremyia saundersii (Will)
Zenillia caesar (Aldrich)
Phryxe pecosensis (Tns)

It was found that there was a steady decline in the budworm population from 18.1 larvae per 100 terminals in the spring to 4.1 larvae per 100 terminals at the end of pupation. This represents a reduction of 77.3% made up as follows:

Larval parasites	45.3%
dead diseased & predatorized	6.4%
pupal parasites	24.8%
unknown	0.8%
	77.3%

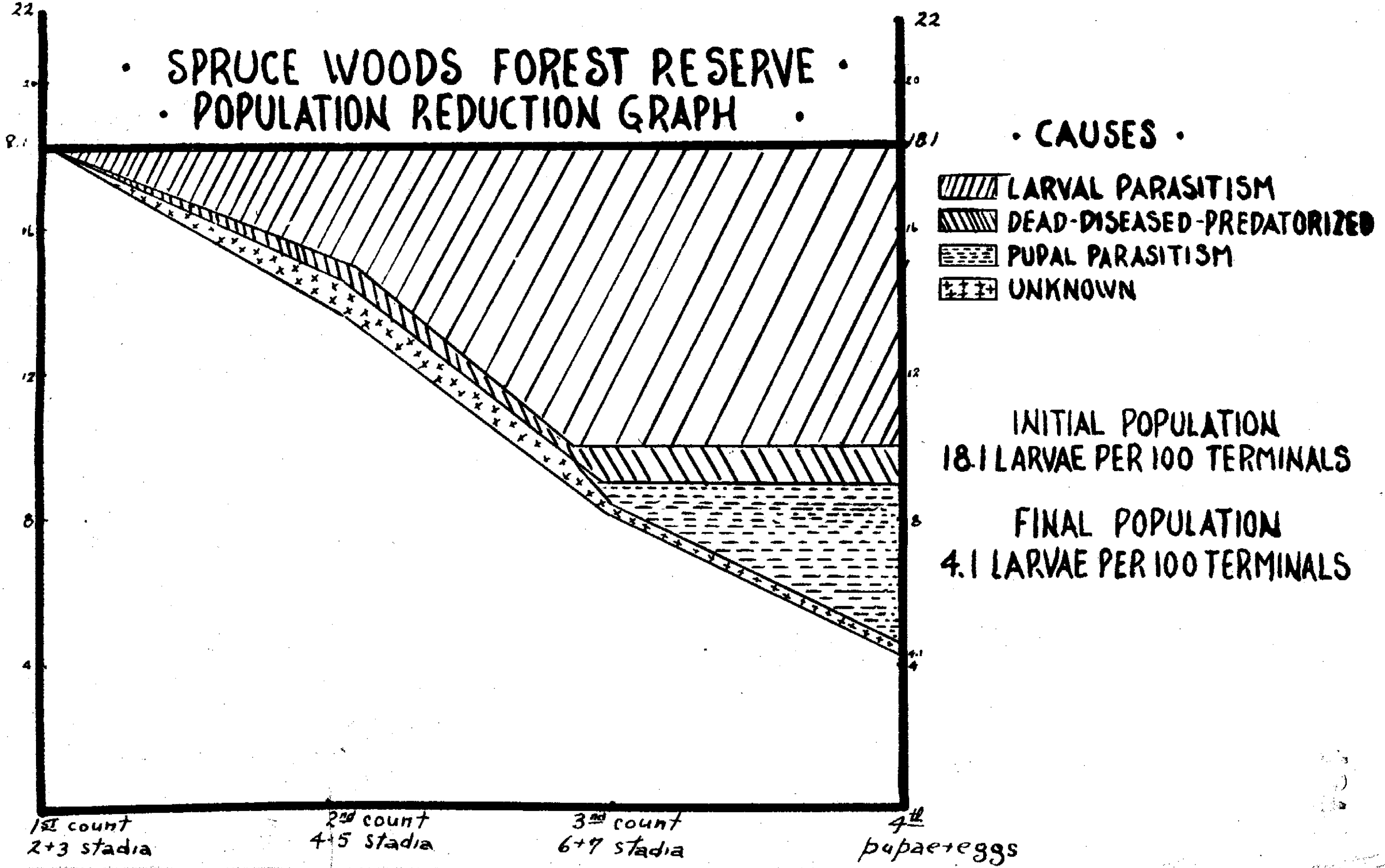
Two parasites, *Glypta* sp. and *Apanteles* sp. accounted for practically all the larval parasitism, while *Itoplectis* sp., *Phaeogenes hariolus* (Cress) and a Diptera contributed to pupal mortality.

The rather unbelievable part of these results is that the above factors apparently caused nearly all the observed budworm mortality, since only 0.8% could not be accounted for. It was believed that a considerable mortality, difficult to apportion, would be due to weather and nutritional factors. Perhaps these factors may make the budworm more susceptible to parasitism. However, inasmuch as the work was done systematically and accurately, it must be accepted at its face value.

These results indicate that natural enemies were the prime control factor during the period of larval and pupal development in 1946. It will be of interest to observe the effect of introducing two new parasites into the area.

One in particular has been quite effective in other parts of Canada and, in the Spruce Woods, fills a gap in the sequence of parasitism between larval and pupal parasites where few parasites are ordinarily present.

The complete story of the role of natural enemies in control cannot be fully evaluated until budworm fluctuations are determined throughout entire life cycles from the laying of eggs in any one year to the same point of the cycle in the following year. An important task is the determination of the initial population at egg laying time in July and the mortality which takes place until commencement of feeding the following spring.



• SPRUCE WOODS FOREST RESERVE •
• POPULATION REDUCTION GRAPH •
• CAUSES •
LARVAL PARASITISM
DEAD-DISEASED-PREDATORIZED
PUPAL PARASITISM
UNKNOWN
INITIAL POPULATION
18.1 LARVAE PER 100 TERMINALS
FINAL POPULATION
4.1 LARVAE PER 100 TERMINALS
1st count 2+3 stadia
2nd count 4+5 stadia
3rd count 6+7 stadia
4th pupae+eggs
22
8
4

VI. LARCH SAWFLY STUDIES (Barker, Filuk)

A. Distribution

The larch sawfly (Pristiphora erichsonii Htg.), remains one of the most important forest insects in the Prairie Provinces. It spread very little in Manitoba, but it did appear in some new localities in Saskatchewan, namely at: Prince Albert National Park, near Nipawin, just north of Fort a la Corne, and northeast of Prince Albert along the north Saskatchewan River. No larch sawfly has been reported in Alberta.

Sawfly was distributed generally throughout southern Manitoba wherever tamarack occurred. Light infestations occurred throughout the Whiteshell Forest Reserve. The infestation in Sandilands Forest Reserve was somewhat heavier this year. Infestations of larch sawfly were reported as far north as Norway House and Elk Island in God's Lake. In the interlake area the stands, though not very healthy, continued to sustain attacks of the larch sawfly. In western Manitoba, the old outbreak in the Spruce Woods Forest Reserve has almost disappeared. No cocoons were to be found in late fall when two attempts were made to obtain them. Infestations within Riding Mountain National Park continued. The worst spots in the Park were along the Norgate Road, particularly at Mile 7 and at Mile 13 on Lake Audy Road. Defoliation was approximately the same as last year near Moon Lake and near the P.O.W. camp. The western portion of the Park was extensively sampled this year. Moderate to severe defoliation was recorded. Duck Mountain Forest Reserve was again heavily hit by sawfly, particularly in the northern part, and in tamarack stands outside the Reserve between Renwer and Sclater. The tamarack in the Porcupine Forest Reserve near Mafeking was lightly defoliated. Just south of Overflowing River on the Pas highway, there was an infestation of larch sawfly. Average defoliation caused throughout a strip twenty-five miles wide was 45%.

B. Sample Plots

1. Permanent sample trees.

Statistical sampling of the population of larch sawfly cocoons was continued in the permanent sample trees established for this purpose in 1944. The exact location of these trees at Mile 7, Norgate Road, Mile 13, Lake Audy Road, Golf Course, and near Riverton, Manitoba, are given in the 1944 Annual Report. The same method of cocoon sampling was conducted as in 1945 (See: M. L. Prebble - Sampling studies of the European Spruce Sawfly in Eastern Canada. Transactions of the Royal Society of Canada, 3rd series, Sec. V. Vol. XXXVII, 1943).

Sampling in 1946 was done over four 1 ft. square areas under each sample tree. A square frame of this size (made of wood) was set down to mark the area for sampling and the sample was secured by cutting the moss with a hay knife around the border of the wooden frame. Samples were taken diagonal to the 3-4 corner of each stake, (1944, 1-2 corner; 1945, 2-3 corner). The cover (usually moss) was removed a handful at a time, placed on a ground sheet and the contents of the sample examined, counted and recorded as to tree number and stake letter.

The cocoons found in each sample were segregated according to the following classification: new sound, moused (destroyed by mice), miscellaneous (included parasitized and dead), and old sound - which were apparently sound cocoons formed prior to 1946. Old sound cocoons were distinguished by the darker colour of the cocoon.

All cocoons found in these foot square samples were tabulated. The average depth and constituents of ground cover from the surface to the mineral were recorded. The general condition and current defoliation were also noted.

The following tabulations give the data obtained from sampling of the permanent sample trees at Riding Mountain National Park and Riverton. It should be noted that at Mile 7 Norgate Road, Stakes A and C Tree No. 4, Stake A under

Tree No. 7, Stakes B and C under Tree No. 9, Stakes A, B, C, and D under Tree No. 11, are all overlapped by foliage from nearby tamarack. Hence these samples may contain cocoons from these other trees.

When the four foot square samples from each permanent tree are checked the next and final year, it will be possible to summarize and draw up a table to cover the period of four years over which this sampling method has been carried out. Any conclusions drawn from this study will then be published.

2. Non-permanent sample trees.

Plans were drawn up to sample several non-permanent trees in an effort to determine the distribution of cocoons under the tree canopy. It was decided to take successive foot square samples running out from the base of the tree in the four cardinal directions.

Unfortunately, lack of time and personnel prevented this study from being carried out. No non-permanent trees were sampled as proposed in the plan above.

3. Permanent Sample plots.

As a means of recording sawfly defoliation from year to year, groups of trees in four areas were tagged with a metal tag and marked with white paint. Each year visual defoliation of these trees is estimated in 16ths.

These records have been kept for six years consecutively, and the following summary is in the form of a history of larch defoliation from 1941 to 1946, in Riding Mountain National Park. In only one area, mile 13 Lake Audy Road, Riding Mountain Park, has the population increased, whereas in the others it has decreased. In the plots studied there is some evidence that the larch sawfly follows approximately a five year cycle of abundance following which it declines. This cycle seems to be related to availability of food, and its speed appears to vary directly with intensity of defoliation. A close check will be kept on the population levels in permanent sample plots for further evidence regarding such a cycle.

SUMMARY OF LARCH SAWFLY STATISTICAL STUDY, 1946
(Permanent Sample Trees), Riverton, Manitoba.

Tree No.	Condition of Tree	Defoliation 1/16's	Stake A In. Depth	Cover	Moisture	New Sound	Housed	Misc	Old Sound
1-319	Healthy. Some curled Tips	1/16	6	grass & moss	very moist	0	0	0	0
2-320	Many curled tips. Foliage fall complete.	?	1	grass & dirt	moist	2	0	0	0
3-321	Healthy. Curled tips. Foliage shed.	?	3	grass & moss	very moist	0	0	0	0
4-322	Healthy. Impossible to determine defoliation, but not heavy. A few curled tips.	?	+8+	moss	moist	10	25	0	0
5-323	Many curled tips. Needle fall well advanced.	?	+12+	moss lab.tea	moist	1	60	1	0
6-324	A few curled tips. Foliage partially shed.	?	3	grass & moss	very moist	3	0	0	0
7-325	Healthy. A few curled tips.	?	$1\frac{1}{2}$	grass & moss	moist	5	7	1	2
8-326	Needle fall well advanced, but also appears to be heavily defoliated. Many curled tips.	?	12+	moss	very moist	6	44	0	0
9-327	Appears to be heavily defoliated, although needle fall well advanced. Condition fair.	?	5	moss	moist	5	6	0	1
10-328	Needle fall well advanced. Apparently moderate defoliation. Some curled tips.	?	2	grass & moss	moist	1	2	0	0
11-329	Appears to be heavily defoliated, and in poor condition. Many curled tips.	?	$1\frac{1}{2}$	moss & grass	moist	4	4	0	0
12-330	Moderate to heavily defoliated. Many curled tips. Condition healthy.	?	12+	moss	moist	17	58	7	0
TOTALS						54	206	9	3

SUMMARY OF LARCH SAWFLY STATISTICAL STUDY, 1946
(Permanent Sample Trees) Riverton, Man.

Stake B							Stake C							Stake D						
Depth ins.	Cover	Moisture	New Sound	Housed	Misc.	Old Sound	Depth ins.	Cover	Moisture	New Sound	Housed	Misc.	Old Sound	Depth ins.	Cover	Moisture	New Sound	Housed	Misc.	Old Sound
6	moss & grass	very moist	3	3	0	1	12+	moss & grass	moist	12	63	2	0	5	Moss	Moist	7	39	4	0
1	grass & dirt	moist	0	0	0	0	1	grass & dirt	moist	1	0	0	0	1	grass & dirt	moist	2	1	1	2
2	grass & moss	moist	0	0	0	0	1	grass & moss	moist	3	25	0	0	1½	moss & roots	very moist	0	0	0	0
8+	moss	very moist	14	8	0	11	1	grass & roots	moist	2	1	0	1	12+	moss	very moist	14	17	0	0
12+	moss	moist	6	1	0	0	2	grass moss	moist	5	1	0	0	12+	moss & lab. tea	moist	6	51	0	0
6¼	moss grass	very moist	1	3	0	3	3½	grass moss	very moist	0	0	0	0	1	grass roots	moist	0	0	0	0
3	moss	moist	9	3	1	10	2	grass moss roots	moist	2	3	0	1	2	moss roots	moist	1	0	0	0
7	moss	very moist	5	57	12	0	1	moss roots	moist	7	8	0	0	6	moss	moist	4	17	0	0
1	grass roots	very moist	2	2	0	0	7	moss & lab. tea	moist	7	30	6	0	2	grass moss	moist	0	1	0	0
3	moss & grass	moist	5	1	0	4	3/4	grass & dirt	moist	1	20	0	0	1½	grass & dirt	moist	3	5	0	0
2½	moss	moist	0	10	5	0	2	moss & roots	moist	5	2	0	0	2	moss & lab.tea	moist	0	2	7	0
6	moss	moist	3	26	0	0	6	moss	moist	7	45	0	0	5	moss	moist	5	30	1	0
TOTALS			49	114	18	29				52	198	8	2				42	163	13	2

SUMMARY OF LARCH SAWFLY STATISTICAL STUDY, 1946
(Permanent Sample Trees), Mi. 7 Norgate Rd.,
Riding Mountain National Park, Man.

Tree No. Rec.	Tree No. Acct.	Condition of Tree	Current Defoliation 1/16's	Stake A: In. Depth	Stake A: Cover	Stake A: Moisture	Stake A: New Sound	Stake A: Moused	Stake A: Misc.	Stake A: Old Sound
1	301	Foliage production below normal. Health of tree - fair	2/16	3	moss & dirt	wet	0	1	0	4
2	302	Poor Foliage	1/16	1½	moss & grass	wet	1	0	0	1
3	303	Poor health.	2/16	2	moss & dirt	moist	0	0	0	2
*4	1472	Very poor foliage production	4/16	1½	moss & dirt	wet	0	0	0	0
5	1485	Foliage production fair	1/16	2	grass & mud	very wet	0	1	0-	5
6	1496	Tree appears dead.	-	2½	moss & dirt	moist	0	0	0	0
*7	1499	Very poor foliage. No foliage on some branches.	4/16	3	moss	wet	2	0	0	0
8	51	Very little bud development due to weak condition of tree.	3/16	1½	moss & grass	wet	0	0	0	0
*9	304	Very poor foliage production. Tree not healthy.	2/16	2½	moss	very wet	2	0	0	1
10	305	General condition poor.	3/16	4	moss	moist	2	0	0	1
*11	49	Foliage production below normal. Some dead branches on lower half.	2/16	1½	moss & grass	very wet	0	0	0	3
12	306	Foliage very poor.	3/16	8	moss	damp	0	62	0	0
TOTALS							7	64	0	17

(cont.) SUMMARY OF LARCH SAWFLY STATISTICAL STUDY, 1946
(Permanent Sample Trees), Mi. 7 Norgate Rd.,
Riding Mountain National Park, Man.

STAKE B							STAKE C							STAKE D						
Depth ins.	Cover	Moisture	New Sound	Moused	Misc.	Old Sound	Depth ins.	Cover	Moisture	New Sound	Moused	Misc.	Old Sound	Depth ins.	Cover	Moisture	New Sound	Moused	Misc.	Old Sound
2½	moss & grass	Wet	0	0	0	0	4	moss & turf	wet	1	0	0	1	2	moss & turf	wet	0	0	0	1
1½	moss & grass	wet	0	0	0	3	1½	Moss & mud	very wet	0	0	0	0	2	moss & mud	wet	0	0	0	4
3½	moss	wet	0	0	0	6	5½	moss	moist	0	4	0	1	3	moss & grass	wet	1	1	0	5
1½	moss & grass	wet	1	0	0	2	1½	moss & grass	very wet	0	0	0	2	1½	moss & grass	wet	2	1	0	0
1	moss & grass	very wet	0	0	0	3	1	grass & mud	very wet	0	0	0	1	1½	moss & dirt	very wet	0	0	0	0
2	moss & grass	wet	1	0	1	1	1½	moss & grass	moist	0	0	0	1	2	grass & dirt	wet	0	0	0	0
2	moss	wet	2	0	0	0	2	moss & grass	moist	0	1	0	1	2	moss & grass	wet	3	0	0	0
1½	moss	wet	0	0	0	0	3/4	grass & dirt	wet	0	0	0	3	1½	grass mud	wet	0	0	0	0
2½	moss & grass	wet	1	0	0	1	9	moss	wet	4	8	2	2	5	moss	very wet	1	1	0	2
3	moss & dirt	wet	1	0	0	4	2½	moss, grass lab. tea dirt	moist	1	2 6	50	5	2	moss & dirt	wet	0	0	0	2
1½	moss & dirt	wet	0	0	0	0	2	moss & dirt	very wet	0	0	0	5	2	moss	very wet	0	0	0	21
2	moss & grass	wet	0	0	0	4	3	moss	very wet	0	0	0	8	2	moss & grass	wet	0	0	0	4
			6	0	1	24				6	11	2	30				7	3	0	39

SUMMARY OF LARCH SAWFLY STATISTICAL STUDY, 1946
(Permanent Sample Trees, GOLF COURSE,
Riding Mountain National Park, Manitoba.

Tree Rec. No.	Acct.	Condition of Tree	1/16's Defoliation	Depth ins.	Cover	Moisture	STAKE A New Sound	Moused	Misc.	Old Sound
1 -	515	Good	1/16	1½	dirt grass	moist	0	0	0	0
2 -	516	Good	1/16	2	light moss turf	moist	0	0	0	3
3 -	517	Good	1/16	3	sphagnum moss	damp	3	3	0	5
4 -	518	Slight defoliation	1/16	3	moss	damp	0	10	0	2
TOTAL							3	13	0	10

Mile 13 Lake Audy Rd.

Tree Rec. No.	Acct.	Condition of Tree	1/16's Defoliation	Depth ins.	Cover	Moisture	New Sound	Moused	Misc.	Old Sound
1--	507	Tree covered by lichen	2/16	2	moss grass dirt	moist	0	0	0	0
2 -	508	Good	2/16	2	grass mud	very wet	0	0	0	7
3 -	509	Tree covered by lichen	2/16	2	dirt grass	very wet	1	0	0	8
4 -	510	Fairly good	5/16	2½	grass moss dirt	damp	5	1	0	2
5 -	511	Poor bud development	3/16	1½	moss dirt	moist	13	0	0	0
6 -	512	Foliage below normal	4/16	1½	grass dirt	very wet	4	0	0	3
7 -	513	Poor foliage. Moss & lichen on tree	7/16	2	moss grass dirt	wet	7	0	0	0
8 -	514	Poor bud development. Lichen on tree	7/16	4	moss dirt	very wet	0	4	0	1
TOTAL							30	5	0	21

(cont.) SUMMARY OF LARCH SAWFLY STATISTICAL STUDY, 1946
(Permanent Sample Trees, GOLF COURSE, Riding Mountain National Park, Man.

STAKE B							STAKE C							STAKE D						
Depth ins.	Cover	Moisture	New Sound	Housed	Misc.	Old Sound	Depth ins.	Cover	Moisture	New Sound	Housed	Misc.	Old Sound	Depth ins.	Cover	Moisture	New Sound	Housed	Misc.	Old Sound
1	dirt & grass	moist	0	0	0	0	2	dirt grass	moist	0	0	0	1	1½	dirt grass	moist	1	0	0	12
1½	grass, moss loam	moist	0	0	0	1	4	moss dirt grass	moist	0	0	0	4	1	loam moss grass	moist	0	0	0	1
1½	turf	dry	2	0	0	6	1	twigs turf	very dry	0	0	0	1	2½	moss	damp	1	0	1	0
4	moss & grass	damp	0	4	0	0	2	moss dirt	dry	0	6	0	0	4	moss & dirt	damp	0	2	0	1
			2	4	0	7				0	6	0	6				2	2	1	14

Mile 13 Lake Audy Rd.

4	grass & mud	very wet	0	1	0	7	1½	grass & dirt	wet	0	0	0	1	3	grass moss dirt	wet	1	0	0	3
2	grass mud	very wet	0	0	0	4	2	grass moss	very wet	4	0	0	8	3	grass dirt	very wet	2	0	0	18
5	grass mud	very wet	5	1	0	5	2	moss grass	very wet	0	0	0	4	1½	moss grass mud	wet	14	1	0	0
3	grass dirt	very wet	3	2	0	15	2	moss grass snow	moist	7	1	0	0	3	grass dirt	very wet	1	0	0	22
2½	grass dirt	very wet	3	4	0	2	3	moss	wet	9	4	0	1	1½	moss dirt	very wet	1	0	0	0
6	moss grass	moist	3	1	0	0	2½	grass dirt	very wet	2	1	0	7	2½	grass dirt	moist	8	2	0	1
1½	grass & moss	wet	4	1	0	0	2½	moss grass	damp	2	1	1	0	1½	wet	wet	4	0	0	4
1½	moss grass dirt	moist	3	0	0	1	3	grass dirt	moist	3	1	0	0	3	grass dirt	very wet	1	1	0	2
			21	10	0	34				27	8	1	21				32	4	0	50

SUMMARY OF SAMPLING

Permanent Sample Trees.

Location	No. of Trees	No. of sq.ft. of Samples	Cocoons per Square Foot				
			New Sound	Old Sound	Total Sound	Moused	Misc. (dead or parasitised)
Riding Mountain National Park							
Golf Course	4	16	0.44	1.5	1.94	1.56	.06
Mi.7 Norgate Rd.	12	48	.54	2.3	2.84	1.6	.06
Mi.13 Audy Lk. Rd.	8	32	3.43	3.94	7.37	.9	.03
Riverton	12	48	4.1	.75	4.85	14.2	1.0

TABLE OF PLOT DEFOLIATIONS (Average Defoliation in %)

Plot No.	Location of Plots	No. of Trees	YEARS 1941	1942	1943	1944	1945	1946
1	Mi 13 Lk. Audy Rd.	51	35.0	18.1	6.5	16.1	15.1	41.8
2	Mi 7 Norgate Rd.	50	12.6	73.1	51.2	92.5	80.6	46.25
3	Golf Course	19	6.6	6.6	1.0	0.31	0.0	0.31
4	Wasagaming Townsite	15	58.3	78.75	71.6	22.5	55.0	43.75

Four sample plots in Riding Mountain National Park were examined for defoliation six years in succession. No conclusive information has been obtained from them, except that the larch may be subjected to severe attacks from larch sawfly with the consequent defoliation without causing mortality to any of the trees. It was noted that a majority of the trees could receive two to four years of almost complete defoliation and still recover.

The following is a summary of each plot.

In plot No. 1, defoliation was not severe enough to cause mortality, and hence it was impossible to estimate the defoliation required to produce mortality. In 1941, only three trees were recorded as being 75% or more defoliated. They all showed remarkable recovery in 1942. The whole plot of trees improved from 1942 to 1945 in foliage production. In 1946, defoliation increased with six trees recorded as 75% or more defoliated.

In sample plot No. 2, 36 trees were 75% or more defoliated in 1942, but only 3 are apparently dead. Of the 11 trees 75% or more defoliated in 1943, only one appeared dead. In the following year, the fourth year of the infestation, 3 more trees were over 75% defoliated. As the infestation began to subside in 1945 and 1946, there was a general improvement in foliage condition with more than 75% defoliated.

Of all the four plots under study, plot No. 3 showed the least variation. It was compantively uniffested.

Plot No. 4 revealed the most irregularity. 7 out of 17 trees showed over 75% defoliation in 1941, and 4 of the surviving 15 were 75% or more defoliated in 1946. Between 1941 and 1946 all of the trees were at least 50% defoliated for one or two consecutive years. Of the two trees recorded as dead, one was lightly defoliated during the preceding year, while the other was heavily defoliated the preceding year.

So far, one definite conclusion can be derived from these records. It was observed that the larch will usually recover after being subjected to two or three years of almost complete defoliation. It can be safely presumed that trees hit hardest by the sawfly at the beginning of an infestation have a very good chance of surviving; those hit during the later years of the infestation have a progressively better chance of survival.

4. Comparison of visual estimation of defoliation with population density of cocoons.

During the last three years, visual estimates of defoliation and cocoon counts have been recorded for each permanent tree. The reliability of visual estimation has been questioned due to variability introduced by judgment of individual observers. However, the cocoon density counts provide a much more accurate estimate of the real population. Until now there had been no way of checking the reliability of the visual estimation with regard to using it as an index to sawfly population. By analyzing the two together, and correlating the methods, it appears that the visual estimates agree to a remarkable degree with cocoon counts. That is, where visual estimates of defoliation have increased, population density of cocoons under that particular tree, as determined by Prebble's sampling method, had increased.

Following is a table summarizing Visual Estimation of Defoliation and Population Density of Cocoons.

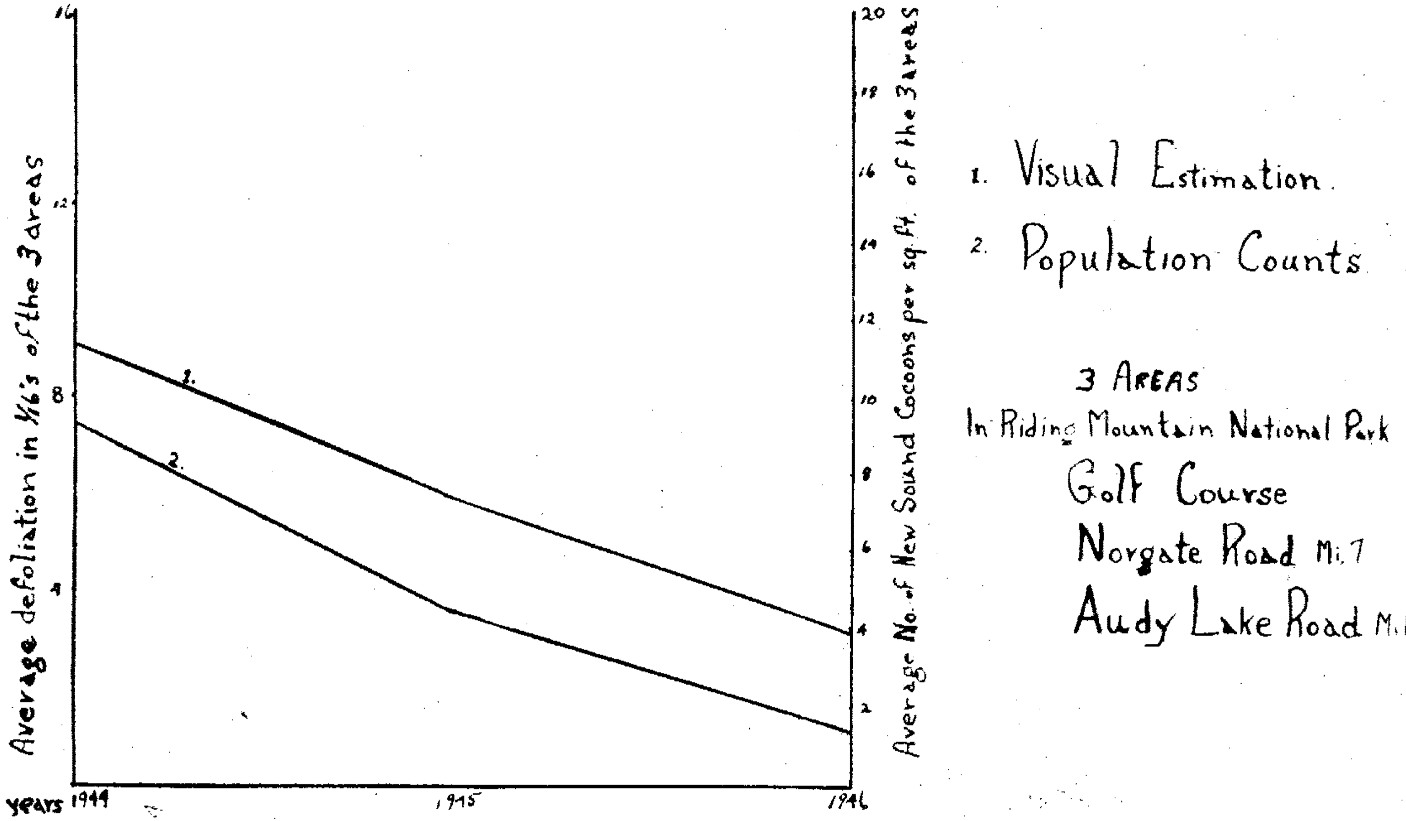
Comparison Table

AREA	No. of Sq. Ft.	Average Defoliation in 1/16s			Average No. of New Sound Cocoons per sq.ft.		
		1944	1945	1946	1944	1945	1946
Golf Course, R.M.N.P.	16	10/16	4/16	1/16	19.0	7.0	0.43
Mi. 7 Norgate Road, R.M.N.P.	48	15/16	13/16	3/16	8.1	4.96	0.54
Mi.13 Audy Lk. Road, R.M.N.P.	32	1/16	2/16	4/16	1.1	1.6	3.43
Riverton, Man.	48	11/16	not * recorded	not * recorded	14.4	10.10	4.1

* During these two years the cocoon sampling was carried out so late that leaves had been shed by the larch, and hence it was impossible to estimate defoliation.

As seen in the Comparison table, the fluctuations in cocoon numbers vary directly as average defoliations for that year. However the number of cocoons is not necessarily indicative of defoliation. For example, in the 3 years at Mi. 7 Norgate Road, the defoliation was quite high, but the number of cocoons was considerably lower as compared with records at Golf Course area. In 1944, with the recorded defoliation of 10/16, the cocoon count was 19.0 per square foot, but at Mi. 7 Norgate Road recorded defoliation was 15/16, yet cocoon count was only 8.1 cocoons per square foot. It would seem that previously defoliated trees have less cocoons under them, by the fact that when adult emerges in spring it seeks a heavily foliaged tree for oviposition, yet the few that do remain are able to cause high defoliation.

The mean for the three years was graphed to indicate the relation between visual estimation and population density of cocoons.


Average defoliation in 1/16's of the 3 areas
16
12
8
4
Average No. of New Sound Cocoons per sq. ft. of the 3 areas
20
18
16
14
12
10
8
6
4
2
1.
2.
years 1944
1945
1946
1. Visual Estimation.
2. Population Counts
3 AREAS
In Riding Mountain National Park
Golf Course
Norgate Road Mi. 7
Audy Lake Road Mi. 1

C. Natural Control.

1. 1945 Results

Results of Incubation of Cocoons of the 1945 season.

Emergence from incubated cocoons was not completed in time to be reported in full in the 1945 Annual Report (Pages 140-142). Additional information on emergence of adults and parasites is therefore given here.

(a) Emergence of adults: Sawflies emerged from 24% of the cocoons incubated. The ratio of males to females was 1:528. Emergence of sawflies took place from 19 to 111 days after the beginning of incubation. The largest sample of cocoons were collected at Mile 145 Dauphin Rd., Riding Mountain National Park. In this area, which was taken as representative of the emergence, adults came out between 22 and 96 days after incubation began. One peak of emergence (57%) took place between 48 and 55 days, and another smaller peak (26%) between 62 and 79 days.

(b) Parasitism by Mesoleius aulicus.

Emergence of Mesoleius aulicus took place during a period 44 to 94 days after incubation was begun. Only 10 specimens emerged in total. Of these, 3 emerged after 44 days of incubation and the remaining 7 after 80 to 94 days of incubation. The parasites were from cocoons collected at Mile 145 Dauphin Road and Mile 7 Norgate Road in Riding Mountain National Park and at Seddon's Corner. Cocoons from which Mesoleius emerged represent less than .3% of the total incubated from Mile 145 Dauphin Road and considerably less than that in the other two areas.

(c) Comparison of Rearing Methods.

A comparison of emergence from cocoons incubated immediately after removal from storage and cocoons incubated after 48 hours of soaking in melting snow is made below:

Area of Sample	% of Cocoons Emerged	
	Cocoons incubated immediately	Cocoons soaked 48 hours
R.M.N.P.		
Mi. 145 Dauphin Rd.	31.7	33.3
Mi. 7 Norgate Rd.	20.8	22.6
Lake Audy Rd.	19.0	22.5
Golf Course	22.0	37.5
P.O.W. Camp	3.1	--
Spruce Woods Forest Reserve	-	8.8
Duck Mountain Forest Reserve	26.8	31.0
Riverton, Manitoba	19.4	17.5
Seddon's Corner	19.4	23.5

In every area except one (Riverton) where comparison was possible, the percentage of cocoons yielding sawflies or parasites was slightly higher when the cocoons were soaked for 48 hours prior to incubation. However, in several areas the difference was so small that it may not be significant. The additional moisture produced no noticeable effect on the length of time required for emergence of adult sawflies, or of the parasite *Mesoleius aulicus*. However, in areas where the two methods could be compared, first emergence of *Bessa harveyi* took place from 2 to 5 days earlier in cocoons which had received additional moisture.

2. 1946 Results.

(a) Mass collections: Mass collections of "new, sound" cocoons were made for dissections and rearings, to determine parasitism. An attempt was made to sample Manitoba as thoroughly as possible in north-south and east-west directions.

Collected cocoons were layered in moist moss within screened, wooden frames for shipment. All cocoons collected during 1946 are tabulated in the following table as to number, place of collection and disposition of each frame.

TABLE FOR COCOONS COLLECTED IN 1946

Date collected 1946	Locality	no. of frames	no. of cocoons per frame	Disposition of Frames
Sept. 25	POW Rd. RMNP	5	2000	Sault Ste. Marie, Ontario.
Sept. 18	Whirlpool Lk. Riding Mtn. Nat. Park	1	900	Belleville, Ontario.
Sept. 18	" " " " " "	1	255	Winnipeg Laboratory
Sept. 17	Mi. 145 Dauphin Rd., R.M.N.P.	1	280	" "
Sept. 24	Mi. 13 Audy Lk. Rd., R.M.N.P.	1	180	" "
Sept. 18	Whirlpool Lk., R.M.N.P.	20	200	Buried at R.M.N.P.
Sept. 18	" Lk., R.M.N.P.	8	200	Stored under snow in Winni
Aug. 15	Western part of Riding Mountain N.P.*	14	200	Winnipeg Laboratory
Sept. 7	11 mi. north of 53rd parallel	1	1000	Belleville, Ontario.
Sept. 7	11 mi. " " "	1	600	Winnipeg Laboratory
Sept. 9	Mi. 254 Dauphin-Swan River Hwy.	1	1000	Belleville, Ontario
Sept. 9	" " " " " "	1	500	Winnipeg Laboratory
Sept. 10	Duck Mountain Reserve	1	500	" "
Sept. 10	" " "	1	1000	Belleville, Ontario.
Oct. 2	Seddon's Corner	1	800	" "
Oct. 2	" "	1	200	Winnipeg Laboratory
Oct. 3	Rennie, Manitoba	1	200	" "
Oct. 3	" "	1	800	Belleville, Ontario.
Oct. 9	Piney, Manitoba	1	800	" "
Oct. 9	" "	1	200	Winnipeg Laboratory
Oct. 23	Riverton, Manitoba	1	200	" "
Oct. 23	Riverton, Manitoba	1	800	Belleville, Ontario.

* Points other than specifically referred to in R.M.N.P.

A Total of 10,000 sawfly cocoons were sent to the Sault Ste. Marie laboratory. They will be used to recover Mesoleius aulicus for liberation in infested tamarack swamps in Ontario. A total of 7,100 sawfly cocoons were sent to Belleville Parasite Laboratory in conjunction with the north to south and west to east survey of larch sawfly in Manitoba. Eight different areas in Manitoba were sampled. In the water-level experiment, 5,600 cocoons were collected from Riding Mountain Park, and disposed of as mentioned in E Water-Level Experiment. Those cocoons left in Winnipeg are chiefly for dissection, to determine range and degree of parasitism. Some of these cocoons will be incubated and reared, but as the results from 1945 were not satisfactory, rearing projects will be reduced. In the year mentioned, high mortality was reported and hence a true picture of parasitism was impossible to obtain. Difficulties in controlling moisture and temperature variations is believed to be the cause of this mortality. It was decided to have cocoons which were to be reared left in the root cellar over winter, and in the spring to put them in the insectary, and there leave them. It is hoped reduced handling and more natural atmospheric conditions will reduce rearing mortality.

(b) Dissections for parasitism:

Closely paralleling the Belleville survey of larch sawfly in Manitoba, it was decided to conduct a duplicate survey here, on a smaller scale. Cocoons from eight different points in Manitoba were dissected. A total of 4600 cocoons were examined for parasitism. Hymenopterous eggs and larvae, dipterous larvae and those killed by disease or fungus, were recorded. See Table below:

Area	No. of cocoons	Hymenoptera		Diptera	Diseased & Fungoid	Total% paras-itized & dead	% net parasiti excludi dead
		Eggs	Larvae				
Rid.Mtn.Nat.Park	3900	535	73	21	388	26.1%	16.1%
Duck Mtn.Reserve	100	5	4	0	2	11.0%	9%
Mi.254 Dauph.-S.R.Hwy	100	2	0	0	7	9%	2%
No. of 53rd 1/4/The Pas	100	0	0	1	1	2%	1%
Rennie, Man.	100	1	0	0	7	8%	1%
Seddon's Corner, Man.	100	8	1	0	0	9%	9%
Piney, Man.	100	0	0	0	6	6%	0%
Riverton, Man.	100	9	3	21	31	64%	33%
TOTAL	4600	560	81	43	442		
MEAN	575	70	10.1	5.4	55.2	16.8%	8.9%

Two chief parasites, Mesoleius aulicus and Bessa harveyi were recorded. All but 700 of the cocoons came from Riding Mountain National Park. It should be noted that 1250 cocoons dissected during the water-level experiment, and obtained from Whirlpool Lake area in Riding Mountain, are included.

Records were kept of all these dissections, including number dead due to causes other than by handling, diseased, fungoid, parasitized by Hymenoptera eggs and larvae, and parasitized by dipterous larvae. In areas other than Riding Mountain National Park, samples of 100 cocoons only were dissected.

It has been observed that from one lot of 100 cocoons obtained from Whirlpool Lake area, late in August, dissection gave the following data. This dissection was done to obtain preliminary parasite figures before making mass collections.

100 cocoons dissected: found to contain:-

22 hymenopterous eggs
7 hymenopterous larvae
3 dipterous larvae.

This established a parasitism figure of 32%. However, since then 1250 additional cocoons from Whirlpool Lake area were dissected in conjunction with the water-level experiments.

1250 cocoons dissected. Parasites found were:-

1.5% hymenopterous larvae
11.1% hymenopterous eggs
1.3% dipterous larvae.

This establishes a parasitism figure of 13.9%. As can be seen by comparison with the first figure, the latter percentage is much smaller. Though the time interval between the two dissections is about three months, it would hardly be sufficient to create such a difference. It would seem to indicate that a larger sample should be taken from an area to obtain a more accurate percentage figure for that area.

From the chart it can be seen that parasitism throughout Manitoba average 8.9%. Adding those cocoons examined as dead and fungoid to the parasitism figure, natural control of the sawfly increases to 16.8%, or nearly double the parasitism percentage. The predominance throughout these dissections of Mesoleius eggs is an important factor to be taken into account. Some of these dissections were made as late as December, 1946. The majority of parasitic eggs examined were coated borwn and distorted in shape. Comparing the stage of the Mesoleius larvae found with the Mesoleius eggs and time of year, it is reasonable to presume that those eggs will not hatch. As was indicated in the 1945 report, it is possible that sawfly adults can complete their development and still contain a parasitic egg. It would appear that the sawflies have developed an immunity to these eggs, or that the strain of Mesoleius has weakened to such an extent as to be overcome by its host.

Therefore, by eliminating hymenopterous eggs from the parasite count, presuming from the above statement that eggs do not prevent development of the adult, the parasitism figure comes down to 2.7% as compared with 8.9% in which figure the hymenopterous eggs are included. Thus Mesoleius may be present and parasitize many larvae, yet its effect in the natural control of the sawfly is reduced. A feature at Riverton, Manitoba, was the recurrence of a large number of diseased and fungoid cocoons. 31% of the cocoons examined from there were fungoid. The 1945 figure was 25.4%, and 1944, 50% of the cocoons dissected from Riverton were diseased and fungoid. No explanation can be advanced for such a high figure.

3. Distribution of Parasites.

From the north to south and west to east samples of sawfly cocoons in Manitoba which were sent to Belleville, lots were kept to be dissected in the laboratory. Distribution of Mesoleius was found to be widespread. The two original release points of Mesoleius aulicus are Riding Mountain National Park and Spruce Woods Forest Reserve. Both releases were made in 1913. From the table in Sec.(2) above, it can be seen where Mesoleius eggs and larvae have been recovered.

Bessa harveyi was released at Riverton and Riding Mountain Park in 1939. Recovery of this parasite has not been as successful because its release has been only recent. By closely examining the table in Sec. 2, it can be seen just how far the parasites have spread from their release points. The most northerly recovery of Mesoleius was 110 miles, as the crow flies, measured from the release point in Riding Mountain National Park. The northeast range, measured from Spruce Woods Forest Reserve (another release point) was at Riverton, being 130 airline miles. The same point is 140 airline miles from Riding Mountain Park. Mesoleius was also recovered at Rennie, Manitoba, which is 170 airline miles due east of Spruce Woods Forest Reserve (original release point). A unique point here is that Spruce Woods Reserve is isolated from the timber belt, being surrounded on all sides by prairie. Despite this, Mesoleius was recovered due east of it to the extent of 170 miles. As no other release points are on record closer to Rennie or Seddon's Corner*, it appears that Mesoleius has reached that far from Spruce Woods Reserve. A collection near Piney was obtained, being 60 miles southwest of Rennie, but no Mesoleius were found. As mentioned previously, Bessa harveyi were recovered only near their release points, at Riding Mountain National Park and Riverton, Manitoba. However, this parasite was released only in 1939, so its 10 mile spread in Riding Mountain Park is a good start.

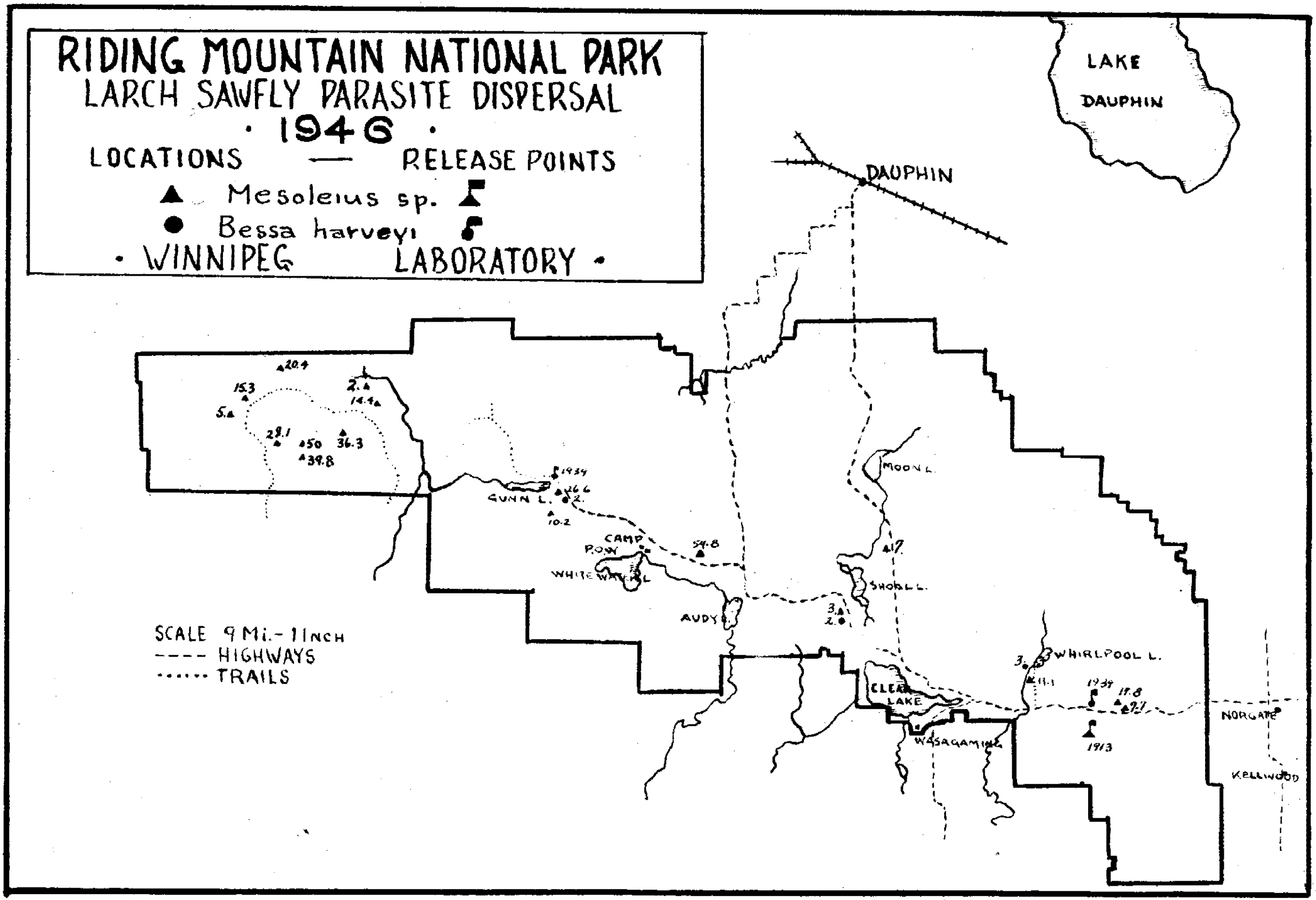
A more detailed and complete picture of parasitism throughout Riding Mountain National Park was obtained by dissection of cocoons collected from 17 different points in the park. Dispersion of the parasites, with percentage parasitism are indicated on the following map. Parasite release points accompanied by the year of release were also marked. This map attempts to show how far the released parasites have spread from their release points, and to what extent. The following chart gives a detailed parasitism per collection. Record numbers are kept on file along with their exact locations and dates of collection.

* A.R. Graham, Can. Ent. 1931, 63:99

Table for Dissections of Cocoons from R.M.N.P.

Rec. No. or Area	Cocoons dissected	Hymenopterous		Dipterous larvae	No. of Dead	Total % parasitised and dead	Net % parasitism excluding dead.
		Eggs	Larvae				
834	110	50	7	0	6	57.3%	54.8
839	125	9	0	0	40	39.2%	10.6
851	200	25	1	0	31	28.5%	15.3
855	190	38	7	0	30	39.4	28.1
866A	145	41	6	0	51	67.6	50.0
867	150	46	5	0	22	48.7	39.8
868	200	64	4	0	13	40.5	36.3
869	130	23	4	2	21	38.4	26.6
870	175	8	0	0	14	12.5	5.0
891	200	4	0	0	5	4.5	2.0
892	200	22	3	0	27	26.0	14.4
895	100	11	9	0	2	22.0	20.4
896A	175	12	0	0	20	18.3	7.7
897	175	19	3	0	51	41.7	17.8
Mi.13 Audy Lk.Rd.	175	5	3	1	1	5.7	5.1
Mi.145 Dauphin Rd.	100	7	1	0	2	10.0	8.0
Whirlpool Lake	1350	151	20	18	52	17.8	14.5
TOTAL	3900	535	73	21	388		
MEAN	229.4	31.5	4.3	1.2	22.8	30.5%	20.9%

Net % parasitism excluding dead is based on number of cocoons dissected minus number of dead cocoons.


RIDING MOUNTAIN NATIONAL PARK
LARCH SAWFLY PARASITE DISPERSAL
· 1946 ·
LOCATIONS — RELEASE POINTS
Mesoleius sp.
Bessa harveyi
· WINNIPEG LABORATORY ·
LAKE DAUPHIN
DAUPHIN
MOON L.
SHOAL L.
WHIRLPOOL L.
CLEAR LAKE
WASAGAMING
NORGATE
KELLWOOD
AUDY
CAMP ROW
WHITEWATER L.
GUNN L.
SCALE 9 Mi. - 1 INCH
---- HIGHWAYS
...... TRAILS
20.4
15.3
5.
2.
14.4
28.1
50
36.3
39.8
1939
26.6
2.
10.2
54.8
17
3.
2.
3.
11.1
1939
17.8
9.7
1913

D. Chemical Control.

1. Object

With the cessation of the war, more and newer insecticides were released for commercial use. It was decided to experiment with two new insecticides, DDT and 666, and to determine their effects on larch sawfly. Work was done in an attempt to obtain information leading to the possibility of spraying from the air. The object was to simulate as nearly as possible dosages and concentrations which might be used by aircraft.

2. Method

Two areas near Mile 145 Dauphin Road, in Riding Mountain National Park, were chosen as having suitable conditions. The terrain was not too rough, and contained very little surface water. Both areas were accessible from the road. Each contained many young tamarack of sufficient density to insure favourable results in the experiment, while at the same time all trees could be reached by a "Dobbins" hand pressure sprayer.

Each area was measured out into small plots 26 ft. square or 1/64 of an acre. Accuracy in measurement was stressed, as it was important that concentrations of insecticide be sprayed over fixed and known areas. To guard against drifting from one plot to another, a ten foot gap was left between two adjacent plots in each case. A total of 26 such plots was laid out, 13 in one area and 13 in another area. (See Table II)

Two different Insecticides were experimented with. One was DDT as an oil suspension in water, and also as a solution in kerosene. The other was 666 as an oil suspension in water, and as a solution in kerosene. Linseed oil was added as an adherent. Below is a method of preparation and formulations employed;

(i) To make 1% DDT - oil suspension in water.

8 oz. pure DDT, add 2 fl. oz. of Triton X. Add velsicol to make 40 fl. oz. This makes a 20% stock solution. To make a 1% solution, take one part stock solution, add one part adherent (linseed oil) and then add water to make twenty parts. The ratio is 18:1:1.

(ii) To make 2% DDT solution in kerosene.

To 8 oz. pure DDT, add kerosene and oil (sticker) to make 400 fl. oz.

The 666 preperations are mede in the same way, using 666 in the place of DDT.

Applications of sprays were as follows:

(a) 1% DDT-oil suspension in water:

1. ½ lb. per acre i.e. 12½ fl. oz. of solution per plot.
2. 1 lb. per acre i.e. 25 fl. oz. of solution per plot.
3. 2 lbs. per acre i.e. 50 fl. oz. of solution per plot.

(b) 1% 666 oil suspension in water.
(same as in (a))

(c) 2% DDT - solution in kerosene.
1. ½ lb. per acre, i.e. 6 1/4 fl. oz. per plot.
2. 1 lb. per acre, i.e. 12 fl. oz. per plot.
3. 2 lbs. per acre, i.e. 25 fl. oz. per plot

(d) 2% 666 solution in kerosene.
(same as in (c))

Twenty-four plots were sprayed, 12 plots in one area with 12 duplicate plots in the other area. Two plots, one in each area, were left untreated to serve as checks. Thus a total of 26 plots was used.

A "Dobbin's Bighead Compressed Air Sprayer" was used in this operation. To assure accuracy and even distribution, the emission of a given volume at a given pressure was timed. Different pressures were obtained by varying the number of strokes of the pump. It was found that 25 strokes of pressure forced 12½ fl. oz. of solution out in 50 seconds. The more strokes, the quicker the emission. For larger quantities, more strokes of pressure are needed to completely empty the container. With a knowledge of the pressure required for the emission of 12½ fl. oz. at 50 seconds, it was easier to deliver a more even distribution of spray over the 26 ft. square plot. As the sprayer is used more, new pressure adjustments will have to be determined to compensate for wear and collection of sediment in the nozzle and other smaller parts.

Shown on the next page is a table of plots, sprays applied, concentrations and dates. Terminals from each of these plots were picked and placed in labelled screen cages twice weekly. The floor of each cage was bedded with moist moss, and moistened every second day. Larvae picked from the surrounding larch trees (away from plots) were placed in these cages, twenty per cage. A daily record was kept of the number larvae that died. After seven days the remaining live larvae were discarded, and a new lot of 20 larvae was put in each cage. There were three such larval transfers.

Table of Plots, Sprays Applied, Concentrations and Dates.

Plot No.	Insecticide used	Fl.oz of Sol.used	lb.s per acre	Date applied	Date of	Larval	Trans
					1	2	3
				1946	July	Aug.	Aug.
1	1% DDT	12½	½	July 20	25	1	8
2	"	25	1	"	"	"	"
3	"	50	2	"	"	"	"
4	"	12½	½	July 25	"	"	"
5	"	25	1	"	"	"	"
6	"	50	2	"	"	"	"
7	Check	-	-	"	"	"	"
8	1% 666	12½	½	"	"	"	"
9	"	25	1	"	"	"	"
10	"	50	2	"	"	"	"
11	"	12½	½	"	" "	"	"
12	"	25	1	"	"	"	"
13	"	50	2	"	"	"	"
14	2% DDT	6 1/4	½	July 27	27	2	9
15	"	12½	1	"	"	"	"
16	"	25	2	"	"	"	"
17	"	6 1/4	½	"	"	"	"
18	"	12½	1	"	"	"	"
19	" "	25	2	"	"	"	"
20	Check	-	-	-	"	"	"
21	2% 666	6 1/4	½	July 26	26	"	"
22	"	12½	1	"	"	"	"
23	"	25	2	"	"	"	"
24	"	6 1/4	½	"	"	"	"
25	"	12½	1	"	"	"	"
26	"	25	2	"	"	"	"

Part 1 <u>Table of Data on Spray Project</u> over Period of 3 Weeks.

% Mortality of European larch sawfly fed foliage sprayed with:

No.	of Days		DDT 1	DDT 2	DDT 3	DDT 4	DDT 5	DDT 6	DDT 7	666 1	666 2	666 3	666 4	666 5	666 6	666 7
1 lb.per acre	1st week	1%	0	0	22	42	50	66	75	5	68	85	100			
		2%	53	56	79	95	100			0	5	11	18	55	87	92
	2nd week	1%	0	0	0	0	6	13	26	0	4	9	29	30	61	66
		2%	4	4	10	31	48	53	53	0	0	23	63	84	84	84
	3rd week	1%	0	0	18	36	64	80	80	0	6	7	33	33	33	33
		2%	*-	-	-	-	-	-	-	0	0	8	16	41	41	50

No.	of Days		DDT 1	DDT 2	DDT 3	DDT 4	DDT 5	DDT 6	DDT 7	666 1	666 2	666 3	666 4	666 5	666 6	666 7
1 lb.per acre	1st week	1%	10	19	39	69	77	87	87	3	33	48	63	100		
		2%	27	44	78	97	100			8	30	53	87	87	100	
	2nd week	1%	0	0	0	6	11	22	31	3	9	17	45	60	75	85
		2%	0	3	13	57	64	97	100	0	8	36	59	77	88	92
	3rd week	1%	0	8	8	67	75	75	83	0	8	6	11	29	43	43
		2%	0	0	7	20	28	42	51	0	0	6	21	31	53	64

No.	of Days		DDT 1	DDT 2	DDT 3	DDT 4	DDT 5	DDT 6	DDT 7	666 1	666 2	666 3	666 4	666 5	666 6	666 7
lbs.per acre	1st week	1%	[illegible]	55	70	83	90	90	90	10	75	84	92	100		
		2%	58	82	100					40	51	87	86	86	100	
	2nd week	1%	0	0	20	27	57	57	57	0	5	11	26	35	60	75
		2%	0	7	64	81	89	95	95	6	19	58	73	80	83	93
	3rd week	1%	0	15	40	80	93	93	93	9	26	27	36	48	81	86
		2%	0	7	15	27	31	35	45	0	0	7	25	31	45	48

* No larvae available.

Part 2 <u>Table of Data on Spray Project over Period of 3 weeks.</u>

% Mortality of European larch sawfly larvae fed foliage sprayed with DDT and 666 minus % Mortality of European larch sawfly larvae fed unsprayed foliage.

			DDT							666						
	No. of Days		1	2	3	4	5	6	7	1	2	3	4	5	6	7
½ lb. per acre	1st week	1%	0	0	18	35	23	29	37	6	68	75	94			
		2%	37	61	85	88	80			0	6	12	13	25	33	26
	2nd week	1%	-5	-7	-14	-21	-23	-18	-12	-5	-3	-4	10	0	30	28
		2%	6	6	10	30	18	12	12	0	0	22	63	50	22	
	3rd week	1%	0	0	18	36	63	55	47	0	6	7	33	33	8	0
		2%	-	-	-	-	-	-	-	-8	-11	-14	-17	4	-15	-7
	No. of Days		1	2	3	4	5	6	7	1	2	3	4	5	6	7
1 lb. per acre	1st week	1%	11	20	38	57	45	62	62	3	33	46	87	73		
		2%	28	53	78	91	81			8	30	53	80	70	68	
	2nd week	1%	-5	-7	-14	-16	-20	-8	6	-5	2	3	23	30	45	47
		2%	0	5	25	57	31	62	56	0	8	35	56	45	32	50
	3rd week	1%	0	8	8	66	75	50	50	0	4	6	11	29	17	9
		2%	-8	-11	-14	-13	-18	-18		-8	-11	-17	-12	-7	7	7
	No. of Days		1	2	3	4	5	6	7	1	2	3	4	5	6	7
2 lbs. per acre	1st week	1%	32	55	66	77	73	73	73	10	75	80	86	79		
		2%	56	82	100					39	52	57	79	74	69	
	2nd week	1%	-5	-7	6	15	26	26	43	-5	-2	1	3	4	28	37
		2%	0	7	69	63	46	23		6	20	58	73	26	22	42
	3rd week	1%	0	15	40	80	100			9	26	27	36	56 36	56	53
		2%	-8	-4	-10	-6	-7	-18	-10	-8	-11	-16	-1	-7	-14	-9

3. Observations and Conclusions.

The preceding tables show percentage mortality of European larch sawfly fed on foliage sprayed with the two insecticides. Another aspect shown is percentage mortality of larch sawfly larvae fed foliage sprayed with DDT and 666 minus percentage mortality of larch sawfly fed on unsprayed foliage, i.e. net mortality. During the third week, fresh larvae were scarce, and plots Nos. 17, 21 and 24 were omitted from the counts.

Much difficulty was experienced with the screen cages used. The smaller larvae were able to escape through the screen. Apparently search for unsprayed food caused them to explore outlets, and hence escape only to die from starvation. Thus the insecticide acted as a secondary killer. Many of the larger larvae cocooned, a few days after capture. This may have been precipitated by lack of edible food or an instinct of self-preservation, i.e. before dying to spin a cocoon in self-defence. The cocoons found in these cages were kept to be checked for emergence in the spring. Unfortunately they were damaged by accident, and hence cannot be checked for emergence. Larvae killed by the insecticide were preserved in Frehling's solution for dissection in the laboratory.

During the three weeks in which the major portion of the experiment was conducted, it was extremely dry, and at no time was the residue washed off by rains. This gave a good opportunity to note residual effects of the two insecticides. During the third larval transfer, those terminals taken from plots 1 to 13 received no rain as compared with those taken from plots 14 to 26 which had been subjected to rain. This provided an opportunity to observe the contrast in the residual effect. However, no noticeable difference was observed. Perhaps after three weeks the residual effect was so reduced that after the rain no difference occurred. Loss of larvae through the cages again interfered with making a deduction.

To get net percentage mortality, the % mortality of the check plot was subracted from the % mortality of the sprayed plot. The following charts illustrate the net % mortality for the three quantities of insecticide for the three larval transfers.

TABLE A Results with 1% concentration.

Treatments (duplicate plots averaged)	% Mortality of larvae after 7 days feeding					
	1st week		2nd week		3rd week	
	DDT	666	DDT	666	DDT	666
½ lb. per acre	75	100	26	66	80	33
1 lb. per acre	87	100	31	85	83	43
2 lbs. per acre	90	100	57	75	93	86
Check plot unsprayed	27.5	27.5	38	38	33.3	33.3

Complete mortality was obtained on the 4th day of the 1st week with the 666 treatment.

TABLE B Results with 2% concentrations.

Treatments (duplicate plots averaged)	% Mortality of larvae after 7 days feeding					
	1st week		2nd week		3rd week	
	DDT	666	DDT	666	DDT	666
½ lb. per acre	100	92	53	84	- *	50
1 lb. per acre	100	100	100	92	51	64
2 lbs. per acre	100	100	95	93	45	48
Check plot unsprayed	66	66	44	44	57	57

* No larvae available.

Where 100% mortality was recorded it occurred on the 5th and 6th days of feeding.

Chart A indicates that as an oil suspension 666 is more deadly in the first week, but its residual effect is not as persistent as that of DDT as shown in the 3rd week. Concentration of 666 as low as ½ lb. per acre produced 100% mortality in the first week. No apparent cause could be advanced for the decrease in mortality caused by DDT in the second week, followed by an increase in the third week.

From table B it would seem that DDT is more effective when applied as an oil suspension, but the residual effect of 666 is somewhat higher in the third week. The high mortality of larvae from some of the check plots was rather unexpected and unexplainable.

As mentioned previously, many larvae escaped through the screen mesh from which the cages were made. Mortality figures therefore are not true, but based on living larvae. Thus accuracy is greatly reduced. In 1947, cages made of fine mesh will be used, and with the experience obtained, and other shortcomings remedied, it is hoped better results will be obtained.

E. Water Level Experiment.

A. 1945 Results.

Water Level Study (1945) cocoons)

As mentioned in the 1945 Annual Report (Page 142) about 4,000 cocoons, collected in September at Riding Mountain National Park and at Riverton, were layered in moss and buried in frames near the collection points. They were brought to the Winnipeg Laboratory in the spring, to compare the emergence of sawflies and parasites from cocoons which had been (a) under water for a considerable period and (b) in a dry location. It was planned to retain any unemerged cocoons at the end of the emergence period to determine what effect moisture conditions have on the prolonging of diapause in the sawfly larvae.

Details of the removal of these cocoons are given below:

Area of Collection	Removal Date	Number of Cocoons	Remarks
Riverton	Apr.16	990	Frame buried in a wet location. Found under 8" of water. Moss thawed out.
Riverton	Apr.16	955	Frame buried in dry location. Found frozen in moss.
R.M.N.P. Mi.145 Dauphin Road	May 15	982	Frame buried in a wet location in moss.
R.M.N.P. Mi.145 Dauphin Road	May 15	990	Frame buried in a dry location in moss.

Rearing of Cocoons.

The cocoons were placed for emergence on moss in cages which were placed in the insectary at the Winnipeg Laboratory. Top, bottom and sides of the cages were made of wire screen with ends of wood. Insects which emerged were removed by means of a glass vial trap inserted in the end of the cage. The screen was set up one inch from the bottom of the cage to allow for drainage and circulation of air around the cocoons. Water was added to the moss every day to keep it moist.

Emergence of Sawflies and Parasites

Emergence of sawflies and parasites occurred from cocoons overwintered in dry locations at Riverton and at Riding Mountain National Park. No emergence occurred from cocoons overwintered in wet locations in either area. A summary of the emergence is given below:

Area	Pristiphora erichsonii	Mesoleius aulicus	Bessa harveyi	Other Diptera
Riverton (dry location)	93 (June 7-July 4)	1 (June 25)	12 (June 19-June 27)	1 (June 28)
R.M.N.P. (dry location)	156 (June 7 - July 12)	0	0	2 (June 15-June 22)

"Other Diptera" referred to in the above table were:
June 15-22 - *Megaselia* sp.
June 28 - Specimen too poor to identify.

Unemerged Cocoons

The cocoons remaining unemerged at August 15 were examined as many of them appeared to be dead. This proved to be true as all cocoons were found to contain decayed larvae. Since all the insects were dead, the experiment had to be terminated at this point.

Conclusions

The total emergence of sawflies and parasites represented only 9% and 16% respectively of the cocoons overwintered in dry sites at Riverton and at Riding Mountain National Park. The cause of this low emergence is not known, but may be related to excessive moisture of the moss in the rearing cages. It is noteworthy that no emergence occurred from cocoons overwintered in wet sites in either area. Perhaps excess moisture prior to caging affected these cocoons in such a manner as to prevent their emergence. On the other hand, the emergence of these cocoons may have been delayed by this excess moisture and emergence would have occurred at a later time had rearing conditions been suitable.

Further studies on the effect of the water-level of the site on hibernating larch sawfly are indicated since these results are inconclusive.

B. 1946 Results.

1. Introduction

Riding Mountain National Park is literally covered with lakes, swamps, sloughs and creeks. Though not all these moist areas are accessible, some of the larger ones are. It is usually in these larger areas that the larger blocks of tamarack are found.

Records kept over a period of years show conclusively that mice and shrews destroy large numbers of larch sawfly cocoons in comparatively dry swamps which provide a favourable habitat for these insectivores. Nevertheless, complete control is rarely, if ever, achieved by these agencies.

On the other hand, repeated observations in recent years indicate that wet swamps rarely show severe defoliation, and more often experience no defoliation whatsoever. These two facts offer two possibilities. One is to either drain the swamps and permit greater accessibility to the insectivores, or to dam up the swamps to repeat the observation mentioned above. As stated previously, the former possibility rarely brings about complete control.

2. Object

Preliminary experiments in the spring of 1945, as shown in the first part of this section, indicate that submergence under water for a limited period of time may be fatal to larch sawfly in the cocoon stage. On the basis of these preliminary observations and studies, it was felt that the possibility of regulating water levels in swamps to control the larch sawfly might be worth investigating. If it is found that water levels can be manipulated to advantage, complete control by flooding rather than partial control by insectivores might be achieved in treated swamps.

The influence of several factors must be studied in detail before the merits of this method can be properly appraised. These are: (1) stages in sawfly development where submergence is lethal, (2) length of submergence required to produce mortality, (3) influence of flooding on growth of tamarack, (4) height of water level required to submerge cocoons, (5) cocooning habits in relation to water-levels, (6) influence of water on diapause, (7) feasibility of flooding and draining swamps, (8) selectivity of submergence in mortality of parasitized and unparasitized cocoons, and (9) rate of development as influenced by water.

3. Method

Two areas for study were selected in Riding Mountain National Park. One area is located due east of the golf links across the highway, and the other area is at Mile 7, Norgate Road. Cocoons were buried here at various levels, lots of which will be taken out at monthly or bi-monthly intervals. These lots will be dissected to note any effect of prolonged or variable submergence. Records will be kept of water-level fluctuations in that particular swamp.

In each area, two pits (see Figure I) were dug. One pit will act as a check on the other. Pits were dug well below the water-level of the swamp. The water was allowed to seep in to its normal level. A stake was driven in one corner of the pit, to act as a marker for the water levels. After the original water level was marked on the stake, the water was drained out and frames of cocoons were placed in the pit. Each frame was one foot square, and three inches deep, containing 200 cocoons collected from the Whirlpool Lake area. These cocoons were layered in moss. The frame was made with a hinged screen top to make entry easier and quicker when lots of cocoons are to be taken out.

It was decided to place cocoons at five different heights with respect to the original water level. One is at the water level, with one six inches and one three inches below the water level and one three inches and one six inches above the water level. Suitable spots were chosen to make these heights above water level,possible.

Four such pits were dug, two in each area (see Figure I). They were 50 yards apart in each area. Their exact locations are:

A: SE 168° of Sample tree 317 - 50 feet B: SE 153° of Stake on trail. 84 feet	Golf Course
C: NW 288° of Sample tree 301 - 65 feet D: NE 5° of Sample tree 302-23 feet	Mi. 7, Norgate Rd.

FIGURE I

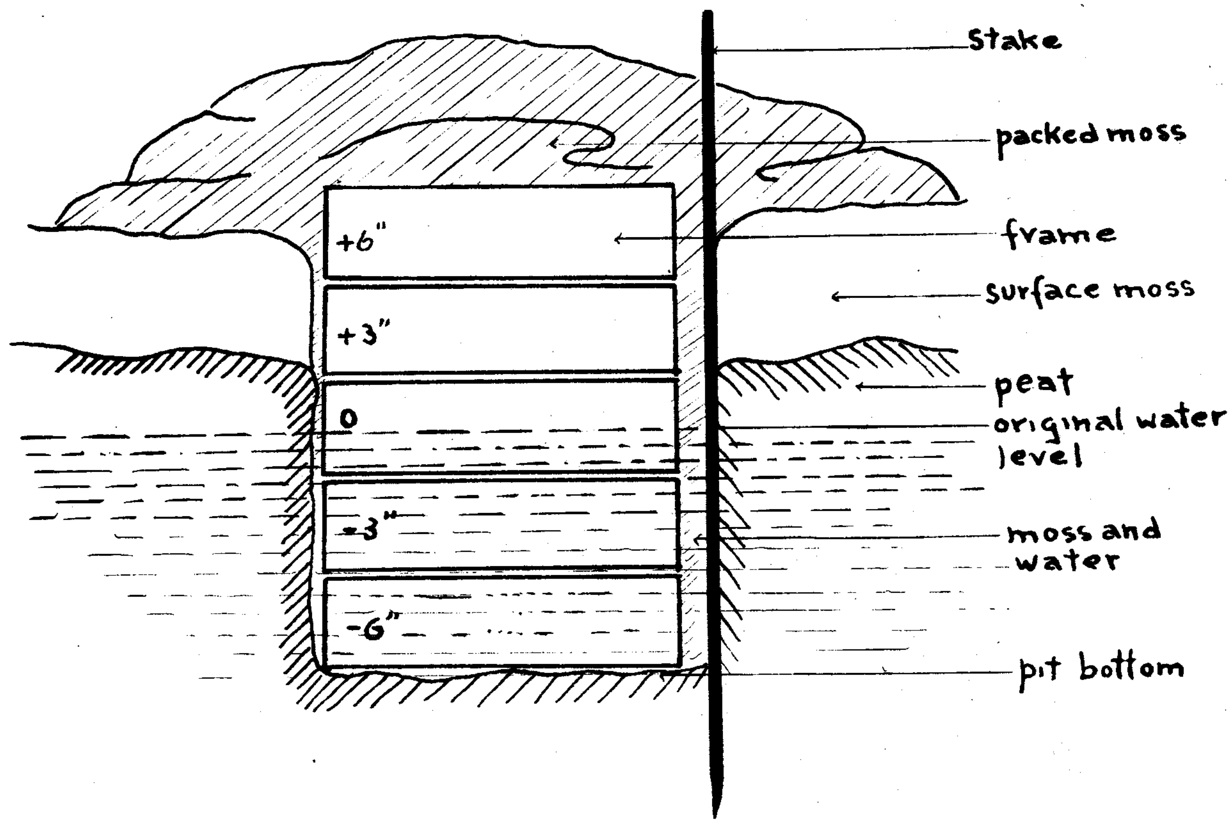
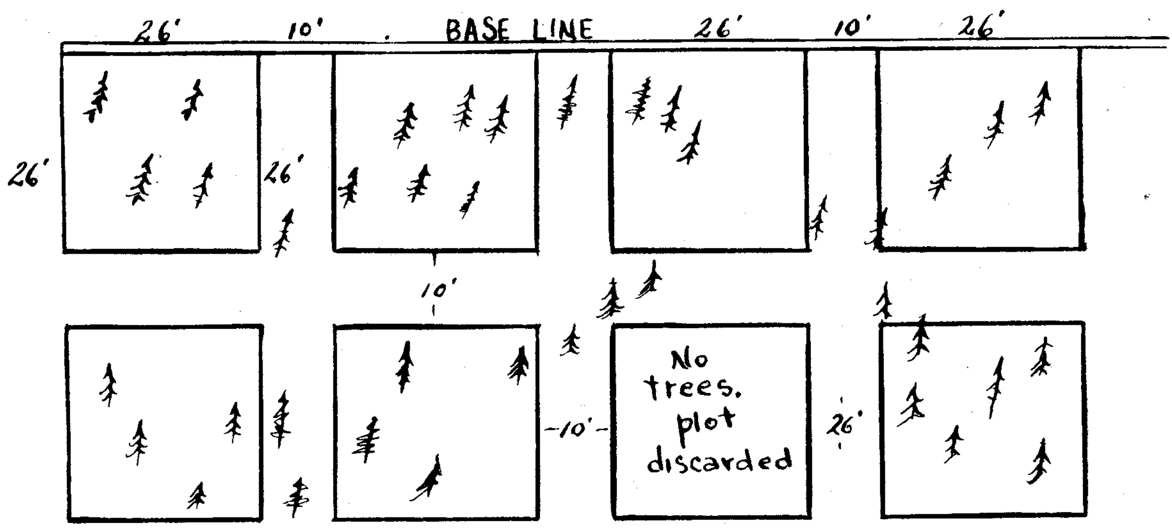


FIGURE II



Closely paralleling the water-level study at Riding Mountain National Park, an artificially controlled water-level experiment was started in the Winnipeg laboratory. The object of this is to keep cocoons submerged for a definite period of time at a fixed water-level.

Special frames were made to fit into metal pans, and 200 cocoons were placed in each frame. They were placed:

2 - to be kept dry all year
2 - to be kept wet all year (under water)
2 - to be kept wet in the fall and dry in the spring.
2 - to be kept dry in the fall and wet in the spring.

As in the previous experiment, a replicate was made of each, giving a total of 8 frames altogether. Those frames to be submerged were placed in the pans, and water was added to completely cover the frames. Those frames to be kept dry were moistened only slightly. By mid-November the water in the pans had frozen, so all frames were buried under the snow to obtain a closer resemblance to natural conditions.

In the spring these frames will be returned to the insectary and further examinations of cocoons will be continued. It is hoped to determine the time element required to kill cocoons under water, and also percentage of emergence as determined by the frames subjected to the variable moisture content.

These two projects were started approximately at the same time - 20 September 1946. In the first month, 25 cocoons from each frame were brought in to the laboratory and dissected. A total of 700 cocoons were dissected each month for two months. As winter commenced, all work on this experiment was suspended due to freezing conditions, and development in cocoons was negligible.

4. Observations.

The first lot of cocoons, having been submerged for 24 days, showed no signs of mortality obviously due to submergence in water. The water-level had risen so that all frames were under water. Along with larval mortality, larval development, activity and parasitism were noted.

As the larvae do not begin metamorphosis until after the diapause phase, no change in development was noted. All larvae were in the eonymph stage. Cocoons placed below the original water level in the swamps contained water, and the larvae in these cocoons were inactive, though alive. However, the submerged larvae from the controlled experiment upon immediate dissections showed no signs of life whatsoever.

A number of these submerged cocoons were incubated at room temperature to see if they would revive. After seven days these cocoons were dissected, and all larvae had recovered. Thus it seems that those cocoons from Riding Mountain National park, which were submerged, had recovered in the interval between removal from the water and dissection.

Natural elements such as snow and rain at Riding Mountain National Park combined to raise considerably the water levels of the swamps in which the cocoons were buried. In one swamp the level rose 6½ inches in the 24 days, and in the other swamp the level rose 3½ inches. In the former swamp all frames were submerged. One month later, both water levels had receded 1½ inches.

Dissections from the second count revealed nothing unusual. This time, cocoons that were under water in the swamps were kept under water in jars up to the time of their dissection. Larval activity was reduced considerably by the colder weather. Severe frosts and lack of any protecting snow may have frozen some of the larvae in the cocoons. 25 of these cocoons were selected and placed in cold storage in wet moss, to be incubated at a later date, and to note any sign of life.

As illustrated by the above mentioned experiment, the sawfly cocoon is permeable to water. The presence of water within the cocoon did not appear to interfere with the living larvae, except to reduce its activity. By placing moist cocoons in a dry atmosphere, the water quickly evaporates from the cocoons.

Observations are to be made on water levels in all tamarack swamps examined, to determine extent of defoliation in relation to moisture. Officials at Riding Mountain National Park are keenly interested in the outcome of this project, and, if it proves successful, will attempt experimentally, control of the sawfly in one or two swamps by regulating water levels in them. Great care will have to be taken not to destroy the tamarack itself, by drowning.

5. Conclusions

Careful watch has been maintained on the gradual westward movement of the larch sawfly. Samples from new areas have been sent in, and it will be interesting to note from how far west these samples come. Permanent sample tree study is a means of comparing the amount of larch sawfly from year to year. In 1947, when the four corners of the stake will have been examined, the data will be summarized. Unfortunately no non-permanent sample trees were sampled this year. It is hoped that more time can be devoted to such samples to be used in a comparison study.

The chemical control work, though not very successful, has promising possibilities. This year a more accurate method will be employed and it is hoped results will be satisfactory.

Water-level studies were commenced this year. It is too early to predict results, but if this method proves satisfactory, much benefit to the Park in general and to the larch specifically will be obtained.

From dissections of the cocoons collected throughout the Riding Mountain Park and other parts in Manitoba, it was found that Mesoleius is quite widespread, but it seems its effect has been greatly curbed. Mesoleius eggs have been found inside the host. These eggs have died, and hence do not hatch and kill the host. Thus the Mesoleius effect has been weakened. Samples have been sent to Belleville for study, to determine if the present strain of sawfly has developed an immunity for the Mesoleius aulicus.

VII. THE INFLUENCE OF DDT AND 666 TREE BANDING ON ADULTS OF THE FALL CANKERWORM (*Alsophila pometaria* Harr.)

A. Introduction

A block of deciduous trees on Lot 592, Henderson Highway, of the East Kildonan suburb, Winnipeg, Manitoba, was treated with DDT for fall cankerworm control. This insect had been quite active in this area during the summer of 1946. The trunks of the trees in this area were sprayed with bands of various concentrations of DDT and 666 over which the female moths would have to pass when ascending the tree.

This experiment was carried out with the object of determining chiefly the effect of stronger and heavier applications of DDT upon the fall cankerworm adult female than were previously employed. A small quantity of 666 was also available for experimentation.

1. Formulations employed:

The following 20% formulations were employed:

(1) DDT oil suspension in water:
DDT - 1 lb.)
+ Tr.x.-4 fl. oz.) add velsicol to make 40 fl. oz.

= 40% stock solution
To make 20% final solution, add one part water to one part stock solution.

(2) 666 oil suspension in water:
+ 666 - 8 oz.)
Tr.x.- 2 fl. oz.) add velsicol to make 20 fl. oz.

= 40% stock solution
To make 20% final solution, add one part water to one part stock solution.

(3) Deenate 50 (DDT) in water:

25 lbs. Deenate 50- add water to make 28,400 cc. total solution
= 20% DDT final solution

Note: Deenate 50W is a general purpose wettable powder containing 50% DDT.

B. Field Experiments

1. DDT Banding: October 4 to October 5, 1946.

(a) Methods:

Trees in a complete block on Lot 592, Henderson Highway, were selected for treatment. Using three applications of DDT in oil suspensions, at the rate of 12 grms/sq.ft; 24 grms/sq. ft; and 48 grms/sq.ft; and one application of 666 at the rate of 12 grms/sq.ft; bands 3½ ft. and 7 ft. wide were sprayed on the trunks of the trees with a "Dobbins Compressed Air" hand sprayer. Four trees only remained untreated, and were used as checks.

Fifteen trees were labelled and received a 3 inch band of tree tanglefoot above the insecticide band. Check trees bore only the band of tanglefoot placed 6 ft. above the ground, and were labelled 401, 402, 403 and 404.

All banding was completed by October 5. Experimental trees were examined periodically for fall cankerworm activity until November 15.

When the insecticide was applied to the tree, the area of the band was computed from the measurement of the circumference and the 20% solution applied as shown in Table I.

TABLE I (a)

Treated Trees

Tree No.	Solution Used	Date Sprayed 1946	Width of Band	Amount of Solution / sq.ft.	Area of trunk sprayed (sq.ft.)	Concentration per sq.ft.	Circumference of tree (ins.)
405 DDT analysis	DDT	Oct. 4	7'	240 cc	26.83	48 grms.	46 DDT sample
406	DDT	Oct. 4	7'	120 cc	22.17	24 grms.	38
407	DDT	Oct. 5	7'	240 cc	14.58	48 grms.	25
408	DDT	Oct. 5	7'	120 cc	22.17	24 grms.	38
409	DDT	Oct. 5	7'	240 cc	9.97	48 grms.	17
410	DDT	Oct. 5	7'	120 cc	11.08	24 grms.	19
411	Deenate	Oct. 5	7'	60 cc	16.5	12 grms.	33
412	DDT	Oct. 4	3½'	60 cc	5.83	12 grms.	20
413	DDT	Oct. 4	3½'	60 cc	5.54	12 grms.	19
414	666	Oct. 4	3½'	60 cc	6.71	12 grms.	23
415	666	Oct. 4	3½'	60 cc	5.83	12 grms.	20

Table I (b)

Check Trees

Tree No.	Distance from ground of tangle-foot band	Area of trunk from ground to band (sq. ft.)	Circumference of tree (ins.)	Circumference (ft.)
401	6'	8	16	1.33
402	6'	10.5	21	1.75
403	6'	12	24	2.00
404	6'	15.5	31	2.58

(b) Results:

The first examination of the tanglefoot bands on the experimental trees was made on October 10, five days after completion of spraying; and were continued periodically until November 15. Table II sets forth the result of such periodic examinations of the tanglefoot rings on the treated and untreated trees.

TABLE II

Number of Days after Spraying	Tree Numbers (Refer to Table I (a) and (b))															Total Number of Moths per examination
	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	
5	4	17	4	10	1	2	1	1	1	4	3	0	1	1	0	50
6	0	3	0	4	0	7	0	1	0	0	0	0	0	0	0	15
7	0	3	0	0	0	0	0	1	0	0	0	0	0	0	0	4
10	1	6	13	6	0	14	0	2	11	1	2	2	0	3	1	52
12	3	6	2	4	0	0	0	0	2	0	0	0	0	0	2	19
13	0	2	2	3	0	4	0	0	0	2	0	1	0	1	2	17
14	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	3
16	1	6	2	4	0	2	0	0	4	3	1	1	1	1	1	27
21	1	4	3	3	0	0	0	0	0	0	1	0	0	1	1	14
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	3
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total No. of Moths per tree for 41 days	10	49	27	36	1	29	1	5	8	10	8	4	2	7	7	204

(i) Miscellaneous observations:

Oct. 10: Fifty females of the fall cankerworm were observed trapped in the bands of tree tanglefoot on the experimental trees.

Oct. 11: Fifteen females trapped in the tree tanglefoot. Cankerworm inactive, probably due to low temperature.

Oct. 12: Four females trapped in the tree tanglefoot. Continued low temperatures probably due to fall cankerworm remaining somewhat inactive.

Oct. 15: Fifty-two females trapped in the tree tanglefoot. Sudden increase in fall cankerworm activity probably due to high temperatures and fair weather.

Oct. 17: Nineteen females trapped in the tanglefoot. Fall cankerworm activity declined somewhat although temperatures still remained quite high.

Oct. 18: Seventeen females trapped in the tanglefoot. Fall cankerworm activity again quite low. Three specimens of the fall cankerworm were collected and placed in a box which had been painted with a DDT concentration of 12 grms/sq. ft. They were left in the box for 15 minutes and then removed and placed in a rearing jar. Although the DDT did seem to have some effect on the specimens, the exposure of the insect to the poison did not prove fatal until 24 hours later.

Oct. 19: Three females trapped in the tanglefoot. Weather exceptionally warm for this date. Temp. approx. 65°.

Oct. 21: Twenty-seven females trapped in the tanglefoot. Fall cankerworm showed a decided increase in activity, probably due to the continued high temperatures.

Oct. 26: Fourteen females trapped in the tanglefoot. Fall cankerworm seems to have again subsided somewhat. Temperatures dropped considerably during the past five days.

Oct. 31: No fall cankerworm activity observed. Heavy snowfall on Oct. 27 and 28.

Nov. 8: Three females trapped in the tanglefoot. Weather became fair and at this time all snow of the previous month had disappeared.

Nov. 15: No fall cankerworm activity observed. Weather was cold during past week, frost has penetrated the soil to a depth of 1" to 1½".

(c) Conclusions:

The unusually large number of female fall cankerworm trapped in the bands of tree tanglefoot immediately after the banding had been completed would indicate that at the time the banding was done the female moths were already emerging and ascending the trunks of trees to oviposit.

Apparently, in no instance was the concentration of insecticide of sufficient strength to prevent all moths from crossing the treated bands. Nevertheless it is to be noted in Table IV that the number of moths crossing treated bands was far less than in the check trees. While those moths which crossed the treated bands survived at least until they were trapped in the tanglefoot, it is not known how much longer they would have survived or to what extent they would have oviposited. Another unknown quantity is the number of moths, if any, which were either killed or repelled upon contact with the insecticide and failed to cross the barrier to reach the tanglefoot.

With the exception of the 24 gram per square foot treatment (Table IV), almost equally effective control was achieved at the lowest and highest rates of application of DDT. This would seem to indicate that there is nothing to be gained by using more than 12 grams p r square foot, and it is quite possible that small quantities can be used with equal effect. The reduced control in the 24 gram rate was caused by one large tree in which the number of moths crossing the barrier was higher than normal. In effect, it is probable that the net application in any treatment did not greatly exceed 12 grams per square foot due to excessive run-off into the ground at the time of spraying. In future work it is proposed to hold the rate of application down to 12 grams per square foot or less.

Due to the very small amount of 666 available for experimentation, only a few trees were treated. Control appeared to be quite good, but the few treatments were not sufficient to deduce the relative efficiency of 666 as compared with DDT.

Table III summarizes the relationship of the number of female cankerworm to the size of the tree. For this summary trees were divided into various circumference classes.

Table III

Circumference Class		Average No. of Females (as counted in tanglefoot)	
Inches at breast height		per tree	per sq.in/Tree
15-20	(6 trees)	6.83	.379
20-25	(4 trees)	31 (1 tree had 49)	1.052
25-30	(1 tree)	27	.885
30-35	(1 tree)	8	.242
35-40	(2 trees)	17	.453
40-45	(1 tree)	1	.021

A relationship graph, which is included at the end of this report, was also drawn up in this connection showing very irregular results, with the exception of those trees of small circumference (15"-20") which apparently attracked fewer cankerworm than those with larger circumferences, which would be expected. A brief analysis of the relationship between the size of the trees treated and the number of females trapped in the tanglefoot, shows that smaller trees may be treated more effectively, due to the bark absorbing less of the solution than that of the larger trees. However, not enought trees of the larger classes were involved to permit any definite conclusions in this respect.

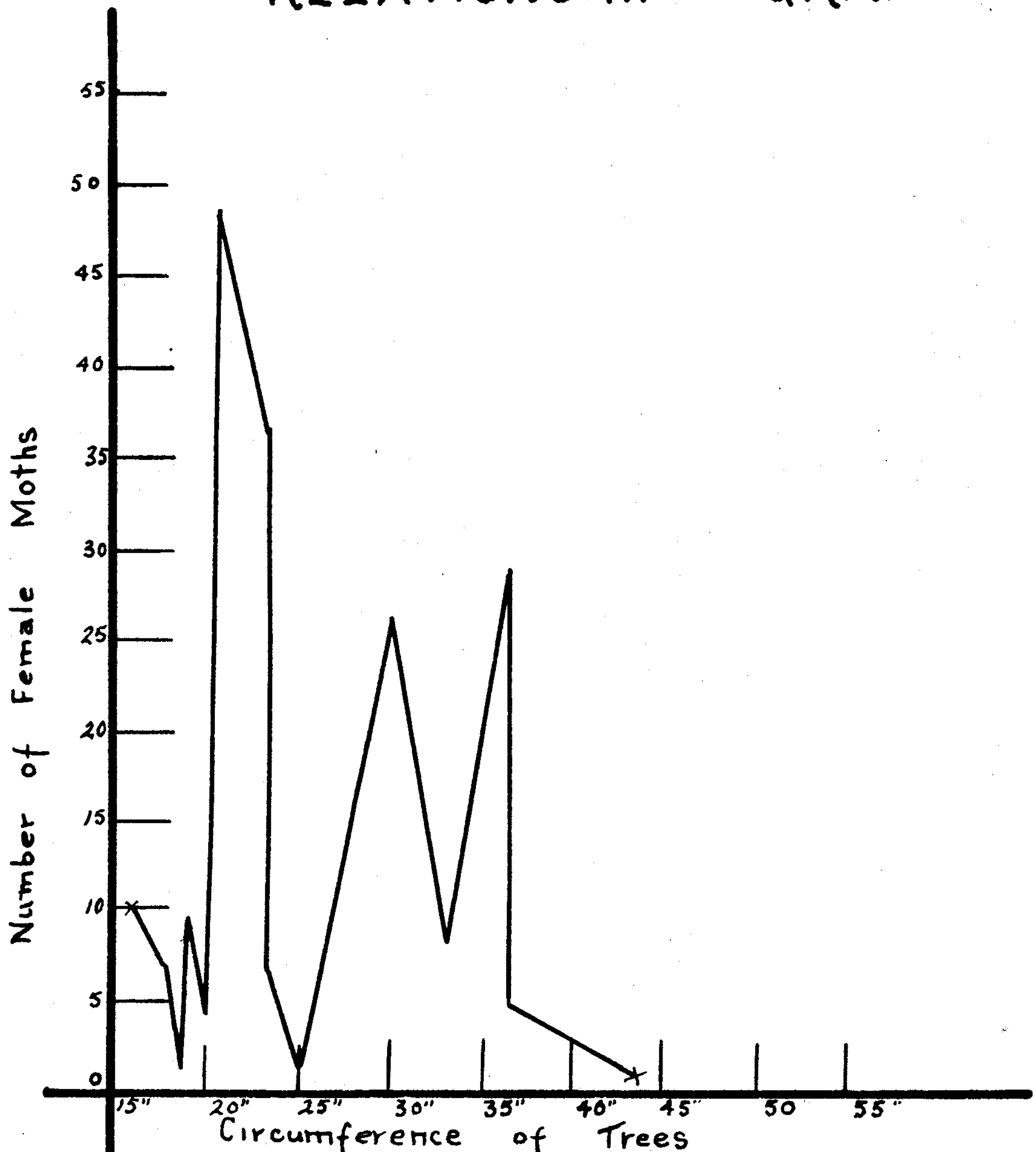
In the final analysis even though the experiment was conducted on a very limited scale, a high percentage of control was obtained from all concentrations used. Table IV summarizes the number of female moths per foot of circumference crossing the treated area of the experimental trees. The relatively low control indicated with DDT at 24 grams per square foot was due to one large tree in which a considerable number of moths crossed the band successfully.

Table IV

Insecticide	Rate	Width of band (ft.)	Moths crossing treated band (per ft. of circ.)	Control* %
DDT	12	3½	1.8	89
DDT	24	7	5.6	65
DDT	48	7	1.4	91
DDT	12	7	2.9	82
666	12	3½	4.0	75
Check	0	0	16.2	----

* Control: $\frac{\text{Check - minus treatment x 100}}{\text{Check}}$

• RELATIONSHIP GRAPH •



• Graph showing the relationship of the number of female cankerworm to the circumference of the tree...

A. V. Hildahl

1. Introduction

The following report outlines the activities of the writer during the summer season and contains observations made for the Forest Insect Survey in certain areas of Manitoba and Saskatchewan. No definite itinerary was followed as this season's work was restricted to special trips and to investigations dealing with serious insect outbreaks reported by forestry personnel.

The greater part of May was spent on work connected with the moving of the permanent field station from East Hawk Lake in Ontario to the new site at Red Rock Lake in Manitoba. Forest Insect Survey field work was commenced in northern Saskatchewan about June 4. During the month of June, four major provincial forests were visited in company with L. L. McDowall. These were the Porcupine, Pasquia, Fort à la Corne and Nisbet Provincial Forests. No serious outbreaks were seen. Permanent sample plots were established at various points in these forests with a view to regular sampling of the plots during the summer months. A reported infestation of bark beetles at Prairie River was investigated. During the second and third weeks of July, a special survey of damage by the aspen tortrix was made in the Duck Mountain Forest Reserve. In early August, an extensive survey of larch sawfly activity in Riding Mountain National Park was commenced. This was perhaps the most complete survey ever undertaken in the park, as numerous areas were visited which had formerly been passed by due to inaccessibility. After leaving the park, the writer continued this work in south-eastern Manitoba, in Duck Mountain Forest Reserve and north of the reserve to The Pas. On September 10, Forest Insect Survey investigations were discontinued for the season.

Three insects stand out as the major pests encountered this season: the larch sawfly, the aspen tortrix and the American poplar-leaf beetle. Of these, the larch sawfly was by far the most important and caused severe damage in Manitoba. Aspen tortrix and American poplar-leaf beetle outbreaks were confined to the Duck Mountain Forest Reserve.

2. Insect Conditions

(a) Larch Sawfly (*Pristiphora erichsonii* Htg.)

With its past record of great destruction of tamarack, this sawfly continues to be a problem of major concern.

It is now widely distributed in Manitoba. In some areas, it has caused very severe defoliation and is becoming increasingly serious. No tree mortality has been observed by the writer as yet, but where repeated attacks have occurred in the past, foliage production is far below normal, and tamarack are not thrifty.

One of the most active infestations of this insect occurred in and around the Duck Mountain Forest Reserve. Sawfly activity in this area increased greatly in 1946 and some stands, where it appeared relatively light last year, suffered from seventy-five to ninety per cent defoliation this year. Tamarack stands in the northern portion of the reserve and stands outside the reserve boundary between Sclater and Renwer experienced the heaviest defoliation. Throughout the remainder of the reserve, sawfly was generally distributed and caused from light to moderate defoliation.

Another, and equally important infestation, which for the past few years has been extremely active, continued to cause very severe defoliation of tamarack stands in the Riding Mountain National Park. This is, perhaps, the oldest active infestation in Manitoba. In it are two heavily infested areas, one near Lake Audy and one along the Norgate Road. Within these two areas, tamarack has suffered particularly severe defoliation. Throughout the remainder of the park, sawfly is generally distributed with moderate to severe defoliation occurring in all stands in the Birdtail Valley and around Gunn Lake, Tilson Lake, Kay's Lake and Crescent Lake. All of these areas are in the western portion of the park.

The most northerly active infestation of larch sawfly observed in the north-western portion of Manitoba was centered at a point about eleven miles north of the 53rd parallel on The Pas highway. As far as it is known, this infestation covered only a relatively small area, in which light to moderate defoliation has occurred. In The Pas district, no evidence of the sawfly was found, although numerous trees were beaten for larvae and the moss under the trees was examined extensively for cocoons.

In the inter-lake area of Manitoba at Riverton, the sawfly infestation continued with very little change from its 1945 level of light to moderate intensity.

Table 1.

Larch Sawfly Reconnaissance - Riding Mountain National Park

LOCATION	DATE 1946	TYPE OF GROUND COVER	MOISTURE	ESTIMATED DEFOLIATION %	REMARKS
Mile 13 Lake Audy Road	Aug. 9	Grass and moss	Free water under moss	75	Accessible by car or other means of transportation; all-weather road.
Mile 21 Lake Audy Road	Aug. 9	Grass and moss	Very wet	43-45	On main road to Lake Audy; easily accessible by car; all-weather road.
Prisoner of War Camp	Aug. 8	Moss and dirt	Moist	62-65	West of buffalo enclosure on road to Prisoner of War Camp; accessible by c fair road, slippery in wet weather.
Mile 13 Norgate Road	Aug. 10	Grass and moss	Free water under moss	70-80	Along main road to Norgate, Man.; accessible by car; all-weather road.
Mile 7 Norgate Road	Aug. 10	Moss	Moist (drying)	30-40	Along main road to Norgate, Man; accessible by car; all-weather road.
Whirlpool Lake Road	Aug. 10	Moss and grass	Wet	35-55	Near Whirlpool Lake along the road; easily accessible by car; all-weather
Sec. 14 T. 22 R. 25	Aug. 12	Grass and moss	Very wet	55	Accessible by car during dry weather only; the road is just a fair trail.
Sec. 32 T. 22 R. 25	Aug. 12	Grass and moss	Very wet	35-45	Accessible by car during dry weather only - a very poor trail.
Sec. 13 T. 22 R.25	Aug. 12	Moss with heavy grass	Free water under moss	65-85	Not accessible by car; by saddle-horse only.
Sec. 19 T. 22 R. 24	Aug. 14	Grassy moss	Free water under moss	55-75	Not accessible by car; saddle-horse only.
Sec. 31 T. 22 R. 24	Aug. 14	Grass (very little moss)	Free water under grass	65-85	Not accessible by car; saddle-horse only.
Gunn Lake	Aug. 13	Grassy moss	Very wet	55-85	Accessible by car only during a very season; this road is not kept in good repair.
Sec. 2 T. 23 R. 24	Aug. 15	Grass and moss	Very wet	35-70	Accessible by car in dry weather;otherwise only by saddle-horse.
Sec. 18 T. 23 R. 24	Aug. 16	Grassy moss	Free water under moss	80-90	Not accessible by car; by saddle-horse only.

Riding Mountain National Park (Con'd)

LOCATION	DATE 1946	TYPE OF GROUND COVER	MOISTURE	ESTIMATED DEFOLIATION	REMARKS
Sec. 33 T. 22 R. 24	Aug. 16	Moss	Moist	40	Not accessible by car; saddle-horse only.
Sec. 3 T. 23 R. 24	Aug. 17	Moss and grass	Very wet	65-75	Not accessible by car; saddle-horse only.
Sec. 35 T. 19 R. 17	Aug. 19	Grassy moss	Very wet	40-85	Not accessible by car; approximately 2 miles north of Norgate Road.
Rolling River Road	Aug. 10	Moss	Moist	30-55	Tamarack swamps along this road are accessible by car in all weather.

Table 2.

Larch Sawfly Reconnaissance - Northwestern Manitoba

LOCATION	DATE	TYPE	MOISTURE	ESTIMATED DEFOLIATION %	REMARKS
Mile 145 Dauphin Highway	Sept. 5	Moss	Plentiful	50-75	Accessible by car; all-weather road.
The Pas	Sept. 6	Generally moss	Plentiful	Nil	Swamps near the highway are accessible by car; travel very restricted since there are no other roads in district.
North of the 53 parallel eleven miles	Sept. 7	Moss and dirt	Quite dry	30-50	This swamp is located near The Pas highway which is an all-weather road.
Mile 245 Swan River Highway	Sept. 9	Dirt and needles (very little moss)	Moist	75-80	Most swamps in this area are accessible by car.
Ethelbert, Manitoba.	Sept. 10	Moss	Moist	30-50	This swamp is located 12 miles west of Ethelbert, Man. and is accessible by car except in wet weather.

Table 3.

Larch Sawfly Reconnaissance - Whitemouth Vicinity of Manitoba.

LOCATION	DATE	TYPE	MOISTURE	ESTIMATED DEFOLIATION %	REMARKS
Sec. 7 T. 13 R. 9	Aug. 28	Thick moss	Moist	30-40	Close to Trans-Canada Highway, accessible by car.
Shelly, Man. Sec. 1 T. 12 R. 11	Aug. 30	Moss	Surface water	Nil	This swamp is located near Shelly, Manitoba; road is rough and not passable in wet weather.
Slave Falls Power Line 8 miles N. of Trans Canada Highway	Aug. 29	Moss and grass	Dry	25-30	The road along the Slave Falls power line is passable in dry weather only; very rough also.
Elmo, Man. 5 miles south of Trans Canada Highway	Aug. 29	Moss and grass	Dry	10-15	Fair dirt roads in this district which are passable in dry weather.
Rennie, Man.	Aug. 29	Moss, dirt and grass	Quite dry	10-15	Numerous swamps along Trans-Canada Highway between Rennie and Whitemouth which are accessible by car.
Sec. 7 T. 13 R. 10	Aug. 28	Moss and grass	Moist	50	Close to Trans-Canada Higway; accessible by car.

Sawfly activity was noticed in all stands of tamarack between Seddon's Corner and Rennie, Manitoba. For several miles north and south of the Trans-Canada Highway between these points, defoliation was light to moderate. Heavy attacks this year around Seddon's Corner resulted in severe defoliation in that area. It should be noted here that in one swamp located south-west of Whitemouth near Shelly, and locally known as the Julius Swamp, the tamarack bore no evidence whatsoever of sawfly activity. This was probably due to surface water which is present every year from early spring to late fall in the swamp. This condition is probably not ideal for larch sawfly survival.

In the Piney district, larch sawfly reconnaissance was not conducted until late in the fall. The status of the infestation could not be definitely determined but all evidence pointed to its being severe. At the time of the survey, the foliage on the trees had changed colour and the needles had already commenced to fall. But with some sawfly defoliation still noticeable and with the presence of an exceptionally large number of cocoons in the moss beneath the trees, it was possible to establish the fact that the sawfly had been extremely active in the tamarack stands from Vita to Piney.

In Saskatchewan, which was visited only during June, before the effects of larval feeding normally become noticeable, no evidence of sawfly was found except in the Poplar Creek Cabin district of the Fort à la Corne Provincial Forest. Here a few larvae were collected, but no damage was seen.

Tables 1, 2 and 3 contain additional information about the tamarack stands visited during 1946. This information is under the following headings: location, date of examination, type of ground cover, moisture conditions, and accessibility of the stand.

(b) Aspen tortrix (Aronips conflictana Wlk.)

A moderate to severe outbreak of this insect is now in progress throughout stands of mature trembling aspen in the western portion of the Duck Mountain Forest Reserve. A very marked increase in population was noticeable in 1946 with the most severe attacks occurring in an area described as follows:

> The north half of Township 30, Range 29; the north-west corner of Township 30, Range 28; the south-west corner of Township 31, Range 28; all of Township 31, Range 29 and extending westward into Saskatchewan as far as Madge Lake.

Defoliation varied considerably with the individual tree. Damage was most apparent on smaller trees, but mature trees also showed a marked degree of defoliation. In July, a count of emerged pupae remaining on the foliage was carried out to serve as an index of population of the aspen tortrix. Aspen were examined at various points throughout the heavily infested area of the reserve. In addition to the tortrix, there was an infestation of American poplar-leaf beetle in the same area. Most trees showed signs of damage by both insects so that it was impossible to determine accurately the defoliation caused by the aspen tortrix alone. However, this was estimated at from 15% to 33% on the tree examined. Data recorded from the count is summarized in Table IV.

(c) American Poplar-Leaf Beetle (Phytodecta americana Schiff.)

The American poplar-leaf beetle was abundant in only one area of Manitoba this year. Outbreaks of infestation proportions were confined to the Duck Mountain Forest Reserve where the insect was generally distributed. Although it caused noticeable defoliation in some areas, it was not severe enough to cause any mortality. Light to moderate attacks occurred in the western portions of the reserve between Bield on the south, Madge Lake (Saskatchewan) on the west, Swan River on the north and the Shell River on the east. Within this area, defoliation and retarded growth caused by this insect were most noticeable in pure stands of young sapling aspen. Although damage was most apparent in young stands, it was not wholly confined to such stands as some mature trees in the area also showed light defoliation. In the third week of July, a count was made of pupae found in the ground cover beneath aspen which were selected at random for sampling. A site was chosen three feet from the base of the tree and one square foot of ground cover removed to a depth of three inches. This material was placed on a beating sheet and carefully examined for pupae. The average number of pupae per square foot sample based on twelve samples in each district is shown in Table V.

Table 4.

Duck Mountain Forest Reserve
Pupal Counts of Aspen Tortrix

Tree No.	Height of Tree	Tree Type	No. of Pupae Per Tree	Remarks
1	6'3"	Orchard	10	Foliage heavy
2	5'8"	Orchard	8	Foliage light
3	6'	Orchard	8	Foliage very heavy
4	5'11"	Orchard	9	Foliage medium
5	6'	Orchard	11	Foliage light
Average No. of Pupae per Tree: 9.2				

Table 5.

Duck Mountain Forest Reserve
Pupal Counts of the American Poplar-Leaf Beetle

District	No. of Pupae per Square Foot Sample
Singoosh Lake	3.5
North-eastern	4.5
North-western	5.2
Madge Lake	9.1
South-western	14.2
South-eastern	8.1

(d) Jack Pine Budworm (Archips fumiferana Clem.)

Only one sample of this jack pine feeding insect was found in north-western Manitoba. It was obtained at Cowan. Although jack pine budworm was present in the area, it was particularly light and caused no noticeable damage. In all probability, samples found now are remnants of an old infestation which was quite active a number of years ago around Cowan.

(e) White Pine Weevil (Pissodes strobi Peck.)

This pest appeared to be somewhat more abundant than last year in the Duck Mountain Forest Reserve with quite noticeable damage in some areas. Trees growing on thinly-wooded sandy slopes in the south-eastern portion of the reserve suffered the greatest damage. In this particular area, one tree out of twenty-five showed a dead or distorted leader. However, thus far, damage appeared to be confined to open-growing reproduction spruce ranging from six to ten feet in height.

(f) Bark Beetles (Ips sp.)

An infestation of bark beetles was reported by G.B. McNeill of the Saskatchewan Department of Natural Resources and Industrial Development to be so serious in the Prairie River District that the beetles were attacking and killing green spruce. However, at the time of the investigation in Section 22 Township 44 Range 6 W 2, the infestation appeared to be on the decline as sampling of trees in the area indicated that bark beetle activity was very light. In 1942, all of Township 44 Range 6 W 2 was burned over and very little green spruce remains. Probably the bark beetles have migrated to living trees after a large population had been built up in the surrounding fire-killed timber. Individual trees and small blocks of spruce which escaped the fire do not appear particularly vigorous and are thus more susceptible than usual to bark beetle attack.

(g) Yellow-headed Spruce Sawfly (Pikonema alaskensis Roh.)

No serious outbreaks of this spruce-feeding sawfly were observed this year. It was generally distributed over a wide area of Manitoba and was commonly found on spruce plantations. Larvae of this insect were present in spruce collections from The Pas, Singoosh Lake, Deepdale, Grandview, Bird's Hill, Shelly and Whitemouth.

(n) Balsam Fir Sawfly (Neodiprion abietis Harr.)

No serious outbreaks of this insect were observed in Manitoba this year. As many as twenty larvae were found per tree in Section 17, Township 26 Range 24 W.P.M. in the Duck Mountain Forest Reserve, but in no instance did they occur abundantly enough to cause noticeable defoliation. Larvae were present in all spruce collections made in the Duck Mountain Forest Reserve suggesting a general distribution in the area.

Table 6.

3. Negative Reports

A. Manitoba.

Date	Host	Locality
July 13	Jack pine	Shell River Ranger Cabin
July 13	Balsam	Shell River Ranger Cabin

B. Saskatchewan.

Date	Host	Locality
June 8	Tamarack	1 mile north of Usnta
June 8	W. Spruce	100 feet east of Forestry Hdqtrs. Usnta
June 8	Jack pine	½ mile north of Usnta
June 10	W. Spruce	1 mile north of Usherville
June 10	W. Spruce	6 miles east of Reserve
June 12	Tamarack	15 miles north of Lavardville
June 12	B. Spruce	15 miles north of Lavardville
June 12	Jack pine	S. 17 T. 47 R. 5 Hudson Bay Junction
June 13	B. Spruce	Chemong
June 13	Balsam	Chemong
June 14	Jack pine	4 miles south of Hudson Bay Junction
June 14	Tamarack	2 miles south of Hudson Bay Junction
June 14	Birch	4 miles south of Hudson Bay Junction
June 14	Tamarack	Prairie River
June 14	B. Spruce	Prairie River
June 15	Jack pine	Holbein
June 20	B. Spruce	Crutwell
June 20	Jack pine	Crutwell
June 20	Birch	Crutwell
June 21	Jack pine	Red Rock Block Nisbet Forest
June 21	Poplar	Red Rock Cabin Nisbet Forest
June 22	Jack pine	MacDowall
June 22	Poplar	MacDowall
June 24	Jack pine	Poplar Creek Cabin, Fort à la Corne
June 24	Spruce	Poplar Creek Cabin, Fort à la Corne
June 25	Jack pine	English Cabin, Fort à la Corne
June 26	Jack pine	West end of Fort à la Corne Forest

Table 7.

4. Personnel Contacted

A. Manitoba.

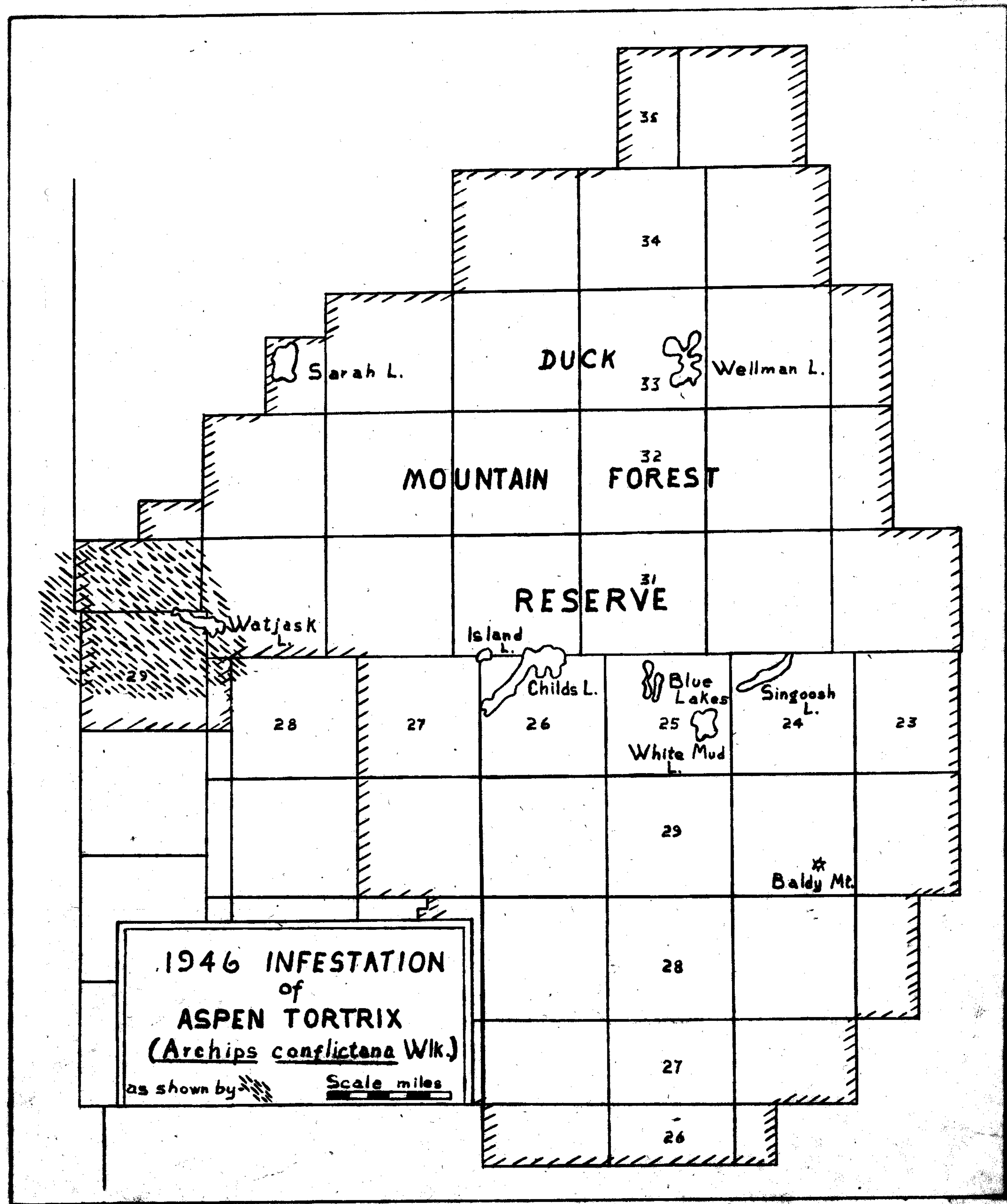
NAME	RANK	PLACE	DEMONSTRATION OF SAMPLING
A. Bainbridge	District Forester	Dauphin	No
B. Balchan	Forest Engineer	Dauphin	No
J. Kozindovich	Forest Ranger	Grandview	Yes
R. A. Ross	Forest Ranger	Bield	Yes
J. Norman	Forest Ranger	Garland	No
C. Dunlop	Forest Ranger	Deepdale	Yes
H. Clee	Forest Ranger	Minitonas	Yes
F. Brodie	Supervisory Warden	Wasagaming	No
D. B. Binkley	Park Warden	Lake Audy	Yes
R. Hand	Park Warden	R. M. N. P.	No
J. Ryska	Park Warden	Rossburn	Yes
R. McKinnon	Park Warden	Oatseed	Yes
J. Allen	Park Warden	Neepawa	Yes
H. Kendrick	Forest Ranger	Whitemouth	Yes
W. F. Mawdsley	Forest Ranger	Birch River	No
R. Harvey	District Forester	The Pas	No

Table 7.

4. Personnel Contacted

B. Saskatchewan.

NAME	RANK	PLACE	DEMONSTRATION OF SAMPLING
J. L. Dobie	Field Officer	Pelly	No
L. F. Bryson	Field Officer	Usherville	Yes
B. A. Matheson	Field Officer	Hudson Bay Junction	Yes
C. L. Schell	Field Officer	Hudson Bay Junction	Yes
F. Warburton	District Superintendent	Hudson Bay Junction	No
Anderson	Ass't Field Officer	Hudson Bay Junction	Yes
O. B. McNeill	Field Officer	Prairie River	Yes
E. J. Marshall	Director of Forests	Prince Albert	No
O. G. Horncastle	Ass't Director of Forests	Prince Albert	No
A. MacDonald	Field Officer	Holbein	Yes
Anderson	Field Officer	Beaver House	No
T. Adams	Field Officer	Strong Pine	Yes


35
34
DUCK
Sarah L.
Wellman L.
33
32
MOUNTAIN FOREST
31
RESERVE
Watjask L.
Island L.
Childs L.
Blue Lakes
Singoosh L.
29
28
27
26
25
24
23
White Mud L.
29
Baldy Mt.
28
27
26
1946 INFESTATION
of
ASPEN TORTRIX
(Archips conflictana Wlk.)
as shown by
Scale miles

B. A. Anderson and J. Drouin

1. Introduction

Forest insect conditions in Alberta were studied in some detail in 1946. These investigations were carried on during June, July, August and September. Starting in the Cypress Hills area, the writers went from there to Waterton Lakes National Park; thence to the Crowsnest-Bow River Forest District. After a week in this district, a very stiff schedule made it necessary to proceed to the Kananaskis Experimental Station and from there to the Clearwater Forest District. After that, the observers went to the Brazeau-Athabaska Forest District. Having spent the alloted amount of time there, the investigators moved north to Slave Lake and then to Grande Prairie, reaching the latter point in early August. A return trip was made to all of these places except the Cypress Hills before the middle of September. The highlight of these investigations is that the forests of Alberta appear to be singularly free from severe insect infestations. However, infestations of the following insects were noted; aspen tortrix, bronze birch borer, American poplar leaf beetle, poplar borer and bark beetles. These will be discussed at some length below.

2. Insect Conditions

(a) Aspen Tortrix (Archips conflictana Wlk.)

Two heavy but small infestations of this insect were found in the southern part of the province. The first of these was in the Waterton Lakes Park area and the second was in the Castle River District.

The former infestation stretched along the Waterton Lakes from the Narrows to the end of the aspen groves, a distance of about four miles. This strip was about three-quarters of a mile in width. In this area, the foliage of the poplar trees had a browned appearance as a result of the feeding damage of the insect. All trees were infested; the average defoliation was three-sixteenths.

The outbreak in the Castle River District was restricted to small bluffs of trembling aspen in cultivated fields. The infested patches were found in Sections 29, 30, 31 and 32 of Township 6 Range 2 W 5, along the Castle River. Of 150 trees counted, 75 were infested; the average defoliation was two-sixteenths.

(b) American Poplar Leaf Beetle (Phytodecta americana Schiff.)

Of this insect, two small outbreaks, limited in locality, were found. One of these was in the Cypress Hills, on the plateau immediately south of Elkwater Lake. No damage was seen in early June. The other outbreak was at Crimson Lake in the Clearwater Forest District, six miles northwest of Rocky Mountain House. This infestation apparently caused little visible damage.

(c) Bronze Birch Borer (Agrilus anxius Gory.)

Damage by this insect was observed at Kinuso, south of Lesser Slave Lake and east from there along the highway to Slave Lake, Scattered trees were seen along the highway from the latter point south to Westlock.

(d) Poplar Borer (Saperda calcarata Say.)

A heavy infestation of this borer was found at Deadman's Flats, near Canmore. The affected area was in Sections 12 and 13, Township 24, Range 10 W 5 and Sections 7, 17 and 18 of Township 24, Range 9 W 5. In one area every tree was infested with borers; some trees had one borer for every two feet of trunk height. Many trees were dead; and the majority of the remainder were dying.

(e) Bark Beetles

Reports of damage to the Douglas fir and lodgepole pine within the townsite of Waterton Lakes Park led to an investigation which showed that many of these trees were infested with bark beetles. Some of the trees were dead; others were dying. Such trees spoiled the appearance of the park. Injury was first noticed in the twigs and, as the insects flourished, the damage became evident in the branches and eventually in the trunk of the tree. Most of the trees killed were Douglas fir. An infestation count was taken, 100 trees being examined in each of five areas picked at random. The results of these examinations are shown in the following table:

	AREA OF WATERTON LAKES PARK	PERCENTAGE INFESTATION
1	Fish Pond	5
2	Camp Ground	11
3	Entrance to C. G.	21
4	Superintendent's Office	14
5	Headquarters Buildings	18
	AVERAGE	13.8

Beyond the Townsite, a few infested trees were found along the highway leading to the registration office and on the surrounding mountainsides.

Table 1.

3. Negative Reports

DATE	HOST	LOCALITY
June 5	Lodgepole pine	Elkwater Lake, Cypress Hills, east end of reserve
June 10	(W) spruce, fir	Cameron Lake
June 12	(B) poplar plot	Chief Highway, Waterton Lakes Park
June 14	(W) spruce, Lodgepole pine	Stony Creek Cabin, Waterton Lakes Park
July 5	Lodgepole pine	Foran Creek, Kananaskis Experimental Station
July 12	Lodgepole pine	Clearwater district, Ram River Oil Wells
July 13	(W) poplar	Nordegg Road, Rocky Mountain House
July 15	Tamarack	Rocky Mountain House
July 19	(B) poplar	Galloway, Edson
July 20	Birch	Peers, Edson
July 23	(W) spruce, Lodgepole pine	Swanson Trail, Edson
July 26	(W) spruce, Balm of Gilead, poplar	Edson, 4 miles north
July 29	(W) poplar, balsam	Slave Lake
Aug. 2	Jack pine, birch, (W) poplar	South of Slave Lake
Aug. 5	(W) spruce, (W) poplar	1 mile east of De Bolt
Aug. 7	Lodgepole pine, birch	Branch of Wapiti Road
Aug. 20	Lodgepole pine	Edson Branch
Sept. 3	(W) pine	Akimina Road, Waterton Lakes Park
Sept. 7	(B) spruce plot	Kananaskis Experimental Station
Sept. 11	(W) spruce	Edson, Swanson Trail

Table 2.

4. Personnel Contacted

NAME	RANK	PLACE	DEMONSTRATION OF SAMPLING
T. F. Blefgen	Director of Forestry	Edmonton	No
J. A. Hutchison	Assistant Director of Forestry	Edmonton	No
H. Holman	District Forest Officer	Edmonton	No
D. Crossley	Ass't District Forest Officer	Edmonton	No
J. P. Alexander	Superintendent	Calgary	No
F. G. Edgar	Assistant	Calgary	No
J. McLennahan	Supt. Kananaskis Exp. Station	Seebe	No
J. R. H. Hall	Superintendent	Rocky Mountain House	No
D. Buck	Superintendent	Edson	Yes
J. L. Janssen	Superintendent	Slave Lake	Yes
T. R. Hammer	Superintendent	Grande Prairie	No
J. D. Champion	Chief Forest Ranger	Thelma	No
J. H. Boulton	Chief Forest Ranger	Coleman	Yes
A. E. Freeman	Chief Forest Ranger	Beaver Mines	No
J. Kovach	Chief Forest Ranger	Canmore	No
W. Liddell	Forest Ranger	Coleman	Yes
K. Arnold	Forest Ranger	Canmore	No
C. Larsen	Forest Ranger	Sundre	No
R. Mackie	Forest Ranger	Jumping Pond	No
C. Enwright	Forest Ranger	Rocky Mountain House	Yes
W. Strum	Forest Ranger	Thelma	Yes
E. L. Whidden	Timber Inspector	Rocky Mountain House	No
H. E. Noble	Timber Inspector	Edson	No
W. Wood	Timber Inspector	Westlock	No
H. deVebber	Superintendent	Waterton L., National Park	No
G. Barnes	Forest Ranger	Waterton L. National Park	No

Table 3.

5. Intelligence

S - Satisfactory U - Satisfactory

PLACE	HOTELS		CAFES	
	Name	Grade	Name	Grade
Edmonton	Corona H.	S	Ronnie's	S
Calgary	Carlton H.	S	Carlton Lunch	S
Edson	Edson H.	S	H. Lunch Room	S
Athabaska	Grand Union	S	H. Lunch Room	S
Rocky Mtn. House	Mountview H.	S	H. Lunch Room	S
Coleman	Empire H.	S	H. Lunch Room	S
Kinuso	Kinuso H.	S	H. Lunch Room	S
Lethbridge	Alexander H.	S		
Waterton Lakes	Waterton Lakes H.		Frank's Cafe	S
Sylvan Lake			Sylvan Lake Hotel	S
Red Deer			Club Cafe	S
Canmore	Canmore H.	S	Three Sisters' Cafe	S
McLennan	McLennan H.	S		
Westlock	Victory H.	S	H. Lunch Room	S
Grande Prairie	Donald H.	S	Storm Inn	S
Peace River	Victory H.	S	H. Lunch Room	S
Medicine Hat			White Lunch	S
Pincher Creek			Koffee Kup	S
Rochester			Rochester Cafe	U
Spirit River	Dominion H.	S	H. Lunch Room	S

Table 4.

6. Sample Plots

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Elkwater Lake	Lodgepole pine #2	# 87	June 5	1 adult of the 2-barred click beetle, *Ludius propola* Lec. 1 adult of the 3-lined click beetle, *Ludius triundulatus* Mand. 2 adults of a leaf bug, Mirid sp.
	W. Spruce	# 99	June 5	2 adults of the 2-barred click beetle, *Ludius propola* Lec. 1 adult of a ground beetle, Carabid sp. 1 adult of a ground beetle, Coleoptera sp. 1 adult of a plant louse, Aphid sp.
	B. Poplar	# 100	June 5	37 larvae of the American poplar leaf beetle, *Phytodecta americana* Schiff. 1 gall bud of a maggot, *Dipterous* sp.
	Lodgepole pine #1	# 101	June 5	1 adult of the 3-lined click beetle, *Ludius triundulatus* Mand. 1 adult of a click beetle, Elaterid sp. 1 adult of a click beetle, Elaterid sp. 2 adults of a flower bug, Mirid sp.
Waterton Lakes Park	Juniper	# 165	June 12	6 larvae of a looper, *Eupithecia* sp. 1 adult of a soldier bug, *Chlorochroa uhleri* Stal. 2 adults of a solder bug, Pentatomid sp.
	Birch	# 175	June 13	1 larva of a sawfly, Tenthredinid sp. 4 cocoons of a sawfly, Tenthredinid sp. 1 larva of a looper, Geometrid sp. 1 larva of a Phalaenid, Phalaenid sp. 1 larva of a leaf roller, Tortricid sp. 2 adults of a firefly, Lampyrid sp. 1 adult of a click beetle, *Ludius* sp. 1 adult of a small beetle, Carabid sp.

Sample Plots (Con'd)

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Waterton Lakes Park (Con'd)	W. poplar	W 175	June 15	6 pupae and 1 hymenopterous parasite of the aspen leaf roller, Archips conflictana Wlk. 5 masses of multiple parasite, probably from the aspen leaf roller, Hymenopterous sp. 5 puparia of a parasite, Diptera sp. 1 cocoon of a parasite, Hymenopterous sp. 10 larvae of a leaf tyre, Tortricid sp. 3 larvae of a looper, Itame exauspicta Wlk. 7 larvae of the American poplar leaf beetle, Phytodecta americana Schiff. 8 adults of the American poplar leaf beetle, Phytodecta americana Schiff.
	Lodgepole Pine	W 176	June 15	1 larva of a budworm, Tortricid sp. 4 larvae of a small leaf roller, Tortricid sp. 1 adult of a thrips, Terebrantia sp. 1 adult of a click beetle, Elaterid sp. 1 adult of a click beetle, Elaterid sp. 1 adult of a ladybird beetle, Anatis mali Say.
	Lodgepole pine	W 178	June 12	2 adults of the American poplar leaf-eating beetle, Phytodecta americana Schiff. 1 adult of a firefly, Lampyrid sp. 1 adult of a click beetle, Elaterid sp.
	W. spruce	W 179	June 15	2 larvae of the black-headed fir sawfly, Neodiprion abietis Harr. 1 adult of the American poplar leaf beetle, Phytodecta americana Schiff. 1 adult of a leaf-eating beetle, Chrysomelid sp.
Coleman	Lodgepole pine	W 214	June 18	5 adults of a leaf-eating beetle, Dichelonyx sp. 2 adultsof a pine weevil, Pissodes sp. 1 adult of a green weevil, Curculionid sp. 1 adult of a brown weevil, Curculionid sp. 1 adult of a snake fly, Raphidia sp.

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Coleman (Con'd)	Juniper	# 216	June 18	2 larvae of a looper, Geometrid sp. 3 larvae of a looper, Geometrid sp. 1 larva of a looper, Geometrid sp.
	W. poplar	# 258	June 19	1 larva of a phalaenid, Phalaenid sp. 3 adults of the 2-barred click beetle, Ludius propola Lec. 1 adult of a click beetle, Elaterid sp.
	Lodgepole pine	# 259	June 19	1 adult of a flat bug, Aradus sp. 1 nymph of a bug, Hemipterous sp. 1 adult of a click beetle, Elaterid sp. 1 adult of a flat-headed borer, Buprestid sp.
Kananaskis Experimental Station	W. poplar	# 369	July 1	1 cocoon of a sawfly, Tenthredinid sp. 1 cocoon of a sawfly, Tenthredinid sp. 9 adults of a leaf chafer, Dichelonyx backii Kby. 1 adult of a flat-headed borer, Dicerca sp.
	W. spruce	# 375	July 1	1 pupa of a leaf roller, Tortricid sp. 1 larva of the hover fly, Metasyrphis lapponicus Zett. 1 larva of a hover fly, Syrphid sp. 1 larva of a hover fly, Syrphid sp. 1 larva of a hover fly, Syrphid sp.
	Lodgepole pine	# 370	July 1	3 larvae of a sawfly, Neodiprion sp. 1 adult of a leaf chafer, Dichelonyx sp. 1 adult of a leaf chafer, Dichelonyx sp. 2 adults of a click beetle, Limonius aeger Lec. 1 nymph of a grasshopper, Locustidae sp.

Sample Plots (Con'd)

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Kananaskis Experimental Station (Con'd)	Willow	W 571	July 1	1 larva of the sawfly, *Nematus tri lineatus* Nort. 1 larva of a sawfly, Tenthredinid sp. 3 larvae of a sawfly, Tenthredinid sp. 1 adult of the western willow leaf beetle, *Galerucella decora* Say.
	Juniper	W 576	July 1	1 larva of a looper, Geometrid sp. 1 adult of a sawfly, Tenthredinid sp. 5 adults of a plant bug, Mirid sp. 1 adult of a plant louse, Aphid sp.
Rocky Mountain House	W. spruce	W 541	July 15	1 larva of the smoky moth, *Lexis bicolor* Grt. 1 larva of the yellow-headed spruce sawfly, *Pikonema alaskensis* Roh. 1 larva of the green-headed spruce sawfly, *Pikonema dimmockii* Cress. 1 larva of a sawfly, Tenthredinid sp. 1 adult of a firefly, Lampyrid sp. 1 adult of a fly, *Diptera* sp.
	W. poplar	W.543	July 15	1 larva of a leaf-eating beetle, Chrysomelid sp. 5 adults of the American leaf beetle, *Phytodecta americana* Schiff. 1 adult of a weevil, *Lepyrus palustris* Scop.
	Lodgepole pine	W 547	July 15	1 adult of a plant bug, Mirid sp. 1 adult of a plant bug, *Hemiptera* sp. 1 adult of a fly, *Diptera* sp.
	Lodgepole pine	W 550	July 16	2 adults of a darkling beetle, *Hymenorus* sp.
Edson	Tamarack	W 653	July 24	5 larvae of a looper, *Semiothisa* sp. 1 larva of a looper, *Semiothisa sexmaculata* Pack. 1 cocoon of the little larch sawfly, *Anoplonyx canadensis* Hrgtn. 1 adult of a clear wing moth, Aegeriid sp.

Sample Plots (Con'd)

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Edson (Con'd)	W. spruce	# 642	July 24	Twigs are infested with a rust, Chrysomyxa sp. 1 adult of the pericopid, Cnophoela latipennis Bvd. 1 adult of an ant, Formicid sp.
	W. poplar	# 643	July 24	1 adult of the American poplar leaf beetle, Phytodecta americana Schaff. 1 adult of a leaf-eating beetle, Chrysomelid sp. 1 adult of a fly, Diptera sp.
	Lodgepole pine	# 644	July 24	1 larva of a ladybird beetle, Coccinelid sp. 1 adult of the 3-barred click beetle, Ludius triundulatus Rand. 1 adult of the click beetle, Agriotes limosus Lec.
Slave Lake	W. birch	# 765	July 31	1 larva of a woolly bear, Arctiid sp. 1 adult of the tree hopper, Telamona querci Fitch.
	W. spruce	# 772	Aug. 2	1 larva of a leaf roller, Tortricid sp. 1 larva of a phalaenid, probably Feralia jocosa Gn. 1 larva of the green-headed spruce sawfly, Pikonema dimmockii Cress. 1 adult of a darkling beetle, Tenebrionid sp.
	Balsam	# 773	Aug. 2	1 larva of the looper, Eupithecia luteata Pack. 2 larvae of a hover fly, Syrphid sp. 1 empty puparium of a hover fly, Syrphid sp. 1 adult of the 3-barred click beetle, Ludius triundulatus Rand. 1 adult of a plant bug, Mirid sp.
	Tamarack	# 776	Aug. 2	1 larva of a looper, Geometrid sp. 1 adult of a bug, Hemiptera sp.

Sample Plots (Con'd)

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Grande Prairie	Lodgepole pine	# 823	Aug. 7	1 larva of a looper, Geometrid sp. 1 adult of a ladybird beetle, <u>Adalia disjuncta</u> Rand. 1 adult of a leaf hopper, Cicindellid sp.
	Tamarack	# 824	Aug. 7	9 larvae of the green larch looper, <u>Semiothisa sexmaculata</u> Pack. 2 larvae of the Marlatt's sawfly, <u>Anoplonyx canadensis</u> <u>Hrgtn</u>.
	Lodgepole pine	# 825	Aug. 7	4 larvae of a looper, <u>Eufidonia</u> <u>notataria</u> Wlk. 1 larva of a looper, <u>Eupithecia</u> sp. 1 larva of a looper, Geometrid sp. 1 pupa of a small moth, <u>Microlepidoptera</u> sp.

C. P.C. Thomas

1. Introduction

Investigations of the forest insect conditions in the province of Manitoba were made during the months of May to September inclusive. In the course of these investigations, contact was made with the personnel of the forest and park services. The form of this contact depended on circumstances but, wherever possible, demonstrations of insect sampling were made. The insects of particular importance encountered in the course of this work were: the jack pine budworm, the European larch sawfly, the jack pine scale and the aspen leaf miner. Details of the information gathered concerning these pests are set down under "Insect Conditions".

2. Insect Conditions

(a) Jack Pine Budworm (*Archips fumiferana* Clem.)

The jack pine budworm was observed only in the south-eastern section of Manitoba. The infestation was general in the jack pine forests lying south of the Winnipeg River and east of the Red River. In the Sandilands Forest Reserve, a medium infestation (in the jack pine forest) extended north-east from the northern part of Township 5, Ranges 9 and 10 E.P.M. to the northern part of Township 7, Ranges 10 and 11 E.P.M. This infestation was somewhat heavier than that of 1945. Cutting operations were being carried out in the infested areas of the Reserve and all trees with a butt of ten inches or more were removed.

Light infestations were noticeable in the Whiteshell Forest Reserve and around Seddon's Corner.

(b) European Larch Sawfly (*Pristiphora erichsonii* Htg.)

On the whole, this sawfly seemed to be less abundant in Manitoba in 1946 than in 1945. The heavy infestation around Bissett was still apparent. At Berens River, one small tamarack stand was heavily attacked. In Riding Mountain National Park, a heavy infestation existed in the middle of the park. In the eastern section, the damage was not as noticeable as in the central area. In the Porcupine Forest Reserve, a light infestation was observed in a swamp near Mafeking.

(c) Jack Pine Scale (Toumeyella sp.)

The jack pine scale infestation in the Sandilands Forest Reserve now covers a greater area than that of 1945. It has killed a large number of seedlings in the southern part of the reserve. The main patch of this infestation (see map) extended north from the southern border of the reserve to beyond the middle of Township 5, Ranges 9 and 10 E.P.M. It occupied, in Township 4 Range 10, Sections 29 to 32 and part of Sections 28, 33 and 34. In Township 5 of Range 9, it covered the following Sections and the adjacent area: 10, 11, 12, 13. In Township 5 of Range 10, it was found in Sections 5, 6, 7, 8, 17, 18, 19, 20 and spurs extended out into Sections 9, 10, 15 and into Sections 29 and 28. Smaller patches were found as follows: along the Dawson Cabin Road (Sections 20, 28, 29 and 33 of Township 6 Range 10 E.P.M. and Section 5 of Township 7 Range 11 E.P.M.). This scale was not noticed outside of the Sandilands Forest Reserve.

(d) Aspen Leaf Miner (Lithocolletis tremuloidiella Braun.)

The infestation of these miners on trembling aspen still existed in the area east of Lake Winnipeg, from Lac du Bonnet to Berens River. As high as ninety per cent of the leaves were mined at the following points: Bissett, Sasaginnigak Lake, Little Grand Rapids and Berens River. Some leaves contained as many as five larvae.

(e) Mistletoe (Razoumofskya sp.)

A heavy infestation of mistletoe was found on jack pine thirteen miles north of The Pas on the Clearwater Bay Road. The forest in which this disease existed was put under permit for cutting.

Table 1.

3. Negative Reports

Date	Host	Locality
May 27	Pin cherry	Sandilands For. Res. 2 mi. N. of hdqtrs.
" 27	Poplar	" " " " " " " "
" 27	Choke cherry	" " " " " " " "
" 27	Jack pine	" " " " " " " "
June 5	Spruce	Sandilands For. Res.
" 5	Jack pine	" " "
" 5	Pin cherry	" " "
" 12	Spruce	Red Rock Lake (sample plot)
" 13	Tamarack	West Hawk Lake
" 21	Ash	Turtle Mountain For. Res.
" 21	Red pine	" " " "
" 21	Saskatoon	" " " "
" 27	Poplar	Mile 6½ Norgate Rd. R.M.N.F.
" 27	Spruce	" 5½ " " "
July 1	(B) Spruce	Mile 3½ Blue Lake Rd. D.M.F.R.
" 1	Poplar	Blue Lake D.M.F.R.
" 1	(B) Spruce	D.M.F.R. (sample plot)
" 6	Ash	Mile 32½ No. 10 hwy. D.M.F.R.
" 6	Elm	" " " " "
" 17	Birch	North-west shore of Stuart Lake
" 17	(W) Poplar	" " " " " "
" 28	Balsam	Riverton sec. 18-24-4E
" 29	(B) Poplar	6 miles east of Hodgson
" 29	Birch	Mile 1 Bennett Lake Rd. Bissett
" 29	Balsam	" " " " " "
" 29	Spruce	" " " " " "
Aug. 1	(W) Poplar	5 miles east of Steeprock
" 1	Jack pine	10 miles south of Gypsumville
" 1	Birch	" " " " "
" 1	(W) Poplar	" " " " "
" 1	Spruce	1 mile south of Grahamdale
" 1	Oak	Steeprock
" 1	(W) Spruce	Gypsumville
" 1	Birch	"
" 1	Choke cherry	"
" 2	Spruce	2 miles west of Mooseborn
" 4	Jack pine	Bissett
" 14	(B) Spruce	Berens River
" 14	(W) Spruce	" "
" 14	Jack pine	" "
" 14	Juniper	" "
" 25	Juniper	Sasaginnigak Lake
" 25	Balsam	" "

Table 2.

4. Personnel Contacted

NAME	RANK	PLACE	DEMONSTRATION OF SAMPLING
J. Inkster	Chief Ranger	Sandilands For. Res.	Yes
J. E. Harrison	Ranger	Woodridge Ranger Station	No.
J. Wright	Ranger	Sprague	No
B. Emes	Ranger	Dawson Ranger Station	No
W. Wardrop	District Ranger	Sprague	No
F. Townsend	Dominion Forester	Sandilands For. Res.	Yes
V. H. Phelps	Chief Dominion Forester	Sandilands For. Res.	Yes
J. H. Vickers	Chief Ranger	Turtle Mountain For. Res.	No
F. J. Brodie	Chief Park Warden	R. M. N. P.	No
J. C. Goodison	Chief Park Engineer	R. M. N. P.	Yes
A. Bainbridge	District Ranger	Dauphin	No
R. T. Pike	Forest Engineer	Singoosh Lake	No
W. F. Mawdsley	Ranger	Birch River	Yes
J. W. Thompson	Ranger	Mafeking	No
R. Harvey	District Ranger	The Pas	No
G. Bates	Ranger	The Pas	Yes
J. C. Somers	Provincial Forester	Cormorant Lake	No
C. H. Patterson	Chief Ranger	Lac du Bonnet	No
D. Wardrop	Ranger	Lac du Bonnet	No
G. H. Davies	Fire Ranger	Bissett	Yes
B. Berens	Fire Ranger	Berens River	Yes
S. Kuryk	Fire Ranger	Sasaginnigak Lake	Yes
T. B. Vermilyea	Chief Ranger	Sandilands For. Res.	No

Table 3.

5. Intelligence

S - Satisfactory U - Unsatisfactory

PLACE	HOTELS		CAFES	
	Name	Grade	Name	Grade
Steinbach			Tourist Hotel	S
Piney			Piney Hotel	S
West Hawk Lake			Trans Canada Cafe	S
Rennie			Rennie Hotel	S
The Pas	Wapasquia H.	U	Paris Cafe	S
Lac du Bonnet	Lake View H.	S	Coffee Shop	S
Bissett	San Antonia H.	S	Coffee Shop	S
Berens River			Log Cabin Inn	S
Carberry	Nelson H.	S	C. V. Cafe	S

Table 4.

6. Sample Plots

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Sandilands Forest Reserve	W. Poplar	W 88	June 6	1 larva of a semi looper, Autographa sp. 1 larva of a Phalaenid, Phalaenid sp. 1 larva of a sawfly, Tenthredinid sp. 3 adults of a leaf-eating beetle, Galerucella sp.
	Jack pine #1	W 90	June 6	20 larvae of the jack pine budworm, Archips fumiferana Clem. Small amount of pinkish rust on needles.
	Jack pine #2	W 91	June 6	30 larvae of the jack pine budworm, Archips fumiferana Clem. 1 puparium of a hover fly, Syrphid sp.
	Birch	W 92	June 7	1 larva of a shoot moth, Olethreutid sp. 1 larva of a sawfly, Tenthredinid sp. 1 nymph of a leaf-hopper, Cicadelid sp.
	Juniper	W 93	June 7	1 adult of a stink bug, Chlorochroa uhleri Stahl
	Cedar	W 95	June 7	1 adult of a click beetle, Ludius ochreipennis Lec. 1 adult of a click beetle, Agriotes limosus Lec.
	Spruce	W 96	June 7	1 larva of the chameleon caterpillar, Anomagyna elimata Gn. 1 larva of a Phalaenid, Phalaenid sp. 3 larvae of an Aphid, Syrphid sp. 1 adult of the large spruce weevil, Hypomalyx piceus de G.

Sample Plots (Con'd)

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Sandilands Forest Reserve (Con'd)	Tamarack	# 124	June 7	1 larva of the little larch sawfly, Anoplonyx sp. 3 larvae of a leaf roller, Tortricid sp. 1 pupa of a leaf roller, Tortricid sp. 1 adult of the large spruce weevil, Hypomolyx piceus de G.
Red Rock Lake	Juniper	# 131	June 12	2 larvae of a looper, Thera contractata Pack. 1 larva of a looper, Prochoerodes transversata Wlk.
	Tamarack	# 132	June 12	1 larva of a dotted-line looper, Protoboarmia porcelaria Gn. 2 larvae of a hover fly, Syrphid sp. 1 adult of a three-barred click beetle, Ludius triundulatis Rand. 1 adult of a click beetle, Elaterid sp.
	W. Poplar #1	# 136	June 12	1 larva of a leaf roller, Tortricid sp. 6 adults of a leaf-eating beetle, Chrysomellid sp. 1 adult of a fire fly, Lucidota sp. 1 adult of a stink bug, Podisus placidus Uhl.
	Spruce		June 12	Nil results from this plot.
	Jack pine	# 134	June 12	3 larvae of the jack pine budworm, Archips fumiferana Clem. 1 adult of a weevil, Curculionid sp.
	W. Poplar #2	# 135	June 11	1 larva of a sawfly, Nematus sp. 1 adult of a leaf-eating beetle, Chrysomellid sp.

Sample Plots (Con'd)

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Red Rock Lake (Con'd)	W. Birch	W 133	June 12	1 larva of a lappet moth, *Tolype* sp. 1 larva of a leaf roller, possibly *Depressaria* sp. 1 adult of a leaf hopper, *Cicadelid* sp. 1 adult of a leaf-eating beetle, *Calligrapha* sp.
Turtle Mountain Forest Reserve	W. Spruce	W 232	June 20	2 larvae of the black-headed budworm, *Acleris variana* Fern. 2 larvae of the leaf roller, *Zeiaphera ratzburgiana* Ratz. 5 larvae of the green-headed spruce sawfly, *Pikonema dimmockii* Cress. 1 larva of a flower fly, *Syrphid* sp. 1 larva of a flower fly, *Syrphid* sp. 2 adults of a click beetle, *Elaterid* sp.
	Willow	W 254	June 21	1 larva of a looper, *Geometrid* sp. 1 larva of a Phalaenid, *Phalaenid* sp. 1 pupa of a leaf roller, *Tortricid* sp. 1 larva of a sawfly, *Tenthredinid* sp. 2 larvae of a sawfly, *Tenthredinid* sp. 1 cocoon of a sawfly, *Tenthredinid* sp.
	Elm	W 255	June 21	Leaves damaged by a mite, *Eriophyes* sp.
	Ash		June 21	Negative results from this plot.
	W. Birch	W 262	June 21	1 larva of a sawfly, *Arge macleayi* Nort.
	Oak	W 266	June 21	1 larva of a looper, *Geometrid* sp.

Sample Plots (Con'd)

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Turtle Mountain Forest Reserve (Con'd)	W. Poplar	W 269	June 21	3 larvae of a Phalaenid, Phalaenid sp. 1 larva of a Phalaenid, Phalaenid sp. 1 parasite (probably of the aspen leaf roller) Hymenopterous sp. Several emerged pupae of the aspen leaf roller, Archips conflictana Wlk.
Riding Mountain National Park	W. Poplar		June 27	Negative results from this plot.
	Spruce		June 27	Negative results from spruce plots 1 and 2.
	Tamarack	W 324	June 27	1 larva of the spruce budworm, Archips fumiferana Clem. 1 larva of a sawfly, Tenthredinid sp.
	Jack pine	W 325	June 27	2 adults of the three-barred click beetle, Ludius triundulatus Rand.
	Willow	W 322	June 27	1 larva of a looper, Lygris sp. 1 prepupa of a looper, Dysmigia loricaria Evers. 1 larva of a leaf roller, Tortricid sp. 1 larva of a leaf roller, Tortricid sp. 1 larva of the sawfly, Nematus trilineatus Nort.
Duck Mountain Forest Reserve	Willow	W 356	July 1	2 larvae of a leaf roller, Tortricid sp. 1 larva of a leaf roller, Tortricid sp. 1 larva of a Phalaenid, Phalaenid sp. 1 larva of a looper, Lygris sp. 2 egg clusters of a looper, Geometrid sp. 2 larvae of the sawfly, Nematus trilineatus Nort. 1 adult of the western willow leaf beetle, Galerucella decora Say.

Sample Plots (Con'd)

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Duck Mountain Forest Reserve (Con'd)	B. Poplar	# 357	July 1	1 larva of a Phalaenid, Phalaenid sp. 1 larva of a leaf roller, Tortricid sp. 1 larva of a sawfly, Tenthredinid sp. 1 larva of the american poplar leaf-eating beetle, Phytodecta americana Schiff.
	Spruce		July 1	Nil results from this plot.
	Tamarack	# 360	July 1	3 larvae of Marlatt's sawfly, Anoplonyx sp. 2 larvae of a sawfly, Tenthredinid sp. 1 larva of a sawfly, Tenthredinid sp. 3 cocoons of a sawfly, Tenthredinid sp.
	W. Poplar	# 366	July 1	3 adults of the american poplar leaf-eating beetle, Phytodecta americana Schiff. Several leaf galls made by a mite, Eriophyes sp.
Porcupine Forest Reserve	Willow	# 417	July 6	1 cocoon of a sawfly, Tenthredinid sp. 1 larva of a sawfly, Nematus sp. 1 larva of a Phalaenid, Phalaenid, sp. 13 adults of the western willow leaf beetle, Galerucella decora Say.
	Jack pine #2	# 420	July 6	3 larvae of a looper, Semiothisa sp. 1 larva of a looper, Geometrid sp. 1 larva of the slug moth, Incisalia niphon clarki Frmn.
	Jack pine #1	# 423	July 6	2 larvae of a leaf roller, Tortricid sp. 1 larva of a leaf roller, Tortricid sp. 4 larvae of the jack pine hair streak, Incisalia niphon clarki Frmn. 1 adult of the inky click beetle, Ludius appropinquans Rand.

Sample Plots (Con'd)

LOCALITY	HOST	F.I.S. NO.	DATE	CONTENTS
Porcupine Forest Reserve (Con'd)				1 adult of the click beetle, Agriotes limosus Lec. 1 adult of a lace wing, Hemerobuis sp.
	W. Birch	W 426	July 6	1 adult of the inky click beetle, Ludius appropinquans Rand. 1 adult of the click beetle, Ludius nitidulus Lec.
	Spruce	W 428	July 7	2 larvae of a hover fly, Syrphid sp.
	W. Poplar #1	W 430	July 6	1 larva of a tussock moth, Liparid sp. 1 larva of a leaf roller, Tortricid sp. 2 adults of the western willow leaf-eating beetle, Galerucella decora Say.
	W. Poplar #2	W 431	July 6	1 larva of a leaf roller, Tortricid sp. 1 larva of a looper, Lobophora nivigerata Wlk. 1 larva of a sawfly, Tenthredinid sp. 1 adult of a leaf-eating beetle, Chrysomellid sp.
	Tamarack	W 433	July 7	1 larva of the European larch sawfly, Pristiphora erichsonii Htg. 1 larva of the Marlatt's sawfly, Anoplonyx sp.

D. L.L. McDowall

1. Introduction

A tour of the forested areas of Saskatchewan, accessible by automobile, was made during the months of June to September inclusive. In June, the writer was accompanied by V. Hildahl and for ten days in August by W. C. McGuffin; the balance of the trip was made alone. A schedule was laid out to permit the visiting of the principal forested areas twice during the season. Proceeding first to the Porcupine Provincial Forest where five days were spent, the observer then went to the Pasquia Provincial Forest for six days. The Fort a la Corne and the Nisbet Provincial Forests were visited next. Ten days, from June 30 to July 10, were spent in Prince Albert National Park. After a week in the Big River Provincial Forest, a visit was paid to the Meadow Lake Provincial Forest and the Bronson Provincial Forest. Leaving the Bronson area, the writer travelled back over this route. Approximately one week was spent in each of the areas mentioned above and, in addition, a brief visit was made to Emma Lake Provincial Park. The trip was completed on September 23.

Forest conditions were generally good and relatively few serious infestations of insects occurred in the province. The larch sawfly, bronze birch borer, jack pine scale, white pine weevil, yellow-headed spruce sawfly, American poplar leaf beetle, western willow leaf beetle and the parasitic plant, mistletoe, were encountered as outbreaks. Details of the location and intensity of these outbreaks are given below.

2. Insect Conditions

(a) Larch Sawfly (Pristiphora erichsonii Htg.)

This sawfly, one of the foremost insect problems of the western provinces, was encountered in only three areas of Saskatchewan. The most severe outbreak was seen in a tamarack stand seventeen miles north of Pelly (Township 35 Range 31 W.P.M.) where defoliation was very heavy. Sawfly infestation was reported by forest service personnel as generally heavy south of Pelly to Madge Lake, but since this area was traversed in early June before larval feeding was noticeable, no evidence of damage was seen. There were several small outbreaks of sawfly in Townships 50 and 51 Range 11 W 2, northeast of Carrot River. Defoliation of tamarack was light in this area. A few larvae were found while making two collections about one mile north of the main gate in Prince Albert National Park but no defoliation could be detected.

(b) Bronze Birch Borer (*Agrilus anxius* Gory)

This borer was quite severe in one part of Prince Albert National Park. Thirty per cent of the white birch trees along the road between Waskesiu Lake and Hanging Heart Lake were either dead or dying. The insect was also recorded in the Meadow Lake Provincial Forest in a stand of birch estimated to cover about two acres. It was located on the highway ten miles north of Midnight Cabin.

(c) Jack Pine Scale (*Toumeyella* sp.)

A jack pine scale infestation reported by O. C. Horncastle, District Superintendent at Prince Albert, to be present in the Nisbet Provincial Forest was investigated. This infestation was found on Section 18 Township 49 Range 27 W 2 and on Section 24 Township 49 Range 1 W 3 and bordered highway number three, starting at a point ten miles west of Prince Albert. Although there is every indication that scale had been quite active last year in this area, very few living scales were discovered this year. Only one out of a hundred terminals was found to be infested, and these infested terminals averaged three scales each.

(d) White Pine Weevil (*Pissodes strobi* Peck.)

Damage by this pest appeared to be very light in all three areas where it was encountered. The weevil was found in a small stand of jack pine and in nearby white spruce trees on the Hanging Heart road, five miles west of Waskesiu Lake in Prince Albert National Park. In the Nisbet Provincial Forest, there was an infestation on spruce one mile south of the ranger's cabin at MacDowall. Some damage to spruce was also encountered in the Meadow Lake Provincial Forest at a point ten miles south of the north boundary on Highway No. 4.

(e) Yellow-headed spruce Sawfly (*Pikonema alaskensis* Roh.)

Severe outbreaks of yellow-headed spruce sawfly occurred on planted spruce in many districts this year. In Prince Albert National Park and the Emma Lake Provincial Forest, over fifty per cent of these trees were partially or completely stripped of needles. Other stands of spruce not as heavily infested were found in the Nisbet Provincial Forest. One was at MacDowall, one-half mile south of the ranger's cabin in a small plantation and the other was at Holbein, adjacent to the ranger's cabin.

(f) American Poplar Leaf Beetle (Phytodecta americana Schiffr.)

At Pelly, and from Ushta north to Hudson Bay Junction, damage by this beetle was evident. Defoliation of trembling aspen ranged from light to medium. Very heavy damage occurred at Rabbit Cabin in Prince Albert National Park. All aspen within a five mile radius of Rabbit Cabin were from seventy-five to one hundred per cent defoliated. Light infestations were encountered at MacDowall, one mile west of the ranger's cabin in the Nisbet Provincial Forest.

(g) Western Willow Leaf Beetle (Galerucella decora Say.)

Large outbreaks of willow leaf beetle occurred in many districts this summer. From Birtwell west to Tisdale, and from Prince Albert twenty miles south to St. Louis, severe damage was seen. The Meadow Lake Provincial Forest, Glaslyn and Jackfish Lake areas suffered heavy attacks. Much of the willow foliage in these areas was skeletonized to a burned-over appearance.

(h) Mistletoe (Razoumofskya sp.)

Causing grave concern among officials of the Department of Natural Resources in Prince Albert is the parasitic plant, mistletoe, on jack pine. In the Nisbet Provincial Forest, jack pine suffered greatly and all efforts to combat this disease seem hopeless. Mistletoe has attacked large areas of forest, killing and disfiguring the trees, thereby rendering them unfit for commercial use.

Table 1.

3. Negative Reports

Date	Host	Locality
June 8	Tamarack	Ushta, Saskatchewan
June 8	White spruce	Ushta
June 8	Jack pine	Ushta
June 10	White spruce	Usherville
June 10	White spruce	Reserve
June 12	Tamarack	Lavardville
June 12	Black spruce	Lavardville
June 12	Jack pine	Hudson Bay Junction
June 13	Black spruce	Chemong
June 13	Balsam	Chemong
June 14	Jack pine	Hudson Bay Junction
June 14	Tamarack	Hudson Bay Junction
June 14	Birch	Hudson Bay Junction
June 14	Tamarack	Prairie River
June 14	Black spruce	Prairie River
June 19	Jack pine	Holbein
June 20	Black spruce	Crutwell
June 20	Jack pine	Crutwell
June 20	Birch	Crutwell
June 21	Jack pine	Prince Albert
June 21	Trembling aspen	Prince Albert
June 22	Jack pine	MacDowall
June 22	Trembling aspen	MacDowall
June 24	Jack pine	Prince Albert
June 24	White spruce	Prince Albert
June 25	Jack pine	Prince Albert
June 26	Jack pine	Prince Albert
June 28	Tamarack	Prince Albert
June 28	White spruce	Prince Albert
July 2	Tamarack	Waskesiu Lake, P.A.N.P.
July 2	White spruce	Waskesiu Lake, P.A.N.P.
July 4	Tamarack/	Sandy Lake, P.A.N.P.
July 4	Trembling aspen	Sandy Lake, P.A.N.P.
July 5	White spruce	Cookson
July 5	Tamarack	Cookson
July 10	Balsam	Waskesiu Lake, P.A.N.P.
July 15	Jack pine	Big River
July 17	Jack pine	Big River
July 17	Trembling aspen	Big River
July 19	Tamarack	Meadow Lake

Table 1 (Con'd)

Negative Reports

Date	Host	Locality
July 19	Jack pine	Meadow Lake, Saskatchewan
July 23	Jack pine	Meadow Lake
July 24	Jack pine	Meadow Lake
July 24	Trembling aspen	Meadow Lake
July 26	Jack pine	Loon Lake
July 26	Jack pine	Loon Lake
July 26	Trembling aspen	Loon Lake
July 31	Jack pine	Meadow Lake
Aug. 9	Woolly willow	Weekes
Aug. 14	Trembling aspen	Meadow Lake
Aug. 28	White spruce	MacDowall

Table 2.

4. Personnel Contacted

NAME	RANK	PLACE	DEMONSTRATION OF SAMPLING
J. L. Doble	Field Officer	Pelly	No
L. F. Bryson	Field Officer	Usherville	Yes
F. Warburton	District Superintendent	Hudson Bay Junction	No
C. Schell	Field Officer	Hudson Bay Junction	Yes
E. A. Matheson	Field Officer	Hudson Bay Junction	Yes
O. B. McNeil	Field Officer	Prairie River	Yes
T. H. Adams	Field Officer	Prince Albert	Yes
O. G. Hormcastle	District Superintendent	Prince Albert	No
W. Marshall	District Forester	Prince Albert	No
A. McDonald	Field Officer	Holbein	Yes
E. Bilquist	Field Officer	MacDowall	Yes
H. Knight	Park Superintendent	P. A. N. P.	Yes
S. C. Pocock	Warden	P. A. N. P.	Yes
H. E. Harrison	Warden	P. A. N. P.	No
F. Jervis	Warden	P. A. N. P.	No
E. L. Millard	Warden	P. A. N. P.	Yes
G. L. Holden	Warden	P. A. N. P.	Yes
H. W. Genge	Warden	P. A. N. P.	Yes
C. T. Dell	Field Officer	Big River	Yes
E. C. Over	Field Officer	Big River	No
H. G. Pond	Field Officer	Big River	No
F. W. Redhead	Field Officer	Big River	No
J. Barnett	District Superintendent	Meadow Lake	No
A. W. Benson	Field Officer	Meadow Lake	Yes
R. Turner	Field Officer	Meadow Lake	No
F. Mitchell	Field Officer	Loon Lake	Yes
F. Beaudoin	Field Officer	Green Lake	No
C. A. Otterbein	Field Officer	Carrot River	Yes
G. F. Reed	Field Officer	Love	No

Table 3.

5. Intelligence

S - Satisfactory U - Unsatisfactory

PLACE	HOTELS		CAFES	
	Name	Grade	Name	Grade
Yorkton	Blackstone	S	Broadway	S
	Balmoral	S		
Hyas	Hyas	U		
Endeavour	Endeavour	S	Endeavour	S
Hudson Bay Junction	Marcottes	S	Railway	S
Tisdale	Tisdale	S		
Prince Albert	Avenue	S	Princess	S
	Marlborough	S	Wings	S
Reserve	Reserve	U	Reserve	U
Nipawin	Maple Leaf	U	Royal	S
P. A. N. P.			Pleasant Inn	S
			Lakeview	S
Shellbrook			Coffee House	S
Big River	Lakeview	S	Lakeview	S
Meadow Lake	Empire	S	Empire	S
Loon Lake	International	U	International	U
North Battleford	Marlborough	S	Victory	S
	Grand	U		
Melfort	Winston	S		
Saskatoon	King George	S	Honey Dew	S

Table 4.

6. Sample Plots

LOCALITY	HOST	DATE	F.I.S. NO.	CONTENTS
Oshta	W. Spruce	June 8	W 114	2 larvae of a budmoth, *Zeiraphera fortuana* Kft.
	Jack pine	June 8		Negative results.
Reserve	Balsam	June 11	W 180	1 larva of a semi looper, *Autographa selecta* Wlk. 1 larva of a woolly bear, *Haploa confusa* Lym. 2 puparia of a hover fly, *Metasyrphus lapponicus* Zett. 1 larva of a hover fly, *Syrphid* sp. 1 cocoon of a parasite, *Hymenopterous* sp.
Hudson Bay Junction	W. Spruce	June 11	W 172	1 larva of a budmoth, *Zeiraphera fortuana* Kft. 1 larva of the black-headed budworm, *Acleris variana* Fern.
	W. Spruce	June 12	W 167	1 larva and six puparia of a hover fly, *Metasyrphus lapponicus* Zett. 2 larvae of a hover fly, *Syrphid* sp. 1 puparium of a hover fly, *Syrphid* sp. 2 adults of a ladybird beelte, *Adalia disjuncta* Rand. 1 adult of a ladybird beetle, *Coccinellid* sp.
MacDowall	B. Spruce	June 18	W 219	8 larvae of the yellow-headed spruce sawfly, *Pikonema alaskensis* Roh. 1 larva of the green-headed spruce sawfly, *Pikonema dimmockii* Cress.
	Jack pine	June 22		Negative results.
	Poplar	June 22		Negative results.

Sample Plots (Con'd)

LOCALITY	HOST	DATE	F.I.S. NO.	CONTENTS
Prince Albert	Jack pine	June 20	# 238	5 larvae of the pitch pine nodule maker, Petrova albicapitana Busck.
	Tamarack	June 20	# 260	1 larva of a semi looper, Catocola sp. 2 larvae of Marlatt's larch sawfly, Anoplonyx sp. 5 adults of a plant louse, Aphidid sp.
	Spruce	June 20		Negative results.
Red Rock cabin	Jack pine	June 21	# 274	14 larvae of a jack pine sawfly, Neodiprion sp. 2 larvae of a semi looper, Zale benesignata Smith
	Poplar	June 21		Negative results.
Elk House	Tamarack	June 26	# 307	4 larvae of the Marlatt's sawfly, Anoplonyx sp. 1 larva of a hover fly, Syrphid sp. 1 larva of a ladybird beetle, Coccinellid sp.
	Spruce	June 26	# 311	3 larvae of a hover fly, Syrphid sp. 4 galls of the spruce pineapple gall aphid, Adelges abietis L.
	Jack pine	June 26		Negative results.
Waskesiu Lake	Tamarack	July 3	# 378	6 larvae of a budmoth, Zeiraphera diniana Gn.
	Balsam	July 9		Negative results.
	W. Spruce	July 4	# 401	1 larva of a leaf roller, Tortricid sp. 5 larvae of the yellow-headed spruce sawfly, Pikonema alaskensis Roh. 1 larva of a hover fly, Syrphid sp.

Sample Plots (Con'd)

LOCALITY	HOST	DATE	F.I.S. NO.	CONTENTS
Waskesiu Lake (Con'd)	Jack pine	July 9	# 470	1 larva of a semi looper, Zale largera Hbn. 1 larva of a semi looper, Zale sp.
	Birch	July 9	# 471	2 larvae of a looper, Deuteronomus sp. 1 larva of a lappet moth, Lasiocampid sp. 1 cocoon of a sawfly, Tenthredinid sp. 1 larva of a sawfly, Tenthredinid sp.
Big River	Jack pine	July 15		Negative results.
	W. Spruce	July 16	# 569	6 larvae of the yellow-headed spruce sawfly, Pikonema alaskensis Roh. 1 larva of the green-headed spruce sawfly, Pikonema dimmockii Cress.
	Poplar	July 16		Negative results.
	Tamarack	July 16	# 568	3 larvae of the Marlatt's sawfly, Anoplonyx sp. 1 larva of a ladybird beetle, Coccinellid sp. 1 larva of a leaf-eating beetle, Chrysomelid sp.
Meadow Lake	W. Spruce	July 23	# 641	2 larvae of the yellow-headed spruce sawfly, Pikonema alaskensis Roh. 2 larvae of the green-headed spruce sawfly, Pikonema dimmockii Cress. 2 larvae of a sawfly, Hemichroa sp.
	Jack pine	July 23		Negative results
	Tamarack	July 24	# 638	1 larva of the green larch looper, Semiothisa sexmaculata Pack. 3 larvae of the Marlatt's larch sawfly, Anoplonyx sp.

Sample Plots (Con'd)

LOCALITY	HOST	DATE	F.I.S. NO.	CONTENTS
Loon Lake	W. Spruce	July 26	W 675	1 larva of a Phalaenid, *Phalaenid* sp. 2 larvae of the green-headed spruce sawfly, *Pikonema dimmockii* Cress. 1 larva of the yellow-headed spruce sawfly, *Pikonema alaskensis* Roh. 1 cocoon of a sawfly, *Tenthredinid* sp.
	Birch	July 26	W 674	1 larva of a looper, *Ectropis crepuscularia* Schiff. 2 larvae of a leaf roller, *Tortricid* sp. 1 larva of the American lappet moth, *Epicnaptera americana* Harr. 1 larva of a sawfly, *Tenthredinid* sp. 1 adult of a mayfly, *Ephemerid* sp.
	Jack pine	July 26		Negative results.

		TOTALS	GENERAL ADMINI-STRATION	FOREST INSECT SURVEY	SPRUCE & JACK PINE BUDWORM	CANKER WORM	SAWFLY	MAINTENANCE			
Buildings & Repairs		459.35						459.35			
Salaries: Temporary		26460.11	4238.26	14747.45	4281.89	80.40	2531.05	10.06	571.06		
Wages: Temporary		1496.15		604.50	447.65			444.00			
Equipment: General Scientific	 1050.32 239.69	1290.01									1290.01
Express, Freight & Cartage		138.74	35.05	26.44	10.40		2.75				64.10
Miscellaneous		231.43	29.53	14.58				187.32			
Supplies: General Photographic Scientific	 1561.57 30.64 269.45	1861.66	36.56	401.72	411.34	21.65	183.68	88.03	439.65	30.64	248.39
Communications Telegraph Postage Telephone	 28.63 111.66 108.43	248.72	148.93	79.06	14.07		6.66				
Travelling Expenses: General		2091.68	374.74	1202.14	288.98	6.60	219.22				
Maintenance Pass.Car E-25 Pass.Car E-26 Pass.Car E-101 Truck E-51 Truck E-80 Truck E-81 Truck E-82 Truck E-83 Motor Boat	 585.39 367.35 188.20 286.57 289.56 405.43 363.87 273.07 4.30	2763.74	610.52	1379.02	450.09	26.10	298.01				
TOTALS		37041.59	5473.59	18454.91	5904.42	134.75	3241.37	1188.70	1010.71	30.64	1602.50

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