- 1949 -

ANNUAL TECHNICAL REPORT

FOREST INSECT LABORATORY, WINNIPEG

SUBJECT INDEX

I INTRODUCTION

ANNUAL TECHNICAL REPORT

Introduction

Special efforts were made during the past year to improve the Forest Insect Survey and to channel larch sawfly studies into high priority projects. Collections received by the Survey reached an all-time high. Moreover coverage was increased as were supplementary data on the biology, habits, and infestation status of forest insects. Survey activities were also enlarged to include parasite surveys to determine the incidence of native and introduced species.

Three important projects on the larch sawfly progressed substantially. These projects are:

(a) A thorough study of the effect of moisture and water levels on emergence and survival of cocoons of the larch sawfly.
(b) Factors governing the effectiveness of _Mesoleius aulicus_ and
(c) Growth habits of tamarack in relation to defoliation by the larch sawfly.

Miscellaneous work on the larch sawfly included studies on the respiration rates of cocoons, the fungous _Beauveria_ sp., and the parasite _Bessa harveyi_.

Several other projects were continued or initiated. Biological control and ecological aspects of the infestation of the spruce budworm in the Spruce Woods Forest Reserve, Manitoba, were investigated. Several phases dealing with reproduction and fecundity of the jack-pine budworm were studied. Wood boring insects as deteriorating agents of fire-killed timber were again investigated in Saskatchewan. A new project on the biology and control of the pitch nodule maker, an important pest of young pine, was initiated.

A number of projects were not reported on or not covered adequately because the investigative officers were absent on Educational Leave. Three important projects falling in this category are the jack-pine budworm, pitch nodule maker and larch sawfly parasite (M. aulicus) investigations. These reports will be brought up-to-date when the officers responsible return to continuous duty.

Facilities for field studies were vastly improved by the completion of a permanent field station in the Whiteshell Forest Reserve, Manitoba. The station, consisting of a single building, contains a large laboratory and complete housing facilities for eight men. It will serve as a base for fundamental field studies but it will not, of course, do away with investigations on specific problems or infestations in other parts of the territory of the Winnipeg Laboratory.

Respectfully submitted,

R. R. Lejeune.

II ORGANIZATION

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R. R. LEJEUNE	Officer-in-Charge, SSE-283 Reclassified May 1, 1949 from Agricultural Scientist Grade 3 to Agricultural Research Officer Grade 5. (April 1, 1949 to March 31, 1950)
H. R. WONG	SSE-3321 - Senior Agricultural Assistant (April 1, 1949 to March 31,19
W. F. BLACK	SSE-3038 - Technical Officer Grade 1 (April 13, 1949 to September 30, 1949) Leave of Absence without pay from October 1, 1949 to March 31, 1950.
W. J. TURNOCK	SSE-3320 - Technical Officer Grade 1 (April 25, 1949 to September 22, 1949) Leave of Absence without pay from September 23, 1949 to March 31, 1950.
E. A. LISCOMBE	SSE-3461 - Technical Officer Grade 1 (April 25, 1949 to March 31, 1950.)
D. P. BURBIDGE	SSE-3319 - Technical Officer Grade 1 (May 9, 1949 to March 31, 1950.)
A. W. DOW	SSE-3395 - Technical Officer Grade 1 (May 26, 1949 to March 31, 1950.)
W. H. FELL	SSE-3322 - Technical Officer Grade 1 (April 26, 1949 to September 18, 1949) Leave of Absence without pay from September 19, 1949 to March 31, 1950.
J. A. MULDREW	SSE-3372 - Technical Officer Grade 1 (May 3, 1949 to January 1, 1950) Leave of Absence without pay from January 2, 1950 to March 31, 1950.
J. D. SMITH	SSE-3167 - Technical Officer Grade 1 (April 25, 1949 to March 31, 1950).
R. M. PRENTICE	SSE-254 - Student Assistant Range 3 (April 26 to September 20, 1949).

W. G. H. IVES	SSE-3680 - Student Assistant Range 2 (May 2, 1949 to September 23, 1949).
G. L. WARREN	SSE-3462 - Student Assistant Range 2 (May 2, 1949 to September 21, 1949).
H. A. McKINNON	SSE-3679 - Student Assistant Range 3 (May 23, 1949 to September 17, 1949).
B. LAMOND	Extra Labour - Laboratory Assistant (June 21, 1949 to August 30, 1949).
V. HILDAHL	SSE-3177 - Insect Ranger Grade 2 (April 1, 1949 to March 31, 1950).
L. L. McDOWALL	SSE-3256 - Insect Ranger Grade 1 (April 1, 1949 to March 31, 1950).
J. A. DROUIN	SSE-3255 - Insect Ranger Grade 1 (April 1, 1949 to March 31, 1950).
J. B. MARTIN	SSE-3176 - Insect Ranger Grade 1 (April 1, 1949 to March 31, 1950).
H. A. J. EDMUNDS	SSE-3258 - Insect Ranger Grade 1 (April 1, 1949 to November 7, 1949).
J. J. LAWRENCE	SSE-3434 - Insect Ranger Grade 1 (April 1, 1949 to March 31, 1950).
M. R. H. PRATT	SSE-3622 - Insect Ranger Grade 1 (April 19, 1949 to March 31, 1950).
E. A. CAMPBELL	SSE-3621 - Insect Ranger Grade 1 (June 1, 1949 to March 31, 1950).
G. LALOR	SSE-3257 - Insect Ranger Grade 1 (June 16, 1949 to March 31, 1950).
J. C. E. MELVIN	SSE-3522 - Assistant Technician Grade 1 (April 1, 1949 to March 31, 1950).
E. V. HORN	SSE-3147 - Stenographer Grade 2 (April 1, 1949 to March 31, 1950).

C. O. LUETCHFORD	SSE-3297 - Stenographer Grade 2 (April 1, 1949 to March 31, 1950).
E. BOYKO	SSE-3611 - Clerk Grade 1 (April 1, 1949 to August 19, 1949).
R. DESROSIERS	SSE-3611 - Clerk Grade 1 (October 1, 1949 to March 31, 1950).
C. GIBSON	SSE-3694 - Caretaker, Part-time (December 1, 1949 to March 31, 1950) Extra Labour April 1, 1949 to December 1, 1949).

PROVINCES OF MANITOBA AND SASKATCHEWAN

FORESTED AREA

H. R. Wong, J. D. Smith, and V. Hildahl

Forest Insect Laboratory, Winnipeg, Manitoba

INTRODUCTION

In 1949, 3166 insect collections were received at this laboratory, an excess of 1405 over the total for the previous season. The increase is attributable to the continued co-operation of the various Dominion and Provincial services, private organizations, companies, and individuals; and to an increase of two men in the staff of forest insect rangers.

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

Coniferous host	No. of collections
White spruce	472
Black spruce	63
Spruce (species not given)	48
Jack pine	407
Lodgepole pine	1
Scotch pine	1
Pine (species not given)	4
Tamarack	654
Siberian larch	3
Balsam fir	53
Juniper	2
Cedar	1
Total	1709

Deciduous host	No. of collections
Poplar (all species)	543
Willow	275
White birch	39
Birch (species not given)	176
Bur oak	20
White elm	11
Manitoba maple	25
Choke cherry	155
Pin cherry	14
Saskatoon	32
Alder	74
Hazel	14
Ash	5
Dogwood	7
Others	36
Total	1426

Miscellaneous and unknown hosts .. 81
Total........................ 81

GRAND TOTAL ---- 3216*

* Some collections were made from more than one species of host. Alberta collections sent to Winnipeg are not included.

The accompanying table lists the insects by species, in order of importance, and indicates their abundance in the samples.

Insects	Number of Larval Collections	Total Number of Larvae	Larvae per Collection	Number of Trees	Larvae per Tree Sampled*
Larch sawfly	511	17219	33.7	3334	5.1
Jack-pine budworm	59	444	7.5	261	1.2
Spruce budworm	27	73	2.7	135	0.4
Large aspen tortrix	92	639	6.9	444	1.1
American poplar beetle	145	8383	57.8	849	11.1
Prairie willow leaf beetle	166	2088	12.6	173	9.1
White-pine weevil	28	254	9.0	214	0.8
Pitch nodule maker	120	836	6.9	637	0.8
Forest tent caterpillar	8	44	5.5	149	0.3
Red-pine sawfly	10	518	51.8	50	9.8
Birch sawfly	7	480	68.6	69	5.3
Balsam-fir sawfly	214	8247	38.5	1153	7.1
Bronze birch borer	4	9	2.2	12	0.7
Spruce needleworm	33	71	2.2	258	0.3
Yellow-headed spruce sawfly	66	583	8.8	323	1.8
Ugly-nest caterpillar	93	3143	33.8	228	10.0
Spotless fall webworm	64	2220	34.7	197	9.3
Anoplonyx sp. on tamarack	112	664	5.9	564	1.1
Hemlock looper	17	41	2.4	93	0.4
False hemlock looper	9	13	1.4	43	0.3
Black-headed budworm	19	29	1.5	126	0.2

* Includes only quantitative samples

Of the season's total, 1899 collections were made in Manitoba, 1259 in Saskatchewan, 7 in Alberta, and 1 in Ontario. Co-operators and laboratory personnel supplemented the information on many collections with special reports on insect activity or damage. Random sampling of commercial and non-commercial tree species was done throughout the season. From May to early July the examination of balsam, spruce, and jack pine was stressed for the detection of spruce and jack-pine budworms. Later, emphasis was placed on sampling for larch sawfly, and estimation or injury to tamarack stands.

IMPORTANT INSECTS

Larch Sawfly, *Pristiphora erichsonii* (Htg.).--Severe defoliation of tamarack stands by the larch sawfly was evident again throughout Manitoba and Saskatchewan. However, in Manitoba the outbreak appears to be subsiding except in the northwest. Although not supported by statistical data, indications are that parasites, especially the parasitic fly Bessa harveyi (T.T.), and small predatory mammals are important contributing factors in the decline. In Saskatchewan, on the other hand, defoliation has become more widespread, and damage was severe in the eastern and central areas although still negligible in the western part of the Province.

In Manitoba the infestation extending south of the Winnipeg River to the United States border moderated in 1949. The only areas in which last year's severe defoliation persisted were the northern part of the Sandilands Forest Reserve, the East Braintree area, and east of Whitemouth along the Boggy River flats. Between Lac du Bonnet and Traverse Bay on Lake Winnipeg, sawfly activity was moderate, and caused only light defoliation. Heavy summer rains in this area were noted by C. Bayly, Manitoba Paper Company, to have washed larvae from the trees, as many were found lying drowned in surface water.

An aerial survey made east of Lake Winnipeg at the end of July indicated defoliation to be generally light to moderate. Circumstances did not permit later re-survey to check on the progress of the infestation. Several collections received from this area later in the season indicated that defoliation had not increased appreciably.

As in 1948 the infestations in the Interlake Area remained light to moderate, the areas of moderate defoliation being confined to Riverton and Grand Rapids. A ground fire early in the season in the Riverton district may have contributed to the reported degree of injury. Consequently the amount of defoliation first attributed to the larch sawfly in this area may have been over-estimated.

Defoliation in western Manitoba was light to moderate in the south and moderate to severe toward the north. There was little evidence of larval feeding in the Spruce Woods Forest Reserve. In Riding Mountain National Park, the moderate to severe infestation of 1948 declined to light in the eastern and western portions, whereas the moderate infestation in the central portion persisted, with defoliation of stands ranging from 35 to 40 per cent in 1949. Light to moderate infestations also extended through the Duck Mountain Forest Reserve to Swan River.

No appreciable change in the status of the larch sawfly was observed in 1949 from north of Swan River to The Pas; for the most part defoliation remained moderate to severe. North of The Pas to Cranberry Portage, complete stripping of the foliage was common, and many trees were observed to have put forth a second growth of needles.

Throughout most of Saskatchewan, the intensity of the outbreak has either increased or remained unchanged. The only areas showing declining populations were Madge Lake in the Duck Mountain Provincial Park, and Pelly, where defoliation was light and light to moderate, respectively.

North of Pelly, in the Porcupine and Pasquia Provincial forests, the moderate to heavy infestation of 1948 continued at the same level; severe defoliation was conspicuous in the southern part of the Pasquia, and along the northern boundary of the Porcupine Provincial forests.

West of this region, to the Fort à la Corne Provincial Forest, most of the defoliation was light, except at Bjorkdale and Battle Heights, where it ranged from moderate to severe. Scattered tamarack stands along Highway No. 55 between White Fox and Smeaton were observed to be moderately attacked, with defoliation averaging 60 per cent.

The area of serious defoliation of tamarack extended beyond the 1948 limits at Prince Albert, west and north to the Canwood Block of the Nisbet Provincial Forest. In the Fort à la Corne Provincial Forest, intensified larch sawfly attacks caused more serious injury in 1949, especially in Tp. 50, rge. 19, W. 2nd mer., where the defoliation averaged 95 per cent. Severe defoliation continued in the vicinity of Prince Albert. Though this infestation has been active for the past three years, to date no tree mortality has resulted. In the Nisbet Provincial Forest, the infestation was less intense than at Prince Albert, with defoliation ranging from moderate to severe in most areas, except for a light infestation in the Red Rock Block.

Sawfly populations in the Torch River Provincial Forest were generally light except for a moderate infestation in Sec. 24, tp. 54, rge. 15, W. 2nd mer. Tamarack stands in the Nipawin, Candle Lake, and Emma Lake Provincial forests were only lightly defoliated, and appeared in excellent condition.

There was a wider distribution of the sawfly throughout Prince Albert National Park, but defoliation remained light in 1949. No evidence of defoliation was noted between the Park and Lac la Ronge. In the area from west of the Park, to the Saskatchewan-Alberta boundary, including the Big River, Meadow Lake, Bronson, and Waterhen Provincial forests, defoliation varied from a trace to light.

An aerial survey of tamarack stands in northwestern Saskatchewan disclosed an absence of larch sawfly damage at Cold and Primrose lakes, and at Ile à la Crosse.

The Survey is again indebted to W. MacNeill, of the Saskatchewan Department of Natural Resources, for much information on the distribution of the larch sawfly in northwestern Saskatchewan.

The accompanying table indicates the relative abundance of the larch sawfly in collections received during the period of larval activity:-

District	Collections from Tamarack	Collections Containing Larch Sawfly	Per cent
Manitoba			
Eastern	93	73	78
Central	16	16	100
Western	167	139	83
Saskatchewan			
Hudson Bay	152	139	91
Prince Albert	111	108	97
Meadow Lake	99	86	87

The abundance of larch sawfly larvae in relation to that of other insects collected from tamarack is listed below:

Month	Total Number of Larvae	Larch Sawfly		(Anoplonyx sp.)		Green Larch Looper	
		Larvae	Per cent	Larvae	Per cent	Larvae	Per cent
June	879	706	80.3	173	19.7	0	0.0
July	8711	8549	98.2	152	1.7	10	0.1
August	8254	7898	95.7	84	1.0	272	3.3
September	352	66	18.7	255	72.5	31	8.8
Total	18196	17219	94.6	664	3.7	313	1.7

	Collections	Reports
Manitoba	256	63
Saskatchewan	335	228

Jack-pine Budworm, Choristoneura sp. .--This species was notably active during 1949 only in Manitoba. In Saskatchewan the budworm was not detected in the few areas where it was collected in 1948, despite extensive sampling of jack-pine stands throughout the Province.

The main body of the budworm infestation was located in eastern Manitoba. Information concerning the intensity of defoliation in the area east of Lake Winnipeg was derived chiefly from aerial surveys, supplemented by a limited number of ground inspections. Moderate to severe "pocket" infestations, situated between the Winnipeg and Oiseau rivers to the south, and the Berens River to the north, (see 1948 Annual Report of the Forest Insect Survey) merged into a single moderate infestation in 1949. North of Berens River to Charron Lake, ground inspections indicated the budworm to be present but it caused no noticeable defoliation.

The jack-pine budworm was generally distributed in the Winnipeg River district from Pine Falls to Pointe du Bois, but as in 1948, no defoliation was evident. The infestation north of Stead, in Tps. 17 and 18, rge. 8, E. P. mer., (moderate in 1948) was reported as moderate to severe in 1949 by B. Gilmore of the Manitoba Forest Service. A complete survey of this area was made to determine the intensity of attack, and to map the location of budworm-damaged jack pine as an aid to the Manitoba Forest Service in directing cutting operations. Severe defoliation was observed on pollen-bearing, open-grown trees along the ridges in Secs. 21 - 28, tp. 17, and in Secs. 10, 15 - 18, tp. 18, rge. 8, E. P. mer. Jack pine in Secs. 15 and 16, tp. 18, rge. 8, E. P. mer., was also heavily infested with mistletoe.

In the Whiteshell Forest Reserve, the only appreciable change in the status of the jack-pine budworm was a decline of the infestations near Red Rock Lake which were moderate to severe in 1948. Scattered collections made in the Reserve at Mantario, West Hawk, and Falcon lakes, and at points along the Trans-Canada Highway between Rennie and West Hawk Lake, indicated a general but light infestation. Jack-pine stands near Molson and Seddon's Corner, on the Trans-Canada Highway, continued to show moderate defoliation. Traces of defoliation were noted in the vicinity of Beausejour and Whitemouth.

The intensity of the infestation in the Sandilands Forest Reserve abated in 1949. The "pockets" of moderate and severe defoliation in the northern part of the Reserve have moderated but increased in size, whereas defoliation in the remainder of the northern region continued light. In the center of the Reserve, the several small areas which were severely attacked in 1948 have coalesced to form a continuous infestation of moderate intensity but reduced in overall size. An extensive fire in early May in the southeastern section of the Reserve destroyed a large area of jack pine which had been badly damaged by repeated defoliation. In contiguous unburned areas, jack pine was found to be only lightly infested. Distribution of the budworm and intensity of defoliation in the Reserve were mapped completely in 1949 to provide information requested by the Manitoba Forest Service for planning salvage operations.

The jack-pine budworm was found in most jack-pine stands south-east of the Sandilands Forest Reserve, but only light defoliation was noted in the vicinity of Whitemouth Lake, Badger, Piney, and other points examined.

In the Interlake Area, the infestation between Riverton and Hodgson was of light to moderate intensity in 1949, and appeared to be centered in an area of some 40 square miles around the town of Rosenburg. Small populations of the budworm were observed at Ashern, but no appreciable defoliation was evident. A small infestation on jack-pine ridges in Tp. 31, rge. 9, W. P. mer., south of Gypsumville, was the most serious in Manitoba. Average defoliation of the current growth in an area of approximately 80 acres was between 85 and 95 per cent.

No changes were observed in the status of the jack-pine budworm in western Manitoba. Defoliation remained very light at Cowan and in Riding Mountain National Park, Sec. 25, tp. 19, rge. 18, W. P. mer.

The following table indicates the relative abundance of the jack-pine budworm in collections received during the period of larval activity:-

District	Collections from Jack pine	Collections Containing Jack-pine Budworm	Per cent
Eastern Manitoba	93	52	56
Central Manitoba	21	9	43
Western Manitoba	41	5	12

	Collections	Reports
Manitoba	70	41
Saskatchewan	0	8

Spruce Budworm, <u>Choristoneura fumiferana</u> (Clem.).--Records of occurrence of this species in 1949 were limited to Manitoba. As in the case of the jack-pine budworm, extensive sampling by co-operators and Insect Rangers failed to locate it in Saskatchewan.

During aerial surveys referred to in the preceding section on the jack-pine budworm, very low populations of the spruce budworm were found, except at one location east of Lake Winnipeg where spruce and balsam were sampled. The 1949 records indicated the presence of the spruce budworm at Island Lake, about 125 miles north of the most northerly record for 1948. Although this whole region has been watched carefully since the species was first discovered in it in 1944, there is still no evidence of any alarming increase in population. On the other hand, the comparative ease with which spruce budworm larvae could be collected, by the usual sampling methods, over such a large area indicated a widespread distribution and some increase in the numbers of this insect.

Only one small area of damaged spruce was observed from the air in eastern Manitoba, in the vicinity of Bissett. The area covered about two acres but it was impossible to make a ground check to determine the cause of the injury. It may or may not have been caused by the spruce budworm.

The spruce budworm was recorded for the first time in southeastern Manitoba, at East Braintree and in the Sandilands Forest Reserve. However, its occurrence in this region may be termed occasional. Scattered areas of very low populations were recorded in the Whiteshell Forest Reserve. The only noticeable defoliation in this region was observed on ornamental spruce at Waugh.

No increase in budworm abundance or defoliation was evident in the Interlake Area, west of Lake Winnipeg.

The old infestation in the Spruce Woods Forest Reserve appeared to be declining in 1949. White spruce stands in the Reserve were, for the most part, only lightly defoliated, with the occasional small areas of moderate or severe attack located southwest of Carberry. In some sections of the Reserve, the spruce needleworm, Dioryctria reniculella (Grt.), was more numerous than the spruce budworm.

The status of the spruce budworm in western Manitoba remained much the same as in 1948. Very low populations were again encountered in Riding Mountain National Park. It was collected for the first time at Singoosh Lake in the Duck Mountain Forest Reserve and at Birch River.

The following table indicates the relative abundance of the spruce budworm in collections received during the period of larval activity:-

Districts	Collections from Spruce & Balsam	Collections Containing Spruce Budworm	Per cent
Eastern Manitoba	51	18	35
Central Manitoba	6	3	50
Western Manitoba	102	12	12

	Collections	Reports
Manitoba	35	14
Saskatchewan	0	5

Large Aspen Tortrix, Archips conflictana (Wlk.).--The distribution of the large aspen tortrix remained much the same as in 1948, although the size and intensity of infestations in northwestern Manitoba and western Saskatchewan have increased in 1949.

In Manitoba the area most seriously affected extended from The Pas north to Cranberry Portage. Defoliation averaged 70 per cent along a 54-mile stretch of the Manitoba Northern Railway, from a point six miles north of The Pas to Mile 60. Just south of Cranberry Portage an area of almost pure poplar, two miles wide and about ten miles long, suffered 90 per cent loss of foliage.

The severe infestations of previous years between Singoosh and Blue lakes, in the Duck Mountain Forest Reserve, subsided to very light in 1949. Defoliation averaged 15 per cent in a ten-square-mile area near the Durban Ranger Station (Sec. 29, tp. 33, rge. 28, W.P. mer.). Elsewhere in western Manitoba, poplar stands were very lightly attacked by this insect. Light defoliation was observed also in the Spruce Woods and Sandilands Forest reserves and at Hodgson.

Most of the defoliation of poplar in western Manitoba is attributable to the large aspen tortrix, even though the American poplar beetle was found throughout that region.

In western Saskatchewan the severe infestation reported around the town of Glaslyn in 1948 increased in area and intensity. The area of severe defoliation expanded from three square miles in 1948 to include, in 1949, the region within a ten-mile radius of the town. Though some trees appeared to be completely stripped, defoliation generally ranged from 30 to 70 per cent.

Light concentrations of this insect were observed in eastern Saskatchewan. The old infestation at Madge Lake, adjoining Manitoba, continued to abate. Northward in the Porcupine and Pasquia Provincial forests, and westward to the Greenwater Lake Provincial Park and Carrot River, damage by the large aspen tortrix was light. In this area most of the defoliation was caused by the American poplar beetle.

The following table indicates the relative abundance of the large aspen tortrix in collections received during the period of larval activity:-

Districts	Collections from Poplar	Collections Containing Large Aspen Tortrix	Per cent
Manitoba			
Eastern	54	2	4
Central	24	1	4
Western	118	47	40
Saskatchewan			
Hudson Bay	100	55	55
Prince Albert	44	7	16
Meadow Lake	31	13	42

	Collections	Reports
Manitoba	49	6
Saskatchewan	76	34

American Poplar Beetle, Phytodecta americana (Schffr.).--As in 1948, no serious infestations were observed in Manitoba or Saskatchewan. The main areas attacked were confined to western Manitoba and central Saskatchewan. This species was found commonly in association with the large aspen tortrix.

At Madge Lake, in the Duck Mountain Provincial Park, Saskatchewan, an increase in activity of the American poplar beetle caused light to moderate defoliation whereas the large aspen tortrix declined in numbers. A more active infestation was reported at Glen Elder northwest of Madge Lake, and in Greenwater Lake Provincial Park, where moderate defoliation was recorded.

Light feeding damage to poplar stands was encountered in the Porcupine, Pasquia, Candle Lake, and Meadow Lake Provincial forests, and in Prince Albert National Park. Distribution of the insect was general in the Nisbet Provincial Forest, but noticeable defoliation was observed only in the Home Block. Poplar stands near Prince Albert were moderately defoliated. In this region, the American poplar beetle was observed feeding on willow in areas where the poplar leaves had been damaged by an early frost. Although isolated trees in the Big River Provincial Forest were moderately defoliated, the infestation there was generally very light. Little defoliation by this species was noted as far north as the Waterhen Provincial Forest (Tp. 66, rge. 16, W. 3rd mer.) by W. MacNeill, Saskatchewan Department of Natural Resources.

In Manitoba, light defoliation was observed in the Duck Mountain and Porcupine Forest reserves, and along their southern and eastern boundaries. Light feeding damage was also reported from the Interlake Area at Riverton, Hodgson, and Ashern.

	Collections	Reports
Manitoba	55	6
Saskatchewan	129	87

Prairie Willow Leaf Beetle, Galerucella decora (Say).--Virtually all willow stands throughout Saskatchewan and Manitoba showed evidence of feeding by this insect. In areas of moderate and severe attack, skeletonizing of the leaves caused stands to take on a conspicuous scorched-like appearance. Willow is the preferred host but poplar was also attacked in some places where the willow foliage was completely skeletonized.

The most severe infestations were observed in eastern and southern Manitoba. Leaves of willow and poplar were almost completely skeletonized in the area along the Trans-Canada Highway east of Whitemouth to Rennie, and north of Rennie to Brereton Lake in the Whiteshell Forest Reserve. A similar condition was observed on willow from Lac du Bonnet to Pointe du Bois and at East Braintree. Another severe infestation was reported east of Lake Winnipeg at Bissett. In western and northern Manitoba, areas of conspicuous injury were observed at Durban and Mafeking.

In Saskatchewan, severe infestations were observed in the vicinity of Hudson Bay Junction and Carrot River. A moderate infestation was noted near Smeaton, and light to moderate infestations were noted at Madge Lake, Pelly, and Ushta. In western Saskatchewan, some damage by this insect was reported at Beacon Hill (Tp. 62, rge. 24, W. 3rd mer.) and between St. Walburg and Loon Lake.

	Collections	Reports
Manitoba	170	22
Saskatchewan	95	36

White-pine Weevil, Pissodes strobi (Peck).--This species has injured the terminal shoots of white-spruce and jack-pine regeneration.

In Manitoba scattered leaders in young stands of white spruce were damaged at Ashern, and near the Blue Lakes in the Duck Mountain Forest Reserve. Although weevil damage to white spruce was general in Riding Mountain National Park, the only severe infestation reported was observed by J. Goodison, National Parks Service, in a white-spruce nursery (Sec. 34, tp. 19, rge. 18, W. P. mer.). Light infestations were reported in the Park along the Dauphin Trail (Sec. 12, tp. 22, rge. 21, W. P. mer.) and along the Norgate Road (Sec. 25, tp. 19, rge. 18, W. P. mer.). Many dead or wilted leaders of white spruce were observed by J. J. Wright, Manitoba Forest Service, in the Spruce Woods Forest Reserve (Sec. 24, tp. 9, rge. 15, W. P. mer.). The degree of weevil damage to jack pine increased to moderate in the northern part of the Sandilands Forest Reserve, where a further increase in severity of infestation is expected in 1950. Jack-pine stands at Seven Sisters, Rennie, Whitemouth, and Riverton were only lightly injured.

The white-pine weevil was less abundant in Saskatchewan. Light damage was observed on white spruce near Pelly, and on jack pine in the Nisbet, Big River, and Nipawin Provincial forests.

	Collections	Reports
Manitoba	36	9
Saskatchewan	9	5

Pitch Nodule Maker, Petrova albicapitana (Busck.).--Pines, dead or deformed through the activities of this species, were found scattered throughout plantations and areas of natural regeneration in Saskatchewan and Manitoba. Although no severe infestations were detected anywhere, the widespread and general nature of its distribution indicates that the overall loss must be considerable.

In Manitoba, collections were received from the regions extending from Piney to as far north as Bowden Lake (Tp. 68, rge. 8, W. P. mer.) in the eastern half, and from Treesbank north to Cranberry Portage in the western half of the Province.

In the Hudson Bay Junction, Prince Albert, and Meadow Lake districts of Saskatchewan most of the damage to natural regeneration of jack pine was light. This species was collected also in the northern region from Tp. 67, rge. 24, W. 2nd mer., and Tp. 69, rge. 12, W. 3rd mer. Appreciable injury was observed only in Prince Albert National Park where 25 per cent of the young jack pines in a stand in Sec. 22, tp. 57, rge. 27, W. 2nd mer., were attacked.

	Collections	Reports
Manitoba	47	15
Saskatchewan	75	36

Forest Tent Caterpillar, Malacosoma disstria (Hbn.).--Evidence of defoliation, probably caused by this insect, was found at several places in eastern Manitoba between Lake Winnipeg and the Ontario boundary. An aerial survey north of the Winnipeg River showed severe defoliation of poplar between Little Grand Rapids and Moar Lake. Small areas of defoliation were noted on the south shore of Bigstone Lake, on an island in Sasaginnigak Lake, on a peninsula in Quesnel Lake, and near Viking Lake. In the Whiteshell Forest Reserve, poplar on a large island at the south end of Big Whiteshell Lake was completely defoliated by this species.

Outside of eastern Manitoba a single collection of the forest tent caterpillar was received from a point six miles north of The Pas, Manitoba.

	Collections	Reports
Manitoba	8	5

Red-pine Sawfly, <u>Neodiprion</u> <u>nanulus</u> Schedl.--The only report of severe infestation by this species was in an 100-acre stand of jack pine in the Mooshorn district of Manitoba (Sec. 12, tp. 31, rge. 10, W. P. mer.). This infestation was reported by H. Clee of the Manitoba Forest Service. A light to moderate attack on jack pine was observed at Cowan, and light defoliation occurred in Riding Mountain National Park, in the Duck Mountain Forest Reserve, and at Rennie, and Manigotagan Lake.

In Saskatchewan, very light defoliation was reported in the Pasquia, Nisbet, and Meadow Lake Provincial forests.

	Collections	Reports
Manitoba	9	6
Saskatchewan	3	5

Birch Sawfly, <u>Arge</u> <u>pectoralis</u> (Leach).--In 1949 the birch sawfly was found in much smaller numbers in southeastern Manitoba than in 1948. Light defoliation was reported in the Whiteshell Forest Reserve at Red Rock Lake, and on the west side of Whiteshell Lake.

No defoliation was reported elsewhere in Manitoba or Saskatchewan. One small collection was received from a point seven miles south of Waskesiu in Prince Albert National Park, Saskatchewan.

	Collections	Reports
Manitoba	6	3
Saskatchewan	1	2

Balsam-fir Sawfly, <u>Neodiprion</u> <u>abietis</u> (Harr.).--Small numbers of larvae could be found in most of the spruce and balsam-fir stands of Manitoba and Saskatchewan. Defoliation was negligible except in a few areas in eastern Saskatchewan and western Manitoba, where it was light. Near Elk Lake, Manitoba, in the Duck Mountain Forest Reserve, a scattered stand of spruce was 20 per cent defoliated. Similar defoliation was recorded at Wade Point, on Lake Winnipegosis. A 10 per cent loss of foliage was reported in an infestation north of Clear Lake, in Riding Mountain National Park. In Sec. 2, tp. 51, rge. 9, W. 2nd mer. in Saskatchewan, defoliation ranged from 5 to 25 per cent. The smaller trees appeared to be the more heavily damaged.

	Collections	Reports
Manitoba	125	6
Saskatchewan	108	15

Yellow-headed Spruce Sawfly, Pikonema alaskensis (Roh.).--Larvae were reported from several widely scattered points in the forested areas of Saskatchewan and Manitoba, but, as usual, little defoliation was evident. One collection was received from eastern Manitoba, and several from western Manitoba and eastern Saskatchewan. This sawfly was found also in a few places in the Prince Albert and Meadow Lake districts in Saskatchewan.

	Collections	Reports
Manitoba	30	8
Saskatchewan	38	14

Striped Alder Sawfly, Hemichroa crocea (Fourc.).--An infestation of this insect was reported by W. MacNeill, Saskatchewan Department of Natural Resources, in the Bronson Provincial Forest, Saskatchewan. Along the northern end of the east shore of Bronson Lake, alder was severely attacked, and in many cases 100 per cent defoliated. Less intense attack was noted at Gallety Lake, and defoliation was negligible at Peck Lake. The striped alder sawfly was not collected elsewhere in Saskatchewan or Manitoba.

	Collections	Reports
Manitoba	0	2
Saskatchewan	2	5

A Tent Caterpillar, Malacosoma lutescens (N. & D.).--This species was more prevalent in 1949 in Manitoba and Saskatchewan than in 1948. A moderate infestation was observed in Manitoba east of Seddon's Corner, for two miles along the Trans-Canada Highway. In the Nisbet Provincial Forest, Saskatchewan, severe defoliation occurred south of Macdowall, along Highway No. 12. Choke cherry trees in this locality were almost completely stripped of their leaves, and in some cases larvae were observed feeding on willow and second-growth poplar. Elsewhere in the two provinces this insect occurred only sporadically, on young wild cherry trees growing in the open.

	Collections	Reports
Manitoba	25	6
Saskatchewan	24	10

Ugly-nest Caterpillar, *Archips cerasivorana* (Fitch).--This species was common on young choke cherry in Manitoba and eastern Saskatchewan, along highways and in recently cleared areas. A particularly dense concentration of webs was reported seven miles east of Seddon's Corner, Manitoba, along a transmission line. Moderate infestations were recorded also in the vicinity of Piney, in the Spruce Woods Forest Reserve, and north of Audy Lake in Riding Mountain National Park.

In eastern Saskatchewan the situation was similar to that in Manitoba. Numerous nests were found around Chelan, where defoliation ranged from light to moderate. Light concentrations of this insect were found in the Fort à la Corne and Nisbet Provincial forests.

	Collections	Reports
Manitoba	78	30
Saskatchewan	27	17

Spotless Fall Webworm, *Hyphantria textor* Harr. .--The fall webworm was prevalent on a number of host species in Manitoba, but was not reported from Saskatchewan in 1949. Serious defoliation was confined to southeastern and western Manitoba. In southeastern Manitoba a severe infestation was observed in a triangular area bounded by Badger, Sundown, and Sprague. A similar condition occurred in western Manitoba along Highway No. 10 from Sclater to Mafeking, where defoliation ranged from 5 to 75 per cent.

	Collections	Reports
Manitoba	74	13
Saskatchewan	0	2

Sawyer Beetles (*Monochamus* spp.) .--Wood borers attacked dead trees in large areas of timber burned in Saskatchewan and Manitoba in 1949. In view of the importance of borers in the rapid deterioration of recently killed timber, studies on the relative susceptibility of burned pine and spruce to borer attack have been continued. The aim is toward the formulation of more specific recommendations regarding the salvage of fire-killed jack pine.

Stands of dead and dying jack pine in eastern Manitoba were inspected during September to determine to what extent wood borers were contributing to tree mortality. Only a small percentage of the dead and dying trees were found to be infested with sawyer beetle larvae. Moreover, it appears that the majority of the infested trees were attacked in midsummer or early fall, some time after evidence of deterioration of stands was first noted. It is thought that a sequence of unfavourable climatic events has been the chief factor in the death of much jack pine in this area.

	Collections	Reports
Manitoba	11	3
Saskatchewan	4	4

A Pine Scale (<u>Toumeyella</u> sp.) .--The old infestation of this scale continued active in some parts of the Sandilands Forest Reserve, Manitoba. A moderate infestation covering eight acres was observed on jack pine regeneration in Sec. 13, tp. 5, rge. 9, E. P. mer. Along the Sundown Trail, south of the Reserve headquarters, a light infestation was recorded in Sec. 30, tp. 5, rge. 9, E. P. mer. Light infestations occurred also in the Interlake Area at Shorncliffe and Rosenburg.

	Collections	Reports
Manitoba	11	8

LIST OF CO-OPERATORS

Manitoba Forest Service

Name	Collections
Allan, D.C.M.	2
Balchen, B.	48
Boynsky, Wm.	1
Clee, H.	10
Cooper, D.E.	18
Danyluk, W.	7
Davies, G.H.	2
de Delly, F.R.	2
Dowson, C.	2
Dunlop, C.	1
Emes, B.	1
Evans, G.J.	11
Fenner, F.	3
Fitzmaurice, P.	4
Gauthier, H.P.	3
Gill, H.N.	7
Gilmore, B.R.	3
Gow, R.D.	1
Hanley, D.C.	1
Harrison, J.E.	5
Harvey, R.	3
Hislop, W.L.	15
Inkster, J.H.	6
Kokindovich, J.	3
Kolba, C.	4
Larson, H.	1
Linn, C.E.	7
Machuk, A.	15
Maudsley, W.	1
McKay, A.M.	8
McKelvey, F.W.	3
Mesman, W.J.	11
Mitchell, P.C.	1
Mooers, S.W.	8
Nespor, J.G.	1
Norman, J.B.	3
Palmer, W.G.	1
Patterson, C.H.	3
Polkoski, W.	4
Presloski, W.	6
Ritchie, C.	5
Russell, J.	3

Manitoba Forest Service (continued)

Name	Collections
Ruth, W.W.	47
Shannon, W.A.	2
Sinclair, D.S.	8
Stenlake, L.J.	3
Sveinson, S.	5
Trowsdale, W.W.	4
Tucker, W.E.	6
Wardrop, W.D.	13
Wright, J.J.	7

Prince Albert National Park

Name	Collections
Jarvis, F.	1
Strong, E.	1

Riding Mountain National Park

Name	Collections
Binkley, D.	1
Burgess, G.D.	1
Goodison, J.G.	4
Hyska, J.	10
McKinnon, R.	3

Manitoba Paper Company

Name	Collections
Bayly, G.	13
Campbell, B.H.	1
Carter, R.	2
Forsyth, G.J.	5
Fortier, T.	2
McDonald, E.	1
McFadden, F.	2
McLeod, R.J.	2
McNichol, W.R.	1
Naysmith, D.	2
Randall, F.	1
Rigg, R.J.	7

Dominion Entomological Lab., Brandon, Man

Name	Collections
Allen, W.	1
Bird, R.D.	3

Saskatchewan Dept. of Nat.Rscs.

Name	Collections
Arnold, R.F.	2
Bacon, J.M.	10
Beaudoin, F.	2
Brady, J.P.	1
Bryson, L.F.	9
Cowie, J.E.	12
Craig, F.	61
Crothers, W.	9
Feiuse, A.	9
Fremont, A.	3
Honig, V.P.	2
Horne, L.S.	14
Heron, J.	1
Johnson, B.H.	1
Labey, C.	8
Lakevold, W.	6
Lintott, C.G.	34
MacNeill, W.	169
May, A.W.	7
McConegal, J.	1
McNeil, O.B.	3
Michaud, P.	7
Olson, C.	3
Over, E.C.	3
Pederson, G.	2
Pond, D.L.	1
Randall, H.	15
Redhead, F.	1
Reznechenko, L.	36
Riese, E.	6
Russell, A.C.	3
Schell, C.	5
Sharmon, E.A.	20
Stav, H.	12
Towill, A.C.	5
Wagner, W.J.	6
Whitlock, R.	3

Private Co-operators

Name	Collections
Andrews, E.C.	1
Brietung, M.	3
Cherrett, Mrs. W.G.	1
Ebman, C.M.	1
Fenner, G.	1
Gajerski, F.M.	4
Girrard, D.A.	1
Jenkins, H.A.M.	1
Marion, Mrs. M.L.	1
Martin, Mrs. J.	1
McKenzie, F.W.	2
McNeil, Mrs. O.B.	3
McSkimmings, A.	1
Mossman, G.	1
Pepper, Mrs. J.	1
Reader, P.	2
Riley, Dr. C.G.	8
Shoemaker, G.	2
Taylor, Mrs. M.J.	1
Tunstead, W.G.	1
Turnbull, G.	1
Urbanowski, J.	1

Winnipeg Laboratory

Name	Collections
Black, W.	23
Boyko, E.	5
Burbidge, D.	26
Campbell, A.E.	410
Dow, D.	17
Drouin, J.A.	591
Edmunds, H.A.J.	395
Fell, W.	13
Hildahl, V.	180
Ives, W.	24
Lalor, G.	467
Lamond, B. (Miss)	1

Name	Collections
Winnipeg Laboratory (continued)	
Lawrence, J.	508
Lejeune, R.R.	13
Liscombe, R.	14
Martin, J.B.	576
McDowall, L.	431
McKinnon, H.	34
Melvin, J.	41
Muldrew, J.	40
Pratt, M.	633
Prentice, R.	9
Smith, J.	18
Templin, Miss C.	1
Turnock, W.	44
Warren, G.L.	13
Wong, H.R.	13

1. V. Hildahl

(a) Introduction

The following report outlines the activities of Chief Insect Ranger V. Hildahl during the field season of 1949. No definite itinerary was followed as the season's activities were devoted primarily to supervision of the Insect Rangers working in the field and to special trips and assignments.

During the early part of the season, the writer devoted some time to making mass collections of jack-pine budworm larvae for parasite studies by the Dominion Parasite Laboratory, Belleville, Ontario. During July and August, considerable time was spent making large scale releases of larch sawfly parasites in selected tamarack stands throughout the Eastern and Western forest districts of Manitoba, and the Hudson Bay District of Saskatchewan. The parasites were supplied by the Dominion Parasite Laboratory, Belleville, Ontario. Aerial reconnaissance of the forested areas east of Lake Winnipeg in Manitoba was continued in 1949. The reconnaissance was conducted jointly with personnel from the Forest Insect Laboratory, Sault Ste. Marie, Ontario.

The major trips made by the writer during the field season are described in some detail below.

During the early part of June (June 7 to 16 inclusive) the writer made a trip through the Western District of Manitoba and the Hudson Bay District of Saskatchewan inspecting survey work being carried out by insect rangers in the districts. Forest Service personnel were also contacted regarding survey activities in their respective districts.

On June 28 and 29, the writer was engaged in an aerial reconnaissance of the forested areas east of Lake Winnipeg. This was conducted jointly with personnel from the Forest Insect Laboratory, Sault Ste. Marie, Ontario and was intended primarily to determine the extent of budworm damage to jack-pine, spruce and balsam stands.

Larch sawfly parasites were released in the Whiteshell Forest Reserve on July 26.

During the periods August 2-5, August 11-18, and August 22-23 inclusive, the writer was engaged in releasing larch sawfly parasites in western Manitoba and at Hudson Bay, Saskatchewan. Forest service personnel of the Northern District of Manitoba were also contacted during this period regarding Forest Insect Survey activities.

Mr. W. J. Turnock was assisted in an inspection of plantations in the Spruce Woods Forest Reserve on September 7-8.

During the latter part of September the writer was in the Riding Mountain National Park to assist the forest insect rangers in establishing permanent survey sample plots.

The period October 18-23 inclusive was spent at The Pas, Manitoba contacting forest service personnel of the Northern District.

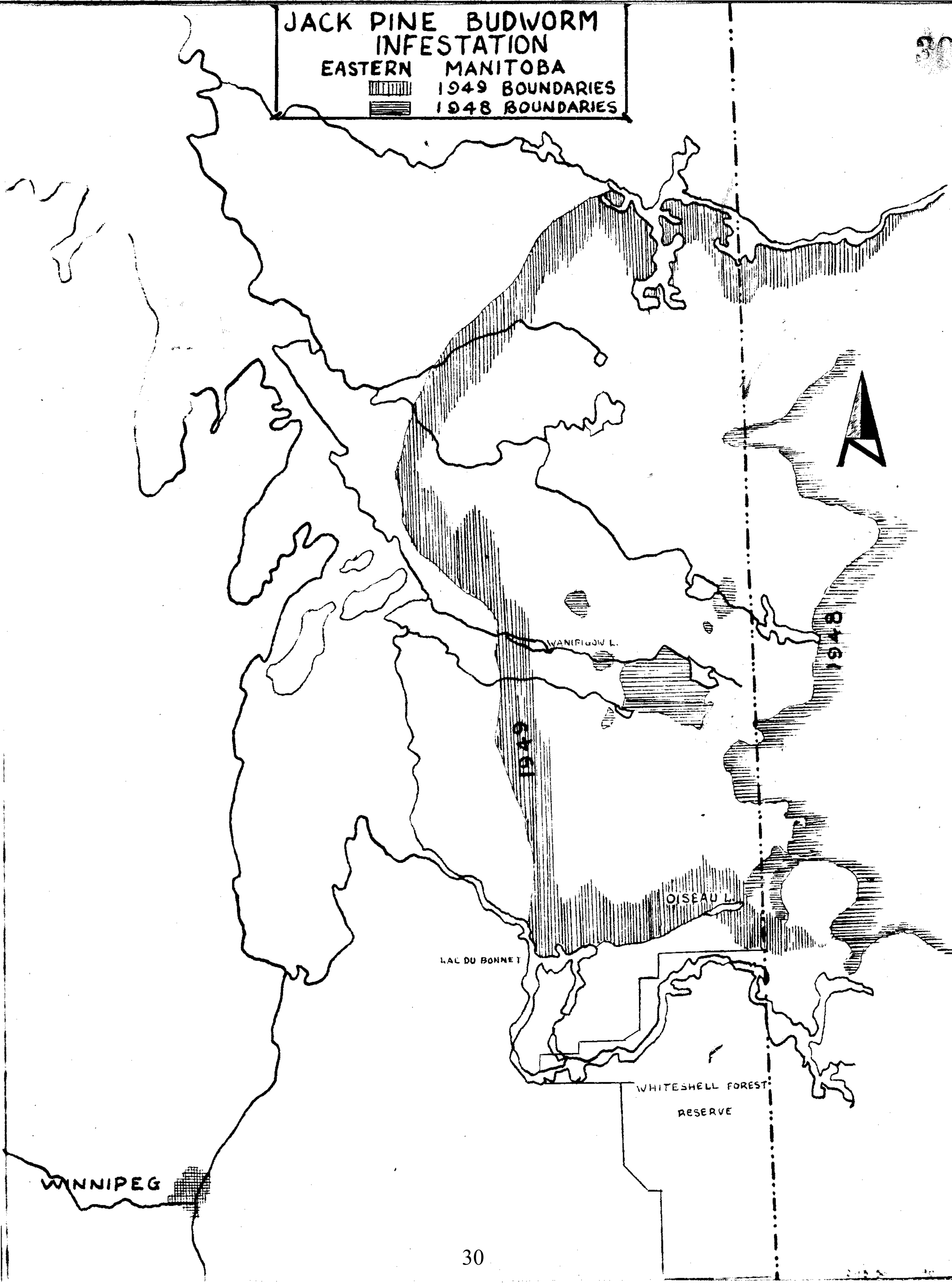
On November 21-23 inclusive, the writer accompanied Insect Rangers J. Drouin and G. Lalor on a survey of budworm damaged jack pine south of Gypsumville, Manitoba. Some 160 acres of jack pine were cruised to determine the percentage defoliation and extent of damage caused by the jack-pine budworm.

(b) Insect Conditions

(i) Jack-Pine Budworm (Choristoneura fumiferana Clem.) - Extended activity by the jack-pine budworm was evident in 1949 in that part of Manitoba east of Lake Winnipeg, bounded in the south by the Winnipeg River and in the north by Bigstone and Island lakes. Information regarding the status of the infestations in this region was derived chiefly from aerial surveys supplemented by a limited number of ground checks. In 1948, when the survey of this region was made, only "pockets" of moderately to severely damaged jack pine were visible from the air. In 1949, however, the "pockets" had merged into a continuous infestation of moderate intensity extending from the Oiseau River in the south to the Beren's River in the north. (See map for 1948 and 1949 infestation boundaries.)

Ground inspections north of Berens River revealed small populations of the jack-pine budworm as far north as Charron Lake (Charron Lake lies approximately 48 miles north of Little Grand Rapids, Manitoba).

In the southern part of the Province, jack-pine stands around Seddon's Corner were lightly to moderately defoliated. Reports submitted by B. Gilmore, Stead, Manitoba, indicated severe defoliation of jack-pine stands in Tps. 17, and 18, rge. 8, E. P. mer. No extreme changes were noted in that status of the jack-pine budworm in the Sandilands Forest Reserve in 1949. The small pockets of



JACK PINE BUDWORM INFESTATION
EASTERN MANITOBA
1949 BOUNDARIES
1948 BOUNDARIES
1948
1949
WANIPIGOW L.
OISEAU L.
LAC DU BONNET
WHITESHELL FOREST RESERVE
WINNIPEG

medium to severe defoliation recorded in 1948 in the northern section of the Reserve had increased in size, but no increase in populations was evident in the centre of these pockets. Light to moderate defoliation continued throughout the central and southern part of the Reserve. South of the Sandilands Forest Reserve, light to moderate defoliation was recorded at Piney, Badger and Sprague.

In the Interlake Area of Manitoba, the jack-pine budworm infestation at Rosenburg continued to flourish and was causing light to moderate defoliation. The infestation covers approximately fourty square smiles of jack pine and is centred around the town of Rosenburg, Manitoba.

Severe defoliation by the jack-pine budworm occurred on jack pine growing on high ridges about nine miles south of Gypsumville, Manitoba. The most severe defoliation in this area was recorded in a 160 acre stand of over-mature high-crown jack pine. In the remainder of the area, jack pine was light to moderately defoliated.

(ii) Spruce Budworm (Choristoneura fumiferana Clem.) During aerial surveys for the detection of budworm in Eastern Manitoba, only one small area of damaged spruce was noticeable from the air. However, ground inspections indicated the presence of spruce budworm larvae in relatively small numbers as far north as Island Lake in Manitoba, (Island Lake lies just south of the 54th parallel of latitude.)

The area of damaged spruce was observed from the air a few miles northeast of the twon of Bissett, Manitoba. The cause of the damage was not definitely determined as ground examinations of the area were not feasible; nevertheless it appeared to be budworm damage and if so, it is the first report of this insect occurring in infestation proportions east of Lake Winnipeg in Manitoba.

Several collections of the spruce budworm were made along the west side of Lake Winnipeg but in all cases populations were light. The collections were made from white spruce at Arnes and Rosenburg.

(c) Personnel Contacted

Manitoba

Name	Rank	Location
G. Somers	Prov. Forester (M.F.S.)	Winnipeg, Man.
T.B. Vermilyea	District Forester	Winnipeg, Man.
W. Braine	District Forester	Winnipeg, Man.
E.A. Koons	District Forester	Dauphin, Man.
A.R. Harvey	District Forester	The Pas, Man.
V. Phelps	Officer-in-Charge	Dom.For.Service,Wpg.
I.C. Goodison	Forest Engr.(R.M.N.P.)	Wasagaming, Man.
B. Balchen	Forest Engineer	Dauphin, Man.
R. Pike	Forest Engineer	Dom.For.Service,Wpg.
C.H. Patterson	Snr. Ranger	Lac du Bonnet,Man.
C.J. Ritchie	Snr. Ranger	Rennie, Man.
R.R. Ross	Snr. Ranger	Dauphin, Man.
J. Kokindovitch	Snr. Ranger	Swan River, Man.
J. Uhlman	Director (M.G.A.S.)	Lac du Bonnet,Man.
P. Brodie	Sup. Warden (R.M.N.P.)	Wasagaming, Man.
G.H. Inkster	Forest Ranger	Rennie, Man.
L.J. Stanlake	Forest Ranger	Minnitonas, Man.
D.J. Sinclair	Forest Ranger	Durban, Man.
J. Wright	Forest Ranger	Carberry, Man.
A. Machuk	Forest Ranger	Garland, Man.
J. Presloski	Forest Ranger	Mafeking, Man.
J.B. Norman	Forest Ranger	Birch River, Man.
D. McKinnon	Forest Ranger	The Pas, Man.
H.W. Gill	Forest Ranger	Cranberry Portage,Man.
G. Bates	Forest Ranger	The Pas, Man.
J. Nespor	Forest Ranger	Lac du Bonnet, Man.
M. Allan	Asst. Ranger	Lac du Bonnet, Man.
J. Russel	Fire Ranger	Bissett, Man.
W. Wardrop	Forest Ranger	Pine Falls, Man.
D. Cooper	Forest Ranger	Marchand, Man.
E. Polkowski	Forest Ranger	Woodridge, Man.
W. Meseman	Forest Ranger	Piney, Man.
E.J. Harrison	Forest Ranger	Sprague, Man.
W. Ruth	Forest Ranger	East Braintree, Man.
F.R. de Delley	Forest Ranger	Douglas, Man.
H. Clee	Forest Ranger	Ashern, Man.
L. J. Stanlake	Forest Ranger	Hodgson, Man.
E. Marner	Forest Ranger	Riverton, Man.
B.C. Emes	Forest Ranger	West Hawk Lake, Man.
Mr. Davies	Fire Ranger	Sasaginnigak Lake,Man.

Personnel Contacted (cont'd)

Saskatchewan

Name	Rank	Location
F. Warburton	District Superintendent	Hudson Bay, Sask.
D.G. Pond	Forest Engineer	Hudson Bay, Sask.
Chas. Schell	Field Supervisor	Hudson Bay, Sask.
H.A. Randall	Field Officer	Hudson Bay, Sask.
J.C. Cockwell	Field Officer	Hudson Bay, Sask.
F.D. Craig	Jr. Field Officer	Hudson Bay, Sask.
C.L. Schell	Field Officer	Pelly, Sask.
L.F. Bryson	Field Officer	Usherville, Sask.
K.D. Sanders	Field Officer	Prairie River, Sask.
A. Feusi	Field Officer	Madge Lake, Sask.
J. Heron	Field Officer	Madge Lake, Sask.
J.M. Bacon	Jr. Field Officer	Somme, Sask.

2. J. A. Drouin and G. Lalor

(By J. A. Drouin)

(a) Introduction

Forest Insect Survey observations and investigations were conducted throughout the forested areas of the Eastern and Southern districts of Manitoba from May 3 to September 30, 1949, by Forest Insect Rangers J. Drouin and G. Lalor.

Work commenced in early May in clearing and planting a nursery at the Winnipeg Laboratory. A large number of coniferous and deciduous trees obtained from different areas in eastern and southern Manitoba were transplanted in the nursery. The main object of the nursery is to furnish the food supply necessary for the insectaries and investigative projects at the laboratory. A short period of four days (May 5-9) was spent by the writer in the Whiteshell Forest Reserve collecting 6,500 larch sawfly cocoons for use in water immersion studies at the Red Rock Lake Field Station. On completion of this work, a short period was devoted to contacting field personnel of the Manitoba Forest Service in an effort to increase the quality and quantity of the co-operator's samples. At the same time Forest Insect Survey containers were distributed to the co-operators. During this time a preliminary survey was made of recently burned timber (April, 1949) in the Sandilands Forest Reserve.

On May 26, the writer proceeded north to Riverton in the Inter-Lake Area on a spruce and jack-pine budworm survey. No defoliation was observed on Hecla Island on either jack pine or spruce. Jack-pine budworm continued to defoliate stands in the Rosenburg area.

On May 30, Mr. Drouin proceeded west to Poplarfield and north to Hodgson and into the Ashern, Gypsumville areas where survey activities were continued until June 4.

The following three days (June 6-8 inclusive) were spent by the writer in the Spruce Woods Forest Reserve assisting W. J. Turnock with experimental spraying for the control of pitch pine nodule maker in young pine plantations. On completion of the spraying project Mr. Drouin proceeded to the Whiteshell Forest Reserve and thence south to East Braintree and Waugh. A few days were spent in the Sandilands Forest Reserve on spruce and jack-pine budworm survey and general sampling. The ranger left Sandilands on June 21, for Lac du Bonnet and on June 22 proceeded by air to Mantario Lake in the Whiteshell Forest Reserve where he remained until June 25. Extensive sampling was carried out for the detection of spruce and jack-pine budworms. Tamarack was also sampled for the presence of larch sawfly. In addition drouth damaged timber along the ridges was examined for beetle and borer attack.

An extensive aerial survey was conducted on June 28 east of Lake Winnipeg from the Winnipeg River north to Island Lake. This survey will be dealt with later in this report under "Special Investigations."

The first three weeks in July were spent in the Eastern District from Pine Falls, Lac du Bonnet to Beausejour and Whitemouth covering as much territory as possible in the Whiteshell Forest Reserve and surrounding areas.

In early July, mass collections of jack-pine budworm pupae were made at Seddon's Corner for shipment to the Dominion Parasite Laboratory, Belleville, Ontario. During the latter part of July (July 25-31 inclusive) a survey of tamarack swamps and larch sawfly infestations was conducted in the Southern District in the Sandilands Forest Reserve. During this period checks were made for bark beetles and wood borers in the fireburn which occurred earlier in the spring. On August 15 the rangers proceeded north to Gypsumville to release larch sawfly parasites. Upon returning, six days were taken for mapping and surveying the jack-pine budworm infestation in the Sandilands Forest Reserve. The infestation this year had decreased in the southern section but increased somewhat in the northern portion of the Reserve. A similar survey was conducted on September 7 near Stead, Manitoba at the request of the Manitoba Forest Service. The latter part of August and the month of September were spent on larch sawfly survey and general sampling. During this period, 19 permanent sample plots were established in tamarack stands in the Southern and Eastern districts.

Field activities terminated on October 1, except for a special survey made in late November at Gypsumville in a heavily infested stand of jack pine. This survey will be dealt with under "Special Reports."

(b) Insect Conditions

(i) Larch Sawfly (*Pristiphora erichsonii* Htg.) - The larch sawfly situation in the Eastern and Southern districts while still serious, caused slightly less damage during the 1949 season.

The intensity of defoliation differed considerably from 1948, these differences being caused by several factors such as water levels, fireburns etc. In many cases the cause of reduced defoliation could not be determined. Larch sawfly feeding in general commenced approximately one and one half to two weeks earlier this year. Tamarack was first sampled for larch sawfly on Hecla Island, May 27, with negative results. The sparseness of the foliage and numerous curled tips indicated that defoliation in 1948 was heavy in this area. Another negative report was obtained on June 14, near Haute, Manitoba, in Sec. 32, tp. 7, rge. 16, E. P. mer. At the time of examination no egg scars were observed. The first samples of larch sawfly larvae and eggs were obtained on June 22 in the Lac du Bonnet area, two miles west of the Pinawa Channel, in Sec. 26, tp. 15, rge. 11, E. P. mer. On June 23 both adults and larvae of the larch sawfly were obtained at Mantario Lake (Sec. 23, tp. 12, rge. 17, E. P. mer.) in the Whiteshell Forest Reserve. At this time defoliation was light.

Observations made on June 28 during an aerial reconnaissance east of Lake Winnipeg indicated that larch sawfly development was somewhat later in the north. Tamarack along the northeast shore of Carr-Harris Lake was carefully examined visually and by beating methods but no larch sawfly larvae were found. This area was moderately defoliated in 1948. A survey of tamarack stands in the Lac du Bonnet area on July 4 to July 7 showed wide variations in sawfly development. On July 4 in a small stand of tamarack near Seddon's Corner (Sec. 10, tp. 13, rge. 9, E. P. mer.) the larvae were in the 1-3 instar and were found in clusters around the egg scars. On July 5, along the Bird River Road in Tp. 18, rge. 15, E. P. mer. (territory unsurveyed) some mature larvae were collected and on July 7 along the Pointe du Bois Road in Sec. 11, tp. 10, rge. 13, E. P. mer., adults were observed laying eggs.

Towards the middle of July defoliation had advanced rapidly to medium in most of the areas surveyed and in some cases the larvae had completed development and were dropping to the ground to cocoon. On July 13, in one small stand of tamarack along the Trans-Canada Highway (Sec. 6, tp. 13, rge. 10, E. P. mer.) larvae had penetrated to a depth of 2 to 3 inches in the moss and litter. East of Whitemouth a large stand of tamarack extends along the Boggy River flats for a distance of approximately 11 miles. The stand is fairly continuous along the river flats broken only along the higher ground by rock ridges covered with dense stands of black spruce, black poplar, jack pine and birch.

Growth in this area during 1949 was good with abundant foliage. During the latter part of July, tamarack along the Boggy River was examined and defoliation ranged from 70 to 80 per cent. This stand was re-examined again during the first two weeks of September and it was noted that considerable refoliation had taken place.

In the Whiteshell Forest Reserve sawfly defoliation was recorded as still light in most areas by the middle of July. Most accessible tamarack stands east of Rennie to West Hawk Lake and south of No. 1 Highway along Falcon Lake Road were examined.

During the last two weeks of July tamarack stands in the Southern District around Piney, Sprague, and in the Sandilands Forest Reserve were examined and defoliation recorded. In a stand, examined on July 25, five miles west of Piney in Sec. 3, tp. 2, rge. 10, E. P. mer., defoliation was light while two miles east of Piney in Sec. 28, tp. 1, rge. 12, E. P. mer., defoliation ranged from 25 to 35 per cent with the smaller trees (6 to 7 feet in height) being completely defoliated.

One stand examined in the Sprague area in Sec. 16, tp. 1, rge. 14, E. P. mer., covering approximately two sections showed 40 to 50 per cent defoliation. In the Southern District, at the time of the survey, defoliation was generally medium and averaged 40 to 45 per cent bu it reached 50 per cent in some areas. Throughout stands at Vassar (Sec. 18, tp. 2, rge. 13, E. P. mer.) Woodridge, (Sec. 32, tp. 3, rge. 11, E. P. mer.) and in the southern section of the Sandilands Forest Reserve defoliation averaged 35 to 40 per cent.

In the northern sections of the Sandilands Forest Reserve, along the Dawson Trail from Richer, and along the western side of the Reserve boundary to Reynolds defoliation was severe. These areas were examined toward the latter part of the sawfly season and in most cases feeding was nearly completed. The larvae were mature and some were dropping to the ground to spin cocoons. The highest defoliation recorded in this area was 85 per cent which occurred in a stand of approximately 10 acres situated on private land one mile east of Reynolds in Sec. 21, tp. 8, rge. 12, E. P. mer.

During August efforts were concentrated on recording and surveying all accessible swamps in the Eastern District. In the Pine Falls area larch sawfly activity had decreased considerably from 1948 and comparatively few larvae were found at the time of examination. Part of the reduced defoliation was attributed to the heavy rains which occurred in the area during the latter part of July; total rainfall in the region was about 14 inches for the month of July. There was surface water in most of the stands and many drowned larvae were observed. It was presumed that high larval mortality occurred owing to the heavy rains, which washed the larvae to the ground and drowned them in the surface water than present. A number of stands along the Bear River Road which were accessible only on foot were examined. For the most part, these are located on Manitoba Pulp and Paper Company timber limits. In the first stand examined on the timber berths, one half mile south of Pine Falls in Tp. 19, rge. 9, E. P. mer., defoliation averaged 50 per cent but it was doubtful whether many larvae would survive this year owing to surface water and saturated ground conditions. The same conditions occurred in Sec. 3, tp. 19, rge. 11; Sec. 6, tp. 18, rge. 10; and Sec. 29, tp. 19, rge. 12, E. P. mer.

Defoliation in two stands in the Bear River district had decreased in intensity over the past year according to observations made by Mr. G. Bayly, employed by the Manitoba Pulp and Paper Company. In these two locations (Sec. 26, tp. 19, rge. 12; and Sec. 29, tp. 19, rge. 12, E. P. mer.) defoliation ranged from 25 to 30 per cent. Here again surface water may have some effect on next year's sawfly populations.

A fairly well drained stand was encountered in Sec. 13, tp. 19, rge. 11, E. P. mer., and at the time defoliation had reached 35 per cent.

In the Interlake Area the larch sawfly was generally light; only one area of medium defoliation was recorded, in Sec. 29, tp. 23, rge. 4, W. P. mer. A ground fire had swept through this area earlier this year damaging the roots and trunks of the trees and burning off ground cover thus making it difficult to determine accurately the degree of sawfly defoliation.

In a large stand seven miles north of Riverton defoliation was light (about 25 per cent). A ground fire had swept through a section of this stand but damage to the stand by fire was negligible. One stand examined at Poplarfield in Sec. 24, tp. 23, rge. 1, W. P. mer., was lightly defoliated. Farther north, to the Hodgson district, three tamarack stands were examined, one in each of the following sections:

Sec. 36, tp. 25, rge. 2, W. P. mer.
Tp. 26, rge. 2, W. P. mer.
Sec. 3, tp. 25, rge. 2, W. P. mer.

In these three swamps defoliation averaged 30 per cent.

Larch sawfly activity in the Eastern District declined in early August and the last collection of larch sawfly larvae was made by the Insect Rangers on August 9, in the Riverton area (Sec. 32, tp. 23, rge. 4, E. P. mer.). Several samples of larch sawfly were received later from co-operators in the District. On August

11 numerous larvae were obtained by Mr. G. Bayly in Sec. 9, tp. 19, rge. 10, E. P. mer., in the Pine Falls area, and by Mr. P. Fitzmaurice in Sec. 18, tp. 13, rge. 12, E. P. mer., in the Seven Sisters district. In the Interlake Area the last samples of sawfly larvae were received on August 19 from Mr. H. Clee. These were collected in Sec. 23, tp. 32, rge. 9, W. P. mer.

The latter part of August was devoted to a larch sawfly survey and recording defoliation in the tamarack stands in the Eastern District.

A large stand was examined two miles east of Seven Sisters along the new grade to the Diversion Dam in Tp. 13, rge. 12, E. P. mer. The swamp extended over approximately five sections with the density of tamarack varying from light to nil, interspersed with dense stands of black spruce, and black poplar along the higher land levels. Defoliation in this stand was approximately 40 per cent.

All accessible swamps north and south of No. 1 Highway (Trans-Canada) and south into the Sandilands Forest Reserve were surveyed and the overall defoliation was noted as medium, defoliation in general varying from 55 to 75 per cent. Sawfly reports were made out for all swamps examined for defoliation estimates and mass collections of cocoons. Mass collections of cocoons were difficult to obtain. It was presumed that the advanced season and low water levels were attributing factors to the scarcity of cocoons in these areas. The low-water levels in the swamps undoubtedly allowed larger foraging areas for natural predators of the larch sawfly. The number of cocoons destroyed by mice were more numerous in comparison to previous years.

Very little tree mortality was observed in the swamps examined during the season. In the majority of cases the mortality was due directly to other causes. Ground fires, mechanical and animal damage, and high water levels, seemed to be the four major causes of mortality. It is possible that with some trees mortality was caused by defoliation which followed injuries caused by the other factors.

A few larvae which appeared diseased and parasitized were collected in Sec. 32, tp. 7, rge. 11, near Dawson Cabin during the season. These were put in vials and forwarded to Sault Ste. Marie, Ontario, for examination. No reports have been received.

During September, 19 permanent sample plots were established in tamarack stands in the Eastern and Southern forest districts (see table). Tree rings were obtained from two trees in the immediate vicinity of each plot. The rings were taken from the butt, middle and top third of the tree.

Mass cocoon collections were also made from five widely separated areas in the District. These were stored for dissection and examination during the winter.

Place	Date	Sec.	Tp.	Rge.	Mer.	No. of Cocoons
Riverton	Sept.28	32	23	4	E.P.	430
East Braintree	Sept.29	28	8	16	E.P.	512
Seddon's Corner	Sept.28	3	13	9	E.P.	218
Lac du Bonnet	Sept.30	21	15	12	E.P.	150
Lac du Bonnet	Sept.30	24	15	12	E.P.	66

(ii) Spruce Budworm (<u>Choristoneura fumiferana</u> Clem.) - No severe infestations of this insect were found in the Eastern District; nevertheless samples were obtained from widely scattered points in eastern Manitoba. The first larvae were collected on June 13, near Falcon Lake in the Whiteshell Forest Reserve (Sec. 34, tp. 8, rge. 16, E. P. mer.).

During aerial surveys of the regions east of Lake Winnipeg, spruce budworm was found in small numbers at several points. Collections of the insect were made at Mantario, Moar, Carr-Harris lakes and as far north as Island Lake. In all instances, defoliation was negligible.

Around Mantario Lake, several small pockets of black spruce and balsam fir appeared to have "red-tops," from a distance but on close examination it was noted that heavy cone production had caused the discoloration.

West of Lake Winnipeg in the Interlake Area, three samples were obtained. Two of these collections were made at Arnes; one in Sec. 15, tp. 21, rge. 4, E. P. mer., and the other in Sec. 16, tp. 21, rge. 4, E. P. mer. The third collection was made near Rosenburg, in Sec. 36, tp. 24, rge. 2, E. P. mer.

In the Southern District two larvae were collected from white spruce one mile west of East Braintree (Sec. 34, tp. 5, rge. 9, E. P. mer.). Three samples, containing only a few larvae each, were collected from second growth balsam fir and white spruce in the vicinity of Falcon Lake (Secs. 18 and 34, tp. 8, rge. 16, E. P. mer.).

At Haugh, Manitoba, four ornamental white spruce and balsam fir in the Waugh Rock Gardens were lightly defoliated. Both the spruce budworm and spruce needleworm were found on the attacked trees. At the time of inspection, it was assumed that most of the defoliation had been caused by the spruce budworm. Control measures were recommended to the ground's keeper.

Another collection containing two larvae was taken from white spruce in the southern part of the Sandilands Forest Reserve (Sec. 34, tp. 5, rge. 9, E. P. mer.).

Several larvae which appeared diseased were obtained from white spruce at Waugh (Sec. 4, tp. 8, rge. 17, E. P. mer.) and East Braintree (Sec. 32, tp. 7, rge. 14, E. P. mer.). Another collection of diseased larvae was collected from balsam fir at Mantario Lake (Sec. 26, tp. 12, rge. 17, E. P. mer.). This material was forwarded to the Forest Insect Laboratory, Sault Ste. Marie, Ontario, for further examination.

A table showing all collections of the spruce budworm made in 1949, follows.

Spruce Budworm Collections

Eastern and Southern Forest Districts of Manitoba - 1949

Date	Location	Sec.	Tp.	Rge.	Mer.	Tree Species	No. of Insects
June 13	Falcon L., W.F.R.	34	8	16	E.P.	White spruce	4 larvae
June 23	Mantario Lake	unsurveyed	12	17	E.P.	White spruce	1 larva
June 23	Mantario Lake	"	12	17	E.P.	White spruce	1 larva 1 pupa
June 24	Mantario L., Ont.Sh.	"	12	17	E.P.	Balsam fir	1 larva
June 28	Moar Lake	"	[illegible]	17	E.P.	Black spruce	1 larva 1 pupa
June 28	Island Lake	"	56	---	E.P.	White spruce	1 larva
June 28	Carr-Harris Lake	"	39	12	E.P.	Balsam fir	4 larvae
June 14	Waugh-Indian Bay	4	8	17	E.P.	Balsam fir	2 larvae
June 14	Waugh	4	8	17	E.P.	White spruce	2 larvae
June 14	Waugh	4	8	17	E.P.	White spruce	3 larvae
June 13	Falcon Lake	18	8	16	E.P.	Balsam fir	5 larvae
June 13	Falcon L., W.F.R.	34	8	16	E.P.	Balsam fir	4 larvae
June 16	Sandilands F.R.	34	5	9	E.P.	White spruce	2 larvae
June 13	East Braintree	32	7	14	E.P.	White spruce	2 larvae
July 7	Arnes	15	21	4	E.P.	White spruce	3 pupae
July 7	Arnes	16	21	4	E.P.	White spruce	2 pupae
July 8	Rosenburg	36	24	2	E.P.	White spruce	1 pupa

(iii) Jack-Pine Budworm (Choristoneura fumiferana Clem.) - This insect became more widespread in 1949 in the Eastern District and was prevalent in most areas examined. In some areas the infestation decreased while in other areas an increase in intensity was noticed. Increased defoliation occurred in parts of the Sandilands Forest Reserve, particularly in the northern portion of the Reserve; in the Seddon's Corner area and south of Gypsumville, Manitoba.

Special surveys of jack-pine budworm defoliation were conducted during the season in the Sandilands Forest Reserve, at Stead, and Gypsumville, Manitoba.

Many reports were received from eastern Manitoba during the early part of the season concerning the brown dying appearance of jack pine, particularly the young growth and regeneration. A possible explanation advanced indicated "drouth" damage or frost damage. The most severely affected areas seemed to occur along the Pre-Cambrian Shield, where growing conditions were poor and the top soil was very light. In this area the jack pine had a scorched dying appearance over large areas along the rocky ridges. Aerial surveys made of the areas in the northern part of the Whiteshell Forest Reserve, along the east shore of Lake Winnipeg and along No. 1 Highway in the vicinity of Rennie to Kenora indicated that drouth damage was particularly severe in this region. In the Sandilands Forest Reserve, the northern section was lightly affected. In the Interlake District very few areas surveyed showed any signs of drouth damage.

The jack-pine budworm was general in the Interlake Area. The first samples were collected May 30, at Riverton in Sec. 1, tp. 25, rge. 2, E. P. mer. Population counts were made in the infestation at Rosenburg which continues to flourish with defoliation varying from light to medium. Several samples were collected at Hodgson and Ashern. A population count was made on the jack-pine ridge nine miles south of Gypsumville. The most severe defoliation encountered in the Interlake Area this year occurred in Sec. 13, tp. 31, rge. 9, W. P. mer., approximately 9½ miles south of Gypsumville along what is known as the jack-pine ridge. The ridge, running east and west, is located between the Davis Point Road and Fairford Settlement. The stand is composed mainly of jack pine with an akmisture of white poplar and birch. The soil is a mixture of sand, gravel, and clay.

When examined early in the season budworm feeding had just commenced and defoliation was light but increased to severe as the season advanced. When re-examined in the fall defoliation averaged 85 to 95 per cent through the stand. The most severe defoliation occurred in an area comprising about 180 acres of mature high-crown jack pine.

East of Lake Winnipeg, jack-pine budworm activity covered a wide area between the Winnipeg River in the south to Bigstone and Island lakes in the north. An aerial survey was made in this region on June 28-29 supplemented with a limited number of ground inspections. Small populations of the jack-pine budworm were encountered at Manigotagan, Charron, Moar, Carr-Harris and Wanipigow lakes.

Extensive sampling was conducted at Mantario Lake in the Whiteshell Forest Reserve. Observations indicated the infestation was of moderate proportions. Budworm was general along the central and southern sections of the Whiteshell Forest Reserve, and along the Trans-Canada Highway in the vicinity of Beausejour and Whitemouth.

Jack-pine stands at Seddon's Corner were moderately defoliated. Mass collections of jack-pine budworm were made in this area on July 11 and July 12, for parasite research.

Jack-pine budworm was also evident in jack-pine stands in the Lac du Bonnet, Pine Falls and Pointe du Bois areas. One population count was made along the Pointe du Bois Road (Sec. 36, tp. 15, rge. 12, E. P. mer.).

At the request of the Manitoba Forest Service, a special survey was made of jack-pine stands north of Stead, Manitoba (Tps. 17, and 18, rgs. 8, E. P. mer.). The main part of this stand is located on two sandy elevations and is composed mainly of mature jack pine. Growth is stagnated owing possibly to poor soil and lack of moisture. Defoliation varied from medium to severe throughout the stand. In Tp. 18, infestation of mistletoe was causing severe damage to mature jack pine.

The area was covered by truck and all possible trails were traversed. Inspections were made at half-mile intervals. At each point an estimate of defoliation was made covering each of three d.b.h. classes: 0"-5", 5"-10", and 10" and over. The percentage of dead tops at each inspection point was calculated and recorded according to diameter classes mentioned above. Each area examined was completely described. The number of dead trees were also recorded. A large scale map was drawn up of the area showing the boundaries and the intensity of the infestation.

The jack-pine budworm survey was continued in the Sandilands Forest Reserve during the latter part of August. This survey has been carried out annually for the past three years and is intended for the purpose of obtaining data on annual distribution and intensity of the jack-pine budworm.

The same procedure for recording data was used as described for the Stead infestation. Stops were made at half-mile intervals on all accessible trails. Some variations were observed in the status of the infestation. It had moderated in the southern section of the Sandilands Forest Reserve and increased in the northern portion where occassional pockets of medium defoliation occurred along the main trails.

In general, the northern area was found to be lightly to moderately attacked with pockets of medium defoliation occurring in the northern and central part of the Reserve, and decreasing to light in the southern portion.

A fire swept through the southern part of the Reserve early in May destroying approximately 13,440 acres (21 sections) of timber in the Reserve. Light to moderate infestations of the jack-pine budworm occurred in the Piney, Badger and Sprague areas of southeastern Manitoba. Parasitized and possibly diseased larvae were collected quite frequently during the summer. All diseased material was forwarded to Sault Ste. Marie, Ontario.

Areas where diseased larvae were found are listed in the following table:

TABLE A

Origin of Diseased Jack-Pine Budworm Larvae 1949

Date	Location	Sec.	Tp.	Rge.	Mer.	No. of Diseased Larvae
June 23	Mantario Lake, Manitoba	26	12	17	E.P.	1
June 25	Mantario Lake, Manitoba	24	12	17	E.P.	1
July 7	Pointe du Bois, Manitoba	36	15	12	E.P.	1
July 11	Seddon's Corner, Manitoba	34	12	9	E.P.	2

Pupal parasites of the jack-pine budworm were numerous in two areas in southeastern Manitoba. One area was observed east of Seddon's Corner along the jack-pine ridge and the other in the northern section of the Sandilands Forest Reserve.

Population counts were made in several areas to determine the intensity of the infestation. The population counts consisted of two 18" branches from each of 10 trees. The 18" branches were carefully examined for budworm and the number found thereon recorded.

TABLE B

Jack-Pine Budworm Population Counts - 18" Branches - 1949

Date	Location	Sec.	Tp.	Rge.	Mer.	No. of 18" Branches	Total No. of Larvae
May 30	.6 mi.N.Rosenburg Tower	11	25	2	E.P.	20	30
June 17	Sandilands F.R.Manitoba	28	6	10	E.P.	20	11
June 17	Sandilands F.R.Manitoba	7	6	10	E.P.	20	29
June 2	Gypsumville, Manitoba	24	31	10	W.P.	20	8
June 7	Lac du Bonnet, Manitoba	36	15	12	E.P.	20	13
June 25	Mantario Lake, Manitoba	24	12	17	E.P.	20	6

Mass collections of jack-pine budworm pupae were made from the following areas:

July 11 - Beausejour,Seddon's Corner,Sec.3-34,tp.12,rge.9,E.P.mer. - 340 pupae
July 12 - Mile 54,Seddon's Corner,Sec.33,tp.12,rge.9,E.P.mer. - 1000 pupae
June 21 - Sandilands Forest Reserve,Sec.35,tp.5,rge.9,E.P.mer. - 500 pupae

(iv) Prairie Willow-Leaf Beetle (Galerucella decora Say.) - This insect was abundant throughout the Eastern District during 1949. In the Interlake Area, around Hodgson, Ashern, and Riverton defoliation was light. For the most part, the same conditions occurred in the Southern District where numerous samples were made on willow in the Piney, Sprague and Sandilands areas. The most severe infestations occurred along the Trans-Canada Highway between Whitemouth and Rennie where defoliation varied from 70 to 75 per cent. Between Rennie and West Hawk Lake in the Whiteshell Forest Reserve, defoliation was somewhat lighter and the infestation decreased in intensity. In the Rennie area the prairie willow leaf beetle was found attacking poplar. At the time of examination the defoliation to poplar was estimated at 60 to 65 per cent. East of Rennie, at Telford defoliation to willow,decreased to 40 per cent. Severe defoliation (75 per cent) was recorded in small pockets around Falcon Lake.

Willow was infested along the Pointe du Bois Road and defoliation averaged 75 per cent. This infestation decreased to light along the Bear River Road. Only light defoliation was observed in the Seven Sisters and Pine Falls districts.

(v) Forest Tent Caterpillar (Malacosoma disstria Hbn.) - Only two collections of this insect were made during ground reconnaissance in the Eastern District this season; one at Pointe du Bois in Sec. 34, tp. 15, rge. 14, E. P. mer., on white birch and the other at

Mantario Lake in the Whiteshell Forest Reserve in Sec. 23, tp. 12, rge. 17, E. P. mer., on white poplar.

In both cases only one larva was obtained in the sample from each place. Several small defoliated areas were observed and mapped on an aerial flight east of Lake Winnipeg and north of the Winnipeg River. The most severe defoliation was noted in the Little Grand Rapids district extending eastward to Moar Lake in a broken, patchy, strip. At Moar Lake a large island was severely defoliated. A ground check was made on the eastern shore of the Lake where several larvae and pupae were collected on white poplar and birch.

Other small areas of defoliation were noted on the south shore of Bigstone Lake, on an island in the north end of Sasaginnigak Lake, and another covering the north end of a Peninsula in Quesnel Lake located northwest of Manigotagan Lake.

A small infestation was also noted at Viking Lake in northeastern Manitoba. Ground checks revealed only light populations of the forest tent caterpillar. Defoliation in the infested area was negligible to light.

A large island in the southern end of Big Whiteshell Lake was completely defoliated by the forest tent caterpillar; the infestation was mapped by the staff of the Red Rock Lake Field Camp.

(vi) Large Aspen Tortrix (*Archips conflictana* Wlk.) and American Poplar Leaf Beetle (*Phytodecta americana* Schffr.) - These two poplar defoliating insects were found in relatively small numbers in the Eastern and Southern districts of Manitoba. Collections containing only a few larvae of the large aspen tortrix were made at the following widely separated points; Sandilands Forest Reserve, Shilo, and 15 miles west of Poplarfield (Sec. 9, tp. 22, rge. 4, W. P. mer.). Four collections were made of the American poplar leaf beetle but in each case the collections contained only a few larvae and adults. The collections were made at the following locations: Hecla Island (Sec. 34, tp. 24, rge. 6, E. P. mer.), Poplarfield (Sec. 9 and 4, tp. 22, rge. 2, W. P. mer.), Gypsumville (Sec. 20, tp. 32, rge. 8, W. P. mer.), and Pointe du Bois (Sec. 22, tp. 15, rge. 12, E. P. mer.).

(vii) Ugly-Nest Tortrix (*Archips cerasivorana* Fitch.) - This insect was generally distributed in the Eastern and Southern districts of Manitoba in 1949. While most commonly found on chokecherry, it was occasionally taken from the following hosts: oak, white poplar, rosebush, and Saskatoon.

The most heavily infested area occurred along the Trans-Canada Highway east of Whitemouth in Sec. 30, tp. 11, rge. 12, E. P. mer. It was more or less conspicuous in that as many as fifteen nests could be counted in an area approximately fifty feet square. Nests were common in the areas around Sundown, Piney, Sprague, Beausejour and Lac du Bonnet, and in the Whiteshell Forest Reserve. One collection was made in the Spruce Woods Forest Reserve and one in the Interlake Area near Hodgson (Sec. 30, tp. 25, rge. 1, E. P. mer.).

(viii) Birch Sawfly (Arge pectoralis Leach) - In areas where this insect had caused severe defoliation in 1948, a noticeable decrease in abundance was evident in 1949. In no instance did it cause any serious defoliation, and larvae were present in only two areas examined. The areas where larvae were present were located in the Whiteshell Forest Reserve but in both cases only a few were found.

(ix) Balsam-Fir Sawfly (Neodiprion abietis Harr.) - Very few larvae of the balsam-fir sawfly were obtained in the Eastern and Southern districts except for two areas east of Lake Winnipeg where two samples were obtained.

A few larvae were collected on the northwest shore of Wanipigow Lake in Tp. 25, rge. 11, E. P. mer., and at Mantario Lake, Ontario. However, in both areas defoliation was negligible.

(x) Red-Pine Sawfly (Neodiprion nanulus Schedl.) - One collection of this insect was made in eastern Manitoba on the north shore of Manigotagan Lake in Tp. 22, rge. 14, E. P. mer. Very little damage had been caused at the time of the survey (June 28).

(xi) Jack-Pine Scale (Toumeyella sp.) - A medium infestation of jack-pine scale was encountered in the Sandilands Forest Reserve. The scale damage was confined to young jack pine ranging from 1"-3" d.b.h. and extended over approximately 8 acres in Sec. 13, tp. 5, rge. 9, E. P. mer.

Two other lightly infested areas were surveyed and sampled south of the Reserve Headquarters in the Sandilands Forest Reserve along the Sundown Trail. One infestation occurred in Sec. 30, tp. 5, rge. 9, E. P. mer., and the other in Sec. 30, tp. 5, rge. 10, E. P. mer. Both areas were lightly infested and damage was confined to young jack pine. The trees affected were scattered along the trail and infestation of the trees was 20 to 25 per cent.

(xii) Bark Beetles - Increased bark beetle activity was evident this year owing to drouth conditions existing along the Precambrian Shield in the Eastern District and heavy fireburns in the Southern District. It was noted that bark beetles were prevalent in stands of jack pine affected by drouth. Such areas were confined generally to rocky ridge tops. Trees weakened by drouth were examined at periodic intervals during the season in an effort to determine the time and intensity of attack by bark beetles. For the most part, trees on which some of the foliage was still living were free of bark beetles. This held true for all examinations made during the season. Degree of infestation varied in the areas examined according to time examined, age and diameter, and intensity of drouth damage. Areas affected by drouth in the Whiteshell Forest Reserve were examined extensively throughout the season, and the first samples of bark beetles were obtained around June 15 in the Lac du Bonnet area, and at Mantario Lake on June 23 (Sec. 24, tp. 12, rge. 17, E. P. mer.). The area around Mantario Lake is composed of a very broken, rocky terrain with high ridges, running in an east-west direction. At the time of the survey (June 23) bark beetles were present in the majority of the trees and light wood borer activity was evident.

Toward the beginning of July bark beetles were well established in the stands affected by drouth along the ridge tops. Extensive sampling was conducted along No. 1 Highway between Rennie and West Hawk Lake and south to Falcon Lake.

In the Southern District on April 29 and 30 a fire swept northward through the Sandilands Forest Reserve destroying approximately 12,000 acres of timber in the Reserve. Periodic examinations were made through the summer in the fire burned area to determine the time that elapsed between the fire and infestation by bark beetles and wood borers. By the middle of June bark beetles were well established in jack pine and to a lesser extent in black and white spruce. Until this time balsam fir had escaped attack. In general most trees over 6" d.b.h. supported heavy beetle populations. As the season progressed infestation increased to severe in jack pine and balsam and it was somewhat lighter in spruce. In late July wood borers as well as bark beetles, were more numerous. By late August and early September bark beetles had decreased considerably and only a few adults were found. It was noted that all trees had been completely riddled and tunnelled along the trunk and along the thicker branches.

(xiii) Wood Borers - In 1949, wood borers were general and caused considerable damage to dying and dead timber in the drouth and fire burned areas in eastern Manitoba. The distribution of wood borers through these areas was much the same as described in the preceding report on bark beetles. Generally, wood borer attacks occurred from one to two weeks after bark beetles had become firmly established in the stands.

Particularly heavy damage to trees injured by fire was noted in the Sandilands Forest Reserve. Woods Borers were also numerous in the drouth damaged jack pine in the Whiteshell Forest Reserve. On several occasions they were also found attacking dead tamarack, but damage to this species was negligible.

(xiv) Bronze-Birch Borer (Agrilus anxius Gory.) - This insect was found on two occasions only and in both cases only a small part of the stand had been affected. The dieback and borer damage occurred at Pine Falls in Tp. 18, rge. 9, E. P. mer., and near Lac du Bonnet in Sec. 35, tp. 15, rge. 9, E. P. mer.

(xv) White-Pine Weevil (Pissodes strobi Peck.) - Leader damage caused by this insect was found in widely separated areas in the Eastern District. One collection of the white-pine weevil was made on white spruce during the season at Ashern (Sec. 20, tp. 25, rge. 23, W. P. mer.). All the remaining samples were from jack pine. White-pine weevil damage on jack pine was noted in the Riverton, Whitemouth, Seven Sisters and Rennie areas but in all cases the damage was confined to single trees and found only in widely scattered spots.

A light infestation in a dense stand of second-growth jack pine was examined in the vicinity of the Whitemouth municipal gravel pit in Sec. 11, tp. 13, rge. 10, E. P. mer. Damage was confined mainly to young trees averaging 1" d.b.h. and 6 - 8 feet in height.

The heaviest concentration of this insect was encountered in the northern section of the Sandilands Forest Reserve along the west fireguard in Secs. 7 and 18, tp. 7, rge. 10, E. P. mer. This infestation, of medium intensity, was scattered over sections 7 and 18 in a heavy stand of young growth averaging 1" to 2" d.b.h. and 8 to 10 feet in height. At the time of examination (early September) adults were emerging in quite large numbers indicating that damage may be more severe in this area next year.

(xvi) Poplar Borer (Saperda calcarata Say) - A small grove of white poplar four miles east of Steeprock in Sec. 24, tp. 28, rge. 10, W. P. mer., was lightly infested with poplar borers. The stand was located on private land in an agricultural area.

Another small poplar borer infestation was recorded four miles south of Reynolds in Sec. 7, tp. 8, rge. 12, E. P. mer. Approximately 40 trees were affected in a small private woodlot. The majority of trees affected were streaked from the sap running out of the wounds in the bark caused by borers.

Two infestation reports were submitted on poplar borer infestations which covered only small areas. In the Sandilands Forest Reserve in Sec. 1, tp. 6, rge. 9, E. P. mer., a small bluff of approximately 200 trees ranging up to 5" d.b.h. was lightly infested. No mortality was observed in the stand. Another light infestation was examined in the Lac du Bonnet district (Sec. 22, tp. 15, rge. 16, E. P. mer.) in a light, open growing, privately owned woodlot. Eight larvae were obtained from three trees which were selected, felled and quartered for examination. The stand covered an area of approximately 2 chains long by 1 chain wide. It was composed of white poplar and a heavy undergrowth of willow. The area was apparently being used as pasture and some damage to the trees had been caused by animals.

(xvii) Tent Caterpillar (Malacosoma lutescens N. & D.) - For the most part, this insect was general in the areas traversed in eastern and southern Manitoba, but where detected, tent caterpillar activity was negligible and it was not causing any serious defoliation.

(xviii) Yellow-Headed Spruce Sawfly (Pikonema alaskensis Roh.) - One sample only of yellow-headed spruce sawfly was collected in the Eastern District. This was taken in the Whiteshell Forest Reserve at South Cross Lake in Sec. 25, tp. 10, rge. 16, E. P. mer. The collection contained only two larvae of the yellow-headed spruce sawfly and no defoliation was noted.

(xix) Pitch-Pine Nodule Maker (Petrova albicapitana Busck.) - No heavy concentration of this insect was encountered in the Eastern and Southern Districts of Manitoba. However, the nodule maker was widely distributed and was found in most of the young jack-pine stands throughout the districts.

(xx) Fall Webworm (Hyphantria textor Harr.) - This insect was generally distributed through the Eastern and Southern Districts of Manitoba with heavy concentrations in the Piney, Sprague, Sundown, and Badger areas. Tents formed by this insect were observed on chokecherry, pincherry, elm, willow, and poplar. The most heavily affected area extended between Sundown and Sprague in the Southern District. It was also quite common on chokecherry and white poplar in the Spruce Woods Forest Reserve.

(xxi) Spruce Gall Aphid (<u>Adelges abietis</u> Harr.) - The spruce gall aphid was quite common in eastern and southern Manitoba. No severe infestations occurred and damage was comparatively light.

(xxii) Spruce Needleworm (<u>Dioryctria reniculella</u> Grt.) - The needleworm was generally distributed in the eastern and southern areas of Manitoba. No defoliation was observed due directly to the spruce needleworm but it was generally found where spruce budworm was present.

(c) Special Investigations

(i) <u>Larch Sawfly Cocoon Collections</u>: During the month of September, several mass collections of larch sawfly cocoons were made in various areas of the Eastern District of Manitoba. The mass collections were made in areas selected for permanent sample plots. The number of cocoons collected varied in each area according to the numbers that were obtainable.

The cocoons were stored between thick layers of damp moss in separate frames for each area. These frames were returned to the laboratory and put in cold storage for rearing and dissecting purposes during the winter to determine the species and number of parasites present.

The exact location and numbers contained in each collection are shown in the following table:

TABLE A

Mass Collections - Larch Sawfly Cocoons

Date	Place	Sec.	Tp.	Rge.	Mer.	No. of Cocoons
Sept.26	Gypsumville, Man.	NW23	32	9	W.P.	19 (discarded)
Sept.28	Riverton, Man.	32	23	4	E.P.	430
Sept.29	Lac du Bonnet, Man.	NW24	15	11	E.P.	66
Sept.30	Lac du Bonnet, Man.	21	15	12	E.P.	150
Sept.30	East Braintree, Man.	25	8	16	E.P.	512
Sept.28	Seddon's Corner, Man.	3	13	9	E.P.	218

(ii) Permanent Sample Plots: During the month of August and September, 19 permanent sample plots were established in tamarack stands through the Eastern and Southern districts. Of these, eight plots were established in the Southern District, chiefly in the Sandilands Forest Reserve; seven in the Whiteshell Forest Reserve and Whitemouth district; one at both Gypsumville and Riverton; and two at Lac du Bonnet. The last four mentioned plots are 1 square chain in size. The same procedure was used for establishing all the plots.

TABLE B

Permanent Sample Plots - 1949

Plot Number	Tree Type	Area	Locations	Size of Plot
1	Tamarack	Sandilands Forest Reserve	SW.18-6-9 E.P.mer.	10 chains
2	Tamarack	" " "	SE.5-8-10 E.P.mer.	6 chains
3	Tamarack	" " "	SE.36-7-10 E.P.mer.	6 chains
4	Tamarack	" " "	SW.31-7-11 E.P.mer.	10 chains
5	Tamarack	" " "	NE.32-7-11 E.P.mer.	7 chains
6	Tamarack	" " "	SW.3-8-11 E.P.mer.	10 chains
7	Tamarack	" " "	NW.2-8-11 E.P.mer.	5 chains
8	Tamarack	" " "	SW.34-5-9 E.P.mer.	6 chains
9	Tamarack	Whitemouth, Manitoba	Sec.10-11-13 E.P.mer.	6 chains
10	Tamarack	Whiteshell Forest Reserve	NW.22-10-15 E.P.mer.	10 chains
11	Tamarack	" " "	NE.17-10-16 E.P.mer.	10 chains
12	Tamarack	" " "	Sec.16-10-16 E.P.mer.	5 chains
13	Tamarack	" " "	Sec.30-9-17 E.P.mer.	5 chains
14	Tamarack	" " "	Sec.8-9-17, E.P.mer.	5 chains
15	Tamarack	Whitemouth, Manitoba.	Sec.31-10-14 E.P.mer.	5 chains
16	Tamarack	Riverton, Manitoba.	Sec.32-23-4 E.P.mer.	1 sq.chain
17	Tamarack	Ashern, Manitoba.	Sec.23-32-9 W.P.mer.	1 sq.chain
18	Tamarack	Lac du Bonnet, Manitoba.	Twp. 15-12 E.P.mer.	1 sq.chain
19	Tamarack	Lac du Bonnet, Manitoba.	Twp. 24-15 E.P.mer.	1 sq.chain

(iii) Tree Ring Collections: A series of larch tree ring sections were taken from four of the permanent sample plots in the Eastern District. Three tree rings were cut from each of two trees representative of the stand within the plot. One ring was taken eighteen inches from the ground, one from the mid-periphery of the tree and one six feet from the top of the crown. In all a total of 24 tree ring sections were obtained from the four plots. The tree ring sections will be used in studies to trace through tree ring growth the history of past larch sawfly outbreaks and their effect on tree growth. The exact locations from which the tree rings were obtained are shown in the following table:

TABLE C

Date	Location	Sec.	Tp.	Rge.	Mer.	Size of Plot	No. of Tree Rings
Sept.27	Riverton	32	23	4	E.P.	1 chain square	6
Sept.28	Gypsumville	23	32	9	E.P.	1 chain square	6
Sept.30	Lac du Bonnet	24	15	11	E.P.	1 chain square	6
Sept.30	Lac du Bonnet	21	15	12	E.P.	1 chain square	6

(iv) Budworm Reconnaissance 1949 - Eastern Manitoba: An aerial survey was carried out in eastern Manitoba during the latter part of June in an effort to map and survey the extent of budworm damaged jack pine.

In 1948, moderate to heavily defoliated pockets of jack pine were visible from the air. In 1949, however, the pockets had merged into a continuous infestation of moderate intensity extending from the Oiseau and Winnipeg rivers in the south to the Berens River in the north. A limited number of ground inspections were also made during the aerial reconnaissance. Ground inspections revealed small populations of the jack-pine budworm as far as 50 miles north of Little Grand Rapids. Most of the region from the Winnipeg River in the south to Island and Bigstone lakes in the north was covered during the survey.

(v) Larch Sawfly Parasite Releases: Several colonies of larch sawfly parasites (Mesoleius tenthredinis) were liberated by the writer in 1949. They were liberated at Gypsumville, Manitoba, in Sec. 23, tp. 32, rge. 9, W. P. mer. The shipment consisted of 250 males and 100 females. At the time of release 20 males and 14 females were recorded as dead. The liberation date was August 15, 1949 at 6:00 P.M., C.S.T., on a clear and sunny evening. The approximate temperature was 86° F.

(vi) Jack-Pine Budworm Surveys - Sandilands Forest Reserve: The special survey of current budworm defoliation in the Sandilands Forest Reserve was continued during the 1949 season by Insect Rangers J. Drouin and G. Lalor. A detailed report of this survey will be found in the jack-pine budworm section of the report for 1949.

Stead, Manitoba: A special survey of a heavy jack-pine budworm infestation at Stead was carried out at the request of the Manitoba Forest Service during the early part of September. The area was mapped and surveyed in the same manner as the Sandilands Forest Reserve. Detailed reports and maps were forwarded to the Manitoba Forest Service as a guide for future cutting operations. Complete information will be found, as above, in the jack-pine budworm section of this report.

Gypsumville Budworm Infestation: During the month of November, an extensive survey of a heavily defoliated jack-pine stand located south of Gypsumville (Sec. 13, 18, 19, 24, 25 and 30, tp. 31, rges. 9 and 10, W. P. mer.) was undertaken at the request of the Manitoba Forest Service.

Defoliation averaged 85 to 95 per cent in the area most severely attacked. Strip cruises were run at 10 chain intervals to determine the following:

Per cent dead trees in each d.b.h. class
Per cent dead trees
Per cent dead trees in each crown class
Volume of timber per plot

A detailed report and map were forwarded to the Manitoba Forest Service as a guide for future cutting operations. More information can be found in the jack-pine budworm section of this report.

(vii) Pitch Pine Nodule Spraying Experiment - Spruce Woods Forest Reserve: In the early part of June four days (7-10) were spent by the writer assisting Mr. W. J. Turnock spraying young jack-pine plantations (on a plantation spraying project) in the Spruce Woods Forest Reserve. The project was intended to determine the control that would be achieved against the pitch nodule maker by using insecticides. Several insecticides, namely; DDT, Chlordan, and 497 were used for the spraying experiment. At the completion of the plot spraying a mass collection was made of pitch nodule maker larvae.

(d) Negative Reports

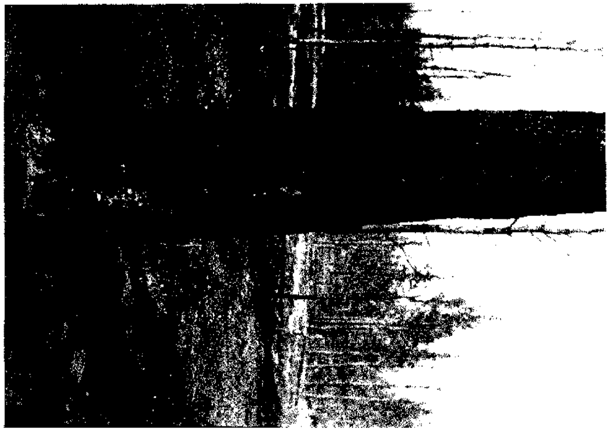
Date	Host	Location
May 27	Tamarack	Hecla Island, Lake Wpg., Sec. 3, tp. 24, rge. 6, E.P. mer.
May 27	Birch	Hecla Island, Lake Wpg., Sec. 9, tp. 24, rge. 6, E.P. mer.
June 13	Cedar	8 miles east of East Braintree, Sec. 9, tp. 8, rge. 15, E.P. mer.
June 14	Tamarack	Haute (E. Braintree district) Sec. 32, tp. 7, rge. 16, E.P. mer.
July 8	Oak	Pine Falls - unsurveyed Tp. 18, rge. 11, E.P. mer.
July 8	Elm	Pine Falls - unsurveyed Tp. 19, rge. 9, E.P. mer.
July 8	Birch	Pine Falls - unsurveyed Tp. 18, rge. 11, E.P. mer.

(e) Personnel Contacted

Name	Rank	Place	Demonstration of Sampling
G. Somers	Director (M.F.S.)	Law Courts, Winnipeg	No
T.B. Vermilyea	District Forester	U. of M. Broadway Site	No
C.J. Ritchie	Snr. Ranger	Rennie, Manitoba.	Yes
C.H. Inkster	Forest Ranger	Rennie, Manitoba.	Yes
W. Danyluk	Asst. Ranger	Rennie, Manitoba.	Yes
C.H. Patterson	Snr. Ranger	Lac du Bonnet	No
J. Nespor	Snr. Ranger	Lac du Bonnet	No
M. Allan	Asst. Ranger	Lac du Bonnet	No
M. Langthorn	Asst. Ranger	Lac du Bonnet	No
H. Taggersen	Fire Ranger	Bird River P.O.	Yes
J. Russel	Fire Ranger	Bissett	No
W. Wardrop	Forest Ranger	Pine Falls	No
F. Westall	Pilot (M.G.A.S.)	Lac du Bonnet	No
G. Emberley	Forest Ranger	Stead	Yes
W. Craigie	Fire Ranger	Stead	No
D. Cooper	Forest Ranger	Marchand	Yes
E. Polkowski	Forest Ranger	Woodridge	No
W. Meseman	Forest Ranger	Piney	No
W. Trowsdale	Forest Ranger	Richer	Yes
W. Ruth	Forest Ranger	East Braintree	Yes
C. Biber	Forest Ranger	East Braintree	Yes
D. Erie	Fire Ranger	Richer	No
D. Meyers	Fire Ranger	Seven Sisters	No
F.R. de Delley	Forest Ranger	Shilo - Douglas P.O.	No
H. Olee	Forest Ranger	Ashern	Yes
L.J. Stanlake	Forest Ranger	Hodgson	No
E. Marner	Forest Ranger	Riverton	No
P. Fitzmaurice	Forest Ranger	Seven Sisters	Yes
S. Sveinson	Forest Ranger	Whitemouth	Yes
B.C. Emes	Forest Ranger	West Hawk Lake	No
W. Thompson	Fire Ranger	Hodgson	Yes
W. O'Brinsky	Fire Ranger	Hodgson	Yes
C. Richmond	Forest Carpenter	Seven Sisters	No
G. Kemp	Game Warden	Rennie	No
E.J. Harrison	Forest Ranger	Sprague	No
W. Braine	District Forester	Winnipeg	No
J. Uhlman	Director, M.G.A.S.	Lac du Bonnet	No
G. Williams	Timber Operator	Hecla Island	No
H. Tomasson	Trader	Hecla Island	No
B. Bevin	Can. For. Assc.	Winnipeg	No
W. Sterling	C.F.A.	Winnipeg	No
B. Jeffries)	Dept. of Agric.,		Yes
J. Menzies)	Soil Surveys	OTTAWA	Yes
A. Hamilton)	Division		Yes

Personnel Contacted (cont'd)

Name	Rank	Place	Demonstration of Sampling
R. Poston	Agric. Rep.	Eriksdale	No
G. Wilson)	Plantation Survey,		Yes
M. Wheaton)	Dominion Forest	WINNIPEG	Yes
W.J. Dyck)	Service		Yes
R. Brown	Pilot C.N.A.	Lac du Bonnet	No
	Manitoba Pulp and Paper Company		
R.J. Riggs	Asst.Woods Manager	Pine Falls	No
D. Naysmith	Silviculturalist	Pine Falls	No
W. Carter	Forest Engineer	Pine Falls	No
G. Forsythe	Cruiser	Pine Falls	No
T. Fortier	For. Engineer	Pine Falls	No
G. Bayly	Cruiser	Pine Falls	Yes
D. Will	Control	Pine Falls	No



5. J. Martin and M. Pratt

(by J. Martin)

(a) Introduction

Forest Insect Survey sampling and observations were conducted throughout the Western and Northern Forest districts of Manitoba from May 2 to September 25, by Forest Insect Rangers J. B. Martin and R. H. M. Pratt.

From May 2 to May 10, all co-operators, whom it was practical to reach, were contacted in an effort to increase the quality and quantity of co-operator's samples.

From May 16 to May 21 newly burned jack pine was sampled in the Sandilands Forest Reserve. During this period test plots were established for a spraying project for the control of pitch pine nodule maker in the Spruce Woods Forest Reserve.

On May 26, a survey for the detection of spruce and jack-pine budworm was started. This survey covered the Riding Mountain National Park, and the Duck Mountain, Cormorant and Porcupine Forest reserves. Random sampling and other observations were conducted on this survey which lasted until June 30.

The period July 5 to July 19 was spent on a larch sawfly survey in the Riding Mountain National Park and the Duck Mountain Forest Reserve.

From July 19 to July 24 was spent on a trip around Lake Winnipegosis on the Manitoba Forest Service launch, "Ranger". Approximately 600 miles were covered. The islands and shores of the Lake were surveyed and sampled for insect activity and damage.

A larch sawfly survey was conducted in the Porcupine and Duck Mountain Forest reserves from July 24 to 29.

Ranger R. H. M. Pratt assisted the laboratory staff in Winnipeg with the Forest Insect Survey during the last two weeks in July. The author was similarly employed for the first two weeks of August. During these periods the ranger in the field worked alone.

The northern part of the district was surveyed for larch sawfly activity and damage from August 1 - 15. Particular attention was paid to tamarack north of The Pas, Manitoba, in the Cormorant Forest Reserve and at Grand Rapids, Manitoba. The area from The

Pas to Grand Rapids was surveyed by air.

Both the eastern and western portions of the Duck Mountain Forest Reserve and the Riding Mountain National Park were examined from August 15 to September 2. Particular attention was paid to tamarack swamps and especially those on which data had been collected in previous years. Permanent sample stations were also established at this time in Riding Mountain National Park and the Duck Mountain Forest Reserve.

On August 30, one colony of parasites was released near Renwer, Manitoba (Sec. 16, tp. 36, rge. 23, W. P. mer.). The colony consisted of 210 Mesoleius tenthredinis and 11,250 Tritneptis klugii.

Permanent sample plots were established in eastern Saskatchewan and western Manitoba from September 7-24. All permanent sample plots were established in tamarack stands. At the same time mass collections of larch sawfly cocoons were made in the same areas. Three insect Rangers were employed on this last assignment. They were: H. Edmunds, E. Campbell and the author.

(b) Insect Conditions

(i) Larch Sawfly (Pristiphora erichsonii Htg.) - The larch sawfly was found in most tamarack stands in the Northern and Western Districts of Manitoba in 1949. The area investigated lies between the east shore of Lake Winnipegosis and the Manitoba-Saskatchewan border, south of Cranberry Portage and north of Riding Mountain, that is, from Township 18 to 65, and from Range 15, W. P. mer., to Range 30, W. P. mer. In addition one flight was made from The Pas to Grand Rapids (Tp. 48, rge. 13, W. P. mer.) on Lake Winnipeg. Defoliation due to larch sawfly was generally lighter south of Mafeking than it was farther north.

The first larch sawfly adult was found June 3 in the Duck Mountain Forest Reserve near Bield, Manitoba (Sec. 22, tp. 26, rge. 26, W. P. mer.). The last adult was found on July 11 near Whirlpool Lake (Sec. 25, tp. 19, rge. 18, W. P. mer.), in the Riding Mountain National Park. The first larva was found near Cowan, Manitoba, on June 27 and the last on August 26 along the Norgate Road in the Riding Mountain National Park. The first cocoon was found near the Blue Lakes, in the Duck Mountain Forest Reserve on July 19.

In the Riding Mountain National Park tamarack was lightly defoliated except for two locations where medium defoliation was observed. These were four miles south of the Park boundary from the Gilbert Plains Warden's Cabin (Sec. 4, tp. 23, rge. 22, W. P. mer.) consisting of three acres of tamarack and in a four acre stand of tamarack five miles west in Sec. 3, tp. 23, rge. 23, W. P. mer.

In the western part of Riding Mountain National Park defoliation was light. All tamarack examined were defoliated less than in 1948. Two swamps north of Oakburn, Manitoba (Sec. 36, tp. 20, rge. 23, W. P. mer.) were examined on July 9, and were less than 10 per cent defoliated. In the Tillson Lake area north of Rossburn, Manitoba (Tp. 22, rge. 25, W. P. mer.) three swamps showed only traces of defoliation.

On August 25 tamarack stands along the Lake Audy-Dauphin Trail were examined and defoliation was noted as light (approximately 8 per cent). In one 40 acre stand (Sec. 30, tp. 21, rge. 20, W. P. mer.) curled tips were very scarce. No dead trees were observed and only three trees were observed with forked tops. This stand was composed of 85 per cent tamarack and 15 per cent black spruce. One mile north of this stand (Sec. 31, tp. 21, rge. 20, W. P. mer.) another stand of 10 acres was examined. Defoliation in this case was about 15 per cent. This stand was about 75 per cent tamarack with black spruce, poplar and willow.

Along the Norgate Road, Riding Mountain National Park, stands were examined two and three miles east of No. 10 Highway (Secs. 25 and 26, tp. 19, rge. 18, W. P. mer.). Here the defoliation ranged from 10 to 17 per cent. Each stand consisted of approximately 40 per cent tamarack with black spruce and poplar. Few curled tips, forked tops and crooked trunks were noted. These two swamps were typical of others examined in this vicinity.

In the central section of Riding Mountain National Park, north of Clear Lake, many tamarack stands were examined. These stands were located at:

Moon Lake (Sec.4,tp.22,rge.19,W.P.mer.)
Mile 145 No. 10 Highway (Sec.23,tp.21,rge.19,W.P.mer.)
Dominion Forestry Camp (Sec.25,tp.20,rge.19,W.P.mer.)

In every case defoliation was light, averaging 5 to 15 per cent.

Five miles west of Dauphin, Manitoba (Sec. 11, tp. 25, rge. 20, W. P. mer.) an isolated stand of 150 acres of tamarack showed light defoliation on July 15. By August 20 no defoliation could be seen in this stand. It was presumed that the trees had replaced their lost foliage. Neither larvae nor cocoons could be found in this stand on August 20.

On July 18, a stand of 7½ sections was examined at Wade Point, Lake Winnipegosis (Tp. 37, rge. 17, W. P. mer.). Defoliation varied from nil to 50 per cent and averaged about 15 per cent.

In the Duck Mountain Forest Reserve north of Grandview, Manitoba (Sec. 25, tp. 27, rge. 24, W. P. mer.) defoliation in two small stands was 5 and 10 per cent on July 25. These stands appeared very healthy and had a good crop of foliage.

In Sec. 10, tp. 26, rge. 26, east of Bield, Manitoba, two large stands consisting of 50 per cent tamarack and 50 per cent black spruce were defoliated about 10 per cent.

Tamarack stands from Cowan to Swan River, Manitoba, were checked every mile along No. 10 Highway for larch sawfly activity. Tamarack was also checked as far east and west of the Highway as it was possible to travel. Defoliation ranged from 25 to 40 per cent with an average of 30 per cent. Moisture conditions in these swamps ranged from damp to very wet. Only a few dead trees were observed. Curled tips were common and every tree sampled had larch sawfly larvae. Along the Wellman Lake Road in Duck Mountain Forest Reserve, all tamarack stands were examined. Many larvae were found and defoliation averaged 35 per cent.

From Swan River north along the east side of the Porcupine Forest Reserve all tamarack was investigated and defoliation was noted as more severe, particularly in the Birch River Veteran's Settlement, where the swamps had been drained. Defoliation in this area averaged 45 per cent.

In the area north of Mafeking, around Dawson Bay and the Red Deer River, defoliation averaged about 60 per cent. From the Red Deer River to the north end of the "Bog" samples were taken every two miles. The area was very wet, and in some places surface water was present. Tree growth in this area is stagnated. Defoliation of tamarack averaged 40 per cent. Larvae were plentiful in all pockets of tamarack in this area and defoliation was quite uniform.

In The Pas area tamarack showed an average defoliation of about 40 per cent. A large swamp from the Saskatchewan River to Big Eddy Settlement (Tp. 58, rge. 26, W. P. mer.) was infested and defoliation varied from moderate to heavy.

The area from The Pas to Cedar Lake and Grand Rapids was examined from the air and defoliation over the entire area ranged from 40 to 60 per cent. Near Grand Rapids, Manitoba, six samples were taken from a swamp 30 miles long by four miles wide.

From Cormorant Lake (Sec. 12, tp. 59, rge. 27, W. P. mer.) to Cranberry Portage (Sec. 19, tp. 64, rge. 27, W. P. mer.) the defoliation of tamarack averaged over 35 per cent. Ranger H. Gill reported that north of Cranberry Portage to Flin Flon and Sherridon the tamarack was less severely attacked and defoliation was approximately 25 per cent. Few curled tips were found in this area and very few crooked trunks or forked tops were noted. Trees were vigorous, healthy and showed a good growth of foliage.

Larch sawfly parasites were released near Renwer, Manitoba (Sec. 16, tp. 36, rge. 23, W. P. mer.) on the following dates:

August 2, 1949 -	800	<u>Mesoleius tenthredinis</u>
	13,200	<u>Tritneptis klugii</u>
August 9, 1949 -	4,100	<u>Tritneptis klugii</u>
August 31, 1949 -	210	<u>Mesoleius tenthredinis</u>
	11,250	<u>Tritneptis klugii</u>

A parasite of larch sawfly, <u>Mesoleius</u> sp., was found on June 3, north of Bield, Manitoba, in the Duck Mountain Forest Reserve (Sec. 25, tp. 19, rge. 18, W. P. mer.).

(ii) A Sawfly (<u>Anoplonyx</u> sp.) - This insect was found with the larch sawfly <u>Pristiphora erichsonii</u> Htg., at various locations. It is difficult to state how much defoliation was caused by this insect. It was observed first on July 14 and the last larvae were found on July 29. Larvae were collected 14 miles northeast of Oakburn, Manitoba, in Riding Mountain National Park; at two locations near Cowan, Manitoba; ½ mile west of Spring Lake, Duck Mountain Forest Reserve; and 5 miles east of Bield, Manitoba.

(iii) Jack-Pine Budworm (<u>Choristoneura fumiferana</u> Clem.) - A survey of the Northern and Western districts of Manitoba, revealed jack-pine budworm to be present only near Cowan and in Riding Mountain National Park. The first larva being found on June 15, and the last on July 8. The defoliation of jack pine by the jack-pine budworm was very light, ranging from zero to 5 per cent, in both the Cowan district of Duck Mountain Forest Reserve and in Riding Mountain National Park.

On June 13 a survey was made of the Cowan district. Samples were taken at half-mile intervals along the prominent jack-pine ridge north of Cowan. Jack-pine budworm was detected at the town limit (Sec. 26, tp. 35, rge. 23, W. P. mer.). The stand was pure jack pine, fairly open growing with trees ranging from 2" to 5" d.b.h., and from 8 to 20 feet in height. A ten tree sample yielded three budworms. A count of twenty 18-inch branches taken at random from 10 trees yielded no budworm. There was no noticeable defoliation due to budworm in this area. Half a mile north of Cowan (Sec. 26, tp. 35, rge. 23, W. P. mer.) a similar 10 tree sample produced only one budworm. A count of twenty 18-inch branches taken at random from 10 trees yielded no budworm. Defoliation averaged about 5 per cent. One mile north of Cowan (Sec. 35, tp. 35, rge. 23, W. P. mer.) 16 budworm were found in a ten tree sample. Twenty 18-inch tips taken at random showed no budworm. Defoliation was negligible.

In the Riding Mountain National Park a survey was made on July 8. Jack-pine budworm was found at only one location in the Park, along the Norgate Road 2.3 miles east of No. 10 Highway (Sec. 25, tp. 19, rge. 18, W. P. mer.). Only one jack-pine budworm was obtained in the sample. A count of twenty 18-inch branches yielded no budworm. Defoliation averaged about 3 per cent.

The jack-pine budworm picture in the Western District remained about the same as in 1948 as far as defoliation and distribution are concerned.

(iv) Spruce Budworm (Choristoneura fumiferana Clem.) - The spruce budworm was found in only a few scattered locations in western and northern Manitoba. It caused only slight damage. The first larva was observed near Singoosh Lake in the Duck Mountain Forest Reserve on June 9. The last larva was collected at Birch River, Manitoba, on June 15. The first pupa of the spruce budworm was collected in Riding Mountain National Park on July 6 and the last on July 7.

The Singoosh Lake area of the Duck Mountain Forest Reserve was surveyed for budworm on June 9. No defoliation of spruce was seen. A stand of white spruce 5.4 miles west of the Reserve boundary was sampled (Sec. 7, tp. 31, rge. 23, W. P. mer.). Only one budworm larva was found. Twenty 18-inch branches were selected at random from 10 trees and examined for spruce budworm but negative results were obtained. The stand composition was as follows:

White Spruce	- 50%
Poplar	- 40%
Balsam	- 10%

A Manitoba Forest Service nursery at Birch River, Manitoba, Sec. 34, tp. 39, rge. 26, W. P. mer., was examined on June 15. Colorado spruce was examined and a count made on twenty 18-inch branches taken at random from 10 trees yielded six spruce budworm. Damage to foliage was less than one per cent.

Riding Mountain National Park was surveyed for spruce budworm on July 6 and 7. Defoliation caused by the spruce budworm was negligible. From one mile north of the junction of the Dauphin and Lake Audy roads (Sec. 14, tp. 20, rge. 19, W. P. mer.) to 2.7 miles south of this junction (Sec. 6, tp. 20, rge. 18, W. P. mer.) four samples were taken. Spruce budworm pupae were found in each sample. Defoliation due to the spruce budworm was less than one per cent. The distribution and damage caused by spruce budworm throughout the remainder of this district was practically the same as in 1948, i.e., nil to negligible.

(v) Large Aspen Tortrix (Archips conflictana Wlk.) and American Poplar Leaf Beetle (Phytodecta americana Schffr.) - Both the large aspen tortrix and the American poplar leaf beetle were distributed over the entire Western and Northern districts of Manitoba in 1949. For the most part they caused little damage except in the areas described below.

The first larva of the large aspen tortrix was collected on June 1 and the last on July 4. The first pupa was noted on June 13 and the last on July 11. The first larva of the American poplar leaf beetle was found on June 10 and the last on June 20. The first adult was observed on June 10 and the last on July 28.

Infestations which had been reported in 1948 were re-examined in 1949. These were located in the Singoosh Lake area of the Duck Mountain Provincial Forest Reserve and in The Pas-Cranberry Portage area of northern Manitoba.

The infestation at Singoosh Lake was noticeably lighter and smaller in size than in 1948. White poplar in the Duck Mountain Forest Reserve near Singoosh Lake was defoliated an average of 20 per cent when examined on July 14. The heaviest defoliation was in Sec. 27, tp. 30, rge. 25, W. P. mer. An earlier survey of this area (June 10) showed less than 5 per cent defoliation. The dominant tree species in this area is white poplar. Smaller stands of white spruce, black poplar, jack pine, balsam fir, tamarack and black spruce are present, in order of abundance as listed.

The infestation north of The Pas, Manitoba, had increased in intensity in 1949 and was also more widely distributed. This infestation extended from six miles north of The Pas, Manitoba, to 60 miles north of The Pas. In this area defoliation averaged 70 per cent on June 22. One large stand 1½ miles wide just south of Cranberry Portage, Manitoba (Sec. 31, tp. 64, rge. 26, W. P. mer.) was defoliated from 90 to 100 per cent with the average estimated at 95 per cent. Samples were taken 25 and 57½ miles north of The Pas and one and two miles north of Cranberry Portage. The stand composition in this area is white spruce, white poplar, black poplar, jack pine, and tamarack.

In the Duck Mountain Forest Reserve near the Durban Ranger Station (Sec. 29, tp. 33, rge. 28, W. P. mer.) a small area was lightly infested on June 14. From the Ranger Station to the tower (Sec. 23, tp. 33, rge. 28, W. P. mer.) defoliation of poplar averaged about 15 per cent. A stand of about 20 acres adjacent to the Ranger Station was defoliated about 25 per cent but not all this damage appeared to be caused by insects. The leaves were dead and brown. Some of the damage was attributed to heavy frosts occurring after the trees had put forth their leaves. Elsewhere throughout the Western and Northern districts the damage to poplar was very light. The heaviest populations of American poplar leaf beetle were seen adjacent to the Grandview Ranger Station in the Duck Mountain Forest Reserve (Sec. 15, tp. 27, rge. 24, W. P. mer.). In this area damage due to this insect was estimated at 5 per cent on June 3.

Parasites of the large aspen tortrix were found in the Duck Mountain Forest Reserve and in The Pas district. Seven miles east of the Blue Lakes, Duck Mountain Forest Reserve (Sec. 27, tp. 30, rge. 25, W. P. mer.) a tachinid parasite was found attacking the large aspen tortrix. Another parasite, Glypta sp., of the large aspen tortrix was found ½ miles south of Cranberry Portage, Manitoba (Sec. 31, tp. 64, rge. 26, W. P. mer.). One mile north of Cranberry Portage (Sec. 6, tp. 65, rge. 26, W. P. mer.) and two miles north of Cranberry Portage (Sec. 7, tp. 65, rge. 26, W. P. mer.) several species of parasites (Hymenoptera and Diptera) were found.

(vi) The Balsam-Fir Sawfly (Neodiprion abietis Harr.) - This sawfly was found in the Duck Mountain Forest Reserve, in Riding Mountain National Park, and on the shore line and islands of Lake Winnipegosis. The first larva of the balsam-fir sawfly was found on June 8 and the last on July 26. The first pupae were found July 9, and the last August 24.

All accessible parts of the Duck Mountain Forest Reserve were examined during June and July. The damage to white spruce by the balsam-fir sawfly was negligible in the Reserve. In the Elk Lake section (Sec. 32, tp. 29, rge. 24, W. P. mer.) a scattered stand of white spruce was defoliated about 20 per cent.

From August 19-25 a survey was made of the Lake Winnipegosis area. The defoliation of white spruce was light. The range of defoliation was from nil to 20 per cent. At Wade Point, Lake Winnipegosis (Sec. 8, tp. 37, rge. 17, W. P. mer.) the defoliation was 20 per cent. On the shores of Cameron Bay (Sec. 11, tp. 46, rge. 22, W. P. mer.) the defoliation varied from nil to 15 per cent. On and around Lake Winnipegosis the stand is composed mainly of white spruce, white poplar, black poplar, white birch and balsam.

An infestation of the balsam-fir sawfly was investigated on July 6, north of Clear Lake in the Riding Mountain National Park, (Tp. 20, rge. 18, and 19, W. P. mer.). The main part of the infestation was in Secs. 1, 9, 10, 11, 12, 14, 15, 16, 17, 23 and 26, tp. 20, rge. 19, W. P. mer. The average defoliation in this area was about 10 per cent with defoliation raning from 3 to 15 per cent. Defoliation in trees under five inches d.b.h. averaged 12 per cent, trees from five to 10 inches d.b.h. 15 per cent, trees from 10 to 15 inches d.b.h. 10 per cent, trees from 15 to 20 inches d.b.h. 7 per cent, and trees over 20 inches d.b.h. 5 per cent.

One hundred and fifty trees were tallied in the area to determine tree mortality. Two per cent of the stand was dead. However, this mortality was not considered due to balsam-fir sawfly attacks as most trees showed indications of damage by animals.

The stand in this area is composed mainly of the following species:

White spruce	White birch
White poplar	Black spruce
Black poplar	Tamarack
Jack pine	

(vii) The Prairie Willow Leaf Beetle (<u>Galerucella decora</u> Say) - The prairie willow leaf beetle was collected from every area sampled in the Western and Northern districts of Manitoba. Adults were found on willow, white poplar, black poplar, jack pine and black spruce However, noticeable feeding damage was observed only on willow. About 12 per cent of the leaves were skeletonized and it ranged from 1 to 50 per cent. Adults of the prairie willow leaf beetle were found from May 28 to August 26. Eggs were found on June 23.

The most severe infestations of this insect occurred in the Durban area, the Mafeking area, and the western part of the Duck Mountain Forest Reserve. The infestation in the Riding Mountain National Park reported in 1948 as medium to severe in Tp. 22, rges. 24, 25, and 26, had decreased to very light in 1949. Skeletonizing of willow in the central part of the Riding Mountain National Park was also very light.

The area around Durban, Manitoba was inspected June 14, and most of the willow in Tps. 33 and 34, rges. 28 and 29, was brown and had a burnt-over appearance. As many as 50 per cent of the leaves were affected. The area from Mafeking, Manitoba (Sec. 12, tp. 42, rge. 26, W. P. mer.) north to the Red Deer River (Sec. 28, tp. 45, rge. 25, W. P. mer.) was examined on August 10. The willow in this area was about 20 per cent affected.

Near Cowan, Manitoba (Sec. 26, tp. 35, rge. 23, W. P. mer.) on August 17, from 10 to 20 per cent of the leaves were skeletonized.

On August 19 the Singoosh Lake area of the Duck Mountain Forest Reserve was examined. Skeletonizing of the leaves was noted as light; it ranged from 5 to 10 per cent. By September 1 in the Riding Mountain National Park, including the central and western portions, the leaves were only lightly damaged. In some areas throughout the parts examined skeletonizing was noticeable. Willow from The Pas north to Cranberry Portage was inspected on August 11, and 10 per cent of the leaves were affected by the beetles.

(viii) The Ugly Nest Tortrix (Archips cerasivorana Fitch.) - The ugly nest tortrix was found on cherry bushes from the Riding Mountain National Park north to The Pas, Manitoba. The first collection of this insect was made on May 30 and the last on August 17. Except for one concentration of nests near Lake Audy Road in the Riding Mountain National Park all collections were found at scattered locations, one nest to a location.

The Riding Mountain National Park infestation extended from No. 10 Highway (Sec. 11, tp. 20, rge. 19, W. P. mer.) along the Lake Audy Road to the Buffalo Park (Sec. 4, tp. 21, rge. 20, W. P. mer.). Twelve samples of the ugly nest tortrix were collected in this area between July 6 and 13. Defoliation ranged from 2 to 10 per cent and averaged 6 per cent.

(ix) The Spotless Fall Webworm (Hyphantria textor Harr.) - The spotless fall webworm was found attacking birch, alder, willow and elm, from Sclater, Manitoba, north to Mafeking, Manitoba. Only two webs were seen south of Sclater, one in the town of Dauphin and one on the north shore of Clear Lake in the Riding Mountain National Park. This webworm was first observed on July 14 and last on September 2, 1949.

The webworm was most plentiful in the area between Sclater, Manitoba (Sec. 23, tp. 34, rge. 23, W. P. mer.) and Renwer, Manitoba (Sec. 16, tp. 36, rge. 24, W. P. mer.). From August 5 to 16, ten samples were taken in this district where defoliation on attacked trees ranged from 3 to 5 per cent and averaged about 2 per cent.

In Lake Winnipegosis, the spotless fall webworm was found on Pemmican, Birch and Rowan islands and at Wade Point. Negligible damage was caused by this insect in the Lake Winnipegosis district.

(x) The Forest Tent Caterpillar (Malacosoma disstria Hbn.) - The forest tent caterpillar was first observed on June 20, six miles north of The Pas, Manitoba. Two larvae were found there on white poplar. The poplar was defoliated from 10 to 20 per cent but the forest tent caterpillar had not caused the defoliation. This caterpillar was not detected at any other place in the Western and Northern districts.

(xi) The White-Pine Weevil (Pissodes strobi Peck.) - The white-pine weevil was found in Riding Mountain National Park from July 9 until September 1, 1949. Its distribution was general within the Park.

Two infestations were noted, one on the Dauphin Trail (Sec. 12, tp. 22, rge. 21, W. P. mer.) where 20 per cent of the small white spruce had dead leaders. The other was along the Norgate Road (Sec. 25, tp. 19, rge. 18, W. P. mer.) where 15 per cent of the young white spruce had dead leaders. The latter stand was examined on August 26.

Scattered damage by the white-pine weevil was also noted in the western and central portions of Riding Mountain National Park. In these areas about 5 per cent of the young white spruce was damaged by the white-pine weevil.

(xii) The Pitch Pine Nodule Maker (Petrova albicapitana Busck) - The pitch pine nodule maker was, for the most part, light in the Western and Northern districts of Manitoba. It was collected from May 27 to

September 1.

In the Riding Mountain National Park it was observed along the Norgate Road in Secs. 30 and 33, tp. 19, rge. 17, W. P. mer. One stand - 400 yards by 100 yards - of pure jack pine was very lightly infested.

In the Duck Mountain Forest Reserve the nodule maker was observed near Garland (Sec. 26, tp. 30, rge. 24, W. P. mer.) and near Cowan (Secs. 1 and 2, tp. 36, rge. 23, W. P. mer.) and Sec. 26, tp. 35, rge. 23, W. P. mer., in the large jack-pine ridge north of Cowan. In this area the nodule maker was not serious.

In the Porcupine Forest Reserve, nodules were collected near Birch River (Sec. 24, tp. 41, rge. 26, W. P. mer.). Damage was negligible. The nodule maker was also found near Mafeking, Manitoba (Sec. 32, tp. 44, rge. 25, W. P. mer.). In this stand of jack pine, 300 yards by 100 yards, damage was very light.

In the Northern District the pitch pine nodule maker was detected at points 10, 30 and 39 miles, respectively south of The Pas, Manitoba. It was also found 16 miles north of The Pas. One mile north of Cranberry Portage, Manitoba (Sec. 6, tp. 65, rge. 26, W. P. mer.) four nodules were found on June 9. In no case was the damage by pitch pine nodule maker of significant proportions.

(xiii) The Hemlock Looper (Lambdina fiscellaria Gn.) - Several larvae of the hemlock looper were found on the shores and islands of Lake Winnipegosis. One larva was also collected near the Grandview Ranger Station (Sec. 25, tp. 27, rge. 24, W. P. mer.). The first larva of the hemlock looper was found on July 18 and the last on July 25, 1949. The hemlock looper was found on the following hosts:

Chokecherry	White poplar
Dogwood	White birch
Willow	White spruce
Maple	Balsam

On Lake Winnipegosis the hemlock looper was found from Tps. 40 to 46 and from Rges. 17 to 24, W. P. mer.

(xiv) The Red-Pine Sawfly (Neodiprion nanulus Schedl.) - The red-pine sawfly was found from June 13 to July 8.

This sawfly was found near Cowan on a jack-pine ridge (Sec. 26, tp. 35, rge. 23, W. P. mer.). It was confined to a few trees and caused no noticeable damage.

The red-pine sawfly was also found on July 8, along the Norgate Road in Riding Mountain National Park (Sec. 25, tp. 19, rge. 18, W. P. mer.). In this area a few trees in a very large stand of jack-pine were attacked. Defoliation in an area 50 by 25 yards was about 5 per cent.

(xv) The Yellow-Headed Spruce Sawfly (Pikonema alaskensis Rph.). - The yellow-headed spruce sawfly was found to be general in the Riding Mountain National Park. It was also found near Camperville, Manitoba, and on Lake Winnipegosis. This sawfly was first detected on June 28 and last on July 19.

In Riding Mountain National Park, this sawfly was usually found with the balsam-fir sawfly and the damage was attributed mainly to the balsam-fir sawfly. Defoliation by the yellow-headed spruce sawfly was estimated at 5 per cent in scattered stands in the central portion of the Park, e.g., near the Dominion Forest Service Camp (Sec. 14, tp. 20, rge. 19, W. P. mer.). In the western part of the Park near Oakburn and Rossburn, Manitoba, scattered samples were found in a few stands and defoliation averaged around 5 per cent. On Lake Winnipegosis this sawfly was found on July 19, at only two locations. In these stands defoliation was very light. The yellow-headed sawfly was not distributed widely nor did it cause much damage.

(xvi) The Green-Headed Spruce Sawfly (Pikonema dimmockii Cress.) - The green-headed spruce sawfly was general but very light in Riding Mountain National Park, Duck Mountain Forest Reserve and on Lake Winnipegosis. In no case were more than three larvae collected per sample. Defoliation caused by this insect was negligible. Collections of this insect were made from June 28 to August 23.

(xvii) The Spruce Needleworm (Dioryctria reniculella Grt.) - Several collections of the spruce needleworm were made in the Riding Mountain National Park, at Mafeking, and near Birch River, Manitoba. In all cases damage to foliage was negligible (less than 1 per cent). The average number of larvae per sample was two. The collections were made during the period June 15 to July 6.

(xviii) The Black-Headed Budworm (*Acleris variana* Fern.) - Larvae of the black-headed budworm were found on spruce in Riding Mountain National Park and in the southern portion of the Duck Mountain Forest Reserve. The collections were made during the period July 7 to July 26. No noticeable damage was caused by this budworm. Three larvae were found in one collection made in the central part of Riding Mountain National Park in Tps. 19 and 20, rge. 18, W. P. mer. Another collection containing one larva was obtained in the Riding Mountain National Park, north of Oakburn, Manitoba (Sec. 11, tp. 21, rge. 23, W. P. mer.). One larvae was also found near Bield, Manitoba (Sec. 9, tp. 26, rge. 26, W. P. mer.).

(xix) Spruce Pineapple Gall Aphid (*Adelges abietis* Leconte) - The spruce pineapple gall aphid was found in all spruce stands examined in the Western and Northern districts of Manitoba but it caused no significant damage. Collections of this insect were made from June 2 to July 22.

The collections obtained were from scattered points in the Riding Mountain National Park, Duck Mountain Forest Reserve, and the Lake Winnipegosis area.

(xx) The White-Spotted Sawyer Beetle (*Monochamus scutellatus* Say) - One adult of the white-spotted sawyer beetle was found on June 14 near the Durban Ranger Station (Sec. 22, tp. 33, rge. 28, W. P. mer.). Another collection was made on Birch Island, Lake Winnipegosis (Sec. 16, tp. 41, rge. 17, W. P. mer.) on July 19.

(xxi) The Birch Sawfly (*Arge pectoralis* Leach), The Poplar Borer (*Saperda calcarata* Say), A Tent Caterpillar (*Malacosoma lutescens* N. & D.), and Jack Pine Scale (*Toumeyella* sp.) - These insects were not found in the Northern and Western districts of Manitoba in 1949.

(c) Special Investigations

(i) Large Aspen Tortrix: A mass collection of larvae was made six miles north of The Pas, Manitoba (Sec. 9, tp. 47, rge. 26, W. P. mer.) on June 20, 1949. Some 300 larvae were collected and mailed to Winnipeg for study by W. F. Black.

(ii) Lake Winnipegosis Survey: On the invitiation of Mr. E. A. Koons, Superintendent of the Western Forest District, the writer accompanied Mr. C. G. Lintott, Forest Ranger, Winnipegosis, and two Geologists, namely, Mr. A. Baillie and Mr. R. Robertson, Department of Natural Resources, Winnipeg, on a launch trip around Lake Winnipegosis. The trip, which started on July 19 from Winnipegosis, Manitoba, covered about 600 miles of the shoreline. Approximately four stops were made each day for the purpose of insect investigations. At Wade Point one exceptionally large stand of tamarack, consisting of about three square miles in Secs. 6, 7, and 8, tp. 37, rge. 17, W. P. mer., was inspected. This stand was lightly infested with larch sawfly, but as it was examined early in the season, damage may have been more severe later. On the shoreline of the Lake all species of trees and shrubs were very heavily infested with spiders. They were so numerous that in many cases all branches to a height of 10 or 12 feet were completely enclosed in spider web. Balsam-fir sawfly was found at most points sampled but had caused only light defoliation. Apart from the larch sawfly and the balsam-fir sawfly, insect damage was negligible.

(iii) Larch Sawfly Cocoon Collections: Mass collections of larch sawfly cocoons were made during September, 1949. Cocoons were very scarce this year and difficult to find. Collections were made at the following points in Western Manitoba:

Mile 253 No. 10 Highway (Sec.15,tp.36,rge.23,W.P.mer.)
Mile 245 No. 10 Highway (Sec.11,tp.35,rge.23,W.P.mer.)
8.4 miles north of Mafeking,(Sec.19,tp.44,rge.25,W.P.mer.)
20 miles north of Mafeking (Sec.16,tp.46,rge.25,W.P.mer.)

(iv) Parasite Releases: Several colonies of larch sawfly parasites were released in the Cowan-Renwer district of Manitoba. Three releases were made between August 2 and August 31. These releases were as follows:

August 2, 1949 -	800	*Mesoleius tenthredinis*
	13,290	*Tritneptis klugii*
August 9, 1949 -	4,100	*Tritneptis klugii*
August 31, 1949 -	210	*Mesoleius tenthredinis*
	11,250	*Tritneptis klugii*

The release point was located near Renwer, Manitoba (Sec. 16, tp. 36, rge. 23, W. P. mer.).

(v) Permanent Sample Plots: During September, 1949, eleven permanent sample plots were established in the Western Forest District of Manitoba. These were all located in tamarack stands. The plots were ½ chain wide by 10 chains long in most cases. To mark the plot a post 5" in diameter was squared, capped and painted white. On this post was carved the plot number. The center line was blazed and a smaller white post was placed at the end of the center line. A compass bearing was taken along the center line from the marker post and recorded.

A tally was made of all trees in the plot and the d.b.h. and numbers were recorded by species. In each plot ten trees were tagged with numbered aluminum tags and the tree marked with white paint. These tagged trees were selected on a pro rata basis for each age class and were as far as possible, representative of the surrounding stand. For these tagged trees the following information was recorded:

Tag Numbers	Shade
Species	Per cent Defoliation
d.b.h.	Other injury
Crown Class	Cause of Injury
Story	Deformities

Injury other than insect

A table showing the locations of the permanent sample plots follows:

Permanent Sample Plots

Plot Number	Location	Sec.	Tp.	Rge.	Mer.
1	Whirlpool Lake Road, R.M.N.P. *	5	20	17	W.P.
2	Lake Audy Road, R.M.N.P.	16	20	19	W.P.
3	Dominion Forest Service Camp, R.M.N.P.	25	20	19	W.P.
4	Mile 145 No. 10 Highway, R.M.N.P.	23	21	19	W.P.
5	Prisoner of War Camp Road, R.M.N.P.	14	21	21	W.P.
6	Norgate Road, R.M.N.P.	36	19	17	W.P.
7	Moon Lake, R.M.N.P.	4	22	19	W.P.
8	Mile 245 No. 10 Highway	11	35	23	W.P.
9	Mile 253.2 No. 10 Highway	15	36	23	W.P.
10	20 miles north of Mafeking, Manitoba	16	46	25	W.P.
11	8.4 miles north of Mafeking, Manitoba	19	44	25	W.P.

* R.M.N.P. - Riding Mountain National Park.

(vi) Permanent Sample Stations: Several Permanent Sample Stations were established in the Western Forest District of Manitoba in 1949.

All sites were selected for accessibility and freedom from interference. The plots were marked with an orange-painted galvanized tin marker which was numbered according to district. Complete descriptions of the stations were filled out on forms provided.

At each station established a compass bearing was recorded to act as a center line and a collection was made along this bearing.

In all, 10 stations were established and three replaced. There are now 32 Sample Stations in Western Manitoba. They are distributed as follows:

Riding Mountain National Park - 16
Duck Mountain Forest Reserve - 16

The exact locations of sampling stations established in 1948 and 1949 are shown in the following tables:

Permanent Sample Setions 1948

No.	Species	Location	Sec.	Tp.	Rge.	Mer.
W1	White spruce	Moon Lake, R.M.N.P.	9	22	19	W.P.
W2	White spruce	Mile 146 #10 Highway, R.M.N.P.	35	21	19	W.P.
W3	Tamarack	Mile 144.5 #10 Highway, R.M.N.P.	25	21	19	W.P.
W4	White spruce	.7 mi.N.Lake Audy Rd.Jct.#10 Hwy.RMNP	14	20	19	W.P.
W5	White poplar	.2 mi.N.Lake Audy Rd.Jct.#10 Hwy.RMNP	10	20	19	W.P.
W6	White spruce	Lake Audy Rd., near #10 Highway, RMNP	3	21	20	W.P.
W7	White poplar	2.1 mi. N. of Baptist Camp, R.M.N.P.	4	21	20	W.P.
W8	Jack pine	Mile 12.9 Norgate Road, R.M.N.P.	33	19	17	W.P.
W9	White spruce	Mile 8.5 Norgate Road, R.M.N.P.	36	19	17	W.P.
W10	White poplar	300 yds.E.of Bridge, Whirlpool R., RMNP	25	19	18	W.P.
W11	White poplar	.7 miles E.of Bield R.S., D.M.F.R.	19	26	26	W.P.
W12	White spruce	Valley River Road, Bield, D.M.F.R.	22	26	26	W.P.
W13	Tamarack	Valley River Road, Bield, D.M.F.R.	22	26	26	W.P.
W14	Jack pine	Grandview R.S., D.M.F.R.	1	27	24	W.P.
W15	Scotch pine	Grandview R.S., D.M.F.R.	1	27	24	W.P.
W16	White spruce	Grandview R.S., D.M.F.R.	1	27	24	W.P.
W17	White spruce	.6 miles W. of Blue Lakes, D.M.F.R.	28	30	25	W.P.
W18	Black poplar	1 mi. W. of Blue Lakes, D.M.F.R.	28	30	25	W.P.
W19	White Poplar	2 mi. E. of Blue Lakes, D.M.F.R.	27	30	25	W.P.
W20	Jack pine	Near Blue Lakes, D.M.F.R.	34	30	25	W.P.
W21	White poplar	Near bridge btwn. Singoosh & Blue Lakes, D.M.F.R.	25	30	25	W.P.
W22	White spruce	Forestry Cabin, Singoosh Lake, DMFR	19	30	24	W.P.

Permanent Sample Stations 1949

No.	Species	Location	Sec.	Tp.	Rge.	Mer.
W23	White spruce	7 mi. N. Jct. Dauphin-Lake Audy Rd., Riding Mountain National Park	14	20	19	W.P.
W24	White spruce	Mi. 146, Dauphin Road, R.M.N.P.	35	21	19	W.P.
W25	White spruce	Moon Lake, Riding Mountain N. P.	9	22	19	W.P.
N1	White spruce	1 mi. W. of boundary old Singoosh Trail, Duck Mountain Forest Reserve	32	29	23	W.P.
N2	White spruce	5½ mi. NW #10 Jct. Lake Audy Rd.,RMNP	17	20	19	W.P.
N3	Tamarack	1 mile N. of Cowan Tower	2	36	23	W.P.
N4	Jack pine	2.3 mi. W. of Pine River, Man.	31	32	22	W.P.
N5	Black spruce	1.9 mi. N. of Grandview R.S., D.M.F.R.	12	27	24	W.P.
N6	White spruce	16.1 mi. NW Jct. #10-Lake Audy Rd., Riding Mountain National Park	7	21	20	W.P.
N7	Tamarack	1.7 mi.N. of P.O.W. Rd., on Dauphin Trail, R.M.N.P.	19	21	20	W.P.
N8	Tamarack	2.9 mi. N. of P.O.W. Rd., on Dauphin Trail, R.M.N.P.	19	21	20	W.P.
N9	Jack pine	3.3 mi. E. of #10 on Norgate Rd.,RMNP	30	19	17	W.P.
N10	White spruce	3.7 mi. NW of #10 on North Shore Road Riding Mountain National Park	1	20	19	W.P.

(d) Negative Reports

Date	Host	Location	Sec.	Tp.	Rge.	Mer.
May 17	Jack pine	Sandilands Forest Reserve	26	5	9	E.P.
May 17	Jack pine	Sandilands Forest Reserve	24	5	9	E.P.
May 28	White spruce	Sample Stn. W.25,R.M.N.P.	34	21	19	W.P.
May 30	White poplar	Lake Audy Road., R.M.N.P.	1	21	20	W.P.
June 3	Black poplar	Sample Stn. W.11, Bield	19	26	26	W.P.
June 4	White spruce	Shell River, D.M.F.R.	31	29	27	W.P.
June 7	White spruce	Garland, Manitoba, D.M.F.R.	33	25	29	W.P.
June 7	Jack pine	Singoosh Lake, D.M.F.R.	33	25	29	W.P.
June 8	Jack pine	Sample Stn., W.20, D.M.F.R.	27	30	25	W.P.
June 9	Balsam fir	Singoosh Lake, D.M.F.R.	15	31	23	W.P.
June 13	Jack pine	Cowan, Manitoba.	2	36	23	W.P.
June 13	Jack pine	Cowan, Manitoba.	16	36	23	W.P.
June 14	Black spruce	Cowan, Manitoba.	15	36	23	W.P.
June 16	Black spruce	7 mi. N. of Mafeking, Man.	31	43	25	W.P.
June 18	Tamarack	41 mi. N. of Mafeking,Man.	5	50	25	W.P.
June 21	Tamarack	Prospector, Cormorant F.R.	22	57	26	W.P.
July 15	Black spruce	Sample Stn. N.1, D.M.F.R.	32	29	23	W.P.
July18	Balsam fir	Wade Point, Lake Winnipegosis	8	37	17	W.P.
July 23	White poplar	Pelican Bay,Lake Winnipegosis	9	44	21	W.P.
July 25	Scotch Pine	Sample Stn.,W.18, D.M.F.R.	1	27	24	W.P.
Aug. 18	Tamarack	Pine River, Manitoba.	31	32	22	W.P.

(e) Personnel Contacted

Name	Position	Address	Demonstration of Sampling
O. Heslip	Park Supt., R.M.N.P.	Wasagaming, Man.	No
I.C. Goodison	Forest Engr., R.M.N.P.	Wasagaming, Man.	Yes
P. Brodie	Supersiving Warden,R.M.N.P.	Wasagaming, Man.	Yes
B. Armstrong	Park Warden, R.M.N.P.	Wasagaming, Man.	No
J. Allen	Park Warden, R.M.N.P.	Norgate, Man.	No
D.B. Binkley	Park Warden, R.M.N.P.	Elphinstone, Man.	Yes
R.T. Hand	Park Warden, R.M.N.P.	R.R.5, Dauphin, Manitoba	Yes
J. Hyska	Park Warden, R.M.N.P.	Rossburn, Man.	Yes
R. McKinnon	Park Warden, R.M.N.P.	Grandview, Man.	Yes
R. Pike	Forest Technician	Wasagaming, Man.	No
J.B. Nash	Beaver Research,D.N.R.	Game Branch, Winnipeg	No
E.A. Koons	Dist. Forester	Dauphin, Manitoba	No
R.R. Ross	Senior Ranger	Dauphin, Manitoba	No
B. Balchen	Dist. Forest Engineer	Dauphin, Manitoba	No
R. Robertson	Park Warden, R.M.N.P.	McReary, Manitoba	No
J. Kokindovich	Senior Ranger	Swan River, Manitoba	No
A.E. Campbell*	Forest Ranger	Minitonas, Manitoba	No
L.J. Stanlake	Forest Ranger	Minitonas, Manitoba	No
D.J. Sinclair	Forest Ranger	Durban, Manitoba	Yes
G. Palmer	Forest Ranger	Bield, Manitoba	No
A. Machuk	Forest Ranger	Garland, Manitoba	Yes
J. Presloski	Forest Ranger	Mafeking, Manitoba	Yes
J.B. Norman	Forest Ranger	Birch River,Manitoba	Yes
C.G. Lintott	Forest Ranger	Winnipegosis,Manitoba	Yes
W. Mawdsley	Forest Ranger	Grandview, Manitoba	Yes
F.W. McKelvey	Forest Towerman	Cowan, Manitoba	Yes
Bud Denby	Capt. Govt. Launch	Winnipegosis, Manitoba	No
A. Baillie	Geologist, D.N.R.	Winnipeg, Manitoba	Yes
R. Robertson	Ass't. Geologist,D.N.R.	Winnipeg, Manitoba	Yes
A.R. Harvey	District Forester	The Pas, Manitoba	No
D. McKinnon	Forest Ranger	The Pas, Manitoba	Yes
H.W. Gill	Forest Ranger	Cranberry Portage,Man.	Yes
W. Guymer	Dist. Game Guardian	The Pas, Manitoba	No
P. Reeder	Game Guardian	The Pas, Manitoba	No
T. Cochran	Pilot, M.G.A.S.	The Pas, Manitoba	No
F.Warburton	District Superintendent	Hudson Bay, Sask.	No
C. Schell	Field Supervisor	Hudson Bay, Sask.	No
H. Randall	Field Officer	Hudson Bay, Sask.	No
F.D. Craig	Field Officer	Hudson Bay, Sask.	No
J. Heron	Field Officer	Madge Lake, Sask.	Yes
A. Feusi	Field Officer	Madge Lake, Sask.	Yes
L. Beedle	Field Officer	Carrot River, Sask.	No
C. Cole	Field Officer (Sask.)	The Pas, Manitoba	No
J.L. Dobie	Field Officer	Somme, Saskatchewan	No

* Resigned

4. H. A. J. Edmunds and A. E. Campbell

(By A. E. Campbell)

(a) Introduction

The following outlines the activities of Forest Insect Rangers H. A. J. Edmunds and A. E. Campbell during the summer season of 1949, conducting forest insect survey and observations in the Hudson Bay District in eastern Saskatchewan.

Field activities commenced May 26 by Insect Ranger H. Edmunds in the Madge Lake area. General sampling and observations were conducted to determine the distribution and extent of the large aspen tortrix in Madge Lake Provincial Park. Several samples were collected at this point. In addition, random sampling was conducted through the area on white spruce and willow, and results from these samples showed that insect activity was limited.

On May 28, H. Edmunds proceeded to Pelly, Saskatchewan, where general sampling was carried on until June 7, when he was joined by A. E. Campbell. The two men then proceeded north into the Porcupine Provincial Forest. Extensive sampling and observations for the detection of spruce and jack-pine budworm were carried out. Areas around Malonick Cabin and Farr Hill Tower and westward via Norquay, Hyas, Sturgis and Endeavour were covered during the survey. Random sampling was also continued through the area traversed.

On June 10 and 11, a survey was conducted in the Usherville area for the detection of spruce and jack-pine budworm. One permanent sampling station was established east of Usherville, located in a fair stand of white spruce. In addition, permanent sampling stations which were established previously were examined and sampled.

During the week of June 13-19 the rangers carried on observations and general sampling in the Prairie River area. Several samples of bark beetles were collected from fire-killed white spruce (1949 spring burn) located in Sec. 9, tp. 43, rge. 5, W. 2nd mer., and Sec. 17, tp. 43, rge. 5, W. 2nd mer. At this time efforts were being made to salvage the fire-killed timber for use as sawlogs and peeled pulpwood.

White spruce and poplar surrounding the burn were sampled and the collections forwarded to the Winnipeg Laboratory. In the Greenwater Provincial Park, a 1949 spring burn was also examined, and a number of samples of bark beetles collected. Random samples were also made in the area traversed. The extent of the burn in this area was estimated to be 2,000 acres and caused considerable damage to young spruce and poplar. From this point the rangers proceeded north to Peesane via Chelan and Bjorkdale, conducting random sampling on spruce and poplar along the route. Several samples of the ugly-nest tortrix were collected from cherry shrubs. A number of samples of the balsam-fir sawfly were also collected. Arriving at Peesane on June 23, an extensive survey was conducted in the area east, surrounding Orley, and Mistatum, Saskatchewan, using speeder and other means of transportation, supplied by the local Field Officer of the Saskatchewan Government, Department of Natural Resources. Forested areas lying west and north of Peesane were covered by auto. Several samples were collected from poplar and willow in the Arborfield and Crooked River areas. A fair coverage was also made of the areas surrounding the borders of the Porcupine Provincial Forest, where several samples of the larch sawfly were collected.

A 1949 spring burn, located in Secs. 4-9, tp. 45, rge. 11, W. 2nd mer. was examined and a number of bark beetle collections were made. On June 27 the rangers proceeded to Carrot River via Tisdale and Codette, Saskatchewan, making several collections of the ugly-nest tortrix enroute. Working north from Carrot River, along The Pas Lumber Company log road, all white spruce and tamarack stands were examined. Several samples of the balsam-fir sawfly and larch sawfly were collected at this time. On June 29 H. Edmunds and A. E. Campbell proceeded to Winnipeg where Campbell remined for two weeks assisting the laboratory personnel in the insectary.

Mr. Edmunds returned to Carrot River July 6 and continued observations and general sampling, remaining in this area until July 10. Mr. Edmunds then proceeded to Hudson Bay where an extensive survey for the detection of spruce and jack-pine budworm was again conducted. Several tamarack swamps north and south of Hudson Bay were examined for larch sawfly and the samples collected were forwarded to the Winnipeg Laboratory. Using speeder supplied by the Saskatchewan Forest Service (Department of Natural Resources) Mr. Edmunds covered areas east of Hudson Bay to Armit, Saskatchewan, examining spruce and tamarack stands along both sides of the C. N. Railway. On July 16 Mr. Edmunds proceeded from Hudson Bay to Winnipeg via Kamsack. He reported to the Winnipeg Laboratory on July 18 where he remained for the next two weeks assistin the laboratory staff in the insectary.

Mr. A. E. Campbell left Winnipeg Headquarters on July 18 for Hudson Bay, Saskatchewan, where he continued forest insect survey observations and general sampling in areas not previously examined.

South of Hudson Bay, a jack-pine stand was examined for jack-pine budworm. Although no budworm was found, several pitch pine nodule makers were collected. Proceeding southeast along Armit Road, locally known as the Ridge Road, random sampling was conducted on willow, poplar and white spruce. A tamarack swamp located in Sec. 28, tp. 44, rge. 1, W. 2nd mer., was examined and a number of larch sawfly larvae were collected.

Using speeder supplied by the Saskatchewan Department of Natural Resources, forested areas west of Hudson Bay along both sides of the Canadian National Railway were examined. All accessible stands of white spruce and tamarack were examined during this survey. North from Veillardville, along the Spruce Products logging road fair coverage was obtained by car.

From July 25 to 27, using a speeder, forested areas along both sides of the Canadian National Railway were examined to the Manitoba-Saskatchewan border. In addition, permanent sample stations were examined west and south of Hudson Bay.

On July 28 the writer proceeded to Pelly, Saskatchewan where the Pelly and other nearby forested areas were examined. This survey commenced in the Madge Lake Area, Duck Mountain Provincial Park. General sampling was conducted on willow and white poplar. An extensive survey was made of tamarack swamps scattered throughout this area. White spruce was also examined and several larvae of balsam-fir sawfly were collected and forwarded to Winnipeg. Isolated stands of tamarack north of Arran and approximately four miles north of Pelly (disease release point) were examined. Larch sawfly larvae were collected in all tamarack stands examined.

The Maloniek Cabin and Parr Hill Tower areas were visited again and a jack-pine plantation surrounding the Maloniek Cabin site was examined. General sampling on tamarack and white spruce was also carried out in this area.

On August 2, Mr. H. Edmunds joined Mr. K. Campbell at Pelly, and together they proceeded to Endeavour, Saskatchewan, examining all accessible tamarack and white spruce stands enroute. Random sampling was conducted on willow and white poplar through the area traversed.

Leaving Endeavour on August 5, the two rangers proceeded to Reserve, Saskatchewan, working the Usherville, Ushta, and Tallpines areas enroute. They remained at Reserve until August 10, and then proceeded to Peesane, Saskatchewan, after working the McBride Lake, Birtwell and the Etomami River areas arriving at Peesane, August 11. An extensive survey of scattered tamarack swamps in this area was conducted. Using speeder supplied by the local Field Officer forested areas along both sides of the Canadian National Railway were examined.

On August 16, the rangers proceeded north to White Fox and thence along the Flin Flon Highway. In this area large stands of jack pine were examined for insect damage and general sampling conducted on white spruce and poplar. They returned to Carrot River on August 17 and thence to Hudson Bay on August 18, working in this area until August 31. Mass collections of larch sawfly cocoons were also collected during this period. In addition random sampling was conducted on tamarack and white spruce in the areas where larch sawfly cocoon collections were made.

On September 1, the rangers proceeded to Winnipeg via Tallpines and Pelly, Saskatchewan, collecting larch sawfly cocoons enroute from the following locations:

Sec. 2, tp. 39, rge. 5, W. 2nd mer. - 1000 cocoons
Sec.16, tp. 34, rge. 2, W. P. mer. - 250 cocoons

All mass collections of cocoons were forwarded to Winnipeg to be dissected later to determine the percentage of parasitism etc. Arriving in Winnipeg September 2 and departing again September 7 for Pelly, Saskatchewan, Rangers Edmunds and Campbell accompanied by Mr. J. B. Martin arrived at Pelly, September 8. Permanent sample plots were established in tamarack stands located in Sec. 16, tp. 34, rge. 2, W. P. mer.

On September 9 the three rangers proceeded to Hudson Bay, where two more permanent sample plots were established; one located in Sec. 29, tp. 49, rge. 2, W. P. mer., and the other approximately 12 miles east of Hudson Bay on the south side of the Canadian National Railway.

On September 13, the rangers proceeded to Riding Mountain National Park, where permanent sample plots were established in tamarack swamps throughout the district. Field work was completed on September 24 and the Insect Rangers returned to the Winnipeg Headquarters on September 25.

(b) Insect Conditions

(1) Larch Sawfly (*Pristiphora erichsonii* Htg.) - The first larch sawfly larvae in the Hudson Bay District were found on June 22 near Prairie River, Saskatchewan. All accessible tamarack stands from Madge Lake, north through Nipawin and Hudson Bay, Saskatchewan, were examined, during the survey. In the Madge Lake Provincial Park several samples were collected but in general only light defoliation was observed. For the most part, tamarack throughout this area is scattered.

North of Arran, Saskatchewan, in Sec. 7, tp. 34, rge. 30, W. P. mer., and north and east of High Bluff, Saskatchewan only light defoliation of tamarack was observed. A tamarack swamp four miles north of Pelly, Saskatchewan in Secs. 15, and 16, tp. 34, rge. 32, W. P. mer., where a fungus (Beauveria sp.) was released in 1948, was examined. Defoliation at the time of examination was approximately 5 to 10 per cent. On a later examination defoliation had increased and ranged from 25 to 75 per cent and some refoliation was evident. In another swamp six miles north of Pelly light defoliation was observed. In Sec. 30, tp. 33, rge. 32, W. P. mer., three miles west of Pelly along Highway No. 49, light defoliation was observed in a tamarack swamp covering approximately 300 acres. In the Malonick Ranger Station area, located in Sec. 14, tp. 36, rge. 32, W. P. mer., defoliation of small isolated stands of tamarack ranged from 5 to 10 per cent and feeding by the larch sawfly appeared to be well advanced.

Nine miles east of Endeavour, Saskatchewan, in Sec. 11, tp. 37, rge. 4, W. 2nd mer., a small stand of tamarack covering approximately 1½ acres was examined and defoliation for the entire stand was estimated at 20 per cent. Production of foliage appeared somewhat retarded in this area.

Severe defoliation was observed in Sec. 35, tp. 38, rge. 5, W. 2nd mer., five miles north of Usherville, Saskatchewan, along Highway No. 9, averaging approximately 85 per cent on the more mature trees. Sawfly feeding appeared well advanced and some new foliage was noted.

Several small isolated stands of tamarack were examined 6.5 miles north of Usherville, Saskatchewan, in Sec. 2, tp. 39, rge. 5, W. 2nd mer.; defoliation ranged from 50 to 100 per cent on the more mature tamarack. Light defoliation was also observed in a small tamarack swamp located in Sec. 14, tp. 39, rge. 5, W. 2nd mer., and sawfly were observed feeding.

Along the road leading to McBride Lake, two different stands of tamarack were examined, located in Sec. 15, tp. 40, rge. 5, W. 2nd mer., and Sec. 20, tp. 49, rge. 2, W. 2nd mer. Larch sawfly larvae were feeding in large numbers and defoliation ranged from 10 to 25 per cent. Tamarack in this area was scattered throughout fairly large stands of black spruce.

In Sec. 15, tp. 42, rge. 11, W. 2nd mer., south of Chelan, Saskatchewan, several samples of larva were collected from a tamarack swamp covering approximately 200 acres. Defoliation ranged from 25 to 65 per cent in this swamp.

Moderate defoliation was observed in a tamarack swamp north of

Bjorkdale, Saskatchewan, in Sec. 33, tp. 43, rge. 12, W. 2nd mer. At the time of examination (August 9) feeding appeared to be completed. This same swamp continued into Sec. 32, tp. 43, rge. 12, W. 2nd mer., where larch sawfly samples were collected. Defoliation at this point was approximately 20 to 40 per cent. Light to moderate defoliation was recorded in isolated tamarack stands in the Peesane and Mistatum areas. This area was covered by speeder along the Canadian National Railway; all stands were damaged by the larch sawfly.

A tamarack swamp located in Sec. 7, tp. 45, rge. 11, W. 2nd mer., was examined on August 9. Several samples were collected and defoliation ranged from 5 to 15 per cent. Foliage gorwth appeared poor and numerous curled tips were noted.

East of Orley, Saskatchewan, in Sec. 13, tp. 43, rge. 11, W. 2nd mer. (private lands) a small tamarack swamp was examined where defoliation was estimated from 25 to 60 per cent. Feeding by this insect appeared to be completed at the time of examination.

In Sec. 26, tp. 45, rge. 10, W. 2nd mer., 2.7 miles north of Mistatum, Saskatchewan, larch sawfly was observed causing light defoliation to tamarack scattered throughout small black spruce swamps. Numerous larvae were noted in this area and feeding was well advanced. Light to moderate defoliation was also observed in Sec. 7, tp. 45, rge. 11, W. 2nd mer., one mile east of Peesane, Saskatchewan. Tamarack in this area is scattered, and feeding by the larch sawfly appeared well advanced.

On August 11, the south half of Sec. 18, tp. 45, rge. 11, W. 2nd mer., was examined. Larch sawfly larvae were still feeding on tamarack at the time of examination and defoliation ranged from 25 to 50 per cent on that date. East of Mistatum, Saskatchewan, in Sec. 7, tp. 45, rge. 9, W. 2nd mer., defoliation was approximately 30 per cent. This swamp covered approximately 100 acres and feeding was well advanced. Tamarack in this particular area is scattered and growing in spruce swamps.

In Secs. 10 and 15, tp. 45, rge. 8, W. 2nd mer., larvae were observed feeding in large numbers; several samples were collected and defoliation ranged from 25 to 50 per cent. Feeding was well advanced when examined and on some of the more mature tamarack feeding appeared completed. Defoliation was heavier around the perimeter of the stands. Several samples were also collected from isolated tamarack throughout a black spruce swamp located one mile east of Prairie River, Saskatchewan, in Sec. 31, tp. 45, rge. 7, W. 2nd mer. Numerous curled tips were noted and large numbers of sawfly were observed feeding. In Secs. 12, 11, and 14, tp. 45, rge. 8, W. 2nd mer., severe defoliation continued. At the time of examination defoliation ranged from 35 to 75 per cent; several samples were collected and numerous curled tips were noted. The mature tamarack appeared to be suffering the severest attack. In a continuation of the above swamp in Sec. 9, tp. 45, rge. 8, W. 2nd mer., 3½ miles west of Prairie River, Saskatchewan, larvae were causing moderate defoliation to scattered tamarack. Feeding was well advanced and several samples were collected from this area. Numerous curled tips were again noted on tamarack.

In Secs. 23, and 24, tp. 45, rge. 7, W. 2nd mer., north of Orley, Saskatchewan, isolated tamarack was examined. Several samples of larvae were collected and defoliation was approximately 35 per cent at the time of examination.

About 11 miles north of White Fox, Saskatchewan, along the new Flin Flon Highway, a large tamarack swamp was examined and numerous sawfly larvae were observed. Feeding appeared well advanced and defoliation averaged approximately 40 per cent for the entire tamarack stand which is scattered throughout a black spruce swamp.

In the Carrot River district, tamarack was quite scattered consisting mainly of a few trees in isolated stands throughout the semi-agricultural area. Since this area is being newly settled much of it is being broken and cleared each year and the tamarack is being removed. However, some of the remaining small stands of tamarack were examined, in Sec. 34, tp. 50, rge. 10, W. 2nd mer., ¾ of a mile west of Battle Heights, P.O., Saskatchewan. Severe defoliation to the more matured tamarack was observed and numerous curled tips were noted. Feeding was well advanced and in some cases it was completed.

On July 7, a tamarack swamp located in Sec. 13, tp. 50, rge. 9, W. 2nd mer. (Pasquia Provincial Forest) was examined; although several samples of the larch sawfly were collected, defoliation was very light. This same stand was examined later and defoliation had increased to 40 per cent.

In the Hudson Bay area all accessible stands of tamarack were examined and in all cases larch sawfly larvae were observed feeding. Along the Spruce Products winter logging road, light to moderate defoliation was noted. Permanent sampling stations located in Tp. 45, rge. 4, W. 2nd mer., 1.7 miles north of Veillardville, Saskatchewan, and 3 miles north of Beillardville, respectively were examined. Defoliation in these two locations was approximately 20 to 25 per cent. Ten miles north of Veillardville, Saskatchewan, in Sec. 25, tp. 46, rge. 5, W. 2nd mer., a five acre black spruce swamp with scattered tamarack was examined and reports indicate that larch sawfly damage was severe at the time of examination (August 30). Very few sawfly larvae were observed indicating that feeding was almost completed. In an adjoining swamp covering approximately two acres, severe defoliation was noted ranging from 40 to 100 per cent.

Moderate to severe damage was again observed to tamarack located in Sec. 35, tp. 46, rge. 5, W. 2nd mer. Approximately 80 to 100 per cent defoliation was noted in an area covering five acres. Several samples of larch sawfly cocoons were collected at this location.

East of Prairie River, Saskatchewan, in Secs. 9 and 10, tp. 45, rge. 7, W. 2nd mer., defoliation ranged from 25 to 100 per cent at the time of examination (August 29). On a previous inspection of this area (July 13) defoliation was reported as light to moderate. At the latter examination no feeding was observed and several samples of larch sawfly cocoons were collected.

In Sec. 5, tp. 45, rge. 5, W. 2nd mer., 12 miles west of Hudson Bay, isolated stands of tamarack were examined; defoliation ranged from 15 to 50 per cent, the more mature tamarack being the most heavily defoliated. Another nearby tamarack swamp located in Sec. 11, tp. 45, rge. 5, W. 2nd mer., suffered moderate to severe defoliation. The mature trees were completely stripped of foliage and very few sawfly larvae were observed feeding at the time of examination on August 29.

North of Hudson Bay through to Atasquan, Saskatchewan, all tamarack examined showed signs of larch sawfly damage. In Sec. 12, tp. 47, rge. 3, W. 2nd mer., a small stand of tamarack was examined. Defoliation on July 14 ranged from 15 to 25 per cent and numerous sawfly larvae were observed still feeding. Good foliage growth was evident in this stand. In Sec. 18, tp. 47, rge. 2, W. 2nd mer., six miles north of Washee, Saskatchewan, light defoliation was observed, and sawfly feeding was well advanced. Several samples were collected from this area, together with a number of larch sawfly cocoons. A large tamarack swamp 18 miles north of Washee, Saskatchewan was examined. This stand was located in Sec. 17, tp. 49, rge. 2, W. 2nd mer. Defoliation ranged from 25 to 60 per cent. In this stand as in others, the more mature tamarack appeared to suffer the severest defoliation. Several collections of larvae and cocoons were made.

About 12 miles southeast of Hudson Bay, along the Armit Road, in Sec. 6, tp. 44, rge. 1, W. 2nd mer., a black spruce swamp containing approximately 40 per cent tamarack was examined. Defoliation ranged from 60 to 100 per cent with the highest defoliation occurring on the more mature tamarack. During the month of September, larch sawfly parasites, _Mesoleius tenthredinis_, were liberated in this stand.

Moderate to severe defoliation on tamarack was also recorded in Sec. 6, tp. 44, rge. 2, W. 2nd mer., 8.9 miles south of Hudson Bay. Three hundred larch sawfly cocoons were collected from this point. No larvae were observed feeding at the time of examination (August 27.)

The area east of Hudson Bay to the Manitoba border was covered by speeder, supplied by the Department of Natural Resources. All tamarack swamps along both sides of the Canadian National Railway were examined. In Secs.10, 11, and 12, tp. 45, rge. 3, W. 2nd mer., moderate to severe defoliation was recorded. In Sec. 2, tp. 45, rge. 1, W. 2nd mer., 14½ miles east of Hudson Bay sawfly damage was observed on all tamarack examined with defoliation ranging from 80 to 90 per cent. Feeding by the larch sawfly was completed and some new foliage was noted at the time of examination.

(ii) Large Aspen Tortrix (Archips conflictana Wlk.) - The three year old infestation in Madge Lake Provincial Park had subsided in 1949 and was causing no noticeable defoliation. All accessible stands of white poplar were examined during the survey north from Madge Lake through to Pelly, west to Endeavour, and then north to Hudson Bay.

At the beginning of the survey several samples of the large aspen tortrix were collected from the Madge Lake area. On May 27 little or no defoliation was noted on poplar. At one point, located in Sec. 27, tp. 30, rge. 30, W. P. mer., near Ministick Beach only a small number of larvae were observed feeding. In Sec. 28, tp. 30, rge. 30, W. P. mer., several larvae were collected. These were confined mostly to poplar seedlings and at the time of examination feeding had just commenced and there was no noticeable defoliation. On May 30 a white poplar stand was examined in Sec. 30, tp. 30, rge. 30, W. P. mer. Only a few aspen tortrix larvae were observed feeding on young seedlings and defoliation was very light. Several of the larger poplar trees had a reddish appearance on the crown and two trees were felled to determine the cause of injury. On close examination it was believed that a late frost might have been the cause.

In Sec. 33, tp. 34, rge. 32, W. P. mer., north of Pelly, Saskatchewan, scattered stands of white poplar were examined and only a few larvae of the large aspen tortrix were collected; no damage was noted. In Sec. 22, tp. 35, rge. 32, W. P. mer., several larvae of the large aspen tortrix were collected together with numerous larvae of the American poplar leaf beetle. Defoliation was confined to the young poplar. Very little defoliation was noted at the time of inspection.

Three permanent sampling stations, established in 1948 in white poplar stands located near the Malonick Cabin, were examined. At Station 9, 15 larvae of the large aspen tortrix were collected, and at Stations 8 and 10, only a few larvae of this insect were collected. In all instances very light defoliation was observed. Reports from this area would indicate that this leaf eating insect was generally distributed but was causing very little defoliation.

In Sec. 2, tp. 36, rge. 31, W. P. mer., north of Sopoff, Saskatchewan, large aspen tortrix larvae were observed feeding on young poplar. Defoliation was very light and green foliage on poplar was healthy and of normal growth. Light defoliation was observed north of Norquay, Saskatchewan, in Sec. 28, tp. 34, rge. 1, W. 2nd mer. Between Endeavour and Ushta, Saskatchewan, several larvae of the large aspen tortrix were collected from young poplar seedlings. Defoliation was light at the time of examination (June 13). Several larvae were also collected five miles north of Ushta, Saskatchewan (Sec. 22, tp. 39, rge. 5, W. 2nd mer.). For the most part, damage was negligible in this area and feeding was confined to young poplar.

(iii) American Poplar Leaf Beetle (Phytodecta americana Schffr.) - Considerable damage caused by this insect to white poplar was observed in the Hudson Bay District in 1949. The most severe damage occurred on young poplar seedlings. All accessible stands of poplar were examined during the survey, commencing in the Madge Lake Area north through to Pelly and Hudson Bay and thence west to Peesane and Carrot River, Saskatchewan.

Several samples of this leaf eating insect were collected near Ministick Beach in the Duck Mountain Provincial Park. Defoliation in this area was light ranging from 5 to 10 per cent. In Secs. 27, and 28, tp. 30, rge. 30, W. P. mer. the larvae were observed feeding on young poplar but defoliation was light and ranged from 5 to 10 per cent. Numerous larvae of this insect were also observed feeding on young poplar in Sec. 29, tp. 30, rge. 30, W. P. mer. Defoliation was light.

White poplar in Sec. 35, tp.34, rge. 32, W. P. mer., was infested, but only very light defoliation was recorded. In the Malonick Cabin Area, several samples of this insect were collected, with defoliation estimated from 5 to 10 per cent. Continuing the survey north of Pelly, Saskatchewan, the American poplar leaf beetle was observed feeding on young poplar in Sec. 22, tp. 34, rge. 32, W. 2nd mer., with only light defoliation being recorded. In addition three permanent sampling stations established in white poplar in 1948 in the Malonick Cabin Area, were examined. One hundred and fifty larvae were collected in one sample from sampling Station No. 8, but only light defoliation (5 per cent) was observed. At Stations 9 and 10, several samples were collected with very light defoliation recorded. Many larvae were observed feeding on young poplar surrounding the sampling stations. Feeding was well advanced at the time of examination (June 6).

Random sampling was conducted in the area north of Norquay, Saskatchewan, in scattered stands of white poplar. In all cases, the American poplar leaf beetle was observed feeding on young poplar in large numbers. Feeding appeared well advanced and defoliation averaged approximately 5 per cent. North of Swan Plain, Saskatchewan, and the Parr Hill Tower (the latter located in Sec. 11, tp. 31, rge. 1, W. 2nd mer.) several samples were collected with light defoliation recorded.

In the area surrounding Sturgis, Saskatchewan, small isolated stands of white poplar were examined and several samples of the American poplar leaf beetle were collected. There was not noticeable damage since feeding by this insect appeared to have just commenced. In the Glen Elder and Densbury areas numerous larvae of this insect were observed feeding on young poplar but again defoliation was only light. In Secs. 15 and 16, tp. 37, rge. 2, W. 2nd mer., defoliation on young poplar ranged from 5 to 10 per cent. This was second-growth poplar and it appeared to be suffering no set-back from attacks by the American poplar leaf beetle.

A light infestation was reported in Sec. 26, tp. 37, rge. 5, W. 2nd mer., between Endeavour and Usherville, Saskatchewan. Many larvae were observed feeding on poplar but defoliation was light at the time of examination (June 9). East of Endeavour, Saskatchewan, in Secs. 1 and 2, tp. 37, rge. 5, W. 2nd mer., and Sec. 30, tp. 3, rge. 4, W. 2nd mer., light defoliation was observed on poplar. Feeding was well advanced in these two locations. Several samples were collected east of Usherville, Saskatchewan, in Sec. 2, and 22, tp. 38, rge. 5, W. 2nd mer., and in Sec. 6, tp. 38, rge. 4, W. 2nd mer. Defoliation averaged about 3 per cent. The American poplar leaf beetle was general on all poplar examined and feeding was well advanced in this area.

In the Manesachin Lake area (Secs. 22, 26, 27, tp. 40, rge. 4, W. 2nd mer.) located in the Porcupine Provincial Forest, the American poplar leaf beetle was prevalent on young poplar. Feeding was well advanced at the time of examination and ranged from 5 to 15 per cent.

Light infestations were reported in the Ushta, Reserve and Bertwell areas. This insect was observed feeding on all poplar examined in these locations with defoliation ranging from 5 to 20 per cent. Several samples were collected along Highway No. 9 in Secs. 9 and 35, tp. 40, rge. 5, W. 2nd mer., with light to moderate defoliation recorded. Continuing the survey west to the Somme, Porcupin Plains, and Caragana, areas numerous larvae of the American poplar leaf beetle were observed feeding on all poplar examined with defoliation averaging approximately 10 per cent at the time of examination (June 16). In the area surrounding Greenwater Lake Provincial Park, no noticeable damage to white poplar was noted. Several samples were collected and feeding was well advanced. In Sec. 28, tp. 41, rge. 10, W. 2nd mer., this insect was again noted on poplar. Numerous larvae were dropping from the trees to the ground. Defoliation in this location ranged from 5 to 15 per cent. In Sec. 28, tp. 41, rge. 7, W. 2nd mer., along the road to Pee Wee Tower, poplar showed signs of light defoliation, ranging from 5 to 20 per cent.

Permanent Sampling Station No. 6, which was established in white poplar in 1948 and located in Sec. 10, tp. 41, rge. 11, W. 2nd mer., was examined and several samples of the American poplar leaf beetle were collected. Feeding was partially completed and numerous larvae were dropping to the ground. Defoliation ranged from 5 to 25 per cent. The young poplar in this area suffered the most severe attacks. Permanent Sampling Station No. 4, located in Sec. 28, tp. 45, rge. 4, W. 2nd mer., was also examined. Only light activity was noted at this Station and defoliation ranged from 5 to 15 per cent.

(iv) Balsam-Fir Sawfly (*Neodiprion abietis* Harr.) - This insect was observed feeding on all white spruce examined in the Hudson Bay District of Saskatchewan in 1949. Although it is becoming increasingly abundant in most areas, thus far, it is causing only negligible to light defoliation.

Several samples of sawfly larvae were collected from the Bertwell and Dencrest areas in Saskatchewan, with no defoliation noted. Numerous larvae were also observed feeding on white spruce in the area between Somme and Caragana, Saskatchewan, and a light infestation occurred in the Prairie River district (Sec. 7, tp. 45, rge. 2, W. 2nd mer.). Several samples of this insect were collected from the latter area but defoliation was very light. In the area surrounding Peesane and east to Mistatum, Saskatchewan, all spruce examined showed sings of light damage caused by the balsam-fir sawfly.

North of Carrot River, where all accessible spruce stands were examined, very light defoliation was noted and for the most part only occasional trees were affected. A light infestation was reported in Sec. 2, tp. 51, rge. 9, W. 2nd mer. Young spruce from 1 to 3 inches d.b.h. were the most heavily attacked. Defoliation ranged from 5 to 15 per cent.

In the Hudson Bay Area, east to Greenbush and Bannock, Saskatchewan, several samples of this insect were collected, but there was no noticeable damage to the spruce examined.

(v) Ugly-Nest Tortrix (_Archips cerasivorana_ Fitch) - This insect was found generally on shrubs throughout the central part of the Hudson Bay District in eastern Saskatchewan.

In Sec. 3, tp. 43, rge. 10, W. 2nd mer., south of Chelan, Saskatchewan, several nests were collected from cherry trees. Light defoliation was confined to trees on which it was collected. Other collections were made in the Greenwater Provincial Park and at Chelan, Saskatchewan (Sec. 23, tp. 41, rge. 10, W. 2nd mer., and Sec. 4, tp. 42, rge. 10, W. 2nd mer.). In the latter area, one hundred and fifty nests were counted on cherry trees over a distance of one-tenth of a mile.

Several collections were made along the Armit Road in the Hudson Bay Area where it was observed feeing on cherry. Collections were made in the following areas:

Sec. 26, tp. 44, rge. 3, W. 2nd mer.
Sec. 28, tp. 44, rge. 1, W. 2nd mer.
Sec. 4, tp. 44, rge. 3, W. 2nd mer.

Several samples were collected near McBride Lake in the Porcupine Provincial Forest and between Codette and Carrot River, west of the Pasquia Provincial Forest. In all cases the insect was causing no serious damage and was confined mainly to chokecherry bushes.

(vi) Prairie Willow Leaf Beetle (_Galerucella decora_ Say) - This insect was generally distributed throughout eastern Saskatchewan in 1949. Severe infestations occurred in the Pelly, and Hudson Bay areas. During the survey this insect was observed feeding on all willow examined, which is widely scattered throughout the Hudson Bay District.

In Sec. 2, tp. 35, rge. 32, W. P. mer., near the Malonick Cabin area, numerous adults of this insect were observed feeding on willow. Several samples were collected from Sec. 33, tp. 34, rge. 32, W. P. mer., and again in Sec. 32, tp. 35, rge. 32, W. P. mer. In all areas where willow was examined numerous adults were observed feeding.

As examinations were made in the above mentioned areas in the early part of the season (June 6) only light defoliation was recorded.

In the area surrounding Madge Lake located in the Duck Mountain Provincial Park, isolated stands of willow were examined. Feeding by the prairie willow leaf beetle was well advanced and defoliation in most cases was light. Large numbers of adults were noted in the Madge Lake area. In Sec. 35, tp. 39, rge. 3, W. 2nd mer. Seven miles north of Wahta, Saskatchewan, along Highway No. 9, this insect was again observed feeding on willow.

In the area surrounding Carrot River, Saskatchewan, north to White Fox, Saskatchewan, all willow examined showed a reddish burned-over appearance caused by numerous adults feeding on the foliage. Light defoliation was reported in Sec. 5, tp. 51, rge. 9, W. 2nd Mer., where several samples were collected.

Severe infestations were observed surrounding the Hudson Bay and Veillardville areas of Saskatchewan. In Sec. 22, tp. 45, rge. 4, W. 2nd mer., small stands of willow were completely defoliated. On August 29, scattered stands of willow were examined in Sec. 9, tp. 46, rge. 4, W. 2nd mer. Several samples of the prairie willow leaf beetle were collected and defoliation varied from 25 to 100 per cent.

From Hudson Bay, east to the Manitoba-Saskatchewan boundary, and south along the Armit Road, all willow examined showed signs of light to moderate defoliation. Light to moderate infestations were noted in the Somme, and Porcupine Plains districts of Saskatchewan, on widely scattered stands of willow.

(vii) A Tent Caterpillar (Malacosoma lutescens N. & D.) - The only reported infestation of this insect was in the Pelly area where several samples were collected from rose bush and cherry trees. Collections were made in Sec. 28, tp. 34, rge. 32, W. P. mer., near the Malonick Cabin in Sec. 30, tp. 34, rge. 30, W. P. mer., north of Arran, Saskatchewan, and along a road allowance in Sec. 36, tp. 33, rge. 1, W. 2nd mer., west of Pelly, Saskatchewan. Defoliation was very light and was confined to the shrubs on which the insects were found.

(viii) Jack-Pine Scale (Toumeyella sp.) - This scale was not found on jack pine in the Hudson Bay District of Saskatchewan in 1949.

(ix) Poplar Borer (<u>Saperda calcarata</u> Say) - No adults or larvae of the poplar boring insect were observed on poplar in the Hudson Bay District of Saskatchewan during the 1949 survey.

(x) Bronze Birch Borer (<u>Agrilus anxius</u> Gory.) - Only one sample of this insect was collected in the Hudson Bay District of Saskatchewan during the 1949 survey. The collection was obtained from the following location: Sec. 9, tp. 45, rge. 10, W. 2nd mer., between Orley and Mistatum, Saskatchewan. Birch throughout the Hudson Bay District appeared healthy and showed good growth.

(xi) White-Sawyer Beetle (<u>Monochamus scutellatus</u> Say) - Only one collection of this insect was made in the Hudson Bay District in 1949. The collection was made in Sec. 3, tp. 39, rge. 5, W. 2nd mer., three miles north of Ushta, Saskatchewan.

(xii) Bark Beetles and Wood Borers - Bark beetles were common in areas in the Hudson Bay District of Saskatchewan, where fires in early spring destroyed large stands of white and black spruce. Several species of bark beetles were collected on fire-killed spruce located in Secs. 8, 9, 10, 16, 17, and 20, tp. 43, rge. 5, W. 2nd mer. Partly burned spruce were the most severely attacked by these insects. In another burn located in Secs. 9, and 17, tp. 43, rge. 5, W. 2nd mer., bark beetles were found in fire-killed spruce. One adult of the flat-headed wood borer, <u>Dicerca tenebrosa</u> Kby. was also found at this location.

In the Prairie River area bark beetles were reported attacking fire-killed spruce in Sec. 3, tp. 45, rge. 8, W. 2nd mer. The pine engraver beetle was also observed feeding on fire-killed timber in this area.

On June 21, adults of a flat-headed wood borer were observed in a stand of fire-killed spruce in Sec. 34, tp. 44, rge. 8, W. 2nd mer. No entry into the wood by these insects was noted at the time of examination. Another large burn occurred in the Greenwater Provincial Park. This burn destroyed approximately 2,000 acres of spruce. Several collections of bark beetles were made in Secs. 10, and 15, tp. 41, rge. 10, W. 2nd mer. Adults of the pine engraver were also infesting fire-killed spruce in this area.

Adults of the flat-headed borer were observed on fire-killed spruce in the Carrot River district. The pine-engraver was also common in this burn. Adults of bark beetles were observed attacking fire-killed spruce in Sec. 9, tp. 50, rge. 9, W. 2nd mer. Another collection of bark beetles was made in Sec. 1, tp. 50, rge. 9, W. 2nd mer., east of Carrot River.

(xiii) Yellow-Headed Spruce Sawfly (<u>Pikonema alaskensis</u> Roh.) Green-Headed Spruce Sawfly (<u>Pikonema dimmockii</u> Cress.) - Several larvae of the yellow-headed spruce sawfly were observed feeding on ornamental spruce located in the town of Crooked River, Saskatchewan, and were causing light to moderate defoliation. This was the only collection made of this insect in the Hudson Bay District. No collections were obtained of the green-headed spruce sawfly in the Hudson Bay District in 1949.

(xiv) Black-Headed Spruce Budworm (<u>Acleris variana</u> Fern.) - Only one larvae of this insect was collected. This collection was obtained from white spruce in the Greenwater Provincial Park (Sec. 10, tp. 41, rge. 10, W. 2nd mer.).

(xv) False Hemlock Looper (<u>Nepytia canosaria</u> Wlk.) - One larvae of this insect was collected in 1949 from white spruce in Sec. 2, tp. 51, rge. 9, W. 2nd mer.

(xvi) Spruce Needleworm (<u>Dioryctria reniculella</u> Grt.) - This insect was observed on widely scattered spruce throughout the Hudson Bay District of Saskatchewan but no serious defoliation was reported. Several samples of this insect were collected from white spruce in Sec. 26, tp. 30, rge. 30, W. P. mer., in the Madge Lake area and Sec. 8, tp. 37, rge. 4, W. 2nd mer., east of Endeavour, Saskatchewan. East and north of Usherville, Saskatchewan, in the Porcupine Provincial Forest, the spruce needleworm was found on white spruce in the following locations:

Sec. 19, tp. 37, rge. 4, W. 2nd mer.
Sec. 23, tp. 38, rge. 5, W. 2nd mer.
Sec. 28, tp. 38, rge. 5, W. 2nd mer.

A stand of white spruce seedlings located between Bertwell and Bonerest, Saskatchewan, was examined and several larvae of this insect were found on the foliage. Other collections were made in Sec. 10, tp. 45, rge. 7, W. 2nd mer., located in the Prairie River area and in Sec. 10, tp. 41, rge. 7, W. 2nd mer., in the Greenwater Provincial Park, but in all cases there was no noticeable defoliation.

(xvii) Pitch Nodule Maker (*Petrova albicapitana* Busck.) - This insect was observed in scattered jack-pine stands in areas surrounding Hudson Bay and White Fox, Saskatchewan. Although no serious infestations were noted this insect was commonly found on regeneration jack pine. Several collections were made in Sec. 28, tp. 44, rge. 3, W. 2nd mer., south of Hudson Bay. Collections were also made in Sec. 32, tp. 44, rge. 3, W. 2nd mer. Scattered jack pine along the new Flin Flon Highway was lightly infested.

(xviii) Spruce Gall Aphid (*Adelges abietis* L.) - This insect was widely distributed throughout spruce stands in the Hudson Bay District of Saskatchewan but was causing no noticeable damage.

(xix) Spruce Budworm (*Choristoneura fumiferana* Clem.) - This insect was absent from any spruce examined in the Hudson Bay District during 1949.

(xx) Jack-Pine Budworm (*Choristoneura fumiferana* Clem.) - No signs of this insect were observed on jack pine sampled in the Hudson Bay District in 1949.

(xxi) Forest Tent Caterpillar (*Malacosoma disstria* Hbn.) - No collections of this insect were made in the Hudson Bay District during 1949.

(c) Special Investigations

(i) Larch Sawfly Cocoon Collections: Several mass collections of larch sawfly cocoons were made at widely separated points in the Hudson Bay District. A table showing the origin of the mass collections follows:

Larch Sawfly Mass Collections

Date	Prov.	Place	Sec.	Tp.	Rge.	Mer.	No. of Cocoons	Check or Release Point
Aug.23	Sask.	11.9 mi.SE Hudson Bay	6	44	1	W 2	1000	check
Aug.23	Sask.	8.9 mi.SE Hudson Bay	6	44	2	W 2	300	"
Aug.26	Sask.	½ mi.E. of Hudson Bay	7	45	3	W 2	1050	"
Aug.26	Sask.	27 mi.N. of Hudson Bay	29	49	2	W 2	1070	"
Sept.1	Sask.	2 mi.S. of Tallpines	2	39	5	W 2	1020	"
Sept.2	Sask.	4 miles north of Pelly	16	34	32	W 1	100	release

(ii) Permanent Sample Plots: Four permanent sample plots were established in tamarack stands in the Hudson Bay District this year. The following table gives the exact location of each plot:

Date	Host	Plot Size	Location				
			Place	Sec.	Tp.	Rge.	Mer.
Sept. 8	Tamarack	5 chs. x ½ ch.	4 mi.N.of Pelly	SW.15	34	32	W 1
Sept.12	Tamarack	7 chs. x ½ ch.	11½ mi.E.of Hudson Bay-Armit Road	SE.12	44	2	W 2
Sept.13	Tamarack	10 chs. x ½ ch.	16.2 mi.N.of Weshee	SW.17	49	1	W 2
Sept.14	Tamarack	5 chs. x ½ ch.	12 mi.N.of Hudson Bay along C.N.R.	SE.10	45	5	W 2

(iii) Sampling Stations: The following table gives the locations of the sampling stations established in the Hudson Bay District in 1949.

Date	Host	Place	Sec.	Tp.	Rge.	Mer.
June 8	White Poplar	Benito Beach Road, Madge Lake	13	33	30	W. 1st
June 15	White Spruce	Usherville, Saskatchewan.	SE.11	39	8	W. 2nd
June 15	White Spruce	Somme, Saskatchewan.	10	41	5	W. 2nd
July 7	Tamarack	Carrot River, Saskatchewan	13	50	9	W. 2nd

(d) Negative Reports

Date	Host	Location	Sec.	Tp.	Rge.	Mer.
May 30	White spruce	Benito Beach, Sask.	26	31	30	W. P.
June 13	Jack pine	f/o Headquarters, Ushta, Sask.	28	38	5	W. 2nd
June 15	Birch	7.1 miles N. of Ushta #9 Hwy.	35	39	5	W. 2nd
July 15	Jack pine	½ mi. off Hwy. Rd. to Erwood	16	44	3	W. 2nd
July 20	Jack pine	SE of Hudson Bay, Sask.	32	44	3	W. 2nd
July 21	Jack pine	S. of Hudson Bay, Sask.	36	44	4	W. 2nd
July 25	Jack pine	4½ mi. S. of Hudson Bay-Armit Rd.	35	44	3	W. 2nd
July 25	Birch	2.2 mi. S. of Hudson Bay, Sask.	4	45	3	W. 2nd
July 26	Jack pine	6 mi. North of Veillardville, S.	8	46	4	W. 2nd
July 29	White spruce	Madge Lake, Sask.	31	30	29	W. 1st

(e) Personnel Contacted

Name	Rank	Location
R. Pike	Forest Technician	Wasagaming, Manitoba
E.A. Koons	District Forester	Dauphin, Manitoba
F. Warburton	District Superintendent	Hudson Bay, Saskatchewan
D.G. Pond	Forest Engineer	Hudson Bay, Saskatchewan
F. Pierce	Equipment Officer	Hudson Bay, Saskatchewan
L. Stewart	Pilot (D.N.R.)	Hudson Bay, Saskatchewan
Chas. Schell	Field Supervisor	Hudson Bay, Saskatchewan
H.A. Randall	Field Officer	Hudson Bay, Saskatchewan
J.G. Cockwell	Field Officer	Hudson Bay, Saskatchewan
F.D. Craig	Jr. Field Officer	Hudson Bay, Saskatchewan
A. Feusi	Field Officer	Madge Lake, Saskatchewan
J. Heron	Assistant Field Officer	Madge Lake, Saskatchewan
J.L. Dobie	Field Officer	Somme, Saskatchewan
J.M. Bacon	Jr. Field Officer	Somme, Saskatchewan
C.L. Schell	Field Officer	Pelly, Saskatchewan
A. Johnson	Jr. Field Officer	Glen Elder, Saskatchewan
L.F. Bryson	Field Officer	Usherville, Saskatchewan
L. Beedle	Field Officer	Carrot River, Saskatchewan
L. Rezanchenko	Jr. Field Officer	Peesane, Saskatchewan
F.S. Hawkins	Field Officer	Chelan, Saskatchewan
K.D. Sanders	Field Officer	Prairie River, Saskatchewan

5. L. McDowall and J. Lawrence

(By L. McDowall)

(a) Introduction

The period April 26 to May 13 was spent on the construction and completion of the Forest Insect Ranger Cabin at Prince Albert, Saskatchewan. Three days of this time were required to contact personnel of the Prince Albert and Meadow Lake districts and to distribute F.I.S. tins.

Forest Insect survey field work in 1949 throughout the Prince Albert and Meadow Lake districts of Saskatchewan commenced in late May and was completed in the latter part of September. This survey was carried out by Forest Insect Rangers L. McDowall and J. Lawrence.

During the month of June an extensive survey for the prevalence of jack-pine and spruce budworm was conducted. The areas visited included Nisbet Provincial Forest, Fort à la Corne Provincial Forest, Torch River Provincial Forest, Prince Albert National Park, Big River Provincial Forest, Meadow Lake Provincial Forest and the Bronson Provincial Forest. A special inspection of the large aspen tortrix infestation in the Glaslyn area was also carried out during this time.

The first two weeks of July were spent by the writer at the Winnipeg Laboratory, assisting in the work of rearing insects. The latter part of July was taken up with a general insect survey along with a larch sawfly reconnaissance of the Prince Albert District.

During the first three weeks of August a survey of tamarack and birch stands was made throughout the Prince Albert and Meadow Lake districts. Two days of this time were spent on releasing parasites; also two days on an aerial survey of tamarack stands north and west of Meadow Lake. The last week of August was spent north of Big River assisting staff from the Winnipeg Laboratory in investigation of wood borer damage to fire-killed timber.

September 1 to 24 was spent establishing permanent sample plots, collecting larch sawfly cocoons and general sampling.

Details of the summer's work and reports of insect conditions are given in the following pages.

(b) Insect Conditions

(i) Larch Sawfly (Pristiphora erichsonii Htg.) - This insect continued to infest tamarack stands in the Prince Albert and Meadow Lake districts of Saskatchewan during 1949. The gradual spread of the larch sawfly north and west of Prince Albert has now become quite apparent. Defoliation in many areas was much heavier than in 1948. The first adults of the larch sawfly were found in the Nisbet Provincial Forest (Sec. 16, tp. 48, rge. 1, W. 3rd mer.) on May 31. Only a few curled tips were noted at this time. During the next three weeks curled tips became more noticeable, and the first larch sawfly larvae were collected in Sec. 16, tp. 49, rge. 28, W. 2nd mer., in the Home Block of the Nisbet Provincial Forest on June 26. Tamarack in this location is very scattered. As feeding had just started no defoliation was visible.

The heavy infestation one mile north of the bridge at Prince Albert (Sec. 8, tp. 49, rge. 26, W. 2nd mer.) showed no signs of abating. At least 75 per cent of the stand was completely defoliated by July 25. During the month of August trees put forth a second growth of foliage. Although this infestation has continued to flourish for the past three years no tree mortality was evident. A mass collection of larch sawfly cocoons was made in the above mentioned location. This swamp was exceedingly wet during the months of July and August.

The heaviest outbreak of this insect was recorded in a large tamarack swamp in the Fort à la Corne Provincial Forest. This swamp is located 4.8 miles north of English Cabin in Secs. 33 and 34, tp. 50, rge. 19, W. 2nd mer. At the time of examination (July 26) feeding was completed and defoliation ranged from 90 to 100 per cent. Towards the latter part of August, a mass collection of larch sawfly cocoons was made and it was noticed that a second growth of foliage adorned the majority of trees. No tree mortality was recorded in this area. Larch sawfly was quite general in tamarack throughout the Fort à la Corne Provincial Forest, with defoliation ranging from medium to heavy.

Last year's infestation in the Steep Creek Block of the Nisbet Provincial Forest, located in Sec. 6, tp. 49, rge. 23, W. 2nd mer., still continued to flourish. At the time of examination (July 22) defoliation was approximately 60 per cent and many larvae were still present. In the Red Rock Block of the Nisbet Provincial Forest only one swamp was examined. This swamp was located in Sec. 32, tp. 49, rge. 25, W. 2nd mer. Here defoliation was recorded as light, and did not increase over the previous year.

Several collections of the larch sawfly were made in the Torch River Provincial Forest. With the exception of one swamp, 3½ miles north of Grassy Lake Tower located in Sec. 24, tp. 54, rge. 15, W. 2nd mer., defoliation was light. In the above mentioned swamp defoliation ranged from 50 to 75 per cent, and when examined late in July it was found to be very wet.

Light defoliation was recorded in the area north of White Fox along the Flin Flon Highway to Crest Post Office. In this area tamarack is very scattered and of no commercial value.

Along Highway No. 55 between White Fox and Smeaton Corner, defoliation ranged from 50 to 70 per cent. Tamarack in this area is growing on privately owned land and occurs in small patches.

From Snowden north to Torch River tamarack was examined at regular intervals with defoliation ranging from light to medium.

In the Candle Lake Provincial Forest defoliation was recorded as light, and all tamarack examined appeared in very good condition.

Two collections of larch sawfly larvae were made in the Emma Lake Provincial Forest. In both areas defoliation was light, and excellent foliage growth noted.

Feeding damage was found to be relatively light in Prince Albert National Park. No increased activity was noted over last year. All swamps examined along Hanging Heart Lake Road showed only light defoliation, from 10 to 15 per cent, the heaviest being in Sec. 27, tp. 57, rge. 1, W. 3rd mer.

From Waskesiu, east to the 3rd mer., along the Lac la Ronge Highway feeding damage was recorded as light. The heaviest defoliation was found in a swamp consisting of approximately 40 acres of second growth tamarack. This stand is located in Sec. 13, tp. 57, rge. 1, W. 3rd mer.; defoliation ranged from 5 to 10 per cent.

South of Waskesiu to the Park Gate tamarack is very scattered, and in most cases only a few clusters of larvae were found. At time of examination (August 19) very few larvae were present. Although defoliation in general appears light in Prince Albert National Park it is thought that the insect is gradually spreading into the area as collections were made in many new areas in 1949.

A swamp 3.5 miles west of Prince Albert in Sec. 11, tp. 49, rge. 26, W. 2nd mer., was severely defoliated. Examination of this swamp on June 28 revealed many curled tips and numerous small larvae.

Towards the end of July, a second visit was made to this area and defoliation was noted as heavy, ranging from 60 to 80 per cent. Many cocoons were also found at this time. Tamarack in this area is very sparse, mixed with black spruce and growing on crown land.

Last year's infestation at Crutwell Corner located in Secs. 27, 22, 15, 16, tp. 49, rge. 1, W. 3rd mer., in the Nisbet Provincial Forest, shows no signs of abating. Unlike last year, cocoons were quite abundant and a mass collection was made late in August from Section 22, where a shipment of parasites (Mesoleius tenthredinis) had been released on August 7. Defoliation ranged from 15 to 70 per cent.

Another area of heavy defoliation was noted in the Canwood Block of the Nisbet Provincial Forest, located in Sec. 16, tp. 50, rge. 4, W. 3rd mer. This swamp covers approximately one hundred acres and is a mixture of tamarack and black spruce. At time of examination (July 24) defoliation ranged from 40 to 65 per cent. A small number of cocoons were also found on the same date.

Collections were made from all accessible tamarack stands from Canwood north along Highway No. 3 to Big River. No serious damage was noted in this area. Defoliation ranged from 15 to 20 per cent.

Larch sawfly was found in most tamarack stands examined in the Big River Provincial Forest, however no great numbers of larvae were collected and defoliation in all cases was recorded as light.

In the Green Lake area larch sawfly damage was very light. Two miles north of Rush Lake in Sec. 13, tp. 60, rge. 14, W. 3rd mer., defoliation was generally light, 15 per cent being the highest recorded defoliation. No serious larch sawfly damage was noted in the Meadow Lake Provincial Forest. The heaviest defoliation by this insect was observed in a large swamp at Turtle Lake in Sec. 34, tp. 53, rge. 18, W. 3rd mer. Defoliation here ranged from 20 to 25 per cent. In all cases only a few larvae were found, and defoliation was confined mainly to the tips of branches on the lower part of the tree.

An aerial survey of tamarack stands north and west of Meadow Lake was carried out by L. McDowell on August 2 and 3. Landings were made and tamarack stands examined at Cold Lake, Primrose Lake, Isle á la Crosse, and Lac des Isles. No larch sawfly larvae were found in any of the above mentioned areas.

Several small tamarack stands were examined in the vicinity of Loon Lake where defoliation was recorded as very light.

Larch sawfly larvae were found in the Prince Albert and Meadow Lake districts during the months of June, July and August. The last collection of this insect was made on September 1, in the Nisbet Provincial Forest.

North of Green Lake in the Waterhen Provincial Forest only one collection of larch sawfly was made (Sec. 29, tp. 66, rge. 12, W. 3rd mer.). Tamarack in this area is very scattered. Defoliation at the time of examination (July 12) was nil.

Larch sawfly was found in all tamarack stands examined in the Nipawin Provincial Forest. At the time of this survey (July 15) defoliation was recorded as very light. The majority of these swamps were wet. No tree mortality was noted in the swamps examined.

(ii) Spruce Budworm - Jack-Pine Budworm (Choristoneura fumiferana (Clem.) - During June an extensive survey for the spruce and jack-pine budworms was carried out in the Prince Albert and Meadow Lake districts of Saskatchewan. No larvae of these two defoliating insects were found.

(iii) Large Aspen Tortrix (Archips conflictana Wlk.) - Large aspen stands around the town of Glaslyn were severely defoliated. Feeding was almost completed when the area was examined on June 15, and only a few larvae were found. However, pupae were quite abundant and several collections of these were made in various locations. A map of the infested area was drawn up in an effort to gain some knowledge of the extent and severity of the damage to aspen by this insect. In a few areas trees were completely defoliated, while in others, defoliation ranged from 30 to 75 per cent. Defoliation was heavy for six miles east of Glaslyn along Highway No. 55. In Secs. 31 and 33, tp. 50, rge. 16, W. 3rd mer., one and three miles respectively, east of Glaslyn, some trees were completely stripped of foliage. Another area of extremely heavy defoliation was located in Secs. 19, 20, 21, 22, 27, 28, 29, and 30, tp. 51, rge. 17, W. 3rd mer., east of Fairholme along Highway No. 55. North of Glaslyn defoliation was light to medium. South of Glaslyn along Highway No. 4 defoliation was medium to heavy. A second area west of Robinhood in Sec. 4, tp. 50, rge. 16, W. 3rd mer., was completely defoliated. The main body of the infestation is centred around Glaslyn in Tps. 50 and 51, rge. 16, and 17. In areas where partial defoliation occurred only the top half of the trees were affected. Trees which were completely defoliated were encased with silken webs.

Information from forest personnel of this district indicated that the infestation appeared somewhat heavier in 1948 than it did in 1949.

During August, a return trip through the infested area revealed that most trees had put forth new leaves. Although no tree mortality was observed dead branches were quite common. The majority of aspen in this area is second growth.

One collection of the large aspen tortrix was made in the Candle Lake Provincial Forest in Sec. 34, tp. 55, rge. 23, W. 2nd mer. In Sec. 25, tp. 55, rge. 4, W. 3rd mer., in Prince Albert National Park, two larvae were collected. A third collection containing one larva was made in Sec. 32, tp. 56, rge. 8, W. 3rd mer., in the Big River Provincial Forest. No defoliation was observed in any of these areas. A map of the large aspen tortrix infestation at Glaslyn, Saskatchewan, is appended to this report.

(iv) American Poplar Leaf Beetle (*Phytodecta americana* Schffr.) - This defoliating beetle was quite general throughout most aspen stands examined in the Nisbet Provincial Forest. Although its widespread activity would indicate serious damage, no heavy defoliation was observed in areas visited. The heaviest defoliation recorded, occurred in the Home Block of the Nisbet Provincial Forest. This was noted in Sec. 16, tp. 49, rge. 26, W. 2nd mer., where defoliation ranged from 25 to 30 per cent. Another area was in Sec. 9, tp. 49, rge. 27, W. 2nd mer., where defoliation ranged from 15 to 20 per cent. Several collections were made in the Red Rock Block, but defoliation in all cases was very light, ranging from nil to 10 per cent. No serious damage by this insect was noted in the MacDowall Block. Aspen in the MacDowall Block is very scattered, generally second growth, and mixed with jack pine. Feeding damage was observed on all aspen examined in the Steep Creek Block but defoliation was light. The heaviest defoliation was recorded in Secs. 28, and 29, tp. 48, rge. 23, W. 2nd mer., and averaged approximately 15 per cent.

Four collections of the American poplar leaf beetle were made in the Candle Lake Provincial Forest. When examined on June 7 defoliation was very light, from nil to 5 per cent, and in no instance were large numbers of larvae found.

A decided decrease in the population of the American poplar leaf beetle was noted this year in the area around Rabbit Cabin, in Prince Albert National Park. In this locality where defoliation ranged from 60 to 80 per cent in previous years, it had decreased to as low as 5 per cent. The most heavily defoliated area was seen in Sec.

34, tp. 53, rge. 4, W. 3rd mer., where defoliation was approximately 15 per cent. Only small trees from 5" to 10" high were being attacked. Light tree mortality was recorded and may be attributed to repeated attacks by this insect. In other areas of Prince Albert National Park insect activity was light.

In the Big River Provincial Forest defoliation in general was light. Isolated trees appeared to be suffering the heaviest damage. In Sec. 14, tp. 56, rge. 8, W. 3rd mer., defoliation was estimated at 20 per cent. The American poplar leaf beetle was found feeding on black poplar in Sec. 12, tp. 56, rge. 8, W. 3rd mer., in the Big River Provincial Forest. This was the only area in which this peculiarity occurred. Heavy frost damage to poplar occurred in Prince Albert National Park and Big River Provincial Forest. Migration of this insect from poplar to willow was observed in some areas in the Prince Albert District. Very light defoliation was caused by the beetle in the Meadow Lake District. In the majority of cases it was found in association with the large aspen tortrix in the Glaslyn area, and an accurate estimate of defoliation could not be made owing to the heavy damage caused by the aspen tortrix.

(v) Prairie Willow Leaf Beetle (<u>Galerucella decora</u> Say) - Defoliation by this insect was found to be comparatively light in all areas where willow was examined. Numerous adults were present but very few larvae were seen during the survey. The first adults were found on May 30 in Sec. 16, tp. 49, rge. 25, W. 2nd mer., in the Nisbet Provincial Forest. Larvae were first noted on July 23 in the Fort à la Corne Provincial Forest in Sec. 8, tp. 50, rge. 19, W. 3rd mer. Defoliation in this area was negligible. The heaviest defoliation recorded was in Sec. 6, tp. 52, rge. 19, W. 2nd mer., two miles south of Smeaton, ranging from 30 to 40 per cent. In Sec. 15, tp. 53, rge. 25, W. 2nd mer., in the Candle Lake Provincial Forest, defoliation averaged about 30 per cent. No damage to willow was noted in Prince Albert National Park and only a few larvae were collected. One collection of the prairie willow leaf beetle was made in the Big River Provincial Forest, but only three larvae were found and there was no defoliation. In the Meadow Lake District no defoliation on willow was observed in the heavily infested areas of previous years.

(vi) Balsam-Fir Sawfly (<u>Neodiprion abietis</u> Harr.) - This insect was found to be quite generally distributed over the Prince Albert and Meadow Lake districts of Saskatchewan in 1949. The first larvae of the balsam-fir sawfly were collected on June 14 in the Big River Provincial Forest. Populations were light and defoliation was nil at that time. Two collections were made in Secs. 5, and 17, tp. 57, rge. 8, W. 3rd mer. Three miles east of Canwood, in a small isolated spruce stand defoliation was noted as light. This stand was located in Sec. 11, tp. 50, rge. 4, W. 3rd mer. Several collections of the balsam-fir sawfly were made this year in Prince Albert National Park, however, no serious defoliation was noted and in all cases only one or two branches on each tree were affected. In Sec. 29, tp. 57, rge. 2, W. 3rd mer., along the Narrows Road, defoliation was estimated as ten per cent. Spruce in this area is very scattered and ranges from 3" to 4" d.b.h. and 15' to 30' in height. Another area of light defoliation was observed three miles south of Waskesiu in Sec. 4, tp. 57, rge. 1, W. 3rd mer.

Two collections were made along Hanging Heart Lake Road, one in Sec. 18, tp. 57, rge. 1, W. 3rd mer., the other in Sec. 29, tp. 57, rge. 1, W. 3rd mer. In both instances there was no defoliation. The 1948 infestation in a small spruce stand adjacent to the administration building at Waskesiu had almost disappeared. Only to larvae were collected in this area in 1949. Two collections of this insect were made in Fort á la Corne Provincial Forest. No defoliation was seen, and insect populations were very light. Two collections of the balsam-fir sawfly were made in the Emma Lake Provincial Forest. In Sec. 18, tp. 53, rge. 26, W. 2nd mer., a number of larvae were found, but defoliation was recorded as light, and confined mainly to the tips of lower branches. Two collections of this insect were made in Torch River Provincial Forest, one in Sec. 13, tp. 55, rge. 15, W. 2nd mer., and the other in Sec. 6, tp. 54, rge. 15, W. 2nd mer. In both cases the larvae were found feeding on black spruce. Defoliation in both areas appeared very light. No serious defoliation was observed in the Meadow Lake Provincial Forest. Wherever the balsam-fir sawfly was encountered only a few larvae were present.

(vii) Yellow-Headed Spruce Sawfly (Pikonema alaskensis Roh.) Green-Headed Spruce Sawfly (Pikonema dimmockii Cress.) - No serious damage was caused by either of these insects in the Prince Albert and Meadow Lake districts. A trace of the yellow-headed spruce sawfly was found in the Torch River Provincial Forest in Sec. 10, tp. 54, rge. 15, W. 3rd mer., but defoliation was negligible. In the Fort á la Corne Provincial Forest several collections of both sawflies were made but these were very scattered and only a small number of larvae were found. In some instances feeding on black spruce was noted. Insect populations were relatively light in Prince Albert National Park. Only one area of light defoliation was seen and it occurred in Sec. 31, tp. 57, rge. 2, W. 3rd mer. The stand consisted of fifteen trees, but larvae were found on only two trees. Both green-headed and yellow headed spruce sawfly were collected at this point. The yellow-headed spruce sawfly was collected at two points in the Meadow Lake Provincial Forest. No defoliation was observed in this area and very few larvae were found.

(viii) Ugly Nest Tortrix (Archips cerasivorana Fitch) - Only three nests of this insect were found, one in the Fort à la Corne Provincial Forest, and two in the Nisbet Provincial Forest.

(ix) White-Pine Weevil (Pissodes strobi Peck) - Damage by this insect was observed in only one area during 1949. In the Big River Provincial Forest in Sec. 29, tp. 56, rge. 8, W. 3rd mer., a stand of young pine was attacked. Trees in this area ranged in height from 10' to 15' and ½" to 1" d.b.h. Approximately 30 per cent of the stand suffered damage from this insect.

(x) Pitch Pine Nodule Maker (Petrova albicapitana Busck.) - This insect was found to be quite general throughout most of the young jack-pine stands in the Prince Albert and Meadow Lake districts of Saskatchewan. Random collections were made during the summer, but no really severe outbreak was encountered. The heaviest damage occurred in a young jack-pine stand 4½ miles east of the third meridian along Highway No. 2 in Prince Albert National Park in Sec. 22, tp. 57, rge. 27, W. 2nd mer. About 25 per cent of the stand was being attacked. Another area where this insect was found to be quite common was a small plantation adjacent to the field officer's headquarters at MacDowall in the Nisbet Provincial Forest.

(xi) Tent Caterpillar (Malacosoma lutescens N. & D.) - This insect was quite generally distributed throughout the Nisbet Provincial Forest. The most severe infestation was centred in the MacDowall area, along Highway No. 12 from MacDowall south to the Forest boundary, in Sec. 34, tp. 45, rge. 1, W. 3rd mer. Chokecherry trees in this locality were between 80 and 100 per cent defoliated, and in some cases the larvae were observed feeding on willow and second growth poplar. At the time of examination (June 10) nests were found to contain scores of dead larvae. Another area where defoliation was noted as heavy, but only on occasional trees, was one mile north of the Prince Albert Cabin in Sec. 21, tp. 49, rge. 26, W. 3rd mer. It was also found scattered along Highway No. 3 as far west as Shellbrook. Through this area the infestation was very light. Collections were also made along Highway No. 55 between

Henribourg and Nipawin; but no serious damage was noted.

(xii) European Alder Leaf Miner (Fenusa dohrnii Tischb.) - This insect was quite general on alder throughout the Meadow Lake and Prince Albert districts of Saskatchewan. No serious outbreak was observed and in all cases only small clumps of trees were being attacked. In the Home Block of the Nisbet Provincial Forest in Secs. 22 and 24, tp. 49, rge. 2, W. 2nd mer., defoliation ranged from 15 to 20 per cent. This was the heaviest feeding recorded. Other collections were made in the Candle Lake Provincial Forest and the Meadow Lake Provincial Forest, Prince Albert National Park and Big River Provincial Forest.

(c) Special Investigations

(i) Large Aspen Tortrix (Archips conflictana Wlk.) - Three days, June 16, 17, and 18, were spent in a reconnaissance of aspen stands in the Glaslyn area. At the time of examination the larvae had completed feeding and were pupating. All stands examined within a radius of six miles of Glaslyn were between 30 to 100 per cent defoliated. The greater part of the infestation is located on privately owned land in pure aspen stands.

Stands in this area are very scattered, for the most part mature, with little second growth and of medium density. The main body of the infestation is centred around the town of Glaslyn in Tps. 50, and 51, rges. 16, and 17. The heaviest defoliation was observed from 1 to 6 miles east of Glaslyn in Secs. 1, 2, 3, 4, and 5, tp. 51, rge. 16, W. 3rd mer., and Secs. 30, 31, 32, and 33, tp. 50, rge. 16, W. 3rd mer. Here defoliation ranged from 80 to 100 per cent. Another area of heavy defoliation was in Secs. 22, 23, 26, and 27, tp. 51, rge. 17, W. 3rd mer., seven miles northwest of Glaslyn. Defoliation ranged from 50 to 85 per cent. In areas where trees had been completely defoliated a large silken net enveloped almost the entire tree. At the time of examination no dead trees were observed. By the first week of September most trees had grown new leaves. A map was made of the infested area showing the varying degrees of defoliation.

(ii) Larch Sawfly Reconnaissance: On August 2 and 3, an aerial survey of tamarack stands was conducted north and west of Meadow Lake. Areas covered were from Meadow Lake west to Cold Lake, north to Ile à la Crosse and return to Meadow Lake. Landings were made and tamarack stands examined at the following places:

Cold Lake
Primrose Lake
Ile à la Crosse
Canoe Lake

All tamarack appeared exceptionally healthy and no sawflies were collected.

(iii) Permanent Sample Plots: Between September 1 and 23, 1949, twelve permanent sample plots were established in tamarack in the Nisbet, Fort a la Corne, Big River, and Meadow Lake Provincial forests of Saskatchewan. These plots vary from 7 to 10 chains in length by half a chain in width.

Ten trees in each plot were permanently makred for future recording of defoliation and tree growth during the next five years. Three trees were selected from each plot and from these three tree rings were taken; the first one 12" from the butt, the second from the middle, and the third one 6' from the top. The locations of the permanent sample plots established in 1949 are shown in the following table:

Permanent Sample Plots - Sask. - 1949.

Number	Species	Provincial Forest	Location
1	Tamarack	Fort à la Corne	Sec. 33, tp. 50, rge. 19, W. 2nd mer.
2	Tamarack	Nisbet	Northeast ¼ Sec.13,tp.49,rge.26,W.2nd me
3	Tamarack	Nisbet	Northeast ¼ Sec.8,tp.49,rge.26,W.2nd mer
4	Tamarack	Big River	Southwest ¼ Sec.30,tp.56,rge.8,W.3rd mer
5	Tamarack	Big River	Sec. 26, tp. 56, rge. 9, W. 3rd mer.
6	Tamarack	Big River	Sec. 32, tp. 55, rge. 7, W. 3rd mer.
7	Tamarack	Fort à la Corne	Sec. 28, tp. 50, rge. 19, W. 2nd mer.
8	Tamarack	Fort à la Corne	Sec. 4, tp. 50, rge. 20, W. 2nd mer.
9	Tamarack	Meadow Lake	Southwest ¼ Sec.12,tp.55,rge.17,W.3rd me
10	Tamarack	Meadow Lake	Sec. 15, tp. 55, rge. 17, W. 3rd mer.
11	Tamarack	Meadow Lake	Sec. 34, tp. 53, rge. 18, W. 3rd mer.
12	Tamarack	Nisbet	Sec. 15, tp. 49, rge. 1, W. 3rd mer.

(iv) Parasite Liberations: Approximately two days were spent in liberating parasites in the Nisbet Provincial Forest. One shipment of the parasite (*Mesoleius tenthredinis* sp.) and one shipment of the parasite (*Tritneptis klugii* sp.) were received from the Dominion Parasite Laboratory, Belleville, Ontario, for liberation in tamarack stands infested with the larch sawfly. These parasites were released in a large tamarack swamp ten miles west of Prince Albert, in Sec. 22, tp. 49, rge. 1, W. 3rd mer., in the Nisbet Provincial Forest.

(v) Larch Sawfly Cocoon Collections: During the last week of August larch sawfly cocoons were collected in the Prince Albert District of Saskatchewan. One thousand cocoons were obtained from each of the following locations.

Secs. 22 and 27, tp. 49, rge. 1, W. 3rd mer., Nisbet P. F.
Sec. 33, tp. 50, rge. 19, W. 2nd mer., Fort à la Corne P. F.
Sec. 8, tp. 49, rge. 26, W. 2nd mer., Nisbet P. F.

All tamarack swamps in the above locations suffered heavy defoliation. Larch sawfly cocoon collections were made for the prupose of obtaining information on the distribution of parasites.

(d) Negative Reports

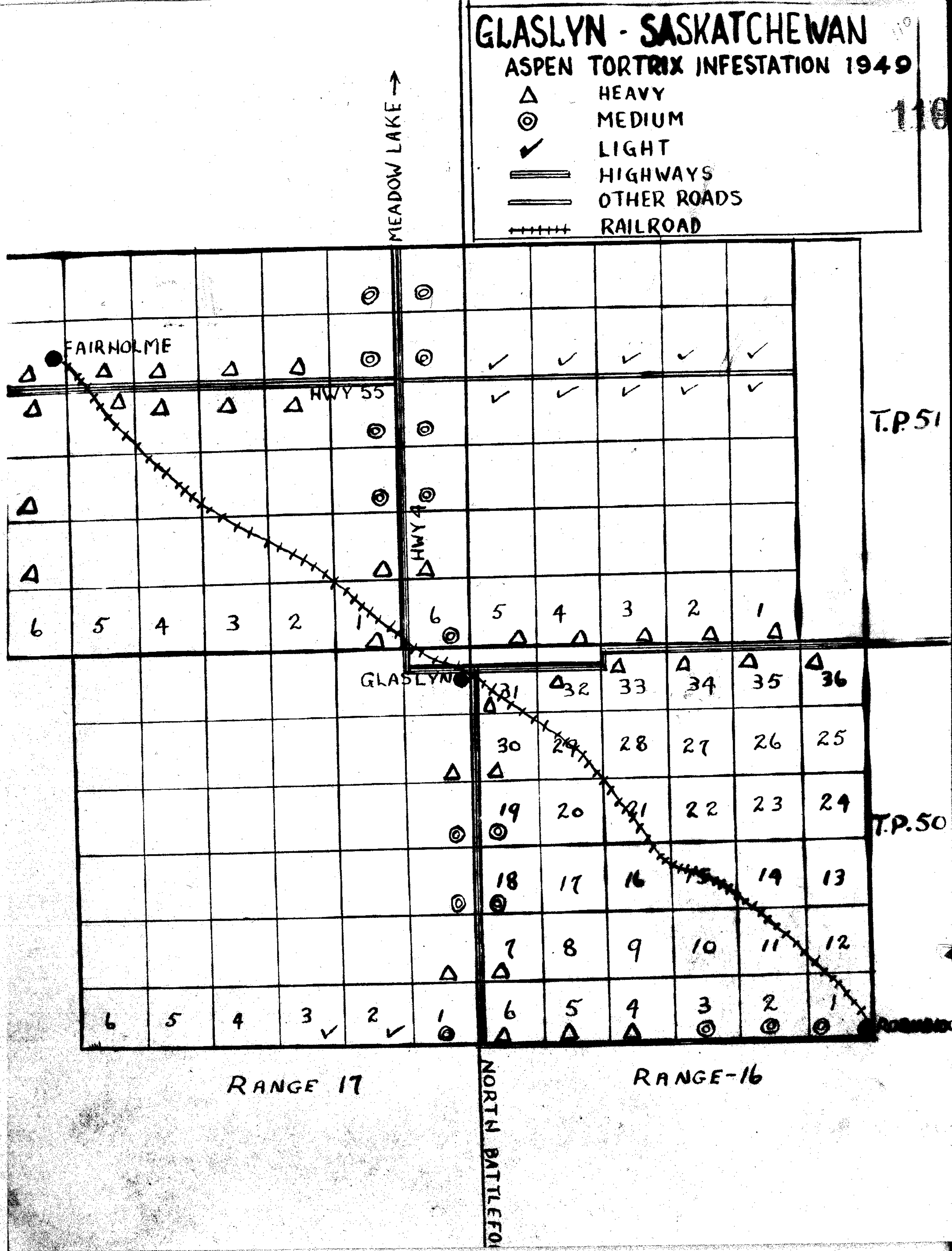
Date	Host	Place	Sec.	Tp.	Rge.	Mer.
June 1	White spruce	Smeaton	26	52	19	W.2nd
June 3	White spruce	Red Rock Block, N.P.F.	22	49	25	W.2nd
June 6	White spruce	Prince Albert Nat. Park	6	53	4	W.3rd
June 7	White spruce	Steep Creek Block, N.P.F.	28	48	23	W.3rd
June 10	White spruce	Prince Albert	16	49	26	W.2nd
Aug. 8	White spruce	Meadow Lake Prov. Forest	33	56	16	W.3rd
Aug. 11	Jack pine	MacDowall Block, N.P.F.	13	48	2	W.3rd
Aug.13	Jack pine	Prince Albert	27	49	1	W.3rd
Aug.17	White spruce	Torch River Prov. Forest	29	53	18	W.2nd

(e) Personnel Contacted

Name	Title	Place	Demonstration of Sampling
E.J. Marshall	Director of Forests	Prince Albert	No
B. Matheson	District Superintendent	Prince Albert	Yes
F. Arnold	Field Officer	Prince Albert	Yes
E. Horne	Field Officer	Smeaton	Yes
E. Shannon	Field Officer	Whitefox	Yes
F. Beaudoin	Field Officer	Paddockwood	Yes
E.L. Millard	Park Warden	Cookson	Yes
F. Jervis	Park Warden	Cookson	No
A.O. Ashim	Field Officer	Prince Albert	Yes
A. Towill	Field Officer	MacDowall	Yes

Personnel Contacted (cont'd)

Name	Title	Place	Demonstration of Sampling
J. Cowie	Cruiser	Big River	Yes
W. MacNeill	Forester	Meadow Lake	Yes
A. Hansen	District Superintendent	Meadow Lake	No
A. Stark	Field Officer	Glaslyn	Yes
A. Howland	Field Supervisor	Meadow Lake	Yes
D. Linton	Field Officer	Lac la Ronge	Yes
W. Raise	Field Officer	Lac la Ronge	Yes
S. Mitchell	Fish Inspector	Prince Albert	No
G. Pederson	Field Officer	Montreal Lake	No
A. Fremont	Field Officer	Montreal Lake	No
B.I.M. Strong	Park Superintendent	Waskesiu, P.A.N.P.	No
C. Pocock	Park Warden	Waskesiu, P.A.N.P.	Yes
R. Whitlock	Field Officer	Nipawin	No
G. Horncastle	Forester	Prince Albert	Yes
A. Russell	Field Officer	Holbein	Yes
H. Eisler	Forester	Prince Albert	No
N. Mazurek	Field Officer	English Cabin	Yes
L. Stubbington	Field Officer	Grassy Lake	Yes
J. MacDonald	Field Officer	Emma Lake	Yes
J. Clay	Game Inspector	Prince Albert	No
C. Labey	Pilot	Meadow Lake	Yes
B. Johnson	Field Officer	Cold Lake, Alberta	Yes
W. Wagner	Patrolman	Cold Lake, Alberta	Yes
O. McNeil	Field Officer	Ile a la Crosse	Yes
B. Crothers	Field Officer	Green Lake	Yes
Dr. Riley	Pathologist	Saskatoon	Yes
G. Davies	Park Warden	Waskesiu, P.A.N.P.	Yes
C. Christie	Forester	Prince Albert	No
E. Over	Field Officer	Big River	Yes
J. Johnson	Field Supervisor	Prince Albert	No
H. Stav	Field Officer	Loon Lake	Yes
W. Lakevold	Field Officer	Meadow Lake	No
E. Sharman	Field Officer	Pierceland	No
C. Otterbein	Field Officer	Prince Albert	Yes
H. Harrison	Park Warden	Waskesiu, P.A.N.P.	No


GLASLYN - SASKATCHEWAN
ASPEN TORTRIX INFESTATION 1949
HEAVY
MEDIUM
LIGHT
HIGHWAYS
OTHER ROADS
RAILROAD
MEADOW LAKE →
FAIRHOLME
HWY 55
HWY 4
GLASLYN
T.P. 51
T.P. 50
RANGE 17
RANGE-16
NORTH BATTLEFO

1. Larch Sawfly - 1949

by L. L. McDowall and V. Hildahl

Introduction

The following report contains complete information on the status of the larch sawfly (*Pristiphora erichsonii* Htg.) throughout larch stands in forested areas of Manitoba and Saskatchewan that were covered by the Forest Insect Survey in 1948. The report also contains information on the distribution and status of larch sawfly parasites as determined by dissections and rearings.

Except for part of Eastern Manitoba, the results contained in this report are based on ground inspections of the stands. Information on the status and distribution of the larch sawfly in Eastern Manitoba from the Winnipeg River north to the Berens and Assapan rivers was derived chiefly from aerial reconnaissance.

A complete survey of the northern districts of Manitoba and Saskatchewan was not attempted owing to restricted travel and the inaccessibility of the areas concerned. There are few roads in the region and the only means of transportation is by aircraft. Adequate coverage was made of the areas around and north of, The Pas in northwestern Manitoba.

(a) Distribution

Tamarack stands in the provinces of Manitoba and Saskatchewan were again subjected to attack by the larch sawfly during 1949.

In the Eastern and Southern districts of Manitoba damage by this insect appeared somewhat lighter than in previous years. The first collection of larch sawfly larvae was obtained on June 22 in the Lac du Bonnet area.

During the latter part of July, an aerial survey was made east of Lake Winnipeg in Manitoba. In the region from the Winnipeg River in the south to the Berens River in the north, defoliation was recorded as only light to moderate. A survey of tamarack stands in the Lac du Bonnet area showed medium defoliation. During the latter part of July a large stand of tamarack east of Whitemouth along the Boggy River flats was examined and defoliation ranged from 70 to 80 per cent. When re-examined in September it was noted that considerable refoliation had taken place.

In the Whiteshell Forest Reserve defoliation was lighter than in 1948. Complete stripping was rare and usually occurred only on trees up to 15 feet in height. In the vicinity of Falcon Lake swamps observed were small and defoliation was moderate, in some cases only traces being present. Along the Brereton Lake road from No. 1 Highway to Red Rock moderate defoliation was recorded. Light to moderate defoliation was observed in tamarack swamps along the Big Whiteshell and Betula lake roads. Tamarack stands examined east and west of Piney showed only light defoliation, with the exception of smaller trees (6 to 7 feet in height) which were completely defoliated. In the Sprague area (Sec. 16, tp. 1, rge. 14, E. P. mer.) a large tamarack stand was examined and defoliation recorded as medium. Defoliation ranged from 35 to 40 per cent in stands at Vassar, Woodridge and in the southern section of the Sandilands Forest Reserve. In the northern sections of the Sandilands Forest Reserve along the Dawson trail from Richer to Reynolds defoliation was severe. The highest defoliation recorded in this area was 85 per cent which occurred in a stand of approximately 10 acres situated on private land one mile east of Reynolds (Sec. 21, tp. 8, rge. 12, E. P. mer.). In the Pine Falls area larch sawfly activity had decreased considerably from 1948 and only a few larvae were found at the time of examination. Part of the reduced defoliation was attributed to the heavy rains which occurred in the area during the latter part of July. There was surface water in most of the swamps and many drowned larvae were observed. A number of tamarack stands along the Bear River Road were examined and defoliation averaged about 50 per cent. It was doubtful whether many larvae would survive owing to surface water and saturated ground conditions in this area.

A large stand was examined two miles east of Seven Sisters and defoliation averaged 40 per cent. All accessible swamps north and south of No. 1 Highway were inspected and the overall defoliation was noted as medium. The number of cocoons destroyed by mice was more numerous in comparison to previous years. No undue tree mortality was recorded in the swamps examined during the season. In the majority of cases the mortality was attributed to other causes. Ground fires, high water levels and mechanical and animal damage seemed to be the four major probable causes of mortality.

Larch sawfly defoliation in the Interlake Area was generally light, with only one area of medium defoliation being recorded. This occurred in Sec. 29, tp. 23, rge. 4, E. P. mer. North of Riverton defoliation was light. Examination of tamarack in the vicinity of Poplarfield revealed light defoliation north to Hodgson, in the stands examined defoliation averaged 30 per cent.

The larch sawfly was found in most tamarack stands examined in the Northern and Western forest districts of Manitoba during 1949. In Riding Mountain National Park tamarack was lightly defoliated except for two locations where medium defoliation was observed. The areas of medium defoliation occurred south of the Park boundary in Sec. 4, tp. 23, rge. 22, W. P. mer., consisting of three acres and in Sec. 3, tp. 23, rge. 23, W. P. mer., in a four acre stand. In the western part of Riding Mountain National Park defoliation was light. Two swamps north of Oakburn were examined and defoliation recorded as three and seven per cent. In the Tillson Lake area north of Rossburn three swamps showed defoliation of two, five and five per cent. Tamarack stands along the Lake Audy - Dauphin trail were examined and defoliation was noted as light. No dead trees were observed and only a few curled tips were evident. Along the Norgate Road defoliation ranged from 10 to 17 per cent. In the central section of Riding Mountain National Park, north of Clear Lake numerous stands were examined and in all cases defoliation was light (5 - 15 per cent.). Five miles west of Dauphin an isolated stand consisting of approximately 150 acres was about three per cent defoliated. At Wade Point on Lake Winnipegosis defoliation varied from nil to 50 per cent. In the Duck Mountain Forest Reserve north of Grandview defoliation in two small stands was five and ten per cent on July 25. These stands appeared very healthy and foliage growth was good. East of Bield, in Sec. 10, tp. 26, rge. 26, defoliation averaged 10 per cent. Larch stands from Cowan to Swan River were checked every mile along No. 10 Highway and defoliation ranged from 25 to 40 per cent. Moisture conditions in these swamps ranged from damp to very wet. Only a few dead trees were observed.

From Swan River north along the east side of the Porcupine Forest Reserve defoliation was more severe, particularly in the Birch River Veteran's settlement, where the swamps had been drained. Defoliation in this area averaged 45 per cent. In the area north of Mafeking, around Dawson Bay and the Red Deer River defoliation averaged about 60 per cent. From the Red Deer River to the north end of the Bay samples were taken every two miles. The area was very wet, and in some places surface water was present. Defoliation averaged 40 per cent.

In The Pas area most of the tamarack was 40 per cent defoliated. A large swamp extending from the Saskatchewan River to Big Eddy Settlement was infested and defoliation varied from moderate to severe. Near Grand Rapids, samples were taken from a tamarack swamp 30 miles long by 4 miles wide. Aerial and ground surveys showed defoliation ranged from 40 to 60 per cent. The area from The Pas to Cedar Lake and Grand Rapids was examined from the air and defoliation over the entire area also ranged from 40 to 60 per cent. From Cormorant Lake to Cranberry Portage defoliation in all stands averaged over 35 per cent. North of Cranberry Portage to Flin Flon and Sherridon tamarack was less severely attacked and defoliation was approximately 25 per cent.

Larch sawfly was present in all tamarack stands examined in the Hudson Bay District of Saskatchewan during 1949.

In the Madge Lake Provincial Park only light defoliation was observed. In several tamarack stands examined north of Pelly defoliation ranged from 25 to 75 per cent. Three miles west of Pelly along Highway No. 49 light defoliation was observed in a tamarack swamp covering approximately 300 acres. Nine miles east of Endeavour in Sec. 11, tp. 37, rge. 4, W. 2nd mer., a small stand of tamarack covering approximately 1½ acres was examined and defoliation averaged 20 per cent. Severe defoliation was observed five miles north of Usherville along Highway No. 9, averaging approximately 85 per cent on the more mature trees. Several small stands six miles north of Usherville were examined and defoliation ranged from 50 to 100 per cent. Along the road leading to McBride Lake tamarack is very scattered and defoliation ranged from 10 to 25 per cent. South of Chelan in Sec. 15, tp. 42, rge. 11, W. 2nd mer., defoliation ranged from 25 to 65 per cent. Light to moderate defoliation was recorded in tamarack stands in the Peesane and Mistatim areas. Tamarack swamps east and west of Prairie River showed moderate to severe defoliation. In the Carrot River district tamarack is quite scattered and consists mainly of a few isolated trees throughout the semi-agricultural area. Defoliation through these stands was severe. On July 7, a tamarack swamp situated in Sec. 13, tp. 50, rge. 9, W. 2nd mer., in the Pasquia Provincial Forest was lightly defoliated. In the Hudson Bay area all accessible tamarack stands were examined and in all cases larch sawfly defoliation was observed. Light to moderate defoliation was noted along the Spruce Products winter logging road. Tamarack stands examined in the area around Viellardville showed moderate to severe defoliation. Tamarack west of Hudson Bay suffered moderate to severe defoliation, with the more mature trees being completely stripped of foliage. North of Hudson Bay through to Atasquan all tamarack showed some signs of larch sawfly defoliation. Defoliation in this area ranged from 15 to 60 per cent. Twelve miles southeast of Hudson Bay, along the Armit Road, a large tamarack swamp was examined. Defoliation ranged from 60 to 100 per cent with the highest defoliation occurring on the more mature trees. East of Hudson Bay to the Manitoba border, all tamarack swamps along both sides of the Canadian National Railway were examined and moderate to severe defoliation was noted throughout the area. Feeding by the larch sawfly was completed and some new foliage was observed at the time of examination.

This insect continued to defoliate tamarack stands in the Prince Albert and Meadow Lake districts of Saskatchewan during 1949. The gradual spread of the larch sawfly north and west of Prince Albert was quite apparent. Defoliation in many areas was much heavier in 1948 than in previous years.

The severe infestation one mile north of the bridge at Prince Albert showed no signs of abating. At least 75 per cent of the trees in the stand were completely defoliated by July 25. No tree mortality was noted in this swamp, although this infestation has continued to flourish for the past three years. The most severe outbreak of this insect was recorded in a large tamarack swamp in the Fort á la Corne Provincial Forest, 4.8 miles north of English Cabin. At the time of examination (July 26) feeding was completed and defoliation ranged from 90 to 100 per cent. During the latter part of August it was noted that the majority of trees had put forth a second growth of foliage. No tree mortality was recorded in this area. Larch sawfly was quite general in tamarack throughout the Fort á la Corne Provincial Forest, with defoliation ranging from moderate to severe. Last year's infestation in the Steep Creek Block continued to flourish and defoliation through the stand averaged 60 per cent. In the Red Rock Block, only one swamp was examined. Defoliation was light, with no increase over last year. With the exception of one swamp three and a half miles north of Grassy Lake Tower, defoliation was light in the Torch River Provincial Forest. In the above mentioned swamp defoliation ranged from 50 to 75 per cent and when examined late in July was very wet. Light defoliation was recorded in the area north of Whitefox along the Flin Flon Highway to Crest Post Office. Along Highway No. 55 between Whitefox and Smeaton Corner defoliation ranged from 50 to 70 per cent. Tamarack in this area is growing on privately owned land and occurs in small patches. From Snowdon north to Torch River defoliation ranged from light to medium. In the Candle Lake Provincial Forest defoliation was recorded as light. Defoliation was also very light in the Emma Lake Provincial Forest.

Defoliation caused by the larch sawfly was relatively light in Prince Albert National Park. All tamarack swamps examined along the Hanging Heart Lake Road showed only light defoliation. From Waskesiu east to the 3rd mer., along the Lac la Ronge Highway defoliation was also light. South of Waskesiu to the Park Gate tamarack is very scattered, and where examined only a few clusters of larvae were found on the trees. Although defoliation in general remained light in Prince Albert National Park the gradual spread of the larch sawfly is becoming evident owing to collections being made in many new areas this year.

Heavy defoliation was evident in a large tamarack swamp three and a half miles west of Prince Albert. Examination of this swamp on June 28 revealed many curled tips and numerous small larvae. Toward the end of July a second inspection was made of this area and defoliation ranged from 60 to 80 per cent. Last year's infestation at Crutwell Corner in the Nisbet Provincial Forest showed no signs of abating, and defoliation ranged from 15 to 70 per cent. Another area of heavy defoliation was noted in the Canwood Block of the Nisbet Provincial Forest situated in Sec. 16, tp. 50, rge. 4, W. 3rd mer. Numerous tamarack stands were examined from Canwood north along Highway No. 3 to Big River. No serious damage was noted in this area. Defoliation ranged from 15 to 20 per cent. Larch sawfly was found in most tamarack stands examined in the Big River Provincial Forest, but defoliation in all cases was light. In the Green Lake area larch sawfly damage was very light, 15 per cent being the highest recorded defoliation.

No serious larch sawfly damage was noted in the Meadow Lake Provincial Forest. The most severe defoliation caused by this insect was observed in a large swamp at Turtle Lake in Sec. 34, tp. 53, rge. 18, W. 3rd mer., where defoliation ranged from 20 to 35 per cent. An aerial survey of tamarack stands north and west of Meadow Lake was carried out, but no defoliation was observed. Several small tamarack stands were examined in the vicinity of Loon Lake but in all cases defoliation was very light. Larch sawfly was found in all tamarack stands examined in the Nipawin Provincial Forest. However, at the time of the survey (July 15) defoliation was recorded as very light.

(b) Special Stand Inspections

A detailed survey of a number of larch swamps in Manitoba and Saskatchewan was carried out during July and August, 1949. In all, 119 swamps were examined which involved approximately 18,200 acres of tamarack. Of the swamps examined 33 per cent were pure stands consisting of 80 per cent or more tamarack.

The most severe defoliation occurred in mixed stands where tamarack formed less than 20 per cent of the forest cover. Trees in the 3" - 6" diameter class suffered the most damage followed next by those in the 0 - 3" diameter class. Dense stands were more severely defoliated than stands of light and medium density. No difference was noted in the degree of defoliation which occurred in stands of light and medium density.

Some correlation was evident between the number of curled tips and percentage defoliation. In stands where severe defoliation occurred, many curled tips were recorded. In stands where defoliation was light curled tips were either occassional or absent. Relatively dry swamps were also severely defoliated. Saturated, wet and moist swamps, for the most part, suffered only light to moderate defoliation.

(c) Larch Sawfly Questionnaires

The following contains a complete summary of the data contained in the larch sawfly reports. A total of 119 reports were submitted in 1949. Wherever possible the data were summarized on the basis of the 119 reports.

(i) Summary:

Number of reports submitted	119
Approximate acreage involved	18,200
Average d.b.h. of tamarack	4 inches
Range d.b.h.	1 to 24 inches
Average height of tamarack	10 to 45 feet
Average defoliation of tamarack (based on 119 reports)	34 per cent
Average defoliation of tamarack (based on 116 reports)	35 per cent

Percentage of stands in which mouse tunnels were observed — 55 per cent

Note: Average defoliation was calculated separately on the basis of 119 reports and 116 reports. In the first instance where the average defoliation was 34 per cent the calculations were based on 119 reports. In the latter instance where the average defoliation was 35 per cent the calculations were based on 116 reports only. For these calculations three reports were omitted as no defoliation was evident in the swamps.

(ii) Relation Between Stand Composition and Defoliation

No. of Reports	Stand Composition	Average Defoliation
39	80 - 100% Tamarack	31
31	50 - 79 % Tamarack	37
35	20 - 49 % Tamarack	35
12	< 20 % Tamarack	38

This year's results indicate that there is no direct relationship between stand composition and defoliation. However, more work will have to be done before any definite conclusions may be arrived at.

(iii) Relation Between Stand Density and Defoliation and Diameter and Defoliation

To determine the relation between stand density and defoliation stand density was classified as light, medium and heavy. It was noted that the most severe defoliation occurred in dense stands. Stands of medium and light density were less severely attacked and for the most part suffered the same degree of defoliation.

To determine the relation between diameter and defoliation the trees were divided into three diameter classes (i.e., 0 - 3" d.b.h.; 3.1" - 6" d.b.h.; and 6.1" - 9" d.b.h.). Average defoliation in the three diameter classes ranged from 31 to 35 per cent.

The relation between stand density and defoliation and diameter and defoliation is shown in the following tables:

Relation Between Stand Density and Average Defoliation	
Density Class	Average Defoliation %
Heavy	51
Medium	32
Light	34

Relation Between Diameter and Average Defoliation	
Diameter Class d.b.h. Inches	Average Defoliation %
0 - 3	31
3.1 - 6	35
6.1 - 9	33

(iv) Relation Between Curled Tips and Defoliation

Some correlation was found between the number of curled tips and the average defoliation. The most severe defoliation occurred in stands where many curled tips were present with less severe defoliation occurring in stands where curled tips were only common, or occasional. The following table shows the number of stands involved and the average defoliation according to the number of curled tips.

Relation Between Curled Tips and Defoliation		
Curled Tips	No. of Stands Involved	Average Defoliation %
Many	8	60
Common	60	45
Occasional	47	17

During the survey a record was kept of moisture conditions in each individual swamp. However, owing to the lack of complete precipitation records no definite conclusions could be arrived at. Dry swamps appeared to suffer the most severe defoliation with less defoliation occurring in saturated, moist and wet swamps in that order.

(d) Larch Sawfly Cocoon Collections and Dissections - 1949

Dissections by: J. Martin
J. Lawrence
E. Campbell
G. Lalor
M. Pratt

Methods

(i) Collecting was done during August, September and October, 1949. A total of 12,400 larch sawfly cocoons was collected. They were hand picked from the moss and litter at the base of tamarack trees. Wherever possible, 1000 cocoons were collected from each area, but it was not feasible to collect this number in every case.

(ii) Storage: The cocoons were packed in damp moss and placed in screen frames 12" x 12" x 3". No more than 1000 cocoons were packed in each frame. The frames were stored in an open root-cellar where temperature varied with atmospheric temperature.

(iii) Dissections: Dissecting was done under the low power lens of binocular microscopes. The larvae were decapitated, inverted with forceps and a blunt needle and the viscera were scraped from the exoskeleton. Then the viscera and exoskeleton were examined for parasite larvae, parasite eggs, disease, fungus, etc.

(iv) Recording was done according to the headings described below. (See Table A.)

Origin of Cocoons: Gives nearest town and the section township, range and meridian where the cocoons were collected.

Parasitism Determined by Dissecting: Gives the total number of cocoons dissected from each location; the total number of cocoons which contained living larch sawfly larvae; the total number of sawfly larvae which contained *Mesoleius* eggs only, *Mesoleius* larvae and *Bessa* larvae; and the total parasitism including *Mesoleius* eggs, *Mesoleius* larvae and *Bessa* larvae.

Dead Larvae: Gives the total number of larch sawfly larvae which were affected with mold or fungus; the total number of larvae which were apparently diseased; the total number of larvae which were dead from miscellaneous causes such as mechanical injury, predators, etc.; the total number of larvae dead, where the apparent cause of death could not be determined; and the total number of dead larvae including those which were affected by fungus and disease, and those which were dead from mechanical injury and cause unknown.

Table B, which is appended to this report, shows the percentage parasitism by Mesoleius aulicus and Bessa harveyi in each area examined in 1949.

(e) Larch Sawfly Rearings

During January and February, 1950, 1,825 larch sawfly cocoons were reared in an incubator to determine larch sawfly parasitism based on actual emergents. The larch sawfly cocoons used for the experiment were collected from various regions of Manitoba and Saskatchewan in the fall of 1949.

The cocoons were reared on moist cotton in jelly jars; 20 cocoons per jar. The initial temperature in the incubator was 45° F. During the first part of the incubation period the temperature in the incubator was raised gradually until a maximum temperature of 70° F. was reached about three weeks after date of incubation.

Some mould and fungus developed on the cocoons but the mortality from this cause was not extensive.

Results of the rearings were summarized and are shown in Table C, appended hereto.

TABLE A

Results of Larch Sawfly Larval Dissections

Origin of Cocoons					Parasitism Determined by Dissecting					Dead Larvae				
Place	Sec.	Tp.	Rge.	Mer.	No. Cocoons Dissected	Living Larvae	Mesoleius eggs only	Mesoleius Larvae	Bessa Larvae	Total Parasitism	Fungus	Disease	Misc.	Cause Unknown	Total Dead
East Braintree	28	8	16	E.P.	241	200	1	8	27	35	6	9	11	15	41
Seddon's Corner, Man.	3	13	9	E.P.	198	144	0	2	24	26	12	8	20	14	54
Lac du Bonnet, Man.	24	15	11	E.P.	54	32	1	[illegible]	3	5	0	1	10	11	22
Lac du Bonnet, Man.	21	15	12	E.P.	132	71	1	1	22	23	18	1	33	9	61
Riverton, Man.	32	23	4	E.P.	188	138	0	3	28	31	13	4	21	12	50
Red Rock Lake, Man.	36	11	14	E.P.	250	238	2	1	23	24	4	1	0	7	12
Telford, Man.	28	10	16	E.P.	250	231	7	9	40	49	0	1	1	17	19
Lake Audy Rd., RMNP	1	21	20	W.P.	19	8	2	0	1	1	7	3	0	1	11
P.O.W. Rd., Swamp #1	12	21	21	W.P.	200	130	10	3	0	3	35	7	21	7	70
P.O.W. Rd., Swamp #2	12	21	21	W.P.	14	13	2	0	0	0	1	0	0	0	1
Mi.145, Dauphin Rd.	25	21	19	W.P.	91	61	6	2	0	2	4	10	7	9	30
Whirlpool Lake Rd.	5	20	17	W.P.	46	0	0	0	0	0	33	0	[illegible]	8	46
Renwer, Man.	11	35	23	W.P.	57	47	1	3	8	11	2	2	4	2	10
Renwer, Man.	15	36	23	W.P.	21	13	2	1	1	2	2	0	0	6	8
Mafeking, Man.	15	44	25	W.P.	250	154	23	11	3	14	56	3	4	33	96
Mafeking, Man.	16	46	25	W.P.	241	160	4	1	5	6	53	6	3	19	81
Pelly, Sask.	15	34	23	W.P.	100	40	8	0	7	7	2	30	4	24	60
Tallpines, Sask.	2	39	5	W.2	245	206	5	5	0	5	5	2	3	29	39
Hudson Bay, Sask.	6	44	1	W.2	245	211	1	1	5	6	18	3	3	10	34
Hudson Bay, Sask.	29	49	2	W.2	242	230	0	0	3	3	8	1	2	1	12
Hudson Bay, Sask.	6	44	2	W.2	192	183	5	0	4	4	2	2	1	4	9
Hudson Bay, Sask.	7	45	3	W.2	241	213	0	0	10	10	4	3	10	11	28
Fort á la Corne, Sask.	33	50	19	W.2	250	215	12	7	0	7	24	0	6	5	35
Prince Albert, Sask.	23	49	1	W.3	250	230	50	5	10	15	4	0	0	16	20
Prince Albert, Sask.	8	49	26	W.2	250	217	90	34	2	36	24	0	0	9	33
Forestry Camp, RMNP				W.P.	200	192	19	4	1	5	4	1	1	2	8
Mi.7, Norgate Rd., RMNP	31	19	17	W.P.	189	149	4	5	69	74	14	7	11	8	40

TABLE B

Larch Sawfly Parasitism as Determined by Dissections
Manitoba and Saskatchewan - 1949

Origin of Cocoons					Per Cent Parasitism			
Place	Location				Hym. Eggs (only)	Hym. Larvae	Dip. Larvae	Total Parasitism
	Sec.	Tp.	Rge.	Mer.				
East Braintree	28	8	16	E.P.	.5	4.0	13.5	17.5
Seddon's Corner	3	13	9	E.P.	0	1.4	16.7	18.0
Lac du Bonnet	24	15	11	E.P.	3.1	6.2	9.4	15.6
Lac du Bonnet	21	15	12	E.P.	1.4	1.4	31.0	32.4
Riverton	32	23	4	E.P.	0	2.2	20.3	22.5
Red Rock Lake	36	11	14	E.P.	.8	.4	9.7	10.1
Telford	28	10	16	E.P.	3.0	3.8	17.3	21.2
Lake Audy Rd., RMNP	1	21	20	W.P.	25.0	0	12.5	12.5
P.O.W. Rd., Swamp #1	12	21	21	W.P.	7.7	2.3	0	2.3
P.O.W. Rd., Swamp #2	12	21	21	W.P.	15.4	0	0	0
Mi.145, Dauphin Rd.	25	21	19	W.P.	9.8	3.3	0	3.3
Whirlpool Lake Rd.	5	20	17	W.P.	0	0	0	0
Forestry Camp, RMNP				W.P.	9.9	2.1	.5	2.6
Norgate Rd., RMNP	31	19	17	W.P.	2.7	3.4	46.3	49.7
Renwer, Mi.245	11	35	23	W.P.	2.1	6.4	17.0	25.4
Renwer, Mi.253.2	15	36	23	W.P.	15.4	7.7	7.7	15.4
Mafeking	19	44	25	W.P.	14.9	7.1	1.9	9.1
Mafeking	16	46	25	W.P.	2.5	.6	3.1	3.8
Pelly, Sask.	15	34	23	W.2	20.0	0	17.5	17.5
Tallpines, Sask.	2	39	5	W.2	2.4	2.4	0	2.4
Hudson Bay, Sask.	6	44	1	W.2	.5	.5	2.4	2.8
Hudson Bay, Sask.	29	49	2	W.2	0	0	1.3	1.3
Hudson Bay, Sask.	6	44	2	W.2	2.7	0	2.2	2.2
Hudson Bay, Sask.	7	45	3	W.2	0	0	4.7	4.7
Fort à la Corne P.F.	33	50	19	W.2	5.6	3.2	0	3.2
Prince Albert	22	49	1	W.3	21.7	2.2	4.3	6.5
Prince Albert	8	48	26	W.2	41.5	15.7	.9	16.6

TABLE C

Summary of Larch Sawfly Rearings - 1949.

Origin of Cocoons	No. of Cocoons Reared	No. of Emergents				No. of Living - Unemerged						Number of Dead in Cocoons						
		Sawfly Adults		Parasites		Sawflies			Parasites			Unemerged			No. of Discards			
									Hym.		Dip.				Mould Fungus	Disease	Mech. Damage	Misc.
		Female	Male	Dip.	Hym.	Larvae	Pupae	Adults	Eggs	Larvae	Larvae	Larvae	Pupae	Adults				
East Braintree	88	49	0	7	0	8	0	0	0	0	0	2	0	3	5	3	0	11
Riverton	147	47	0	24	1	10	1	0	0	0	1	7	4	9	9	5	7	22
Mafeking, Mi.S.4	116	52	0	8	1	8	0	1	0	1	0	4	0	5	8	4	3	21
Tallpines, 2 mi.S.	200	96	1	0	0	8	2	0	0	0	0	20	17	13	15	7	5	16
Hudson Bay, 1 mi.E.	200	122	0	8	0	11	0	0	0	0	0	26	10	6	4	3	1	9
Hudson Bay, 6.9 mi.E.[1]	74	43	1	0	0	8	0	2	0	0	0	5	1	3	2	2	0	7
Hudson Bay[2]	200	79	0	1	0	23	2	0	0	0	0	22	8	20	7	15	3	20
Hudson Bay[3]	200	91	1	0	0	14	3	1	1	0	0	24	3	16	11	13	2	20
Fort a la Corne P.F.[4]	200	29	0	0	0	15	2	0	0	0	0	54	6	22	24	35	4	9
Nisbet P.F.[5]	200	31	0	0	1	10	0	0	2	1	0	52	7	19	30	28	3	16
Crutwell Corner	200	112	0	0	5	6	1	0	0	0	0	7	2	10	6	1	0	50

1. Hudson Bay - Sec. 6, tp. 44, rge. 2, W. 2nd mer.
2. Hudson Bay - Sec. 6, tp. 44, rge. 1, W. 2nd mer.
3. Hudson Bay - Sec.29, tp. 46, rge. 2, W. 2nd mer.
4. Fort a la Corne P.F. - Sec. 33, tp. 50, rge. 19, W. 2nd mer.
5. Nisbet P.F. - Sec. 8, tp. 49, rge. 26, W. 2nd mer.

2. Jack-Pine Budworm (Choristoneura fumiferana Clem.)

(a) Distribution:

No marked changes were observed in the status of the jack-pine budworm infestation covering the Sandilands Forest Reserve in 1949. Nevertheless, a noticeable extension was apparent in the areas of moderate and severe infestation which were first observed in 1948 in the northern part of the Reserve. In general, moderate defoliation continued through the central and southern part of the Reserve with light to moderate infestations occurring near Piney, Badger and Sprague, south of the Reserve.

Jack-pine stands around Seddon's Corner were lightly to moderately defoliated, while reports submitted by B. Gilmore from Stead, indicated severe defoliation in jack-pine stands in Tps. 17 and 18, rge. 8, E. P. mer.

The jack-pine budworm was active in that part of Manitoba east of Lake Winnipeg bounded on the south by the Winnipeg River and on the north by Bigstone and Charron lakes. Information on the status of the budworm in this region was derived chiefly from aerial surveys and a limited number of ground examinations. In 1948 when this survey was made only pockets of moderately to severely damaged jack pine were visible from the air. This year, however, the pockets had merged into a continuous infestation of moderate intensity, which extended from the Oiseau River in the south to the Berens River in the north.

Ground inspections north of Berens River revealed small populations of the jack-pine budworm as far north as Charron Lake. (Charron Lake lies approximately 48 miles north of Little Grand Rapids, Manitoba.)

In the Interlake Area of Manitoba, the jack-pine budworm infestation between Riverton and Hodgson continued to flourish, causing light to moderate defoliation. The infestation covers approximately 40 square miles and is centered around the Town of Rosenburg.

In November a survey was made of jack pine located in Secs. 13, 24, and 25, tp. 31, rge. 9, and Secs. 18, 19, and 30, tp. 31, rge. 10, W. P. mer., south of Gypsumville, Manitoba. The survey was conducted to determine the degree of defoliation and extent of damage caused by jack-pine budworm. The stand is situated on a sandy ridge running in an east-west direction and is composed mainly of mature jack pine interspersed with stunted poplar. The base of the ridge is heavily wooded with black spruce, poplar and tamarack.

Severe defoliation was confined to a small area (approximately 160 acres) of high crowned jack pine on the south-eastern limit of the ridge in Sec. 13, tp. 31, rge. 9, W. P. mer., and Sec. 18, tp. 31, rge. 10, W. P. mer. Defoliation of new and old needles averaged 80 to 95 per cent. Although dead trees were found in all diameter classes in the severely infested area, the greatest mortality occurred in the smaller diameter classes. The remainder of the stand, which extends westward almost to the shore of Lake Manitoba and is composed mainly of open-growing orchard-type jack pine, suffered comparatively light defoliation.

On June 13 a survey was made of the Cowan district. Samples were taken at half-mile intervals along the prominent jack-pine ridge north of Cowan. Jack-pine budworm was detected at the town limits (Sec. 26, tp. 35, rge. 23, W. P. mer.). The stand was pure jack pine, fairly open-growing, with trees from 2" to 5" d.b.h., and from 8 to 20 feet in height. A ten tree sample by beating produced three budworm larvae. A population count on twenty, 18" branches taken at random from 10 trees produced no budworm larvae. There was no noticeable defoliation due to budworm in the area. Half-a-mile north of Cowan (Sec. 26, tp. 35, rge. 23, W. P. mer.), a ten tree sample by beating produced only one budworm larvae. A count of twenty, 18" branches taken at random from 10 trees yielded no larvae. Defoliation averaged about 5 per cent. One mile north of Cowan (Sec. 35, tp. 35, rge. 23, W. P. mer.), 16 budworm were obtained in a ten tree sample by beating. Twenty, 18" tips taken at random in the same area showed no budworm. Defoliation was negligible in the area where this sample was made.

A survey of the Riding Mountain National Park was made on July 8. Jack-pine budworm was found at only one location in the Park. This occurred along the Norgate Road, 2.3 miles east of No. 10 Highway (Sec. 25, tp. 19, rge. 18, W. P. mer.). A ten tree sample by beating produced only one jack-pine budworm larva. A count of twenty, 18" branches in the same area showed no budworm larvae present. Defoliation was light and averaged less than 5 per cent.

Although extensive sampling was conducted through jack-pine stands in Saskatchewan, during June, July and early August, no trace of the jack-pine budworm was found.

(b) <u>Special Surveys</u>:

(i) Current Jack-Pine Budworm Defoliation - Sandilands Forest Reserve - A survey of current jack-pine budworm defoliation in the Sandilands Forest Reserve was carried out during the latter part of August, 1949. Approximately seven days were spent in surveying the entire

Reserve. A large area in the southern section of approximately 13,440 acres of jack pine (21 sections) was burned by a fire which swept up from the south late in April. The fire was, apparently, one of the contributing factors in the decline of the budworm infestation in the southern part of the Reserve as much budworm-susceptible timber was burned. The survey indicated that defoliation had decreased somewhat in the southern section and increased in the northern section of the Reserve. The small pockets of medium to severe defoliation recorded in 1948 in the northern section had increased in size (see map), but no increase in populations was evident in the centre of these pockets. No severe defoliation was recorded in the Reserve during 1949.

Survey procedure was identical to that followed in previous years. All accessible trails and roads in the Reserve were covered. Examinations were made at half-mile intervals and the defoliation on jack pine was recorded for each of the following diameter classes:

0 inches - 5 inches
5 inches - 10 inches
10 inches and over

The percentage of dead tops and dead trees at each inspection point was recorded and calculated according to the diameter classes mentioned above. All points inspected were described and the abundance of male flowers recorded.

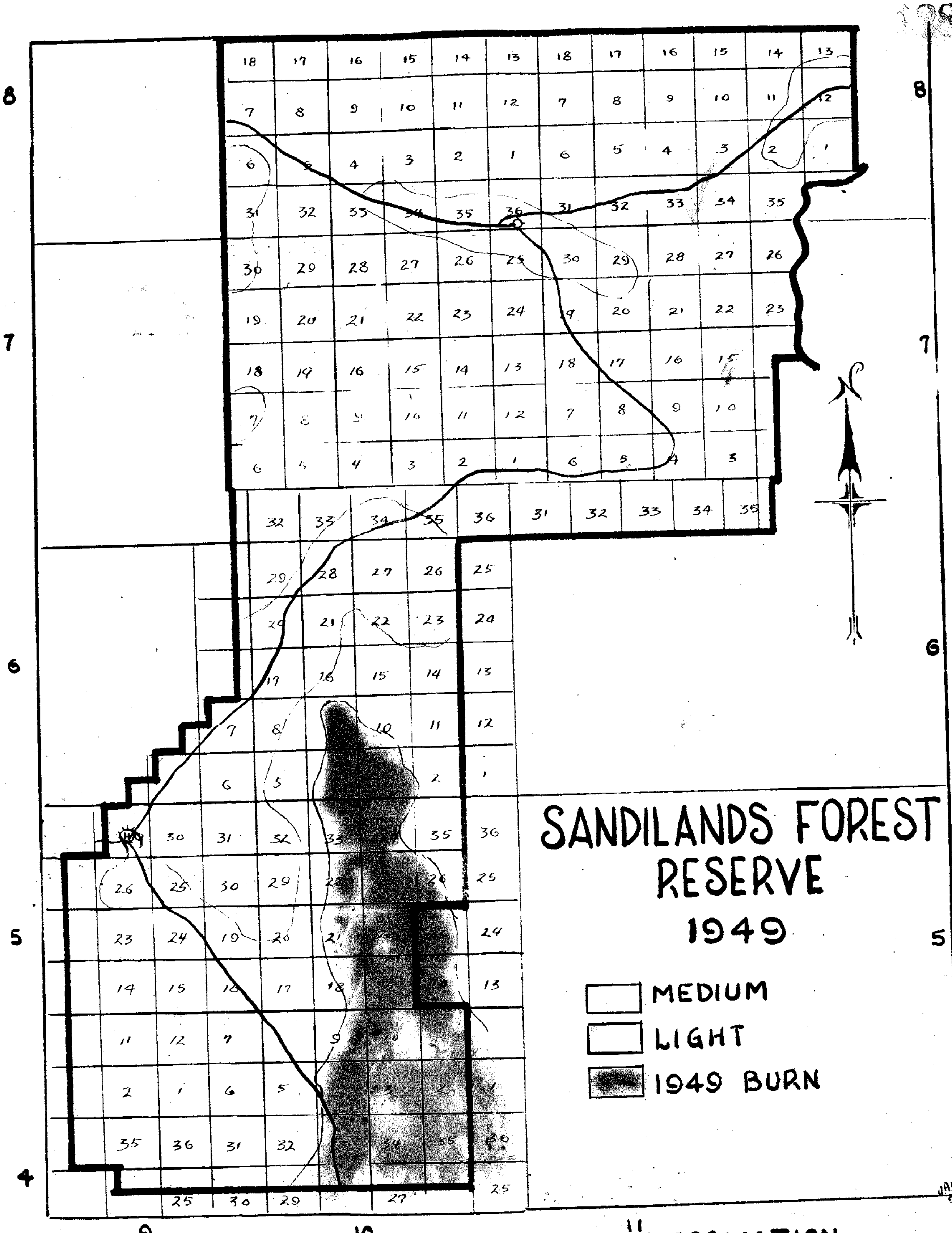
A complete summary of the data obtained from the survey is shown in Table A, which is appended hereto. The table gives the range of defoliation, the percentage of dead tops by diameter classes, percentage of dead trees and general remarks.

(ii) Jack-Pine Budworm Infestation - Stead, Manitoba - In the early part of September two days were spent on a special survey of a jack-pine budworm infestation in the Stead district at the request of the Manitoba Forest Service.

The purpose of this survey was to record the amount and map damage caused by budworm as a guide to future cutting. Wherever possible examinations were made at half-mile intervals to estimate defoliation. Estimates were segregated into the following d.b.h. classes:

0 inches - 5 inches
5 inches - 10 inches
10 inches and over

The percentage of dead tops at each inspection point was recorded and calculated for each of the diameter classes mentioned above.



CURRENT JACK PINE BUDWORM DEFOLIATION

A description of each stand examined was made and a record kept of the abundance of male jack-pine flowers. Throughout the area it was found that regeneration was light and defoliation was heaviest on staminate, open-growing trees in the 5 to 10 inch d.b.h. class.

The severely infected areas are located north of Stead on two natural sandy elevations varying from 750 feet to 950 feet above sea level. The most severe defoliation was centered along the tops of the ridges and decreased to light or absent towards the valley bottom. Approximately 65 per cent of the infested jack pine is composed largely of stagnant male flowering trees, for the most part, open-growing and of fair to poor commercial value.

Defoliation was confined to Tps. 17 and 18, rge. 8, E. P. mer., with the most severe defoliation in Secs. 21, 22, and 28, tp. 17, rge. 8, and Secs. 10, 15, 16, 17, and 18, tp. 18, rge. 8, E. P. mer. Along the tops of these two natural elevations jack pine predominates interspersed with a few small bluffs of white poplar and some birch. White poplar and birch are found on the slopes and black spruce in the lower portions of the valley floor.

A heavy mistletoe infestation was surveyed and mapped along with budworm defoliation in Secs. 15 and 16, tp. 18, rge. 8, E. P. mer. This infection occurs in an over-mature, stagnant stand and is not confined to any particular diameter class. Mortality caused by mistletoe so far is light. Several trees were killed during the year in both the 0 to 5 and 5 to 10 inch diameter classes and numerous others had dead tops due to mistletoe.

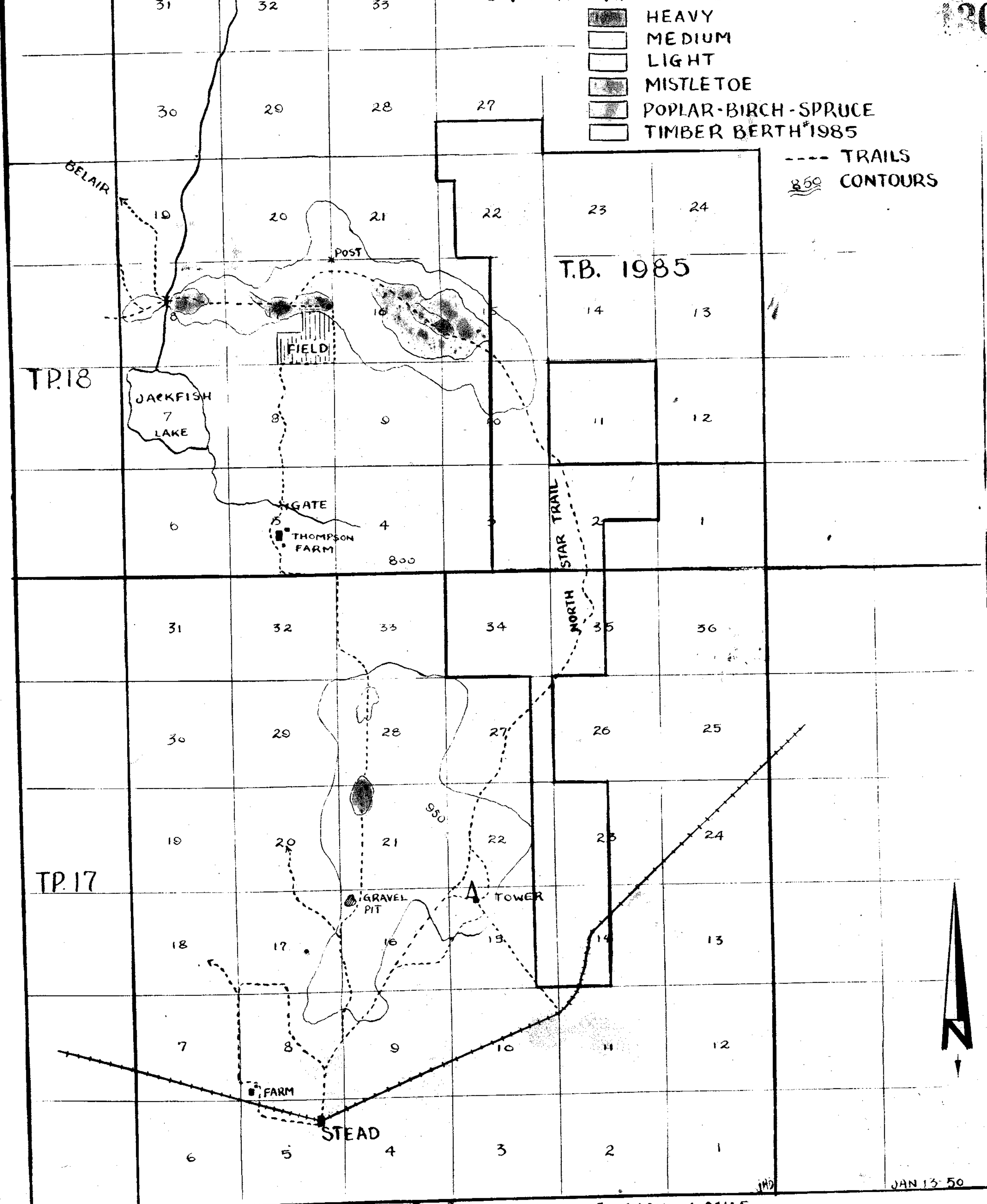
The infection appears to be spreading in an east-west direction along the top of the ridge. Tree mortality throughout the budworm infested area was quite low. Only 1.3 per cent of the trees examined throughout the stand were dead. It was difficult to determine whether death had been caused directly by repeated insect attacks, poor site and growth conditions, disease or a combination of two or more of the factors mentioned.

Dead tops were numerous in the heavily infested areas, particularly in the 5 to 10 inch class. Considering all diameter classes, 28 per cent of the trees examined had dead tops. These were presumably caused by repeated defoliation and poor growth conditions.

The total area infested covered approximately 4,320 acres.

A table was prepared to summarize the results of the survey. (See Table B appended to this report.)

JACK PINE BUDWORM INFESTATION
STEAD MANITOBA — 1949



R-8

SCALE 3/4 INCH - 1 MILE

(iii) Jack-Pine Budworm Infestation - Gypsumville - An extensive survey of a severely defoliated stand of jack pine was conducted on the 22nd and 23rd of November in an effort to determine the extent of damage. The infestation is located in a stand of jack pine along the Gypsumville Road in Secs. 13, 18, 19, 24, 25, 30, tp. 31, rges. 9 and 10. This ridge is located between the Davis Point Road to the north and Fairford Settlement Road to the south. The stand is situated on a sandy loam ridge running in an east-west direction and is composed mainly of mature jack pine interspersed with stunted poplar. The base of the ridge is heavily wooded with black spruce, poplar and tamarack.

Reports received from this area in 1947 and 1948 indicated medium to severe outbreaks of the red-pine sawfly (*Neodiprion nanulus* Schedl.) and light infestations of the jack-pine budworm. During 1949 a jack-pine population count was made in early June in Sec. 24, tp. 31, rge. 10, W. P. mer. Eight jack-pine budworm larvae were obtained from twenty 18" branches. General sampling was also conducted in the immediate area. When first examined (early June) no red-pine sawfly was found and defoliation caused by the jack-pine budworm was light. However, as the season progressed defoliation increased and when re-examined in September it averaged 85 to 95 per cent. The most severe defoliation occurred in Secs. 13, and 18, tp. 31, rges. 9 and 10, in an area comprising approximately 180 acres.

The severe budworm attack is located in a mature stand of jack pine ranging from 1" to 9" d.b.h. growing on a ridge which extends westward from the road almost to the shore of Lake Manitoba. From the road it extends eastward 12 chains before sloping off to swamps wooded with white poplar, black spruce and tamarack.

The severely attacked area extends from the east end of the ridge to 22 chains west of the road. Conditions improve visibly west of this area where the stand changes to opengrowing orchard type trees and is interspersed with stunted white poplar. South of the affected area, the stand is predominantly vigorous growth of white poplar and some scattered white spruce. North of the affected area the stand is less dense with a few pockets of poor growing possibly stagnated, staminate flowering jack pine. Generally in this area, extending to the northern limit of the ridge, the trees are much shorter, averaging 17 to 25 feet in height.

Strips were cruised to obtain precise data on the infestation. The cruise strips were run in an east-west direction at 10 chain intervals through the stand and were ½ chain wide by 10 chains in length. In one instance the infested stand terminated in a spruce and tamarack swamp thereby reducing the length of the cruise strip to 6 chains.

Tally sheets were made up for recording information on the stand. In each cruise strip, the trees were tallied according to the following diameter classes:

.5 to 1.4 d.b.h.
1.5 to 2.4 d.b.h. and
up to 10 d.b.h.

Each tree tallied was classified according to percentage defoliation of current foliage and old needles. Defoliation was divided into the following classes:

0 to 25%
26 to 50%
51 to 75%
76 to 100%

Dead trees were classified according to crown class, under the following classifications; dominant, co-dominant, intermediate, and suppressed. Dead trees were more common in the 3" d.b.h. class followed by the 2" d.b.h. class. In cruise strips #6 and #7 trunk scars were numerous. The scars were, in all probability, caused by old ground fires.

Before commencing the survey it was thought desirable to include a dead top count in the same manner as followed for dead trees. However, defoliation in most cases was too heavy to determine the condition of tree tops by visual examination from the ground. Degree of defoliation was estimated visually for current foliage and old needles. Owing to the lateness of the survey it was impossible to differentiate between flowering and non-flowering jack pine.

Very little variation was noted in defoliation of current foliage and old foliage. In cruise strip #4 the percentage defoliation on the current foliage was higher by 40 per cent than on the old foliage. The results in cruise strip #5 were somewhat the same but defoliation of the current foliage was slightly higher. The stand in the area traversed by cruise strip #4 and in part of strip #5 was mainly open-growing, staminate-flowering orchard-type jack pine averaging 3" to 4" d.b.h. and ranging from 17 to 20 feet in height.

Regeneration throughout the jack-pine stand on the ridge was light. Age grouping was as follows; for the 3" d.b.h. class the age was approximately 40 years and for the 8" d.b.h. class, approximately 60 years. Increment growth was greatly retarded during the last ten years. Average height was 35 feet for the 4 inch diameter class and 40 feet for the 8 inch diameter class.

A complete summary showing total number of trees, diameter of trees, percentage defoliation and percentage of trees dead in each cruise strip is shown in Table C at the end of this report.

The percentage mortality was summarized on the basis of the total number of trees per diameter class in each cruise strip and results are contained in Table D appended to this report.

High mortality rate was evident in trees in the small diameters up to and including the 3 inch d.b.h. In the remaining classes mortality was very light with none occurring in the 8 and 9 inch d.b.h. classes.

On the basis of mortality in relation to crown class, the highest rate of mortality occurred in the suppressed class. In the remaining classes mortality was highest in the co-dominant class followed by intermediate and dominant in that order.

Table E (appended to this report) summarizes dead trees according to crown class.

(c) Negative Reports:

Table F, which is appended hereto, contains a complete list of all negative reports from jack pine from points in Manitoba from the beginning of the season to July 31. Jack-pine samples which contained no insects of any kind are also listed in this Table.

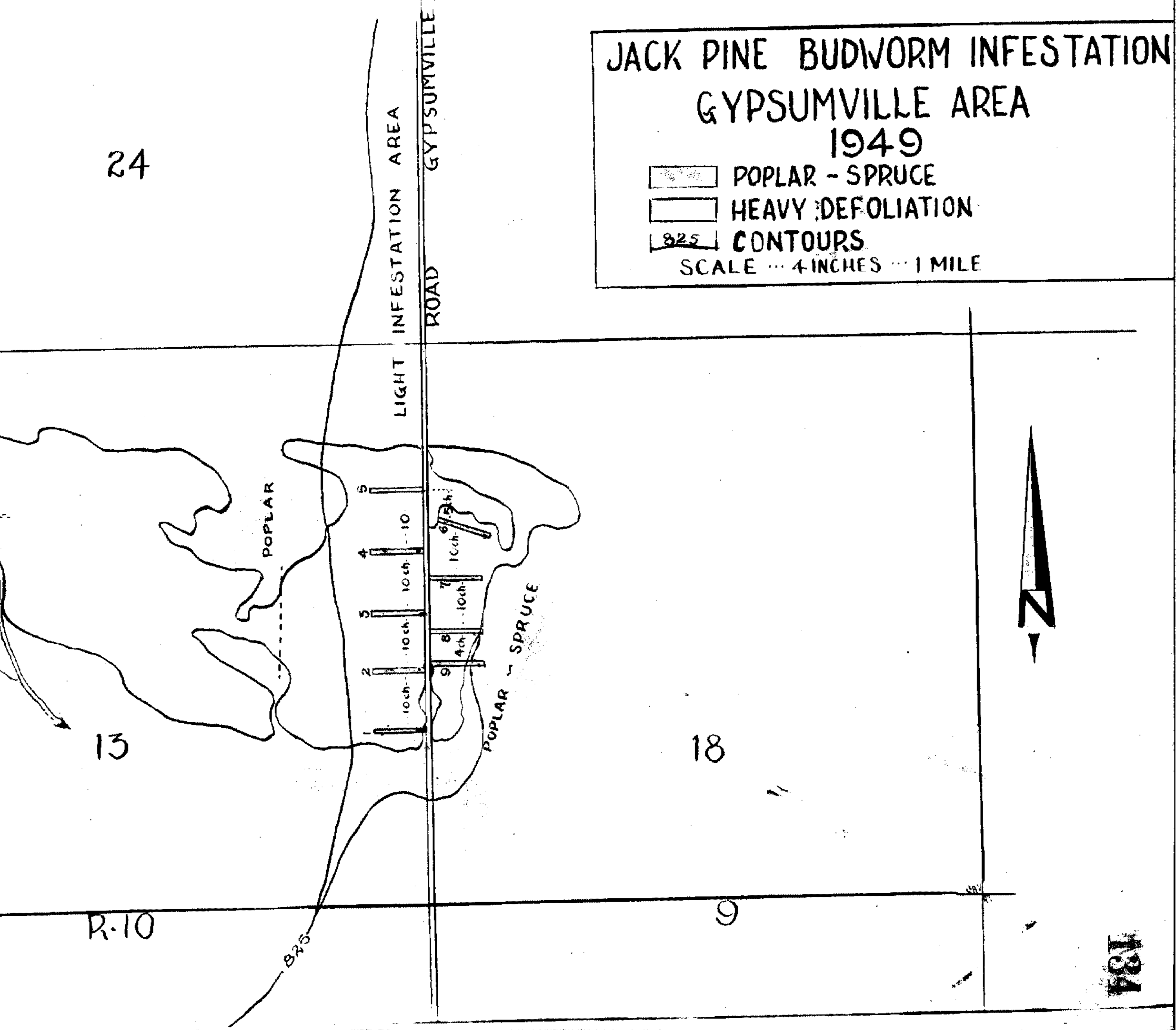

JACK PINE BUDWORM INFESTATION
GYPSUMVILLE AREA
1949
POPLAR - SPRUCE
HEAVY DEFOLIATION
825 CONTOURS
SCALE ... 4 INCHES ... 1 MILE
GYPSUMVILLE ROAD
LIGHT INFESTATION AREA
24
13
18
9
R.10
POPLAR
POPLAR - SPRUCE
825
10ch
4ch
N

TABLE A

Jack-Pine Budworm Survey - Sandilands Forest Reserve - 1949.

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stan.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" ≠	0"-5"	5"-10"	10" ≠				
Reserve H.Q.	medium	medium	medium	nil	nil	nil	nil	medium	8"	Defoliation medium
NE.26-5-9	light	light	--	nil	nil	nil	nil	light	3"	Thick young growth
NW.25-5-9	light	light	--	nil	nil	nil	nil	light	6"	Defoliation light-red-pine regeneration in area
NE.24-5-9	light	light	--	nil	nil	---	nil	light	6"	Light defoliation,few staminate trees
SE.24-5-9	light	light	--	nil	nil	---	21	light	4"	Some trees dying,drouth condition
SW.19-5-10	light	light	--	nil	nil	---	2	light	4"	Scrub growth,light scale
NE.18-5-10	light	light	--	nil	nil	---	nil	light	3"	Heavy stand,young growth
SE.18-5-10	light	light	--	nil	nil	---	nil	light	5"	Mixture of stan. and young growth
NW.8-5-10	light	light	--	nil	nil	---	---	light	5"	Open-growing,light young growth
SE.8-5-10	light	light	--	5	5	---	1	light	8"	Stagnate,medium reproduction
NE.5-5-10	light	light	--	nil	5	---	---	light	5"	Medium density,few staminate
NW.4-5-10	light	light	--	nil	nil	---	---	light	4"	Medium density,medium reproduction
SW.4-5-10	light	light	--	nil	nil	---	---	light	4"	Heavy density,defoliation light
NW.33-4-10	light	light	--	nil	nil	---	nil	light	3"	Firekilled,heavy re-growth
SW.33-4-10	light	light	--	nil	nil	---	nil	light	--	Firekilled
NE.28-4-10	light	light	--	nil	nil	---	---	light	6"	Firekill
NW.28-4-10	light	light	--	nil	nil	---	---	light	7"	Light firekill,mostly ground fire
NE.29-4-10	light	light	--	nil	nil	---	2	light	5"	Firekill
NW.29-4-10	light	light	--	nil	nil	---	1	light	6"	Open-growing
NE.30-4-10	light	light	--	nil	nil	---	2	light	5"	Open-growing,scattered
NW.24-5-9	light	light	--	---	1	---	nil	light	7"	Mixed stand of birch,poplar,light regeneration
SE.23-5-9	light	light	--	---	---	---	nil	nil	5"	Mixed stand of birch,poplar
SW.23-5-9	light	light	--	1	1	---	nil	light	6"	Mixed poplar,birch,open-growing,light defoliation
NE.15-5-9	light	light	--	1	---	---	nil	light	5"	Mixture of young growth,open-growing trees

TABLE A (cont'd)

Location	Defoliation Per Diameter Class 0"-5"	5"-10"	10" /	% Dead Tops Per Diameter Class 0"-5"	5"-10"	10" /	No. of Dead Trees	Stam.	Est.Av. of D.B.H.	Remarks
SE.15-5-9	light	light	--	1	3	---	4	light	6"	Stand medium density, defoliation light
NE.10-5-9	light	light	--	---	---	---	3	medium	7"	Light, open-growing, good regeneration
NE.10-5-9	light	light	--	---	---	---	1	light	5"	Light, opengrowing, defoliation light
SE.10-5-9	light	light	--	---	1	---	---	light	6"	Open-growing, no regeneration
NE.3-5-9	light	light	--	1	---	---	2	light	4"	Stand medium density, defoliation light
NE.34-4-9	light	light	--	---	---	---	4	medium	6"	Open-growing, light regeneration
SE.34-4-9	light	light	--	---	---	---	nil	light	5"	Medium density and young growth
SE.34-4-9	light	light	--	---	---	---	3	medium	4"	Open-growing stand, light re-growth
SW.35-4-9	light	light	--	---	---	---	---	light	4"	Open-growing, medium regeneration
SE.35-4-9	light	light	--	---	---	---	---	light	3"	Heavy young stand with some older staminate trees
NE.35-4-9	light	light	--	---	---	---	---	light	4"	Light, young, open-growing stand
SW.1-5-9	light	light	light	---	---	---	---	light	7"	Scattered, mature trees, mixed poplar, good regeneration
SE.12-5-9	light	light	light	---	---	---	---	light	6"	Prairie, large bluffs, open-growing
NE.12-5-9	light	light	--	---	---	---	---	nil	5"	Dense stand, good growth
NE.12-5-9	light	--	--	---	---	---	---	nil	3"	Dense young growth, light drouth damage
SW.18-5-10	light	--	--	---	---	---	---	light	3"	Young growth, medium density, (on range line)
NW.18-5-10	light	--	--	---	---	---	nil	nil	4"	Dense young stand, growth good
SE.13-5-9	light	--	--	---	---	---	nil	light	4"	Thick stand, good growth, medium scale infes. in area
NW.12-5-9	light	light	--	---	---	---	nil	light	6"	Mature dense stand, light scale
NE.11-5-9	light	light	--	---	---	---	nil	nil	8"	Tall, mature stand, good growth
NW.11-5-9	light	--	--	---	---	---	nil	nil	4"	Defol. light, dense young stand, good growth
SE.10-5-9	light	light	light	---	---	---	nil	light	7"	Heavy, mature stand
NE.3-5-9	light	light	--	---	---	---	2	light	6"	Scattered mature trees, heavy undergrowth
NW.2-5-9	light	light	--	---	---	---	nil	light	6"	Dense stand, light regeneration
NE.2-5-9	light	light	--	---	---	---	nil	light	5"	Scattered clumps
SW.12-5-9	light	light	--	---	---	---	nil	medium	5"	Scattered clumps, open meadows, open-growing
NE.1-5-9	light	light	--	---	---	---	---	nil	4"	Heavy cutting in area, good regeneration

TABLE A (cont'd)

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stan.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" ∠	0"-5"	5"-10"	10" ∠				
NW.6-5-10	light	light	—	—	—	—	4	nil	4"	Dense young growth,light defoliation
NE.6-5-10	light	light	—	—	—	—	nil	light	6"	Good regeneration,mature stand
NW.5-5-10	light	light	—	—	—	—	7	light	5"	Some scale in area,growth condition poor
SW.5-5-10	light	light	—	—	—	—	2	light	5"	Open growing,scattered, good regeneration (Weevil)
NE.31-4-10	light	—	—	—	—	—	2	light	4"	Dense young stand
SW.31-4-10	light	—	—	—	—	—	1	light	4"	Open meadows,mixed birch and poplar
NW.30-4-10	light	light	—	—	—	—	—	light	3"	Mixed mature and young growth
NW.25-4-9	light	light	—	—	—	—	4	light	7"	Mature,open-growing,good regeneration
NW.9-5-10	light	—	—	—	—	—	1	nil	4"	Dense young growth
NE.7-6-10	medium	medium	—	1	2	—	2	light	6"	Solid stand,mature medium defoliation,light re-growth
SW.17-6-10	medium	medium	—	—	—	—	4	light	4"	Solid stand,light drouth kill
SE.20-6-10	light	light	—	—	2	—	6	light	5"	Mixed mature & young growth,light drouth kill
NE.30-6-10	light	light	—	—	—	—	21	nil	3"	Light drouth kill,dense young stand
SW.28-6-10	medium	medium	—	5	1	—	18	light	5"	Drouth kill,medium defoliation,stagnate
NE.28-6-10	medium	medium	—	4	3	—	2	light	6"	Medium defoliation,light young growth
NE.28-6-10	light	light	—	—	1	—	nil	light	5"	Open,mature,swampy
SW.27-6-10	medium	medium	—	1	—	—	8	light	4"	Drouth kill,clumps,dense young growth
SW.26-6-10	medium	medium	medium	1	2	—	3	light	8"	Thick stand, mature
NE.23-6-10	light	light	—	1	—	—	2	nil	6"	Dense mature stand,some spruce,balsam
NE.28-6-10	medium	medium	—	—	1	—	5	light	7"	Mixed spruce,balsam,mature stand
SE.22-6-10	light	light	—	3	—	—	nil	light	3"	Dense young stand,good regeneration
NE.15-6-10	light	light	—	3	12	—	2	medium	6"	Open-growing,light regeneration
NE.10-6-10	light	light	—	1	5	—	1	light	6"	Scattered,mature
SE.10-6-10	light	light	—	—	—	—	nil	light	5"	Mixed black poplar,jackpine
NW.26-6-10	light	light	—	—	1	—	nil	light	4"	Mixed mature and young growth
NE.26-6-10	light	light	—	—	—	—	nil	light	3"	Dense young stand,good regeneration
SW.36-6-10	light	light	—	—	—	—	nil	light	2"	Dense young growth
SE.36-6-10	light	light	—	—	—	—	1	nil	4"	Dense stand
NE.36-6-10	light	—	—	—	—	—	nil	light	4"	Dense young stand,some white spruce

TABLE A (cont'd)

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stam.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" ∠	0"-5"	5"-10"	10" ∠				
SW.6-5-10	light	--	--	---	---	---	6	light	4"	Good re-growth,dense young stand
NW.6-5-10	light	light	--	---	---	---	2	nil	6"	Thick stand,mature
SW.21-5-10	light	light	--	---	---	---	nil	medium	6"	Open-growing,medium regeneration
NW.21-5-10	light	light	--	2	1	---	nil	light	6"	Mature,open-growing,light regeneration
SW.28-5-10	light	light	light	1	4	---	1	light	8"	Overmature,scattered,good regeneration
NW.28-5-10	light	light	--	---	2	---	4	light	3"	Dense young growth,medium regeneration
SW.33-5-10	light	light	light	1	1	---	5	light	5"	Heavy regeneration,overmature,scattered
NE.32-5-10	light	light	--	3	1	---	3	light	5"	Open-growing,dense young growth
NW.32-5-10	light	light	--	1	5	---	6	light	3"	Light drouth kill on 2" D.B.H.,open-growing
SE.6-5-10	light	light	--	1	---	---	nil	medium	5"	Open-growing-good regeneration
SW.6-5-10	light	--	--	---	---	---	nil	nil	3"	Mixed poplar,jack pine
NE.36-5-9	light	light	light	1	4	---	4	light	6"	Overmature,scattered
SW.31-5-10	light	light	light	1	6	2	2	light	8"	Overmature,open-growing,light regeneration
SE.36-5-9	light	light	--	---	1	---	---	medium	6"	Scattered,open-growing,overmature
NW.36-5-9	light	light	--	---	---	---	2	light	5"	Mixed poplar,jackpine, cutting in area
NE.35-5-9	light	light	--	---	---	---	nil	nil	5"	Mixed poplar,birch
NE.35-5-9	medium	medium	--	---	---	---	nil	heavy	7"	Open-growing,staminate
SW.31-5-10	medium	medium	--	1	8	---	2	light	8"	Cutting operation,medium defoliation,open meadows
NE.30-5-10	light	light	--	1	---	---	---	light	6"	Open-growing,mature,light re-growth
SE.30-5-10	medium	medium	--	5	3	---	3	medium	5"	Mixed young & mature growth,medium staminate
NW.29-5-10	light	light	--	---	2	---	7	light	5"	Mixed young & mature,earlier cutting ops.
SW.32-5-10	light	light	--	---	2	---	nil	light	7"	Open-growing,mixed poplar,jack pine
SW.32-5-10	light	medium	--	1	5	---	1	medium	5"	Mature & young growth,previously logged
SW.29-5-10	light	light	--	1	2	---	1	light	5"	Logged area,scattered,good re-growth
NW.20-5-10	medium	medium	--	3	7	---	6	medium	6"	Open-growing,mature,logged,light regeneration
SE.20-5-10	light	light	--	---	---	---	---	nil	4"	Dense young growth
NE.17-5-10	light	light	--	1	---	---	12	light	5"	Logged,drouth kill on regeneration,light scale

TABLE A (cont'd)

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stand.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" +	0"-5"	5"-10"	10" +				
SE.17-5-10	light	light	—	1	—	—	—	light	4"	Young growth, good regeneration
NW.17-5-10	light	—	—	—	—	—	1	light	5"	Open-growing, scattered, light regeneration
SW.20-5-10	light	light	—	—	—	—	nil	light	5"	Thick stand, good regeneration
NE.19-5-10	light	light	—	—	—	—	8	medium	5"	Open-growing, light drouth kill
NE.19-5-10	light	light	—	—	2	—	3	light	4"	Mature & young growth, good regeneration
NE.24-5-9	light	—	—	—	—	—	1	light	4"	Open-growing, light frost kill, good regeneration
NW.23-5-9	light	light	—	—	—	—	nil	medium	5"	Open-growing, clumps dense young growth
SW.26-5-9	medium	medium	medium	—	6	—	2	medium	7"	Open-growing, dense young growth
NE.26-5-9	light	light	—	—	1	—	2	light	7"	Scattered, mature, light regeneration
NW.26-5-9	medium	medium	—	—	1	—	1	medium	6"	Thick, mature stand, mixed poplar, jack pine
NW.1-6-9	light	light	—	—	—	—	1	medium	5"	Mixed poplar, jack pine
SW.7-6-10	medium	medium	—	1	2	—	—	medium	5"	Open-growing, scattered
SE.1-7-10	light	light	—	—	—	—	nil	medium	5"	Open-growing, scattered
SE.6-7-11	light	light	—	2	6	—	3	light	6"	Open-growing, scattered, light regeneration
SW.5-7-11	light	light	—	1	—	—	nil	light	4"	Mixed young & mature growth
SE.36-7-10	medium	medium	—	—	—	—	nil	medium	6"	Thick, mature stand, light regeneration
SW.36-7-10	light	light	—	—	—	—	nil	light	6"	Thick, mature stand
SW.36-7-10	light	light	—	—	—	—	nil	light	6"	Mixed poplar, jack pine
SW.31-7-11	light	light	—	—	2	—	nil	light	6"	Open-growing, mixed spruce, jack pine
SE.31-7-11	light	light	—	—	—	—	2	light	6"	Mixed spruce, larch
SW.32-7-11	light	light	—	1	—	—	nil	light	7"	Mature stand, some spruce
NE.32-7-11	light	light	—	—	—	—	nil	light	5"	Mixed spruce, tamarack
NW.33-7-11	light	light	—	—	—	—	nil	nil	6"	Dense mature stand, some poplar, spruce
NE.33-7-11	light	light	—	—	—	—	nil	nil	6"	Dense mature stand
SW.3-8-11	light	light	—	—	—	—	nil	nil	5"	Mixed spruce & larch, low ground
NE.3-8-11	light	light	—	—	—	—	nil	nil	4"	Very little jack pine, spruce, & larch swamp, some poplar
NE.2-8-11	light	light	—	—	—	—	nil	nil	5"	Dense mature stand, light poplar mixture

TABLE A (Cont'd)

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stam.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" +	0"-5"	5"-10"	10" +				
SE.11-8-11	light	light	—	—	1	—	nil	medium	5"	Open-growing-good regeneration
SW.12-8-11	—	medium	medium	—	1	—	nil	heavy	8"	Open-growing,staminate, mixed poplar,jack pine
NW.12-8-11	medium	medium	—	1	2	—	nil	medium	6"	Open-growing,scattered,some poplar
NE.12-8-11	medium	medium	—	1	—	—	1	light	5"	Open,scattered,mature,medium poplar,re-growth
NE.11-8-11	light	light	—	—	—	—	nil	light	6"	Scattered,open,mature stand
NW.11-8-11	light	light	—	—	1	—	1	light	6"	Logged,mixed poplar,spruce,tamarack
SE.15-8-11	light	light	—	—	—	—	nil	medium	5"	Open-growing,scattered
SW.15-8-11	light	light	—	—	—	—	1	light	6"	Logged,open-growing,mixed poplar,birch
SE.16-8-11	light	light	—	—	—	—	1	light	7"	Logged,open-growing,light regeneration
SW.16-8-11	light	light	—	—	—	—	2	nil	4"	Poplar dominant, light young growth
NE.17-8-11	light	light	—	—	—	—	nil	light	4"	Mixed mature & young growth, scattered
NW.17-8-11	light	light	—	—	—	—	nil	nil	3"	Open-growing young, growth
NW.18-8-11	light	light	—	—	—	—	nil	nil	4"	Mixture young & mature open-growing
SE.24-8-10	light	light	—	—	—	—	nil	nil	5"	Dense stand, young growth
NW.13-8-10	light	light	—	—	—	—	nil	nil	5"	Dense, tall stand, mature
NW.14-8-10	light	light	—	—	—	—	nil	nil	5"	Poplar dominant
SE.3-8-11	medium	medium	—	1	1	—	1	light	7"	Mixed poplar,spruce, logged
NW.35-7-11	light	light	—	—	—	—	3	nil	7"	Logged,scattered,mature timber
SE.35-7-11	light	light	light	6	22	1	4	medium	8"	Logged,scattered,stagnate stand
NE.35-7-11	light	light	light	1	8	2	1	medium	8"	Logged,scattered,light regeneration
NE.36-7-11	light	light	—	3	12	—	2	light	6"	Logged,scattered,light regeneration
SE.1-8-11	light	light	—	1	3	—	1	medium	5"	Logged,open-growing,light regeneration
SE.35-7-11	light	light	—	—	3	—	nil	light	3"	Young stand,logged,open-growing
NE.26-7-11	light	light	—	—	—	—	nil	light	5"	Open-growing,good re-growth
SE.24-7-11	light	—	—	—	—	—	nil	nil	4"	Dense stand of young growth
SE.27-7-11	light	light	—	—	—	—	nil	nil	5"	Logged,dense stand young growth
NE.23-7-11	light	light	—	—	—	—	2	nil	7"	Mixed poplar, jack pine

TABLE A (cont'd)

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stam.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" +	0"-5"	5"-10"	10" +				
SW.23-7-11	nil	nil	—	—	—	—	—	—	—	Mixed spruce, poplar
SW.35-7-10	medium	medium	—	—	—	—	1	medium	5"	Open-growing, medium staminate
SE.34-7-10	medium	medium	—	—	—	—	nil	medium	6"	Scattered,mature stand, light regeneration
NW.34-7-10	medium	medium	—	—	—	—	nil	light	6"	Mixed poplar and spruce
NW.33-7-16	light	light	—	—	—	—	nil	light	6"	Mixed poplar, jack pine
SE.5-8-10	nil	nil	—	—	—	—	nil	—	—	Spruce and tamarack swamp
NW.5-8-10	—	—	—	—	—	—	—	—	—	Poplar,spruce,willow
SE.7-8-10	light	light	—	—	—	—	nil	light	6"	Mixed poplar, jack pine
NW.7-8-10	medium	medium	—	—	—	—	nil	medium	6"	Thick mature stand
SW.7-8-10	light	—	—	—	—	—	nil	light	2"	Dense stand,young growth
NE.6-8-10	medium	medium	—	1	—	—	nil	light	4"	Thick stand, young growth, some mature staminate
SE.6-8-10	medium	medium	—	1	—	—	1	medium	6"	Open-growing, stagnate
NW.31-7-10	light	light	—	—	—	—	nil	light	6"	Mixed poplar, spruce, jack pine
SW.31-7-10	medium	medium	—	—	1	—	nil	light	6"	Mixed poplar, jack pine, open-growing
NW.30-7-10	medium	medium	—	—	1	—	1	light	6"	Scattered,mature stand
SW.30-7-10	light	light	—	—	—	—	nil	light	5"	Open-growing,young growth
NE.19-7-10	light	light	—	—	1	—	nil	light	5"	Mixed poplar, jack pine
SW.20-7-10	light	light	—	—	—	—	1	nil	7"	Mixed poplar, jack pine
NE.18-7-10	—	light	—	—	—	—	nil	nil	4"	Mixed poplar, spruce, jack pine
SE.18-7-10	light	light	—	—	—	—	nil	light	6"	Mixed poplar, spruce, jack pine
NE.7-7-10	medium	medium	—	1	—	—	nil	light	6"	Mixed mature and young growth
SW.7-7-10	medium	medium	—	—	—	—	nil	light	5"	Scattered, good regeneration
NW.6-7-10	—	light	—	—	—	—	nil	nil	6"	Mixed white poplar and jack pine
NW.6-7-10	light	light	—	—	—	—	nil	light	5"	Mixed poplar, jack pine and young growth
NE.32-6-10	light	light	—	—	—	—	nil	light	6"	Open-growing,scattered, good young growth
NE.32-6-10	—	—	—	—	—	—	—	—	—	Spruce, cedar and tamarack
SE.31-6-10	—	—	—	—	—	—	—	—	—	Spruce, cedar, poplar

TABLE A (cont'd)

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stem.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" ∠	0"-5"	5"-10"	10" ∠				
NE.30-6-10	—	—	—	—	—	—	—	—	—	Spruce, cedar, birch, poplar
SE.30-6-10	—	—	—	—	—	—	—	—	—	Spruce, cedar, birch, poplar
NE.19-6-10	—	—	—	—	—	—	—	—	—	Spruce, poplar, birch
SE.19-6-10	—	—	—	—	—	—	—	—	—	Spruce, poplar, birch, cedar
NE.18-6-10	—	—	—	—	—	—	—	—	—	Spruce, poplar, ash
SE.33-6-10	light	light	—	—	—	—	5	medium	5"	Open-growing, good young growth, light drouth kill
SW.34-6-10	light	light	—	3	—	—	nil	light	5"	Mixture young & mature, light regeneration
SW.34-6-10	light	light	—	—	—	—	1	nil	4"	Dense young growth
NE.35-6-10	light	light	—	1	—	—	1	light	4"	Thick young growth, good regeneration
SW.2-7-10	light	light	—	3	2	—	2	light	5"	Open-growing, mature, light re-growth
SE.2-7-10	light	light	—	—	1	—	1	light	5"	Mixed mature and dense young growth
SW.1-7-10	light	light	—	1	—	—	nil	light	4"	Mixed mature and young growth
SE.1-7-10	light	light	—	—	—	—	nil	light	4"	Dense stand young growth
SW.6-7-11	light	light	—	—	—	—	nil	medium	5"	Open-growing, scattered, light regeneration
SE.6-7-11	light	light	—	—	1	—	nil	light	4"	Mixed mature, dense young growth
SE.5-7-11	light	light	—	2	3	—	1	light	3"	Thick young growth, scattered mature
SW.4-7-11	light	light	—	—	3	—	1	light	6"	Mixed poplar, jack pine, scattered
NE.4-7-11	light	light	—	—	4	—	—	light	5"	Mixed mature and young growth
SW.3-7-11	light	light	—	—	10	—	1	light	7"	Logged, overmature, scattered
NE.3-7-11	light	light	light	1	6	—	nil	light	6"	Logged, scattered, mature
SE.9-7-11	light	light	—	—	1	—	2	light	5"	Logged, scattered, mature
SE.8-7-11	light	light	—	2	1	—	1	light	6"	Logged, mixed spruce, cedar, poplar
NE.8-7-11	light	light	—	1	—	—	1	nil	5"	Mixed poplar, spruce and jack pine
SW.17-7-11	light	light	—	—	—	—	2	nil	5"	Thick stand, mature, mixed poplar, spruce
SE.18-7-11	light	light	—	—	—	—	1	light	6"	Mixed mature and young growth
NE.18-7-11	—	—	—	—	—	—	—	—	—	Mixed spruce, cedar, larch, poplar
SW.19-7-11	—	light	—	—	—	—	—	nil	6"	Mixed spruce and jack pine, scattered

TABLE A (cont'd)

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stem.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" +	0"-5"	5"-10"	10" +				
NW.19-7-11	light	light	--	---	---	---	---	nil	3"	Dense young growth
SW.30-7-11	light	light	--	---	1	---	---	light	6"	Scattered mature and young growth
NE.25-7-10	medium	medium	--	---	2	---	1	medium	8"	Mature thick stand, medium defoliation
SE.30-7-11	medium	medium	--	---	---	---	2	light	6"	Mature, medium stand, defoliation medium
NW.30-7-11	medium	medium	--	1	---	---	1	light	4"	Mixed poplar, cedar, white spruce, scattered
SE.30-7-11	light	light	--	---	---	---	nil	light	5"	Scattered, open, mixed spruce, jack pine
SW.29-7-11	light	light	--	2	---	---	nil	light	8"	Light mature stand
NE.20-7-11	light	light	--	1	---	---	3	light	6"	Medium density, 50% young growth
NW.21-7-11	light	light	--	---	---	---	nil	light	7"	Medium density
SE.21-7-11	light	light	--	---	1	---	3	light	7"	Medium density, good young growth
NE.16-7-11	light	light	--	---	1	---	3	light	6"	Light, scattered stand
SW.15-7-11	light	light	--	---	1	---	1	nil	4"	Cutover, good new growth
NE.10-7-11	light	light	--	---	1	---	nil	light	8"	Mature, mixed poplar, birch
SW.14-7-11	---	---	--	---	---	---	---	----	--	Mixed black and white poplar
SE.14-7-11	---	---	--	---	---	---	---	----	--	Mixed poplar, elm
SW.10-7-11	light	light	--	---	---	---	nil	light	7"	Mixed spruce, poplar, jack pine

TABLE B

Jack-Pine Budworm Survey - Stead, Manitoba - 1949.

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stan.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" ≠	0"-5"	5"-10"	10" ≠				
SE.8-17-8	light	light	—	—	—	—	9	medium	6"	Open-growing, staminate, stagnate
NE.8-17-8	light	light	—	—	—	—	nil	light	4"	Thick growth, light defoliation,mixture poplar/and birch
NW.9-17-8	medium	medium	—	—	—	—	nil	medium	5"	Open-growing,staminate,mixed young and mature
NW.16-17-8	medium	medium	—	—	—	—	2	medium	4"	Open-growing, mixed mature and young growth
SW.21-17-8	light	medium	—	—	—	—	nil	medium	5"	Open-growing,scattered mixed oak
NW.21-17-8	heavy	heavy	heavy	5	7	—	1	heavy	6"	Open-growing,scattered, stagnate
SW.28-17-8	medium	medium	—	—	1	—	nil	medium	5"	Cleared land, medium re-growth, mixed mature
NW.28-17-8	light	light	—	—	—	—	2	light	3"	Thick young growth, some mature
SW.33-17-8	medium	medium	—	1	—	—	2	medium	4"	Thick young growth, medium regeneration
NW.33-17-8	—	—	—	—	—	—	—	—	—	White poplar stand
SE.5-18-8	—	—	—	—	—	—	—	—	—	White poplar stand
NW.5-18-8	—	—	—	—	—	—	—	—	—	White poplar stand
SE.8-18-8	—	—	—	—	—	—	—	—	—	White poplar stand
NW.8-18-8	—	—	—	—	—	—	—	—	—	Patented land, white poplar stand
SE.17-18-8	—	—	—	—	—	—	—	—	—	Patented land, under agriculture
NE.17-18-8	heavy	heavy	heavy	4	15	3	5	heavy	7"	Mixed poplar, birch, jack pine, mature, stagnate
NW.17-18-8	medium	medium	medium	6	12	2	2	heavy	7"	Mature, stagnate, open-growing
NE.18-18-8	heavy	heavy	heavy	2	4	—	7	medium	7"	Mature,scattered,stagnate,mixed young growth,poplar,birch
NW.18-18-8	medium	medium	medium	1	—	—	nil	medium	6"	Mature, scattered, light re-growth
NW.16-18-8	medium	medium	medium	—	2	—	1	medium	7"	Mixed birch, poplar, jack pine
NE.16-18-8	heavy	heavy	heavy	—	2	1	1	medium	7"	Scattered,mature,stagnate,mixed poplar,birch,jackpine
SW.15-18-8	heavy	heavy	heavy	7	17	8	4	heavy	7"	Stagnate,scattered,medium mistletoe infestation
NE.10-18-8	medium	medium	—	1	—	—	3	medium	5"	Open mature trees, light regeneration
SE.10-18-8	light	light	—	—	1	—	2	light	6"	Mixed mature and young growth, scattered birch, poplar
NW.2-18-8	—	—	—	—	—	—	—	—	—	Mixed poplar, birch stand
SW.2-18-8	—	—	—	—	—	—	—	—	—	Mixed poplar, birch

TABLE B (cont'd)

Location	Defoliation Per Diameter Class			% Dead Tops Per Diameter Class			No. of Dead Trees	Stem.	Est. Av. of D.B.H.	Remarks
	0"-5"	5"-10"	10" +	0"-5"	5"-10"	10" +				
NW.35-17-8	--	--	--	---	---	---	---	--	--	Mixed poplar,birch stand
SW.35-17-8	light	light	--	---	---	---	2	nil	3"	Dense stand young growth
NE.27-17-8	light	light	--	---	---	---	---	--	3"	Young open-growing, scattered, light mistletoe
SW.27-17-8	light	light	--	---	1	---	many	light	4"	Scattered, open-growing, mistletoe and fireburn
NW.22-17-8	medium	medium	--	---	1	---	nil	medium	5"	Scattered, open-growing, mixed young and mature
SW.22-17-8	medium	medium	--	1	---	---	nil	medium	5"	Scattered, open-growing, light regeneration
NE.16-17-8	medium	medium	--	---	---	---	1	light	3"	Dense young stand, logged
SE.16-17-8	light	light	--	---	---	---	nil	light	5"	Mixed birch, jack pine
SW.16-17-8	light	light	--	3	5	---	1	medium	3"	Scattered, open-growing young stand, logged
NE.9-17-8	medium	medium	--	---	---	---	1	medium	5"	Scattered, open-growing, mature
NE.16-17-8	light	light	--	---	---	---	nil	medium	4"	Scattered, open-growing, light regeneration
NW.15-17-8	medium	medium	--	---	---	---	fire-burn	medium	4"	Fire-killed stand, open-growing
SW.22-17-8	light	light	--	1	---	---	nil	medium	5"	Scattered, open-growing
NE.21-17-8	light	light	--	---	---	---	nil	medium	3"	Scattered stands of thick young growth
NE.21-17-8	medium	medium	--	1	2	---	1	medium	5"	Scattered, cleared, light young growth
NE.17-17-8	light	light	--	---	---	---	nil	light	5"	Mixed poplar, jack pine
SE.20-17-8	light	light	--	---	---	---	1	light	2"	Scattered young growth, cleared land
NE.7-17-8	light	light	--	---	---	---	---	nil	5"	Mixed poplar, birch, jack pine
SE.18-17-8	light	light	--	---	---	---	---	light	5"	Logged, mixed poplar, birch

TABLE C

Cruise Strip Number	Total No. of Trees	Range In D.B.H. Inches	Mean D.B.H. Inches	Defoliation Class Per Cent		% of Trees Dead
				New Foliage	Old Foliage	
1	161	.5/8.4	5.1	76-100	76-100	18.0
2	197	.5/8.4	5.3	76-100	76-100	17.2
3	247	.5/9.4	5.6	76-100	76-100	12.6
4	167	1.5/7.4	4.2	26-100	0-100	.6
5	93	1.5/9.4	5.0	0-50	0-25	7.5
6	150	1.5/9.4	6.0	76-100	76-100	6.7
7	123	1.5/8.4	5.5	0-25	0-25	6.5
8	71	1.5/9.4	6.3	76-100	76-100	5.6
9	124	1.5/9.4	5.6	76-100	76-100	12.9

TABLE D

Dead Trees According to Diameter Classes

Cruise Strip Number	One Inch		Two Inch		Three Inch		Four Inch		Five Inch		Six Inch		Seven Inch		Eight Inch		Nine Inch	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	2	100	17	71	20	20	32	16	31	0	37	16	15	0	7	0	---	-
2	1	100	10	80	32	62	26	15	57	2	43	0	25	0	5	0	---	-
3	2	100	6	100	22	68	41	10	59	3	71	1	34	3	9	0	3	0
4	-	----	7	14	35	0	57	0	55	0	13	0	2	0	---	-	---	-
5	-	----	13	15	12	33	15	7	16	0	19	0	9	0	8	0	1	0
6	-	----	2	50	7	57	13	23	34	3	47	2	33	0	11	0	3	0
7	-	----	3	66	9	44	21	10	30	0	30	0	24	0	6	0	---	-
8	-	----	1	100	2	50	9	22	13	0	13	8	20	0	7	0	6	0
9	-	----	4	75	15	73	22	9	27	0	30	0	17	0	7	0	2	0
Totals	5	100	63	56	152	42	236	10	322	1	303	3	177	.5	60	0	15	0

TABLE E

Dead Trees According to Crown Class

Diam. Class D.B.H.	No. of Trees Tallied	No. of Dead Trees	% Dead Trees by Crown Class							
			% Based on all Trees				% Based on Dead Trees Only			
			D	CD	I	S	D	CD	I	S
1"	5	5	---	---	---	100	----	----	----	100
2"	63	35	---	2.0	4.8	49.2	----	3	8.5	88.5
3"	152	63	---	5.9	5.9	29.6	----	14.3	14.3	71.4
4"	236	23	.4	5.1	1.7	2.5	4.4	52.2	17.3	26.1
5"	322	4	---	1.2	---	----	----	100	----	----
6"	303	9	1.0	2.0	---	----	33.3	66.6	----	----
7"	177	1	---	.5	---	----	----	100	----	----
8"	60	0	---	---	---	----	----	----	----	----
9"	15	0	---	---	---	----	----	----	----	----

TABLE F

Negative Reports for Jack-Pine Budworm - 1949
From Beginning of the Season to July 31

F.I.S. Number	Collection Date	District (Forest)	No.Trees Examined	Detailed Location
52	20-5-49	Eastern	-	Seddon's Corner, Man.
57	20-5-49	Eastern	-	Seddon's Corner, Man.
58	20-5-49	Sandilands F.R.	2	5 mi. S. of Dawson Cabin, Sec.8, tp. 7, rge. 11, E. P. mer.
59	20-5-49	Sandilands F.R.	4	Sec.8,tp.7,rge.11,E.P.mer.
60	20-5-49	Sandilands F.R.	5	Sec.8,tp.7,rge.11,E.P.mer.
82	27-5-49	Eastern	5	Jessica Lake (Whiteshell F.R.)
119	28-5-49	R.M.N.P.	5	Sec.34,tp.19,rge.19,W.P.mer.
125	29-5-49	Eastern	15	7 mi.N.of Shorncliff,Sec.19,tp. 25,rge.3,E.P.mer.
126	27-5-49	R.M.N.P.	5	Norgate Rd.,SW.¼ Sec.33,tp.19, rge.17,W.P.mer.
139	29-5-49	Eastern	-	7 mi.N.of Shorncliff,Sec.19,tp. 25,rge.3,E.P.mer.
146	29-5-49	Eastern	-	Sec.19,tp.25,rge.3,E.P.mer.
157	30-5-49	Eastern	-	6/10 mi.N.Rosenburg Tower,Sec. 11,tp.25,rge.2,E.P.mer.
161	30-5-49	Eastern	-	Sec.11,tp.25,rge.2,E.P.mer.
165	30-5-49	Eastern	-	Sec.11,tp.25,rge.2,E.P.mer.
178	28-5-49	Sandilands F.R.	-	Sec.8,tp.5,rge.10,E.P.mer.
227	2-6-49	Western	5	Grandview Plantation,Sec.13,tp. 27,rge.24,W.P.mer.
237	2-6-49	Eastern	5	9 mi.S.of Gypsumville,Sec.24, tp.31,rge.10,W.P.mer.
252	2-6-49	Eastern	1	Sec.24,tp.31,rge.10,W.P.mer.
395	7-6-49	D.M.F.R.	5	Sec.26,tp.30,rge.24,W.P.mer.
408	9-6-49	Spruce Woods F.R.	-	Sec.10,tp.12,rge.17,W.P.mer.
410	9-6-49	Spruce Woods F.R.	-	Plot 242 J.P. NE.¼ Sec.12,tp. 10,rge.17,W.P.mer.
411	9-6-49	Spruce Woods F.R.	-	NE.¼ Sec.12,tp.10,rge.17,W.P. mer.
412	9-6-49	Spruce Woods F.R.	-	Sec.10,tp.12,rge.17,W.P.mer.
413	9-6-49	Spruce Woods F.R.	-	Sec.12,tp.10,rge.17,W.P.mer.
433	9-6-49	Spruce Woods F.R.	-	Sec.12,tp.10,rge.17,W.P.mer.
470	10-6-49	D.M.F.R.	5	NW ¼ Sec.34,tp.32,rge.24,W.P. mer.
595	13-6-49	Whiteshell F.R.	-	South of Falcon Lake,Sec.29,tp. 8,rge.16,E.P.mer.
653	15-6-49	Sandilands F.R.	6	Sec.33,tp.5,rge.10,E.P.mer.
657	15-6-49	Sandilands F.R.	2	4 mi.S. Reynolds,Sec.7,tp.8,rge 12,E.P.mer.

TABLE F (cont'd)

F.I.S. Number	Collection Date	District (Forest)	No. Trees Examined	Detailed Location
666	15-6-49	Western	5	Birch River Ranger Stn., Sec.34, tp.29, rge.26, E.P.mer.
689	16-6-49	Western	5	Singoosh Lake, Sec.31, tp.31, rge. 24, W.P.mer.
695	16-6-49	Sandilands F.R.	-	Marchand Ranger Stn., Sec.35, tp. 5, rge.9, E.P.mer.
696	16-6-49	Sandilands F.R.	-	2 mi.S.of Marchand Ranger Stn., Sec.25, tp.5, rge.9, E.P.mer.
698	16-6-49	Sandilands F.R.	-	Marchand Tower, Sec.25, tp.5, rge. 9, E.P.mer.
759	16-6-49	Western	5	1 mi.N.of Novra, Tp.40, rge.27, W.P.mer.
763	16-6-49	Western	5	1 mi.E.of Novra, Tp.40, rge.27, W.P.mer.
774	17-6-49	Western	5	15 Mi. N. of Mafeking, Man.
852	18-6-49	Northern	5	61 Mi. N. of Mafeking, Man.
875	20-6-49	Northern	5	4 Mi. N. of The Pas, Man.
927	20-6-49	Eastern	15	Sec.12, tp.15, rge.14, E.P.mer.
976	23-6-49	Whiteshell F.R.	5	Sec.26, tp.12, rge.17, E.P.mer.
977	24-6-49	Whiteshell F.R.	3	Sec.23, tp.12, rge.17, E.P.mer.
983	20-6-49	Eastern	1	Sasaginnigak Lake, Man.
985	22-6-49	Cormorant F.R.	5	½ mi. E. of Prospector Tower
1004	22-6-49	Northern	5	1 Mi. N. of Cranberry Portage
1010	23-6-49	Northern	5	29.1 mi. S. of The Pas, Man.
1056	25-6-49	Whiteshell F.R.	1	Sec.24, tp.12, rge.17, E.P.mer.
1092	27-6-49	Southern	14	Sec.32, tp.1, rge.11, E.P.mer.
1108	27-6-49	Western	1	Sec.1, tp.36, rge.23, W.P.mer. (Minitonas, Manitoba)
1109	27-6-49	Eastern	-	Sec.11, tp.16, rge.13, E.P.mer.
1158	27-6-49	Western	5	Cowan, Sec.26, tp.35, rge.23, W.P. mer.
1161	27-6-49	Western	5	6 mi. W.of Cowan, Sec.16, tp.36, rge.23, W.P.mer.
1212	29-6-49	Eastern	6	Sec.22, tp.17, rge.8, E.P.mer.
1259	5-7-49	Eastern	3	Falcon Portage, Sec.21, tp.17, rge 14, E.P.mer.
1301	7-7-49	Eastern	4	Sec.10, tp.16, rge.13, E. P. mer. (Lac du Bonnet)
1314	7-7-49	Eastern	-	Sec.31, tp.17, rge.11, E. P. mer. (Lac du Bonnet)
1344	8-7-49	R.M.N.P.	10	NW.¼ Sec.25, tp.19, rge.18, W.P.mer
1354	7-7-49	Western	4	Sec.2, tp.35, rge.23, W.P.mer.
1411	12-7-49	Southern	-	Sec.17, tp.11, rge.9, E.P.mer. (Whitemouth)
1412	13-7-49	Eastern	1	Sec.5, tp.13, rge.10, E.P.mer.

TABLE F (cont'd)

F.I.S. Number	Collection Date	District (Forest)	No. Trees Examined	Detailed Location
1448	11-7-49	Eastern	5	Mile 6, Bear River Road
1449	11-7-49	Eastern	2	Mile 7, Bear River Road
1454	12-7-49	Eastern	2	Sec.24,tp.17,rge.12,E.P.mer.
1530	14-7-49	Eastern	3	Sec.2,tp.11,rge.13, E. P. mer. (Rennie)
1532	14-7-49	Eastern	1	Sec.3,tp.10,rge.14, E. P. mer. (Rennie)
1539	14-7-49	Eastern	1	Sec.29,tp.10,rge.14, E. P. mer. (Rennie)
1548	12-7-49	D.M.F.R.	5	Sec.9,tp.30,rge.23,W.P.mer.
1554	12-7-49	D.M.F.R.	3	Sec.27,tp.29,rge.23,W.P.mer.
1632	16-7-49	Whiteshell F.R.	1	Sec.31,tp.10,rge.15,W.2nd mer.
1650	14-7-49	D.M.F.R.	5	Sec.24,tp.30,rge.25,W.P.mer.
1729	20-7-49	Eastern	1	Sec.10,tp.12,rge.10,E.P.mer.
1734	20-7-49	Eastern	-	Sec.10,tp.13,rge.10,E.P.mer.
1744	20-7-49	Eastern	2	Sec.10,tp.13,rge.10,E.P.mer.
1916	25-7-49	D.M.F.R.	5	Sample Stn.,W.14,Grandview Ranger Station
1942	24-7-49	Southern	-	Sec.33,tp.1,rge.11, E. P. mer. (Piney)
1943	26-7-49	Southern	-	Sec.22,tp.1,rge.12, E. P. mer. (Piney)
1951	26-7-49	Southern	-	Sec.32,tp.3,rge.11, E. P. mer. (Woodridge)
2039	27-7-49	Western	5	Sec.26,tp.35,rge.23, W. P. mer. (Cowan)
2079	28-7-49	Western	10	Sec.34,tp.39,rge.26, W. P. mer. (Birch River)
2088	29-7-49	Southern	8	Sec.7,tp.6,rge.26, E. P. mer. (Marchand)
2090	28-7-49	Southern	5	Sec.8,tp.5,rge.10,E. P. mer. (Marchand)

3. Spruce Budworm (<u>Choristoneura fumiferana</u> Clem.)

(a) <u>Distribution</u>:

The spruce budworm infestation in the Spruce Woods Forest Reserve appeared to be declining in 1949. White spruce stands in the Reserve were, in general, lightly defoliated. In one area only (Sec. 19, tp. 10, rge. 15, W. P. mer.), moderate to severe defoliation was observed.

No severe infestations of this insect were found in the Eastern District, but several samples were obtained from widely separated points. The first larvae were observed June 13 near Falcon Lake in the Whiteshell Forest Reserve (Sec. 34, tp. 8, rge. 16, E. P. mer.). Very light defoliation was noted. Spruce budworm was general on blasam fir and white spruce around Mantario Lake in the northern part of the Whiteshell Forest Reserve but was causing only very light defolition.

South of the Whiteshell Forest Reserve, a few larvae were found 1 mile west of East Braintree in Sec. 34, tp. 5, rge. 9, E. P. mer. A light infestation was encountered on four ornamental white spruce and balsam fir in the Rock Garden at Waugh, Manitoba. The spruce budworm and spruce needleworm were present on the ornamental spruce and were causing light defoliation. Control measures were recommended to the ground's keeper. At the time of inspection it was assumed that most of the defoliation had been caused by the spruce budworm.

Several larvae, which appeared diseased, were obtained from Waugh; from the East Braintree district in Sec. 4, tp. 8, rge. 17, E. P. mer., and Sec. 32, tp. 7, rge. 14, E. P. mer., and from balsam fir at Mantario Lake, Sec. 26, tp. 12, rge. 17, E. P. mer.

During the aerial surveys for the detection of budworm in eastern Manitoba, only one small area of damaged spruce was seen from the air. However, ground examinations indicated the presence of spruce budworm larvae in small numbers as far north as Island Lake. (Island Lake lies just south of the 54th parallel of latitude.) Collections were also made at Moon Lake and Carr Harris Lake.

An area of damaged spruce was observed approximately two miles north-east of the town of Bissett and covered about ten acres. The cause of the damage was not definitely determined. From the air it appeared to be budworm damage. If such is the case it is the first report where spruce budworm has become established in infestation proportions east of Lake Winnipeg in Manitoba.

On the west side of Lake Winnipeg, three collections of this insect were obtained, one in Sec. 15, tp. 21, rge. 4, E. P. mer., one in Sec. 16, tp. 21, rge. 4, E. P. mer., and the third in the vicinity of Rosenburg, Sec. 36, tp. 24, rge. 2, E. P. mer. Defoliation was very light.

Riding Mountain National Park was surveyed for spruce budworm on July 6 and 7. Defoliation due to this insect was less than one per cent. From one mile north of the junction of the Dauphin and Lake Audy roads (Sec. 14, tp. 20, rge. 19, W. P. mer.), to 2.7 miles south of this junction (Sec. 1, tp. 2, rge. 19, W. P. mer.), four samples were taken. Spruce budworm pupae were found in each sample. Defoliation was very light.

The Singoosh Lake area of the Duck Mountain Forest Reserve was surveyed for budworm June 9. No defoliation of spruce was observed. A stand of white spruce in Sec. 7, tp. 31, rge. 23, W. P. mer., 5.4 miles west of the Reserve boundary, was sampled; only one budworm was found. Twenty 18" branches were selected at random from 10 trees and no budworms were found. The stand in this area is composed of 50 per cent white spruce, 40 per cent poplar and 10 per cent balsam.

A Manitoba Forest Service nursery at Birch River, Manitoba, was examined on June 15 (Sec. 34, tp. 39, rge. 26, W. P. mer.). Colorado spruce in the nursery was examined and a population count on twenty, 18" branches selected at random from 10 trees yielded six budworms. Damage to the foliage was less than one per cent.

Although spruce stands in Saskatchewan were sampled extensively during the budworm season no trace of this insect was found.

(b) Negative Reports:

The following tables contain a complete list of negative reports from points in Manitoba from the beginning of the season to July 31, from white and black spruce. Spruce samples which were entirely negative and contained no insects are also listed in the tables. (See Table A and Table B appended hereto.)

TABLE A

Negative Reports for Spruce Budworm -1949
From Beginning of the Season to July 31 - White Spruce

F.I.S. Number	Collection Date	District (Forest)	No. Trees Examined	Detailed Location
418	8-6-49	Whiteshell F.R.	4	Plantation at Rennie, Man.
429	8-6-49	R.M.N.P.	5	Wasagaming Townsite
440	9-6-49	Northern	3	Thicket Portage, Sec.15,tp.72, rge.2.W.P.mer.
450	8-6-49	D.M.F.R.	10	Sample Station W. 19
455	8-6-49	D.M.F.R.	10	Singoosh Cabin, Sec.32,tp.31, rge.24, W. P. mer.
458	9-6-49	D.M.F.R.	10	Sec.12,tp.31,rge.24,W.P.mer.
465	10-6-49	D.M.F.R.	5	NW ¼ Sec.31,tp.32,rge.23, W.P.mer.
466	8-6-49	D.M.F.R.	10	Sec.32,tp.31,rge.24,W.P.mer.
471	9-6-49	D.M.F.R.	10	Sec.15,tp.31,rge.23,W.P.mer.
497	10-6-49	D.M.F.R.	10	NW ¼ Sec.34, tp.32,rge.23, W.P.mer.
506	10-6-49	D.M.F.R.	10	NW ¼ Sec.31,tp.32,rge.23, W.P.mer.
507	10-6-49	D.M.F.R.	5	NW ¼ Sec.31,tp.32,rge.23, W.P.mer.
518	13-6-49	Western	10	Forestry Camp, Tp.20,rge.19, W.P.mer.
543	13-6-49	Western	10	Sec.2,tp.36,rge.23,W.P.mer., Cowan, Manitoba.
544	13-6-49	Western	5	Sec.18,tp.36,rge.23,W.P.mer., Renwer, Manitoba.
548	13-6-49	Western	5	Sec.18,tp.36,rge.23,W.P.mer., Renwer, Manitoba.
611	15-6-49	Western	2	R.M.N.P., Sec.9,tp.23,rge.19, W.P.mer.
648	15-6-49	Sandilands.F.R.	5	Sec.34.tp.5.rge.9.E.P.mer.
662	17-6-49	D.M.F.R.	5	Durban Tower,Sec.22,tp.33,rge. 28,W.P.mer.
671	14-6-49	D.M.F.R.	5	Sec.22.tp.33.rge.28.W.P.mer.
672	15-6-49	Western	10	Birch River Ranger Station, Sec.22.tp.29.rge.26.W.P.mer.
693	16-6-49	R.M.N.P.	3	Riding Mountain National Park
714	16-6-49	Southern	16	SE ¼ Sec.33,tp.7,rge.14, E.P. mer.
726	15-6-49	Northern	9	Herb Lake, Manitoba.
749	16-6-49	Western	5	Mi. 328, No. 10 Highway, Man.
753	17-6-49	Western	10	16 Miles N. of Mafeking, Man.

TABLE A (cont'd)

F.I.S. Number	Collection Date	District (Forest)	No. Trees Examined	Detailed Location
755	16-6-49	Western	5	2½ miles N. of Mafeking, along No. 10 Highway
762	17-6-49	Western	10	16 Miles N. of Mafeking, Man.
768	17-6-49	Western	10	16 Miles N. of Mafeking, Man.
775	16-6-49	Western	5	Mafeking, Man., Tp.40, rge.27, W.P.mer.
805	18-6-49	Western	10	Sec.5, tp.20, rge.17, W.P.mer.
808	18-6-49	Western	10	Sec.31, tp.19, rge.16, W.P.mer.
809	18-6-49	Western	10	Sec.8, tp.20, rge.17, W.P.mer.
854	20-6-49	Western	10	Sec.15, tp.20, rge.19, W.P.mer.
856	20-6-49	R.M.N.P.	10	Sec.30, tp.20, rge.19, W.P.mer.
857	20-6-49	Western	10	Sec.8, tp.21, rge.20, W.P.mer.
858	20-6-49	Western	10	Sec.6, tp.21, rge.19, W.P.mer.
861	20-6-49	Western	10	Sec.31, tp.20, rge.19, W.P.mer.
862	20-6-49	Western	10	Sec.4, tp.21, rge.20, W.P.mer.
865	20-6-49	Western	10	Sec.13, tp.21, rge.21, W.P.mer.
866	20-6-49	Western	10	Sec.2, tp.21, rge.20, W.P.mer.
867	20-6-49	R.M.N.P.	10	Sec.15, tp.20, rge.19, W.P.mer.
879	20-6-49	Northern	5	6 Miles N. of The Pas, Man.
924	22-6-49	Eastern	1	Tp.22, rge.9, E.P.mer.
961	17-6-49	Eastern	3	NW ¼ Sec.35, tp.7, rge.14, E.P.mer East Braintree, Manitoba
980	26-6-49	Eastern	3	Tp.35, rge.1, E.P.mer.
988	24-6-49	D.M.F.R.	5	Sec.20, tp.31, rge.29, W.P.mer.
990	23-6-49	Whiteshell F.R.	1	Sec.23, tp.18, rge.17, E.P.mer.
1023	24-6-49	Whiteshell F.R.	5	Plantation A, H.Q.
1048	23-6-49	Northern	4	Townsite of Thicket Portage, Man
1089	25-6-49	Whiteshell, F.R.	5	Red Rock Lake, Manitoba
1090	25-6-49	Whiteshell, F.R.	4	Red Rock Lake, Manitoba
1102	25-6-49	Western	1	Sec.36, tp.34, rge.26, W.P.mer.
1126	30-6-49	Eastern	2	Sec.2, tp.8, rge.14, E.P.mer.
1131	28-6-49	Western	5	Sec.25, tp.30, rge.28, W.P.mer.
1160	29-6-49	R.M.N.P.	5	Sec.23, tp.22, rge.19, W.P.mer.
1164	29-6-49	R.M.N.P.	5	Sec.33, tp.23, rge.19, W.P.mer.
1167	29-6-49	R.M.N.P.	5	Sec.33, tp.22, rge.19, W.P.mer.
1168	29-6-49	R.M.N.P.	5	Sec.3, tp.23, rge.19, W.P.mer.
1176	28-6-49	Eastern	2	Camp 14, Bear Rd., Tp.19, rge.12, E.P.mer.
1177	30-6-49	Northern	5	Sec.16, tp.73, rge.2, W.P.mer.
1185	28-6-49	Western	5	Sec.1, tp.34, rge.20, W.P.mer.
1186	28-6-49	Western	5	Sec.18, tp.33, rge.20, W.P.mer.
1202	25-6-49	Western	5	D.M.F.R., Sec.28, tp.33, rge.25, W.P.mer.
1210	29-6-49	Southern	4	Sec.15, tp.1, rge.14, E.P.mer.

TABLE A (cont'd)

F.I.S. Number	Collection Date	District (Forest)	No. Trees Examined	Detailed Location
1222	28-6-49	Eastern	-	Manigotagan Lake, Tp.22, rge.14, E.P.mer.
1225	30-6-49	Northern	9	Herb Lake, Manitoba
1234	26-6-49	Eastern	-	Sec.30, tp.30, rge.1, E.P.mer.
1252	5-7-49	Spruce Woods F.R.	-	Sec.24, tp.9, rge.15, W.P.mer.
1260	5-7-49	Spruce Woods F.R.	-	Sec.24, tp.9, rge.15, W.P.mer.
1263	5-7-49	Eastern	5	Falcon Portage, Sec.21, tp.17, rge.14, E.P.mer.
1265	5-7-49	Eastern	5	Sec.21, tp.17, rge.14, E.P.mer., Lac du Bonnet, Man.
1277	6-7-49	R.M.N.P.	5	Sec.[illegible], tp.[illegible], rge.19, W.P.mer.
1278	6-7-49	R.M.N.P.	5	Sec.15, tp.20, rge.19, W.P.mer.
1279	7-7-49	R.M.N.P.	5	Sec.32, tp.18, rge.18, W.P.mer.
1283	6-7-49	R.M.N.P.	5	Sec.19, tp.20, rge.19, W.P.mer.
1284	6-7-49	R.M.N.P.	5	Sec.17, tp.20, rge.19, W.P.mer.
1285	7-7-49	R.M.N.P.	5	Sec.31, tp.19, rge.18, W.P.mer.
1286	6-7-49	R.M.N.P.	5	Sec.15, tp.20, rge.19, W.P.mer.
1288	6-7-49	R.M.N.P.	5	Sec.15, tp.20, rge.19, W.P.mer.
1290	7-7-49	R.M.N.P.	5	Sec.1, tp.20, rge.19, W.P.mer.
1292	7-7-49	R.M.N.P.	5	Sec.12, tp.20, rge.19, W.P.mer.
1293	6-7-49	R.M.N.P.	5	SE ½ Sec.20, tp.20, rge.19, W.P.mer.
1295	7-7-49	R.M.N.P.	5	Sec.32, tp.19, rge.18, W.P.mer.
1296	6-7-49	R.M.N.P.	5	Sec.11, tp.20, rge.19, W.P.mer.
1297	6-7-49	R.M.N.P.	5	Sec.16, tp.20, rge.19, W.P.mer.
1300	7-7-49	Eastern	1	Sec.27, tp.16, rge.11, E.P.mer., Lac du Bonnet, Man.
1311	7-7-49	Eastern	5	Sec.11, tp.10, rge.13, E.P.mer., Lac du Bonnet, Man.
1318	7-7-49	Eastern	5	Sec.16, tp.18, rge.4, E.P.mer.
1321	7-7-49	Eastern	5	Sec.17, tp.23, rge.4, E.P.mer.
1323	7-7-49	Eastern	5	Sec.17, tp.20, rge.4, E.P.mer.
1327	7-7-49	Eastern	5	Sec.17, tp.23, rge.4, E.P.mer.
1332	7-7-49	R.M.N.P.	5	Sec.14, tp.20, rge.19, W.P.mer.
1333	7-7-49	Northern	4	Sec.15, tp.73, rge.2, W.P.mer.
1334	8-7-49	R.M.N.P.	5	Sample Stn., W.10, Norgate Rd.
1335	7-7-49	Northern	9	Herb Lake, Manitoba

TABLE B

Negative Reports for Spruce Budworm - 1949
From Beginning of the Season to July 31 - Black Spruce

F.I.S. Number	Collection Date	District (Forest)	No.Trees Examined	Detailed Location
633	15-6-49	Western	1	Campsite Sec.25,tp.20,rge.19, W.P. mer.
673	15-6-49	Birch River	5	Sec.22,tp.39,rge.22,W.P.mer.
748	17-6-49	Mafeking	5	15 mi. N. of Mafeking, Tp.44,rge.26, W.P.mer.
764	17-6-49	Mafeking	10	12.5 mi. N. of Mafeking, along No. 10 Highway
851	18-6-49	Mafeking	5	Mi. 41 N. of Mafeking, Tp. 47, rge. 26, W.P.mer.
812	20-6-49	The Pas	-	1 mile North of The Pas, Man.
878	20-6-49	The Pas	5	2 miles north of The Pas, Man.
1054	23-6-49	The Pas	5	27.9 miles south of The Pas, Man.
1116	20-6-49	Eastern	-	Oiseau Lake, Tp.17,rge.16, E.P.mer.
1143	28-6-49	Eastern	5	N.W. Shore of Wanipigow Lake, Tp.25, rge.11, E.P.mer.
1250	5-7-49	Lac du Bonnet	6	11 Mi. along Bird River Rd., Tp.18, rge.15,E.P.mer.
1254	5-7-49	Lac du Bonnet	1	Falcon Portage,Sec.2,tp.17,rge.14, E.P.mer.
1269	2-7-49	Northern	3	Townsite of The Pas, Manitoba

4. The Large Aspen Tortrix (<u>Archips conflictana</u> Wlk.)

The large aspen tortrix decreased in intensity in 1949, except for two infestations; one in Northern Manitoba and one in Western Saskatchewan. Distribution was general throughout Western Manitoba and all of Saskatchewan. In Eastern Manitoba this insect was observed only at Hodgson (Sec. 11, tp. 22, rge. 2, W. P. mer.).

In Manitoba, the damage caused by the large aspen tortrix was generally very light. Infestations occurred in the Duck Mountain Forest Reserve near Durban, in the Singoosh-Blue Lakes area and in The Pas-Cranberry Portage district.

The Singoosh-Blue Lakes infestation was much lighter than in 1948. On June 10 defoliation in this area ranged from one to five per cent. By July 19, the defoliation averaged 20 per cent with a range of from 10 to 30 per cent. Between the Durban Ranger Station (Sec. 29, tp. 33, rge. 28, W. P. mer.) and the Durban Tower (Sec. 22, tp. 33, rge. 28, W. P. mer.) poplar was defoliated 15 per cent on June 14. A small area of about two acres adjacent to the Ranger Station was 25 per cent defoliated but this was not all due to feeding by the large aspen tortrix.

The infestation at Wanless was heavier and more widely distributed than in 1948. In 1949 it extended from 6 miles north of The Pas to 60 miles north of The Pas. In this area defoliation averaged 70 per cent on June 22. South of Cranberry Portage, Manitoba, a large stand of poplar two miles wide by 10 miles long was approximately 95 per cent defoliated. Defoliation in this stand ranged from 90 to 100 per cent.

Elsewhere in Manitoba poplar stands were very lightly attacked by this insect.

The infestations of the large aspen tortrix in Saskatchewan were lighter than in 1948 except for the Glaslyn infestation which increased in size and intensity during 1949.

The Madge Lake infestation continued to subside in 1949. Very few larva could be found in this area. At Ministik Beach (Sec. 27, tp. 30, rge. 30, W. P. mer.), very light defoliation was observed. In Sec. 30, tp. 30, rge. 30, W. P. mer., no damage could be found.

Northward in the Porcupine and Pasquia Provincial forests and west to Greenwater Provincial Park and Carrot River damage by the large aspen tortrix was light. In this area most of the defoliation of poplar was caused by the American poplar leaf beetle.

In western Saskatchewan the severe infestation reported around the town of Glaslyn in 1948 increased in scope and intensity. The area of severe infestation increased from three square miles to about 300 square miles centered around the town. Some trees were completely defoliated while others were from 30 to 70 per cent defoliated. In areas of partial defoliation, only the top half of the trees were affected. During August many dead branches were observed on poplar and most trees had put forth new foliage. No defoliation was observed at the following points, although large aspen tortrix was found at each location:

Candle Lake Provincial Forest (Sec.34,tp.53,rge.23,W. 2nd mer.)
Prince Albert National Park (Sec.25,tp.53,rge.4, W. 3rd mer.)
Big River Provincial Forest (Sec.32,tp.56,rge.8, W. 3rd mer.)

Parasites of the large aspen tortrix were found in the Duck Mountain Forest Reserve and in The Pas district. In the Duck Mountain Forest Reserve (Sec. 27, tp. 30, rge. 25, W. P. mer.), a tachinid parasite was found attacking the large aspen tortrix. Another parasite, Glypta sp., of the large aspen tortrix was found ½ mile south of Cranberry Portage, Manitoba (Sec.31, tp. 64, rge. 26, W. P. mer.). At points one mile north (Sec. 6, tp. 65, rge. 26, W. P. mer.) and two miles north (Sec. 7, tp. 65, rge. 26, W. P. mer.) of Cranberry Portage several species of parasites (Hymenoptera and Diptera) were found.

One hundred and fourteen collections containing large aspen tortrix were received during 1949. This represents the collections submitted by co-operators and members of the laboratory staff. Forty-two of these samples were from Manitoba and 72 from Saskatchewan.

5. Balsam-Fir Sawfly (Neodiprion abietis Harr.)

This insect was found commonly throughout the forested areas of Manitoba and Saskatchewan in 1949. Although the actual damage to foliage did not exceed that of 1948, populations were noticeably higher and more widespread.

During an aerial survey of the inaccessible areas of eastern and central Manitoba, an infestation of this insect was observed near Mantario Lake on the Manitoba-Ontario boundary (Sec. 18, tp. 12, rge. 17, E. P. mer.). Samples were also taken at Sasaginnigak Lake (Tp. 30, rge. 14, E. P. mer.), and Wanipigow Lake (Sec. 6, tp. 24, rge. 17, E. P. mer.). At these points defoliation was very light and only a few larvae were found. Light infestations were reported from two points in the Manitoba Paper Company lumber limits. These light attacks occurred on white spruce in Block A (Tp. 22, rge. 9, E. P. mer.), and in the Bear River area (Tp. 22, rge. 9, E. P. mer.). In each case larvae were reported as being quite numerous, but defoliation was negligible.

In the Interlake Area of Manitoba, a stand of second growth white spruce in the Moosehorn district (Sec. 1, tp. 31, rge. 10, W. P. mer.) was 50 per cent defoliated. At Sandy Hook (Sec. 16, tp. 18, rge. 4, W. P. mer.), defoliation was very light and only a few larvae were found. Stands of spruce near Riverton (Sec. 17, tp. 23, rge. 4, E. P. mer.) were inspected and defoliation averaged about five per cent. At Lake St. George (Tp. 33, rge. 1, E. P. mer.) balsam fir and white spruce were examined and several larvae were found on the former. Defoliation, however, was very light.

The balsam-fir sawfly was widely distributed throughout the Riding Mountain National Park. Infestation occurred mainly north of Clear Lake along the Lake Audy Road in Secs. 1, 11, 12, 14, 15, 16, 17, 19, 23 and 31, tp. 20, rge. 19, W. P. mer., and along the east end of Clear Lake in Secs. 26 and 34, tp. 19, rge. 18, W. P. mer. At each of these points, different types of stands were selected and five trees from each stand were examined. Populations were high, ranging from 20 to 100 larvae per tree. Defoliation averaged about 10 per cent in the infested area. In the vicinity of the Elphinstone cabin (Sec. 30, tp. 20, rge. 20, W. P. mer.) three plantations of young white spruce were inspected for balsam-fir sawfly. Few larvae were found and defoliation was negligible. One-half mile east of the Buffalo enclosure (Sec. 4, tp. 21, rge. 20, W. P. mer.) a few larvae were also found but again defoliation was negligible.

During the period between June 20 - 30, members of the field staff conducted population counts in stands of white spruce along No. 10 Highway in Riding Mountain National Park between Sec. 3, tp. 21, rge. 20, W. P. mer., and Sec. 13, tp. 21, rge. 21, W. P. mer. The primary purpose of these counts was to determine spruce budworm populations but information regarding balsam-fir sawfly was also obtained. Various types of stands were selected and two eighteen inch branches from each of ten trees in a stand were examined and the insects thereon recorded. The following information on the status of the balsam-fir sawfly was derived from these counts.

Location	No. of Insects Per Ten Trees	Degree of Defoliation
Sec.15,tp.20,rge.19,W.P.mer.	45	light
Sec. 2,tp.21,rge.20,W.P.mer.	27	light
Sec.10,tp.20,rge.19,W.P.mer.	39	light
Sec.13,tp.21,rge.21,W.P.mer.	10	light
Sec. 4,tp.21,rge.20,W.P.mer.	22	light
Sec.15,tp.20,rge.19,W.P.mer.	7	light

Relatively small populations of balsam-fir sawfly were observed on white spruce in Tp. 35, rge. 23, W. P. mer., and in Secs. 2 and 13, tp. 36, rge. 23, W. P. mer. Defoliation in this area averaged about 5 per cent. A more severe infestation occurred in Secs. 1, 11 and 16, tp. 21, rge. 23, W. P. mer., where defoliation to white spruce ranged from 5 to 15 per cent.

In the Duck Mountain Forest Reserve light infestations were observed at widely separated points. White spruce stands in the south-eastern portion of the Reserve (Sec. 22, tp. 26, rge. 26, W. P. mer.) were inspected and although populations were small defoliation to white spruce ranged from 15 to 20 per cent. In Secs. 9, 21 and 26, of the same township and range, isolated stands of white spruce were less severely attacked and were defoliated 10 per cent. Only a few larvae were found on the foliage in this area. Light infestations occurred in Secs. 13 and 25, tp. 27, rge. 24, W. P. mer., and defoliation averaged approximately 10 per cent. Four miles west of the Grandview Ranger Station (Sec. 36, tp. 28, rge. 24, W. P. mer.), defoliation to stands of scattered white spruce averaged 15 per cent but only a few larvae were present. The scarcity of larvae was attributed to the advanced season. In Sec. 32, tp. 29, rge. 23, W. P. mer., white spruce was approximately 20 per cent defoliated although only a few larvae were found. An inspection of a mixed stand of white spruce and balsam fir in Sec. 19, tp. 30, rge. 24, W. P. mer. showed 5 per cent defoliation to white spruce. Farther west, near the Blue Lakes (Secs. 27 and 28, tp. 30, rge. 25, W. P. mer.) scattered stands of white spruce were lightly attacked. In Sec. 31, tp. 32, rge. 23, W. P. mer., a few larvae were found on isolated balsam fir but defoliation was negligible.

West of Pelican Bay on Lake Winnipegosis (Sec. 9, tp. 44, rge. 21, W. P. mer.), defoliation to scattered mature white spruce ranged from 15 to 20 per cent and larvae were reported as numerous. On the west shore of Cameron Bay (Sec. 11, tp. 46, rge. 22, W. P. mer.) a mixed stand of balsam fir and white spruce was inspected. Larval populations were the same on both tree species but where balsam showed little or no defoliation, white spruce was defoliated 15 per cent. At Devil Point, Lake Winnipegosis (Sec. 18, tp. 44, rge. 18, W. P. mer.) a few larvae were found on mature white spruce but no defoliation was observed. At Wade Point, along the east side of Lake Winnipegosis (Sec. 8, tp. 37, rge. 17, W. P. mer.) a large stand of mature white spruce was inspected. Sixty-one larvae and forty-one cocoons of the balsam-fir sawfly were taken from five trees. Defoliation to the entire stand averaged about 20 per cent and about one per cent of the trees in the stand were completely stripped of foliage. Stands of white spruce growing on Hill Island (Sec. 36, tp. 49, rge. 17, W. P. mer.), Birch Island, off Rodwick Point (Sec. 16, tp. 41, rge. 17, W. P. mer.) and Channel Island (Sec. 36, tp. 46, rge. 21, W. P. mer.), on Lake Winnipegosis were inspected and at all points large populations of the balsam-fir sawfly were observed. Defoliation ranged from 5 to 15 per cent. Other species of insects, including the yellow-headed and green-headed spruce sawflies were also present.

Only one report of the balsam-fir sawfly was received from the Northern district of Manitoba in 1949. This referred to the Grand Rapids area (Sec. 11, tp. 48, rge. 13, W. P. mer.) where a large population of the balsam-fir sawfly had caused severe defoliation to balsam fir in a mixed stand of balsam and jack pine. Several larvae were found on black spruce in the vicinity of The Pas but defoliation was reported as negligible.

In the Southern District, a light infestation caused some damage to a pure stand of white spruce in the Spruce Woods Forest Reserve (Tp. 10, rge. 15, W. P. mer.).

Balsam-fir sawfly was found at several points within and in the area immediately surrounding the Pasquia Provincial Forest. Attacks, which occurred on stands of scattered white spruce, caused 5 to 10 per cent defoliation. The infestation was centered in Secs. 1, 11, 12, 13, 14, 16, 17 and 18, tp. 45, rge. 8, W. 2nd mer. In the vicinity of Prairie River (Secs. 6, 7 and 10, tp. 45, rge. 7, W. 2nd mer.) stands of scattered white spruce were lightly infested and defoliation was negligible. White spruce in Secs. 13, 18 and 19, tp. 45, rge. 11, W. 2nd mer., was inspected and a few larvae were found. Defoliation however, was very light. Farther north along the Carrot River in Secs. 1, 2, 13 and 24, tp. 50, rge. 9, W. 2nd mer., and in Sec. 9, tp. 50, rge. 10, W. 2nd mer., sawfly activity was relatively light and had caused only light defoliation to scattered, isolated stands of white spruce. A stand of white spruce in Sec. 2, tp. 51, rge. 9, W. 2nd mer., was inspected and defoliation, to the young growth, averaged about 25 per cent. Owing to previous high winds and heavy rainfall in the area, few larvae remained on the foliage. In the Porcupine Forest Reserve and the surrounding area the infestation was light but fairly wide-spread. Light attacks were observed in stands of white spruce in Secs. 7 and 9, tp. 41, rge. 7, W. 2nd mer. Defoliation to a stand of white spruce near Bertwell (Sec. 30, tp. 41, rge. 4, W. 2nd mer.) was reported as negligible. South of the Reserve, in Sec. 7, tp. 36, rge. 2, W. 2nd mer., defoliation to white spruce was light. Light attacks also occurred in the Greenwater Lake Provincial Park (Secs. 2 and 8, tp. 41, rge. 10, W. 2nd mer.).

In the Prince Albert National Park, balsam-fir sawfly was found mainly in the vicinity of Waskesiu (Tp. 57, rge. 1, W. 3rd mer.). In the townsite of Waskesiu, ornamental hedges of white spruce showed light defoliation. Although larval populations in the area were high and scattered stands of spruce were attacked, defoliation did not exceed 10 per cent. An infestation on white spruce, in the vicinity of Prince Albert (Sec. 30, tp. 53, rge. 19, W. 2nd mer.) was inspected and defoliation averaged 5 per cent. In the Torch River Provincial Forest, a few larvae were found on scattered white spruce five miles north of Grassy Tower (Tp. 55, rge. 15, W. 2nd mer.) but defoliation was negligible. A few larvae found on scattered white spruce in Sec. 15, tp. 48, rge. 18, W. 2nd mer., caused only slight defoliation. Another very light attack on white spruce occurred in the Fort a la Corne Provincial Forest, south of English Cabin (Sec. 4, tp. 50, rge. 19, W. 2nd mer.). White spruce stands in the vicinity of Wapita Cabin (Sec. 26, tp. 49, rge. 18, W. 2nd mer.) and (Sec. 26, tp. 49, rge. 18, W. 2nd mer.) were lightly infested and defoliation averaged about 15 per cent. A stand of black spruce two miles west of the Reserve gate (Sec. 26, tp. 50, rge. 26, W. 2nd mer.) was 5 per cent defoliated.

Four reports were received of the balsam-fir sawfly attacking white spruce hedges in the town of Meadow Lake (Tp. 59, rge. 17, W. 3rd mer.). In all cases only a few larvae were present and defoliation was light.

A light infestation occurred on white spruce east of Bronson Lake in the Bronson Provincial Forest (Sec. 22, tp. 56, rge. 25, W. 3rd mer.) but caused very little damage. Another infestation, also causing little damage, was reported from the Big River Provincial Forest (Sec. 17, tp. 58, rge. 8, W. 3rd mer.).

6. Green-Headed Spruce Sawfly (*Pikonema dimmockii* Cress.)

Samples containing this insect were received from all forested areas of Manitoba and Saskatchewan, but in all cases each collection contained only a limited number of larvae. Defoliation exceeded five per cent in only one place, a scattered stand of white spruce near Carrot River, Saskatchewan (Sec. 2, tp. 51, rge. 9, W. 2nd mer.). White spruce in this area was defoliated about 25 per cent. There were other species of insects in the stand at the time of examination, therefore, it is probable that only a small part of the defoliation could be attributed to the green-headed spruce sawfly.

The origin of collections and reports received of the green-headed spruce sawfly are shown below:

Province	No.of Collections	No.of Reports
Manitoba	27	3
Saskatchewan	21	2

7. Yellow-Headed Spruce Sawfly (*Pikonema alaskensis* Roh.)

Although reports and collections of this insect were received from most points sampled in Manitoba by the Forest Insect Survey in 1949, no serious defoliation was observed. Most samples were taken from ornamental hedges or isolated and scattered stands of white spruce. Populations in spruce plantations in the Whiteshell Forest Reserve and the Riding Mountain National Park were reported as light and were causing no noticeable defoliation.

From Saskatchewan, one report was received of a severe infestation of this insect under natural forest conditions. This occurred in a small isolated stand of white spruce near Loon Lake (Tp. 58, rge. 22, W. 3rd mer.) in the Meadow Lake Forest District.

A moderate infestation in an open-growing stand of white spruce along the shore of Hanging Heart Lake (Sec. 32, tp. 57, rge. 1, W. 3rd mer.) in the Prince Albert National Park caused 30 per cent defoliation. A severe attack, on an ornamental white spruce hedge, was reported from Crooked River (Sec. 6, tp. 45, rge. 12, W. 2nd mer.) in the Hudson Bay District. Defoliation was estimated to be 85 per cent.

At all other points in Saskatchewan where this insect was observed damage remained light.

Distribution of the collections and reports received of this insect according to province are shown below:

Province	No.of Collections	No.of Reports
Manitoba	32	6
Saskatchewan	36	6

8. Pitch-Pine Nodule Maker (Petrova albicapitana Busck.)

Most young jack pine in natural stands and platnations in Manitoba and Saskatchewan were lightly to moderately attacked in 1949 by the pitch nodule maker. Dead and deformed trees were found in plantations, particularly in re-generation in burned areas due to the activity of the pitch nodule maker.

In Manitoba collections of the pitch nodule maker were made in the eastern half of the Province from Piney, in the south, to as far north as Bowden Lake, and from Treesbank north to Cranberry Portage in the western half of the Province. No severe infestations of the pitch nodule maker were reported in eastern Manitoba although nodules were found on most stands of jack pine, particularly on young growth. In the northern Manitoba areas, from Riding Mountain National Park north to Cranberry Portage, the pitch nodule maker was found on most young stands of jack pine and to a lesser degree on the more mature stands.

In Saskatchewan collections were made from the Hudson Bay, Prince Albert and Meadow Lake districts and in most jack-pine stands in Northern Saskatchewan. Mr. W. MacNeill, on August 14, 1949, reported from Meadow Lake District (Sec. 26, tp. 58, rge. 14, W. 3rd mer.) that the pitch nodule maker was very common on jack pine 1½ to 14 feet tall. It was also common in the area south of Meadow Lake along No. 4 Highway in Sec. 25, tp. 58, rge. 17, W. 3rd mer.

Province	No.of Collections	No.of Reports	No.of Larval Collections	No. of Larvae	Larvae Per Collection	No.of Trees
Manitoba	47	15				
Saskatchewan	75	36	120	835	6.9	637

9. Permanent Sample Plots and Permanent Sampling Stations

The establishing of permanent sample plots and permanent sampling stations was continued in Manitoba and Saskatchewan in 1949. Fourty-six permanent sample plots were established in tamarack stands in the two provinces; nineteen in the Eastern District of Manitoba, eleven in the Western District of Manitoba, four in the Hudson Bay District of Saskatchewan, and twelve in the Prince Albert District of Saskatchewan. In addition, fourteen permanent sampling stations were established; ten in the Western District of Manitoba and four in the Hudson Bay District of Saskatchewan.

The same procedure as set out in former years for establishing permanent sample plots and permanent sampling stations was followed in 1949.

Tables showing the location of the plots and stations according to districts are appended hereto.

TABLE A

- Permanent Sample Plots -

Eastern and Southern Districts of Manitoba 1949

Date Established	Plot No.	Tree Species	Location					Directions for Locating Plot
			Place	Sec.	Tp.	Rge.	Mer.	
Sept. 9	17	Tamarack	Marchand	18	6	9	E.P.	Sandilands Forest Reserve
Sept.10	18	Tamarack	Dawson Cabin	5	8	10	E.P.	4.1 mi. W. of Dawson Cabin
Sept.12	19	Tamarack	Dawson Cabin	36	7	10	E.P.	1 mi. E. of Dawson Cabin
Sept.12	20	Tamarack	Dawson Cabin	31	7	11	E.P.	1.5 mi. W. of Dawson Cabin
Sept.14	21	Tamarack	Dawson Cabin	32	7	11	E.P.	2.7 mi. W. of Dawson Cabin
Sept.14	22	Tamarack	Dawson Cabin	5	8	11	E.P.	4.9 mi. E. of Dawson Cabin
Sept.15	23	Tamarack	Dawson Cabin	2	8	11	E.P.	5.6 mi. E. of Dawson Cabin
Sept.15	24	Tamarack	Marchand	34	5	9	E.P.	1 mi. W. of Sandilands H.Q.
Sept.16	25	Tamarack	Whitemouth	10	11	13	E.P.	9 mi. W. of Rennie, Man. along No. 1 Highway
Sept.20	26	Tamarack	Rennie	22	10	15	E.P.	5 mi. E. of Lake Brereton Rd., along No. 1 Highway
Sept.21	27	Tamarack	Rennie	17	10	16	E.P.	9 mi. E. of Rennie; N. of railroad track at Telford Siding
Sept.21	28	Tamarack	Rennie	16	10	16	E.P.	Near Telford Siding
Sept.21	29	Tamarack	West Hawk Lake	30	9	17	E.P.	1 mi. W. of West Hawk Lake
Sept.22	30	Tamarack	West Hawk Lake	8	9	17	E.P.	1.9 mi. S. of No. 1 Highway along Falcon Lake Road
Sept.22	31	Tamarack	Whitemouth	31	10	14	E.P.	7.7 mi. W. of Rennie
Sept.28	32	Tamarack	Riverton	32	23	4	E.P.	2.6 mi. N. of Riverton
Sept.27	33	Tamarack	Ashern	23	32	9	E.P.	.5 mi. N.E. of Gypsumville
Sept.30	34	Tamarack	Lac du Bonnet	24	15	11	E.P.	2.7 mi. from jct. Pine Falls and Pointe du Bois road
Sept.30	35	Tamarack	Lac du Bonnet	—	15	12	E.P.	5 mi. E. of jct. of Pine Falls and Pointe du Bois road

TABLE B

- Permanent Sample Plots -

Western District of Manitoba 1949.

Date Established	Plot No.	Species	Location: Place	Sec.	Tp.	Rge.	Mer.	Directions for Locating Plot
Sept.16	I	Tamarack	Whirlpool Lake, R.M.N.P.	5	20	17	W.P.	1.2 mi. E. of Jct. on left-hand side of Whirlpool Lake Road
Aug. [illegible]	II	Tamarack	Elphinstone, R.M.N.P.	16	20	19	W.P.	2.6 mi. W. of Jct. #10 Hwy., and Lake Audy Rd., 250 yds. S.of road
Sept.17	III	Tamarack	Dom.Forest Service H.Q., R.M.N.P.	25	20	19	W.P.	Due north of Forest Service H.Q. (see diagram on record)
Sept.19	IV	Tamarack	Mile 14, P.T.H. #10, R.M.N.P.	23	21	19	W.P.	4 mi. N. Dom.For.Ser. H.Q.,marker located approx. 1 ch.W. of Hwy.
Sept.20	V	Tamarack	Elphinstone, R.M.N.P.	14	21	21	W.P.	1.7 mi.W. jct. P.O.W. Rd., marker located approx. 3 ch. N.thispoint
Sept.21	VI	Tamarack	Norgate Road, R.M.N.P.	36	19	17	W.P.	4.4 mi.E. Whirlpool Lk. Jct.marker 10½chs.N.35°W. from road.
Sept.21	VII	Tamarack	Dauphin Road, R.M.N.P.	4	22	19	W.P.	10 mi.N. Dom.For.Ser. H.Q. Marker on right-hand side of highway
Sept.23	VIII	Tamarack	Minitonas,Man.	11	35	23	W.P.	Mi.245,#10 Hwy. Marker located 4 chains W. of highway.
Sept.23	IX	Tamarack	Minitonas,Man.	15	36	23	W.P.	Mi.253.2,#10 Hwy. Marker located across C.N.R. track
Sept.24	X	Tamarack	Mafeking,Man.	18	46	25	W.P.	Mi.20.1,N. Mafeking, P.T.H.#10
Sept.24	XI	Tamarack	Mafeking,Man.	19	44	25	W.P.	Mi.8.4 N. Mafeking, P.T.H.#10

TABLE 6

- Permanent Sample Plots -

Hudson Bay District of Saskatchewan 1949

Date Established	Plot No.	Tree Species	Place	Sec.	Tp.	Rge.	Mer.	Directions for Locating Plot
Sept. 8	I	Tamarack	Pelly	15	34	32	W.P.	4 mi. N. of Pelly, Sask.
Sept.12	II	Tamarack	Hudson Bay	12	44	2	W2nd	11½ mi.E.#9 Hwy. on road to Armit Sask.
Sept.13	III	Tamarack	Hudson Bay	7	49	1	W2nd	16.2 mi.N.of Washee,Sask.
Sept.14	IV	Tamarack	Hudson Bay	--	--	--	----	12 mi.W. Hudson Bay along C.N.R. Accessible by speeder only

TABLE D

- Permanent Sample Plots -

Prince Albert and Meadow Lake Districts of Saskatchewan 1949

Date Established	Plot No.	Tree Species	Location					Directions for Locating Plot
			Place	Sec.	Tp.	Rge.	Mer.	
Aug. 29	XVI	Tamarack	Prince Albert	33	50	19	W.2nd	Four miles north of English Cabin Fort a la Corne Prov. For.
Sept. 9	XVII	Tamarack	Prince Albert	13	49	26	W.2nd	2.7 miles northwest of #2 Highway at Jct. of San Road, Nisbet Prov. For.
Sept.10	XVIII	Tamarack	Prince Albert	8	49	26	W.2nd	½ mile west of No. 3 Highway
Sept.13	XIX	Tamarack	Big River	30	56	8	W.3rd	8 miles west of forestry headquarters Big River Prov. For.
Sept.14	XX	Tamarack	Big River	26	56	9	W.3rd	11 miles west of forestry headquarters on Camp 15 road Big River Prov. For.
Sept.14	XXI	Tamarack	Big River	32	55	7	W.3rd	3 miles south of forestry headquarters Big River Prov. For.
Sept.15	XXII	Tamarack	Prince Albert	28	50	19	W.2nd	3 miles north of English Cabin, Fort a la Corne Prov. For.
Sept.17	XXIII	Tamarack	Prince Albert	4	50	20	W.2nd	6 miles west of English Cabin, Fort a la Corne Prov. For.
Sept.20	XXIV	Tamarack	Meadow Lake	12	55	17	W.3rd	13.4 miles south of Divide Fire Tower, Meadow Lake Prov. For.
Sept.21	XXV	Tamarack	Meadow Lake	15	55	17	W.3rd	3.7 miles south of game reserve boundary, Meadow Lake Prov. For.
Sept.21	XXVI	Tamarack	Meadow Lake	—	53	18	W.3rd	¼ mile north of Turtle Lake Cabin along lake shore, Meadow Lake Prov. For.
Sept.23	XXVII	Tamarack	Prince Albert	15	49	1	W.3rd	½ mile north of Crutwell R.R. Station, Nisbet Prov. For.

TABLE E

- Permanent Sampling Stations -

Western District of Manitobe 1949.

Date Established	Plot No.	Species	Location: Place	Sec.	Tp.	Rge.	Mer.	Directions for Locating Plot
July	W-23	White spruce	Garland	32	29	23	W.P.	1 mi. W. of reserve boundary on old Singoosh Lake Trail
July 9	W-24	White spruce	Elphinstone	17	20	19	W.P.	3½ mi. NW. of #10 Highway Jct., on Lake Audy Road
Aug. 16	W-25	Black spruce Tamarack	Minitonas	2	36	23	W.P.	East side of railroad track 1 mile north of Cowan Tower
Aug. 18	W-26	Jack pine	Garland	31	32	22	W.P.	2.3 miles west of Pine River, Man.
Aug. 22	W-27	Black spruce	Grandview	12	27	24	W.P.	1.9 miles north of Grandview Ranger Station
Aug. 29	W-28	White spruce	Elphinstone	7	21	20	W.P.	16.1 miles northwest of #10 Highway Jct., on Lake Audy Road
Aug. 29	W-29	Black spruce Tamarack	Elphinstone	19	21	20	W.P.	1.7 miles north of Lake Audy and P.O.W. road jct., R.M.N.P.
Aug. 29	W-30	Black spruce Tamarack	Elphinstone	19	21	20	W.P.	2.9 miles north of Lake Audy and P.O.W. road jct., R.M.N.P.
Sept. 1	W-31	Jack pine	R.M.N.P.	30	19	17	W.P.	3.3 miles east of #10 Jct., on Norgate Road
Sept. 2	W-32	White spruce	R.M.N.P.	1	20	19	W.P.	Along north shore subdivision road.

TABLE F

- Permanent Sampling Stations -

Hudson Bay District of Saskatchewan 1949

Date Established	Plot No.	Tree Species	Location: Place	Sec.	Tp.	Rge.	Mer.	Directions for Locating Plot
June 8	H.B.11	White poplar	Madge Lake	13	33	30	W.P.	.3 miles north on road to Benito Beach on Madge Lake
June 15	H.B.12	White spruce Black spruce	Usherville	11	39	5	W.2nd	4 miles north of Ushta Junction on Highway to Hudson Bay
June 15	H.B.13	Black poplar White spruce Black spruce	Somme	10	41	5	W.2nd	3½ miles west of Somme, Sask.
July 7	H.B.14	Larch	Carrot River	13	50	9	W.2nd	On east boundary of Block 29F.

A. PART A. STUDIES ON OVERWINTERED COCOONS

(a) Object

To test the effect of submergence in natural swamp water on overwintered and developing stages in larch sawfly cocoons.

(b) Procedure

This experiment was begun in May, 1949, in a small tamarack and black spruce swamp at Red Rock Lake, Manitoba. The experimental cocoons were gathered in early May in the Telford swamp, one mile east of Telford on No. 1 Highway. The cocoons were layered in moss and placed in wooden frames with screened top and bottom, constructed for this purpose. Duplicate frames, differing only in the type of moss, were set up for each treatment. One frame of each set contained sphagnum moss and the other, non-sphagnum moss. As the type of moss was subsequently found to have no effect on mortality and development, duplicate frames were considered replications to all practical purposes.

During treatment, frames containing cocoons were submerged in swamp water in pits dug in the peat, and were held down by rocks. Following treatment, the frames were placed above the water level and covered with moss for the remainder of the experiment. This location was thought to simulate natural conditions and cocoons were compared regularly with samples gathered in the field. Before treatment began on any frame, 20 cocoons were dissected to determine their condition. During and after treatment, 20 cocoons were dissected from each frame every two weeks until mid-August. Cocoons were dissected by slitting along the length with curved scissors and removing contents with a probe.

The stage of development of the insect in each cocoon was recorded and whether it was alive or dead. If dead, the cause of death was recorded where possible; i. e., mortality due to treatment or natural mortality (such as fungus disease, parasites, or predators). In many cases when cocoons were dissected during treatment, some time elapsed before signs of life became evident. Moribund larvae were, therefore, laid on moist blotting paper until recovery or death was certain. Also, only half the cocoons were dissected immediately, the remainder being left under natural, non-submerged conditions for a day or two, to permit recovery. The cause of death and stage of development were obliterated sometimes by decomposition especially in dissections made long after treatment. However, records may in general be considered accurate.

The following is an outline of treatments:

(i) Non-submerged check

The treatment began May 10 on two frames, each containing 180 cocoons. They were placed under natural conditions in the swamp (above the water level) and covered with moist moss. They were to be used as a check on normal sawfly development and mortality and were compared with cocoons collected weekly from the Telford swamp. The latter, of course, provided no count of emerged adults. An additional check was provided by dissection of samples from frames prior to treatment. This was considered the most accurate check.

(ii) Continuous submergence

This treatment was begun on May 10 on two frames each containing 180 cocoons. They were immersed in water continually for the whole experiment.

(iii) Intermittent submergence

This treatment was begun May 10 on four frames of 180 cocoons each. Two of these frames were intermittently submerged and raised above the water level for intervals of one week, recurring throughout the experiment. The same procedure, but with intervals of two days, was carried out with the second pair of frames.

(iv) Submergence by series

This treatment by series was begun on May 11. Each series consisted of six frames, as follows:

Two frames submerged for one week,

Two frames submerged for two weeks,

Two frames submerged for four weeks.

Treatment was begun on Series 1 on May 11, the others following consecutively at intervals of two weeks. Series 6 was submerged July 21. On conclusion of the treatments, all frames were restored to well-drained locations for the remainder of the experiment. From all frames, check samples of 20 cocoons were taken prior to treatment. During and after treatment, dissections of 20 cocoons were made from each frame every two weeks until mid-August.

During the period of emergence, frames were inspected and adults removed as often as possible, sometimes daily. These adults were accounted for in the fortnightly dissections by their ratio to the whole population; i.e.,

$$\frac{\text{No. of adults per sample}}{20} = \frac{\text{No. of adults removed to date}}{\text{No. of cocoons before sample removed}}$$

Then 20 cocoons, less the number of adults to be accounted for, were removed for dissection. The majority of adults were dissected for egg counts.

(e) Analysis and Discussion

Comparison of sphagnum and non-sphagnum moss.

Sphagnum and non-sphagnum mosses were compared for suitability for cocooning and development of the insect. In the check, dissections made in each series prior to treatment, natural mortality was: (1) sphagnum, 21.39% and (2) non-sphagnum, 23.89%. In cocoons from the Natural Diapause Study, which were left untreated until the developmental season ended, emergence of adults was: (1) sphagnum, 31.72% of the population and (2)non-sphagnum, 27.89%. In view of the small difference between the two media in mortality and emergence, it would seem that there is little difference between the suitability of each for sawfly cocoons. Although sometimes there were extensive variations between the two conditions in the material under treatment, these in general cancelled out and could not be attributed to the media. (It was thought that sphagnum moss might be a more favourable medium because of higher pH.)

Non-submerged Conditions

The cocoons which were left in non-submerged frames to act as a check on treated cocoons showed a higher mortality than that caused by most treatments including the one-week-intermittent treatment. (Table 1) Also the percentage of post-diapause stages found and the amount of final emergence was generally far below that found in most series treated. In the later dissections, it became apparent that the high mortality in these cocoons was due to disease. Therefore a substitute check on natural conditions was used, consisting of dissections from each series prior to treatment. (Table V, Fig.1.) Mortality here remained close to 20% until July 21 when it rose to 50%. This is well below that caused by treatment. These checks also furnished a reliable curve of the percentage of post-diapause stages present during the experiment and compared very favorably to conditions found in the field. (Telford swamp dissections Table VI.) Normal emergence was taken as that in the untreated cocoons found in the Natural Diapause Study where 29.3% of the sawflies emerged.

Continuously Submerged (Table II, Fig. 1)

Continuous immersion was begun on May 10 on cocoons where only 8.33% of the insects were in post-diapause stages. Little or no development followed and as treatment continued, mortality rose steadily (Table II, Fig. 1). Forty per cent mortality was recorded after one month of treatment and 80% after six weeks, but not until two months had elapsed was mortality complete. The resistance of diapausing eonymphs seemed, therefore, sufficient to withstand ordinary periods of immersion.

Intermittent Submergence (Table III, Fig.1)

Cocoons which had undergone recurring weekly intervals of submergence and non-submergence, showed a steady rise in mortality which ended at 90% after seven immersions (Table III, Fig.1). As dissections were made after cocoons had been under non-submerged conditions for a week, just before immersion, it was difficult to decide whether insects found in post-diapause stages had survived treatment or had developed since. However, as the rise in mortality corresponded with that of per cent development, it seems likely that each immersion was fatal to the majority of insects in post-diapause development. Then soon after restoration to non-submerged conditions, more larvae broke diapause and began development. No emergence was noted from these cocoons and most development, except for pronymphs, ended after the sixth immersion. This treatment demonstrates that larvae are able to recover and develop as far as the pupal stage in less than a week after an immersion of one week. However, if development has begun before immersion, further development ceases and death may result.

Cocoons which underwent intermittent two-day intervals of submergence and non-submergence were first treated on June 9 when post-diapause stages had reached 22.7% of the population (Table IV). After treatment was begun, only pronymphs and eonymphs were discovered. No emergence was noted and mortality rose steadily but some eonymphs were still found alive when the experiment ended.

It would seem that in eonymphs found alive at the end of these treatments, diapause had not been broken and the insects might have spent another winter in hibernation.

Series Submergence

Series I. Treatment commenced on May 11 when the percentage of post-diapause stages in the population was 8.33. Mortality in cocoons was similar in the three treatments; one week, two weeks, and four weeks of submergence (Tables VII, VII and IX, Fig. 2). Mortality in the four-week treatment was somewhat higher in the early dissections but later on, not much difference was apparent. In general, treatments at this time caused mortality comparable to that found in the non-submerged check cocoons (Fig. 1). In the graphs picturing the per cent of post-diapause stages present at various times (Fig. 7, Tables XXVI, XXVII and XXVIII), the effect of treatment is more noticeable. For cocoons which had undergone one week of submergence, the peak wave of developing insects (i.e. pupae, pronymph and teneral adult) was only slightly delayed compared to that in non-submerged cocoons. The two-week treatment delayed the peak of development about one week while the four-week treatment stopped development of the insects entirely for two weeks and delayed the peak for two weeks. In all treatments, however, the peak of development reached was only slightly below that of untreated cocoons.

The number of adults taken from frames of this series was not as high in proportion to the total population as was found in untreated cocoons (Natural Diapause Study). Except for frame No.1 of the four-week treatment, which was close to normal (Table XXIV), the emergence varied between 15.75% and 7.5%. This low emergence seemed inconsistent with the apparently normal development and mortality found. However, mortality in the final dissections was rather high owing to many diseased pupae and larvae in the frames and it was thought that disease, rather than treatment, accounted for low emergence here. Disease may have been encouraged by the treatment.

Therefore treatment of up to four weeks' submergence at this time on cocoons in this stage of development has little effect other than some delay in development and emergence. In this series, all adults emerged after treatment.

Series II. Cocoons in this series were submerged May 25, when a check dissection showed that 19.99 per cent of the population consisted of post-diapausing insects. Mortality in cocoons subjected to one week of immersion (Table X) followed to a large extent, that found in non-submerged cocoons. Mortality due to two and four week submergences (Tables XI and XII, and Fig. 3) showed a sudden rise in both cases immediately after treatment, followed by a return to slightly above that found in untreated cocoons. If this sudden and excessive rise is due to errors in differentiating between living and dead individuals soon after treatment, as seems feasible, then mortality for the three treatments in this series shows but a small increase over that in non-submerged cocoons.

In cocoons treated at this time a longer delay in the appearance of the peak of development resulted but almost as large a portion of the cocoons finally reached the post-diapause stages as was the case in untreated cocoons (Tables XXVI, XXVII, XXVIII, and Fig.8).

The number of adults which emerged averaged 24.2 per cent of the cocoons which were treated for one week and two weeks. In frames treated for four weeks, only 6.3 per cent of the cocoons produced adults. However, in the latter, the peak of post-diapause stages reached 52.5 per cent after treatment so that the low emergence could not be due entirely to submergence. All emergence from this series occurred after treatment.

Series III. Treatment commenced on cocoons of this series on June 8 when 56.7 per cent of the population was composed of insects in post-diapause stages. Treatment at this time, therefore, caught the largest portion of the insects in development and also caused the highest mortality of the series and the lowest emergence. The per cent mortality in these cocoons (Tables XIV, XV, XVI, Fig. 4) was slightly higher then that recorded for any other cocoon treated at other times to similar periods of submergence. In cocoons treated for four weeks, there was no further sign of post-diapause development (Tables XXVI, XXVII, XXVIII, Fig. 9). Development was also arrested in cocoons which underwent two weeks of treatment but 35 per cent of the population was found in metamorphosis two weeks after the treatment. The one-week treatment was followed by a reduction in the amount of post-diapause insects present from 65 per cent before treatment to 42.5 per cent after treatment.

Emergence from these cocoons showed most clearly the effect of treatment on cocoons where a large portion are in post-diapause stages. Only 3.5 per cent of the cocoons which were submerged four weeks produced adults while only 7.9 per cent emerged from cocoons treated one and two weeks (Table XXV). Most emergence occurred before treatment.

Series IV. These cocoons were submerged on June 23 when the per cent of developing stages in the population was still quite high, 53.1 per cent (Table V). Mortality was not quite so heavy as was recorded for cocoons submerged June 8 (Tables XVI, XVII and XVIII, Fig.5). The sudden rise in mortality immediately after treatment was again present, especially in cocoons submerged two and four weeks. However, after the first dissection, mortality remained fairly steady at 80 per cent of the population until the end of the experiment. The number of developing insects was reduced sharply by all three treatments (Tables XXVI, XXVII, XXVIII, Fig. 10). No metamorphosing insects were found in cocoons which had undergone two and four weeks of immersion while only about ten per cent of the cocoons subjected to one week of treatment showed signs of development.

However, 20 per cent of the cocoons had produced adults before treatments were begun. (This accounts for most of the living insects after a mortality of about 80 per cent.) No adults appeared after treatment and it must be assumed that the submergence at this time came too late to be very effective.

Series V. Treatments on these cocoons were begun July 6 when the percentage of cocoons in post-diapause stages had declined to 25.8 per cent, (Table IV). The per cent mortality was low in all frames before treatment but rose an average of about 40% (Tables XIX, XX, XXI, Fig.6). No further rise was noted after the first dissections. Final mortality of cocoons in all treatments averaged 59.2 per cent. Much of the balance was in the adults which emerged before treatment, 31.50 per cent of the population, (Table XXV). All adults emerged before treatment while no developing insects were found in any cocoons after treatments.

Series VI. Treatment was started on these cocoon on July 21 when the percentage of cocoons in post-diapause stages was reduced to 2.5 of the population. The mortality of the cocoons was relatively unchanged by treatments and was mainly due to natural causes (Tables XXII, XXIII, XXIV). Most metamorphosis was complete and a normal emergence of 31.25 per cent had taken place before treatment (Table XXV). Therefore, water treatment after July 23 had little effect on sawfly populations because it was too late to catch emerging adults.

Comparison of Emergence and Development in Relation to Time of Treatment

A comparison of the percentage of the populations undergoing treatments which emerged as adults with the percentage of developing stages present at time of treatment, shows most clearly the effect of submergence on overwintered cocoons. Figure 12 shows the rise and fall in the percentage of living post-diapause insects in a sample of normal field populations and in untreated experimental cocoons through spring ans summer. The time when most metamorphosing insects were present was June 8. Fifty-seven per cent of those in the field samples and 53 per cent in experimental cocoons were in post-diapause stages. The curves followed each other closely enough to indicate that experimental cocoons are nearly normal. Figure 1#, however, shows that cocoons treated at this time of peak development show the lowest final emergence; 8 per cent of cocoons which were treated up to two weeks and only 3.5 per cent of cocoons treated for a month. Normal emergence was 2.9 per cent (from the Natural Diapause Study). Cocoons treated before June 8 showed some lowering of the number of adults expected to emerge but in the main, emergence was only delayed. In cocoons treated on June 23 when the per cent development was still high, 20 per cent of the population emerged as adults while treatments after this missed most of the developing insects and emergence was normal.

Diapause in Treated Cocoons

No evidence was found of excessive diapause induced in cocoons by water treatments. On the final dissection, September 1, 1949, only 10 live eonymphs were found in all frames.

Date of Treatment	No. Live Eonymphs	Per Cent
May 11	1	1.33
May 25	3	2.38
June 8	1	.93
June 23	1	.99
July 6	3	2.73
July 21	1	1.09
Mean		1.57

Diapause in untreated cocoons averaged 5.5 per cent of population as found in the Natural Diapause Study.

Analysis of Variance in Series, Treatments and Dissections

An analysis of variance was made using the values of total mortality for the first, second and final dissections following the one-week, two-week, and four-week treatments of cocoons in Series I - V, Table XXIX. The sums of squares, degrees of freedom and the variances were calculated for the series, the treatments, the dissections and for the various interactions between them. The variance was also found for replications and this proved to be quite low in relation to most of the other variances. It follows that the duplicates used for each section of the experiment were quite reliable. The two kinds of moss produced no difference on survival or development.

The F values of the various groups were found by dividing each variance by the variance found for the replications. The results were highly significant, beyond the one per cent point, except for the interaction between series and treatments and for the triple interaction of series, treatments and dissections. The F value of the mortality compared between Series I - V, showed a highly significant difference between the effect of treatment at various times during the spring; i.e., the effect on populations with various proportions of developing stages. The difference in length of treatments shows a higher significance but the largest F value is exhibited in the comparison of dissections. This last is, however, to be expected as it occurred even in untreated material, being influenced by natural mortality. Lower, but still significant F values were shown in the interactions of series and dissections, and of treatments and dissections.

TABLE I

PER CENT MORTALITY IN NON-SUBMERGED COCOONS

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
May 10 (ch.)	10	0	10	15	0	15
May 24	10	0	10	5	0	5
June 7	30	5	25	10	5	5
21	25	0	25	40	10	30
July 5	75	20	55	70	20	50
19	90	0	90	80	30	50
Aug. 2	100	0	100	90	5	85
15	90	0	90	90	0	90

Ch = Check dissection made before treatment

Percent emergence: Frame No. 1 - 11.75
Frame No. 2 - 6.67

TABLE II

PER CENT MORTALITY IN COCOONS SUBMERGED CONTINUOUSLY

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
May 10 (ch.)	20	0	20	10	0	10
May 24	20	0	20	15	0	15
June 7	55	30	25	25	10	15
21	85	20	65	80	20	60
July 5	100	15	85	100	15	85
19	100	20	80	100	10	90
Aug. 2	100	15	85	100	20	80
15	100	22	78	100	5	95

Ch = Check dissection made before treatment

No emergence.

*Total Mortality **Developmental Mortality

*** Larval Mortality

TABLE III

PERCENT MORTALITY IN COCOONS INTERMITTENTLY SUBMERGED ONE WEEK

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
May 10 (ch)	10	0	10	5	0	5
May 24	5	0	5	20	0	20
June 7	10	0	10	15	0	15
21	20	10	10	20	10	10
July 5	45	30	15	40	15	25
12	65	55	10	45	10	35
27	85	40	45	80	55	25
Aug. 10	95	15	80	85	20	65

No emergence

TABLE IV

PERCENT MORTALITY IN COCOONS INTERMITTENTLY SUBMERGED FOR TWO-DAY PERIODS BEGUN JUNE 9

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
June 9 (ch)	15	10	5	5	5	0
June 23	35	15	20	35	15	20
July 7	25	10	15	30	20	10
21	60	35	25	65	25	40
Aug. 4	80	20	60	75	20	55
18	95	10	85	65	5	60

No emergence

ch = check dissection made before treatment
* Total Mortality
** Developmental Mortality
*** Larval Mortality

TABLE V

CHECK DISSECTIONS MADE ON NON-SUBMERGED COCOONS
(Made in Series I - VI prior to treatment)

Status	May 11	May 25	June 8	June 23	July 7	July 21
% Dead						
Parasite	25.0	4.2	5.8	5.0	5.0	15.8
Fungus		5.0	0.8	5.8	1.7	1.7
Pronymphs				0.8	2.5	10.0
Eonymphs					4.2	13.3
Pupae		0.8	5.8	2.5	10.8	5.8
T. Adults*						3.3
Total	25.0	10.0	12.4	14.1	24.2	49.9
% Alive						
Eonymph	66.7	70.0	28.3	14.2	19.2	15.8
Pronymph		8.3	24.2	18.3	5.0	
Pupae	8.3	10.8	27.5	25.8	11.7	0.8
T. Adults*		0.8	5.0	9.2	9.2	1.7
Adult			2.5	18.3	30.8	31.7
Total	75.0	89.9	87.5	85.8	75.8	50.1
Total Dev.	8.3	19.9	56.7	53.3	25.8	2.5

* T. Adult = Teneral Adult.

TABLE VI

STAGES IN COCOONS FROM TELFORD SWAMP

Date	Eonymph	Pronymph	Pupae	T.Adult	Adult	Total	% Dev.
May 12	79	2	23	0	0	104	24.38
16	107	2	22	0	0	131	18.32
23	122	19	26	2	0	171	24.49
30	146	12	19	1	2	180	18.87
June 6	15	68	36	6	0	185	59.46
13	134	14	19	12	0	239	43.93
20	111	8	44	13	2	179	37.43
27	31	0	4	13	2	50	38.00
July 4	51	1	10	2	0	64	20.31
11	184	1	3	7	0	195	5.64
18	12	0	0	1	1	14	16.67
25	19	0	1	0	0	20	5.0

No dead or emerged sawfly cocoons counted here.

TABLE VII
SERIES I

PERCENT MORTALITY OF COCOONS SUBMERGED ONE WEEK ON MAY 11

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
May 11 (ch)	40	0	40	20	0	20
May 25	10	5	5	35	10	25
June 8	20	5	15	20	5	15
22	30	10	20	25	5	20
July 6	75	25	50	35	25	10
20	70	50	20	70	10	60
Aug. 3	85	5	80	85	0	85
17	90	5	85	85	0	85

TABLE VIII
SERIES I

PERCENT MORTALITY OF COCOONS SUBMERGED TWO WEEKS

COMMENCING MAY 11

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
May 11 (ch)	10	0	10	35	0	35
May 25	35	5	30	5	5	0
June 8	25	5	20	30	5	25
June 22	20	0	20	25	0	25
July 6	30	20	10	55	15	40
July 20	90	30	60	70	20	50
Aug. 3	90	5	85	85	0	85
Aug.17	85	0	85	80	15	65

* Total Mortality
** Developmental Mortality
*** Larval Mortality

ch = Check dissection made before treatments

TABLE IX
SERIES I

PER CENT MORTALITY OF COCOONS SUBMERGED FOUR WEEKS COMMENCING MAY 11

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
May 11 (ch)	25	0	25	20	0	20
May 25	30	10	20	50	10	40
June 8	35	20	15	60	10	50
22	20	15	5	45	0	45
July 6	45	5	40	45	15	30
20	60	10	50	80	15	65
Aug. 3	60	5	55	95	5	90
17	70	5	65	90	0	90

TABLE X
SERIES II

PER CENT MORTALITY OF COCOONS SUBMERGED ONE WEEK COMMENCING MAY 25

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
May 25 (ch)	15	0	15	5	5	0
June 8	15	15	0	25	25	0
22	30	5	25	15	5	10
July 6	40	30	10	25	20	5
20	65	35	30	65	35	30
Aug. 3	75	5	70	65	5	60
17	75	10	65	70	0	70
Sept. 1	80	10	70			

ch = Check dissection made before treatments

* Total Mortality
** Developmental Mortality
*** Larval Mortality

TABLE XI
SERIES II

PER CENT MORTALITY IN COCOONS SUBMERGED TWO WEEKS COMMENCING MAY 25

Date Dissected	Frame 1			Frame 2		
	T*	D**	L***	T*	D**	L***
May 25 (ch)	5	0	5	15	0	15
June 8	30	10	20	55	45	10
22	35	5	30	40	25	15
July 6	30	15	15	40	25	15
20	60	40	20	75	30	45
Aug. 3	70	10	60	70	0	70
17	70	15	55	75	10	65

TABLE XII
SERIES II

PER CENT MORTALITY IN COCOONS SUBMERGED FOUR WEEKS COMMENCING May 25

Date Dissected	Frame 1			Frame 2		
	T*	D**	L***	T*	D**	L***
May 25 (ch)	5	0	5	15	0	15
June 8	35	15	20	45	20	25
22	85	10	75	70	35	35
July 6	25	5	20	20	15	15
20	65	35	30			
Aug. 3	70	0	70	85	5	80
17	90	0	90	95	15	80

ch = Check dissection made before treatments

* Total Mortality
** Developmental Mortality
*** Larval Mortality

TABLE XIII
SERIES III

PER CENT MORTALITY IN COCOONS SUBMERGED ONE WEEK
COMMENCING JUNE 8

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
June 8 (ch)	10	10	0	20	5	15
June 22	55	40	15	25	25	0
July 6	60	40	20	60	40	20
20	80	20	60	35	20	15
Aug. 3	90	25	65	75	35	40
17	90	10	80	85	5	80

TABLE XIV
SERIES III

PER CENT MORTALITY IN COCOONS SUBMERGED TWO WEEKS
COMMENCING JUNE 8

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
June 8 (ch)	10	5	5	10	10	0
June 22	80	20	60	75	50	25
July 6	45	25	20	45	30	15
20	75	25	50	80	50	30
Aug. 3	95	5	90	90	25	65
17	95	10	85	80	5	75

ch - Check dissection made before treatments

* Total Mortality
** Developmental Mortality
*** Larval Mortality

TABLE XV
SERIES III

PER CENT MORTALITY IN COCOONS SUBMERGED FOUR WEEKS
COMMENCING JUNE 8

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
June 8 (ch)	10	5	5	15	0	15
June 22	95	75	20	85	50	35
July 6	100	50	50	100	55	45
20	80	10	70	85	35	50
Aug. 3	90	0	90	75	15	60
17	95	5	90	95	10	85

TABLE XVI
SERIES IV

PER CENT MORTALITY IN COCOONS SUBMERGED ONE WEEK
COMMENCING JUNE 23

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
June 23 (ch)	15	0	15	15	5	10
July 7	55	45	10	45	35	10
21	55	30	25	65	30	35
Aug. 4	80	20	60	70	15	55
18	75	10	65	61	11	50

ch = Check dissection made before treatments

* Total Mortality
** Developmental Mortality
*** Larval Mortality

TABLE XVII
SERIES IV

PER CENT MORTALITY IN COCOONS SUBMERGED TWO WEEKS
COMMENCING JUNE 23

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
June 23 (ch)	10	10	0	15	0	15
July 7	80	75	5	70	55	15
21	70	20	50	55	20	35
Aug. 4	60	25	35	75	30	45
18	70	15	55	55	15	40

TABLE XVIII
SERIES IV

PER CENT MORTALITY IN COCOONS SUBMERGED FOUR WEEKS
COMMENCING JUNE 23

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
June 23 (ch)	20	0	20	5	0	5
July 7	65	55	10	65	60	5
21	90	40	50	75	25	50
Aug. 4	85	30	55	80	40	40
18	90	10	80	69	19	50

ch = Check dissection made before treatments

* Total Mortality
** Developmental Mortality
*** Larval Mortality

TABLE XIX
SERIES V

PER CENT MORTALITY IN COCOONS SUBMERGED ONE WEEK
COMMENCING JULY 7

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
July 7 (ch)	30	15	15	20	15	5
July 21	45	30	15	75	20	55
Aug. 4	55	0	55	70	10	60
18	50	5	45	50	0	50

TABLE XX
SERIES V

PER CENT MORTALITY IN COCOONS SUBMERGED TWO WEEKS
COMMENCING JULY 7

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
July 7 (ch)	5	0	5	25	10	15
July 21	40	20	20	65	25	40
Aug. 4	60	10	50	55	10	45
18	50	5	45	65	25	40

TABLE XXI
SERIES VI

PER CENT MORTALITY IN COCOONS SUBMERGED FOUR WEEKS
COMMENCING JULY 7

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
July 7 (ch)	35	20	15	35	20	15
July 21	75	20	55	60	20	40
Aug. 4	80	25	55	60	15	45
18	80	20	60	60	5	55

ch - Check dissection made before treatments
* Total Mortality
** Developmental Mortality

*** Larval Mortality

TABLE XXII
SERIES VI

PER CENT MORTALITY IN COCOONS SUBMERGED ONE WEEK
COMMENCING JULY 21

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
July 21 (ch)	35	15	20	75	35	40
Aug. 4	65	15	50	85	0	85
18	65	5	60	85	10	75

TABLE XXIII
SERIES VI

PER CENT MORTALITY IN COCOONS SUMBERGED TWO WEEKS
COMMENCING JULY 21

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
July 21 (ch)	60	35	25	70	20	50
Aug. 4	65	10	55	75	5	70
18	60	5	55	70	0	70

TABLE XXIV
SERIES VI

PER CENT MORTALITY IN COCOONS SUMBERGED FOUR WEEKS
COMMENCING JULY 21

Date Dissected	Frame 1			Frame 2		
	TM*	DM**	LM***	TM*	DM**	LM***
July 21 (ch)	55	10	45	5	0	5
Aug. 4	70	30	40	30	10	20
18	65	10	55	30	5	25

Ch = Check dissection made before treatments
* Total Mortality
** Developmental Mortality
*** Larval Mortality

TABLE XXV

PER CENT EMERGENCE FROM COCOONS UNDERGOING THREE TREATMENTS AT VARIOUS INTERVALS AT VARIOUS TIMES

TREATMENT COMMENCED	Treated 1 Week		Treated 2 weeks		Treated 4 weeks	
	Frame 1	Frame 2	Frame 1	Frame 2	Frame 1	Frame 2
May 11	14.00	8.94	9.25	15.75	28.25	7.50
25	24.75	26.67	26.50	18.74	9.17	3.50
June 8	8.78	7.00	5.06	11.11	3.57	3.46
23	22.50	20.83	21.00	26.83	7.00	21.83
July 7	37.00	15.00	42.00	35.00	21.00	37.00
21	25.00	15.00	36.25	18.75	32.50	60.00

In cocoons treated before June 8, emergence took place after treatment. In cocoons treated on June 8, emergence was very low and came partly before treatment and partly after. In cocoons treated after June 8, emergence came generally before treatment. Emergence from check frames was in No. 1 - 31.72%, No. 2 - 21.89%. The development present in cocoons was:

May 11	-	8.33%	June 23	-	53.33%
May 25	-	19.99%	July 7	-	25.84%
June 8	-	36.67%	July 21	-	2.50%

TABLE XXVI

PER CENT LIVING POST-DIAPAUSE STAGES IN COCOONS SUBMERGED ONE WEEK IN SERIES I - VI

Treatment	Series 1		Series 2		Series 3		Series 4		Series 5		Series 6	
Date Dissected	*F.1	F.2	F.1	F.2	F.1	F.2	F.1	F.2	F.1	F.2	F.1	F.2
May 11	5%	10%										
25	15%	15%	20%	30%								
June 8	40%	55%	5%	35%	55%	75%						
22	60%	55%	35%	60%	65%	20%	40%	60%				
July 6	30%	10%	30%	35%	65%	20%	10%	15%	10%	50%		
20	0	0	5%	0	5%	5%	10%	10%	0	0	5%	0
Aug. 3	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0

TABLE XXVII

PER CENT LIVING POST-DIAPAUSE STAGES IN COCOONS SUBMERGED TWO WEEKS IN SERIES I - VI

Treatment	Series 1		Series 2		Series 3		Series 4		Series 5		Series 6	
Date Dissected	*F.1	F.2	F.1	F.2	F.1	F.2	F.1	F.2	F.1	F.2	F.1	F.2
May 11	10%	5%										
25	10%	0	30%	25%								
June 8	15%	10%	10%	10%	40%	55%						
22	60%	40%	40%	50%	0%	0%	60%	50%				
July 6	25%	25%	45%	40%	40%	30%	0	0	25%	25%		
20	0	0	15%	0	0	5%	0	0	0	0	0	5%
Aug. 3	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0

* - F.1 = Frame 1

TABLE XXVIII

PER CENT LIVING POST-DIAPAUSE STAGES IN COCOONS SUBMERGED FOUR WEEKS IN SERIES I - VI

Treatment	Series 1		Series 2		Series 3		Series 4		Series 5		Series 6	
Date Dissected	*F.1	F.2	F.1	F.2	F.1	F.2	F.1	F.2	F.1	F.2	F.1	F.2
May 11	5%	5%										
25	0	0	15%	5%								
June 8	0	0	5%	0	60%	60%						
22	20%	15%	0	0	0	0	50%	60%				
July 6	45%	45%	55%	50%	0	0	0	0	25%	20%		
20	0	0	0	0	0	0	0	0	0	0	0	5%
Aug. 3	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0

*F.1 = Frame 1.

TABLE XXIX

ANALYSIS OF VARIANCE IN SERIES, TREATMENTS AND DISSECTIONS FROM SERIES 1 - 6 WATER LEVEL EXPERIMENT A

	Sum of Squares	DF	Variance	$F_{(\frac{V}{E})}$	5%	1%
Series	9,073.33	4	2,268.33	19.82	2.57	3.76
Treatments	7,183.89	2	3,591.94	31.39	3.20	5.10
Dissections	11,060.56	2	5,530.28	48.32	3.20	5.10
S x T	1,438.33	8	179.79	1.57	2.14	2.92
S x D	9,103.33	8	1,137.92	9.94	2.14	2.92
T x D	2,119.44	4	529.81	4.63	2.57	3.76
S x T x D	3,251.12	16	203.20	1.78	1.87	2.42
Replications	5,150.00	45	114.44			

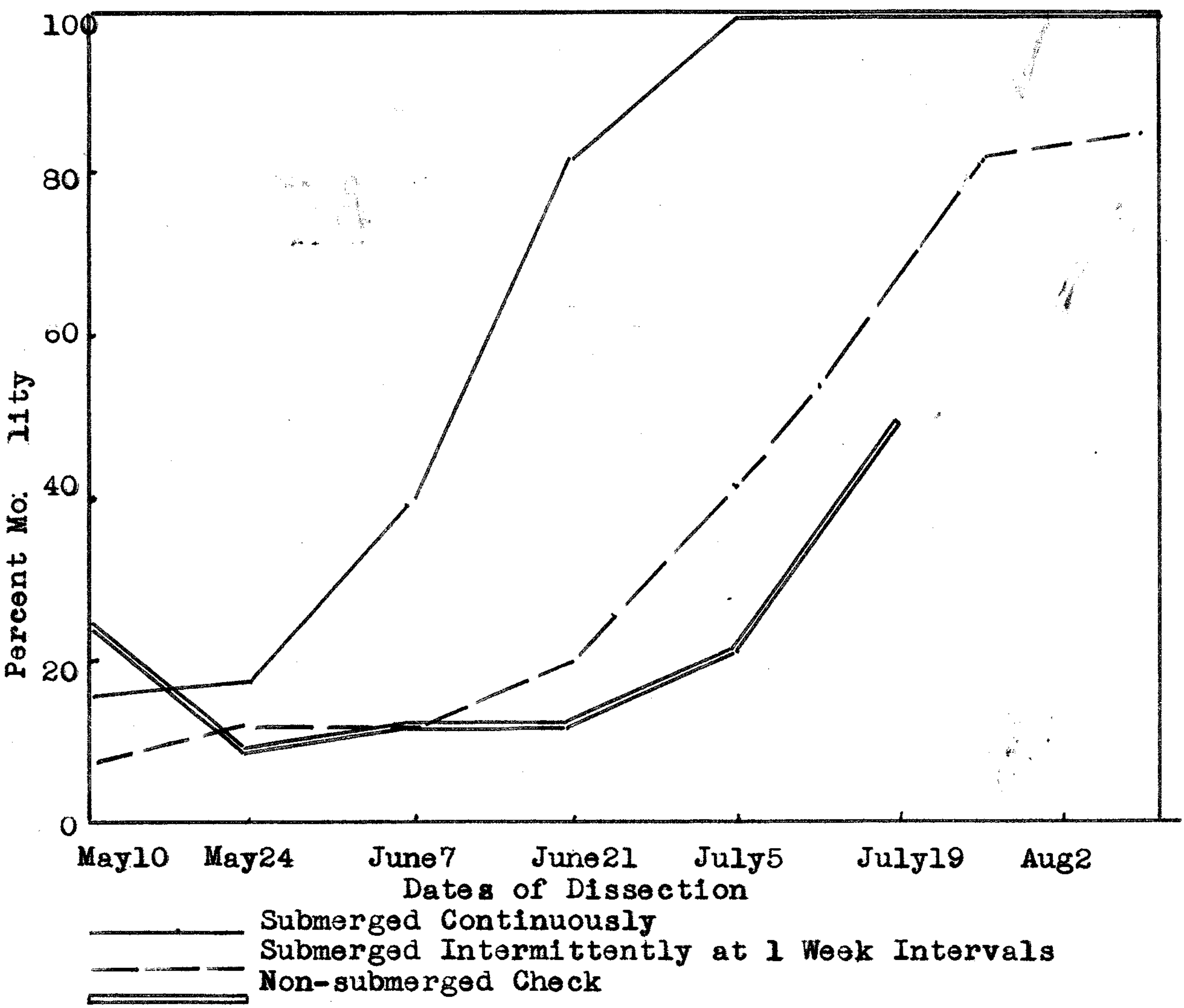


Fig.1 Mortality in larch sawfly cocoons submerged continuously, intermittently at 1 week intervals, and in non-submerged untreated cocoons.

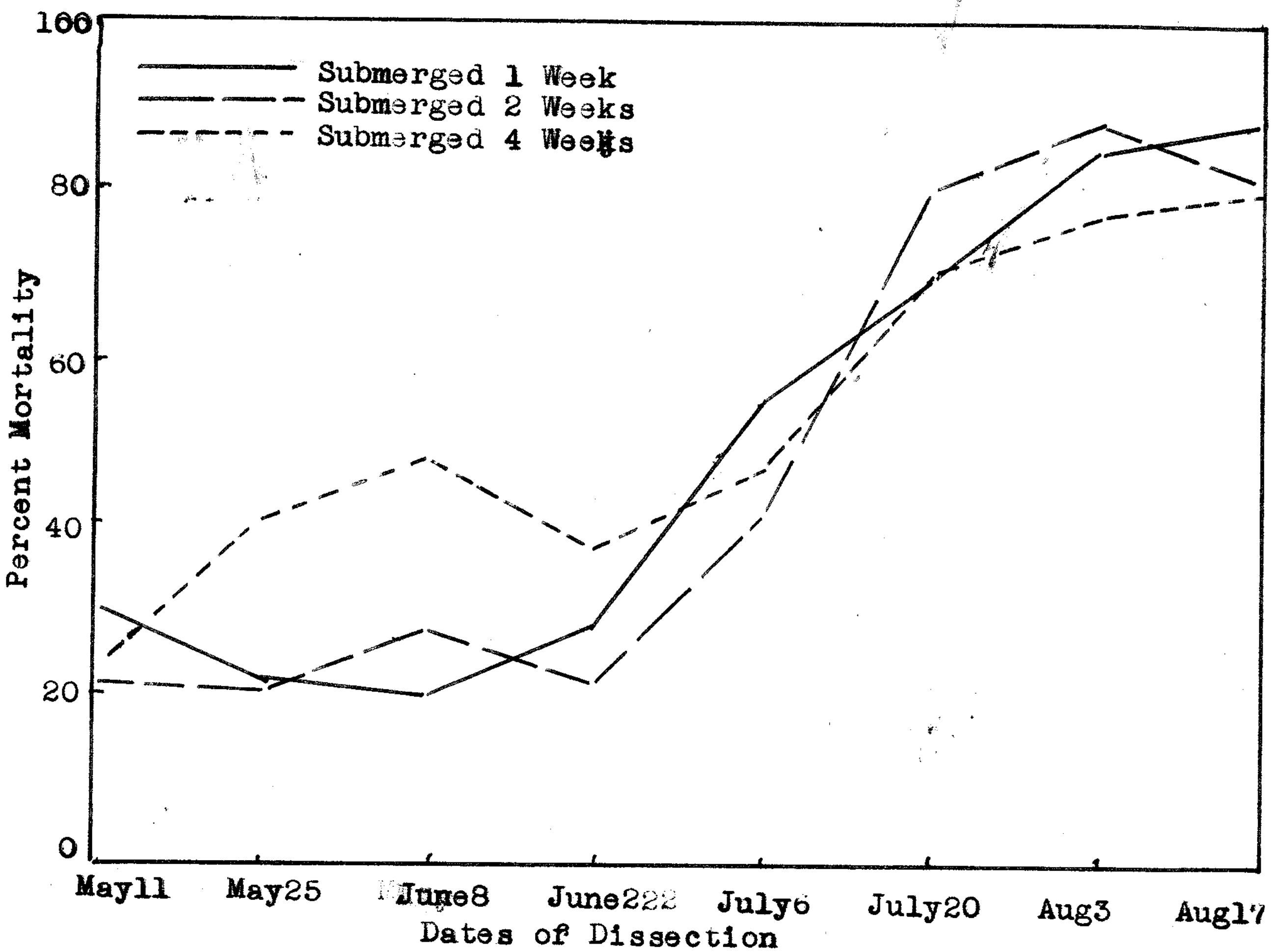


Fig.2 Mortality in larch sawfly cocoons when treatment begun May 11.

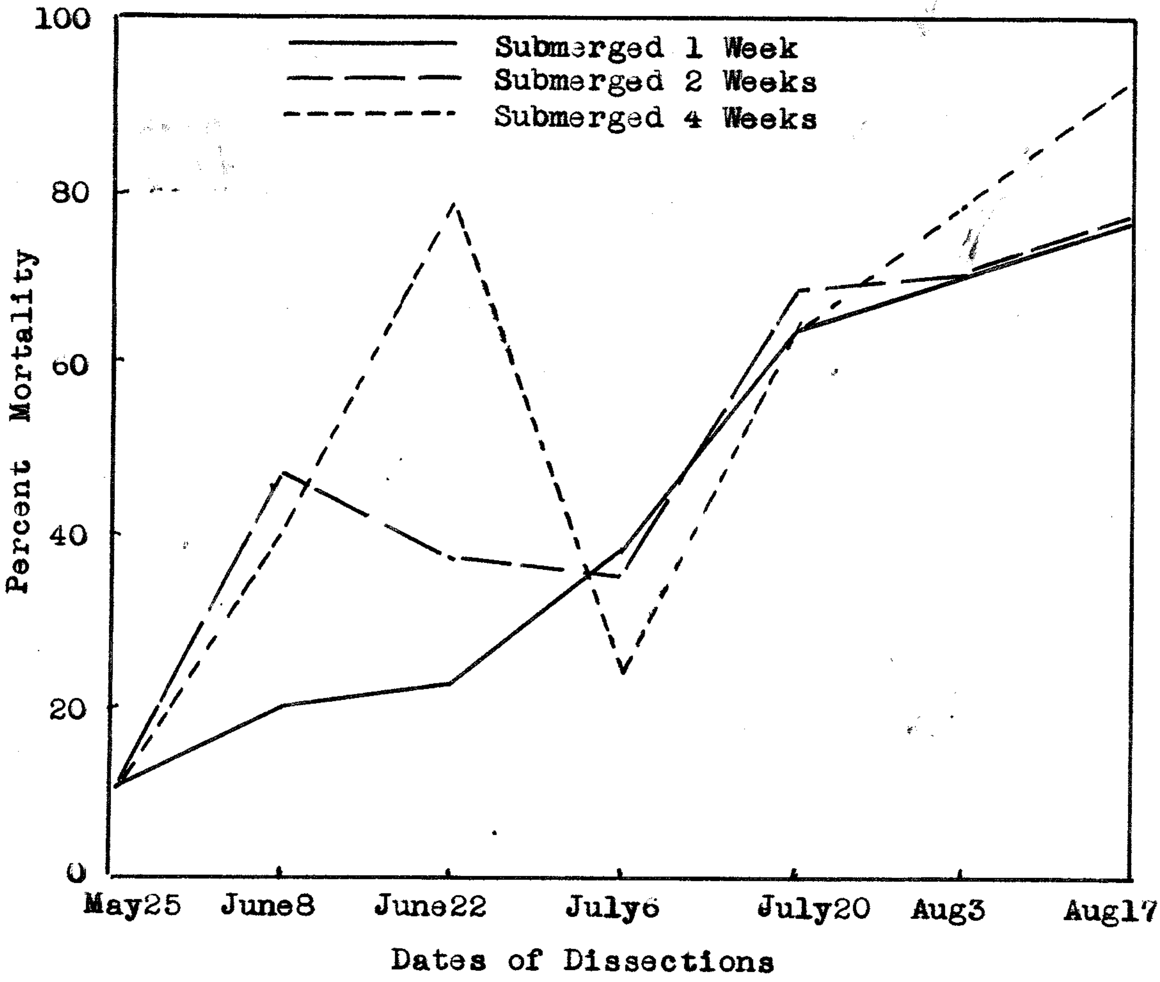


Fig.3 Mortality in larch sawfly cocoons when treatment begun May 25.

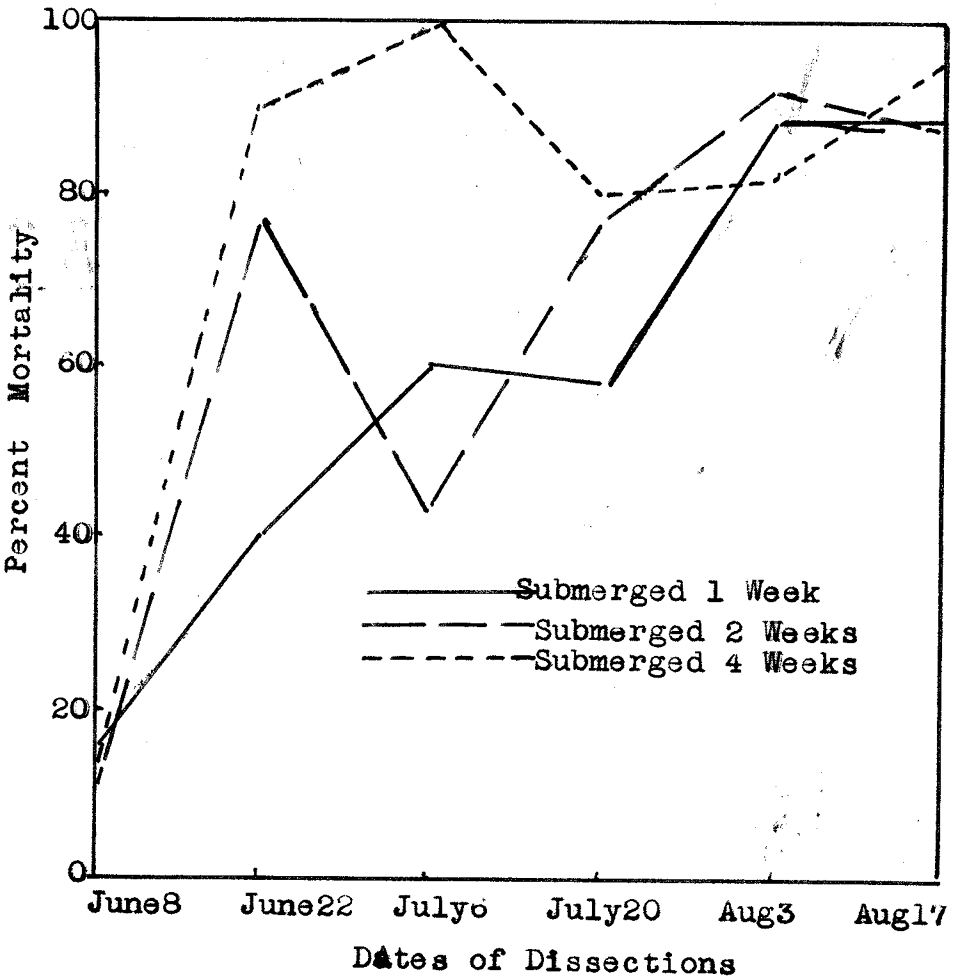


Fig. 4 Mortality in larch sawfly cocoons when treatment begun June 8.

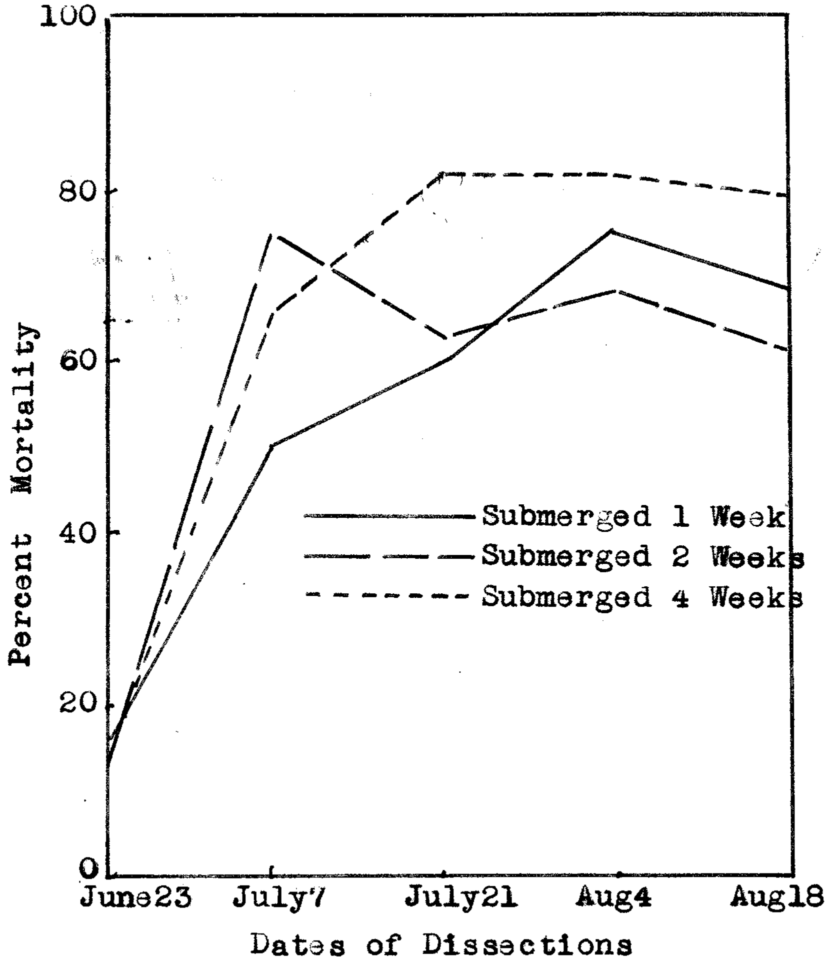


Fig.5 Mortality of larch sawfly cocoons when treatment begun June 23.

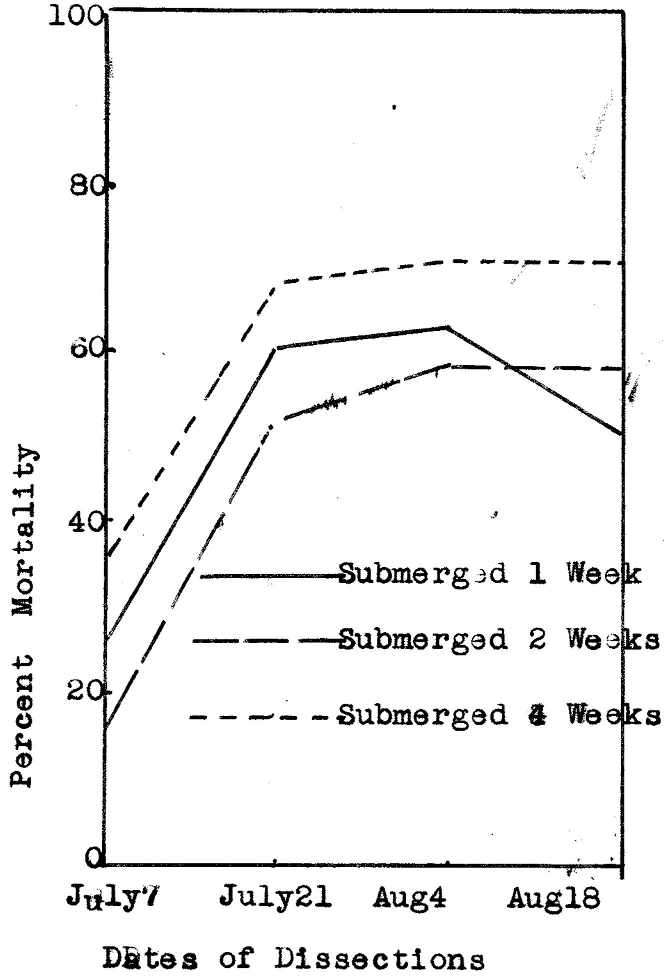


Fig.6 Mortality in larch sawfly cocoons when treatments begun July7.

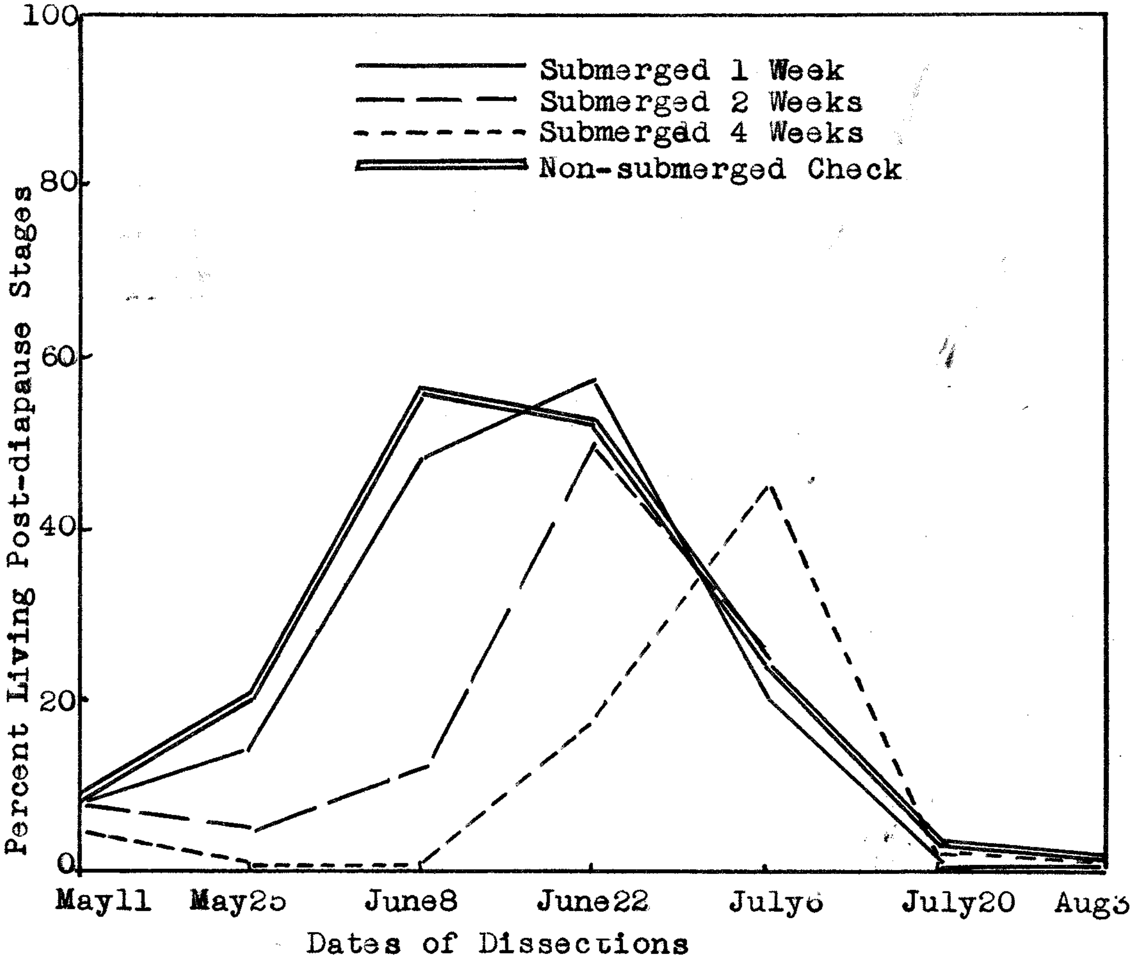


Fig. 7 Living post-diapause stages in larch sawfly cocoons when treatment begun May 11.

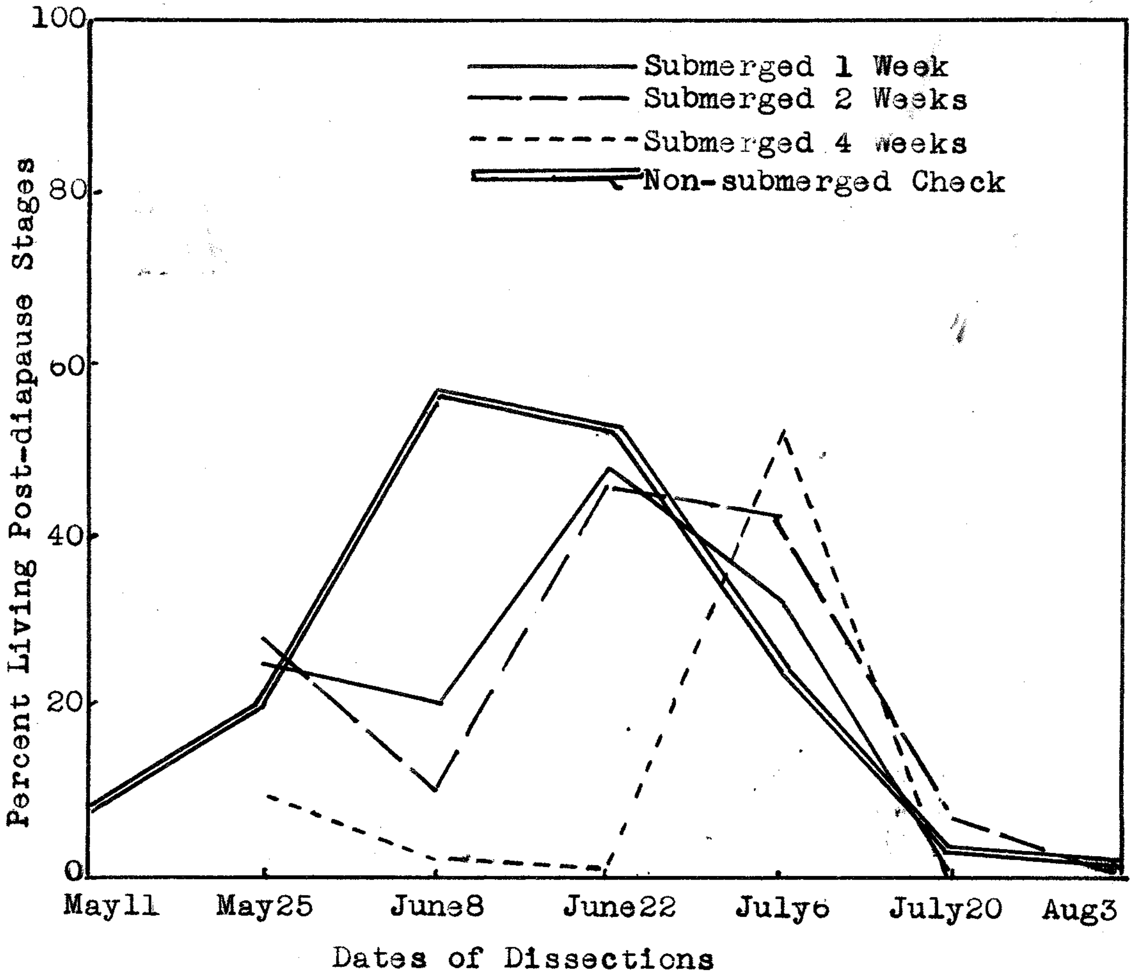


Fig. 8 Living post-diapause stages in larch sawfly cocoons when treatment begun May 25.

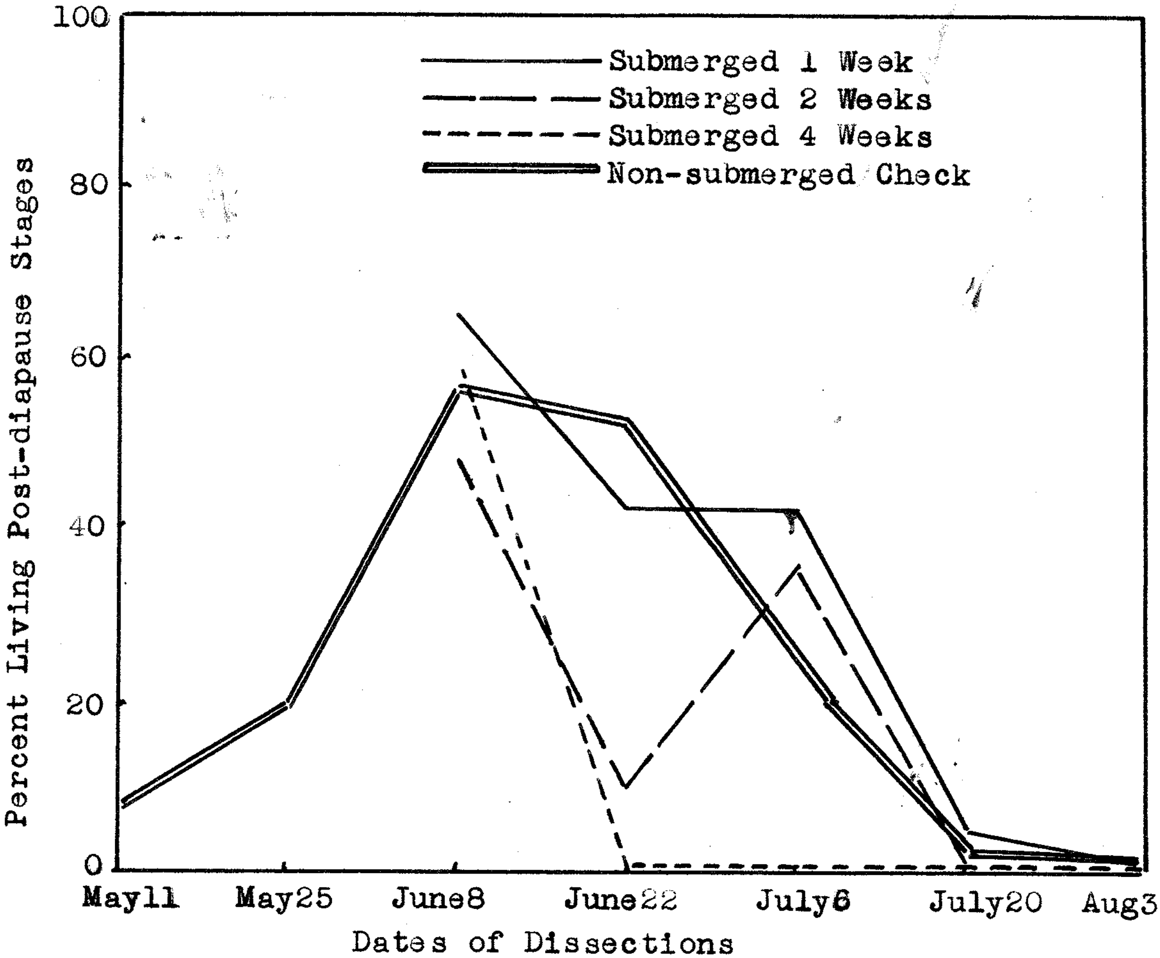


Fig.9 Living post-diapause stages in larch sawfly cocoons when treatmants begun June 8

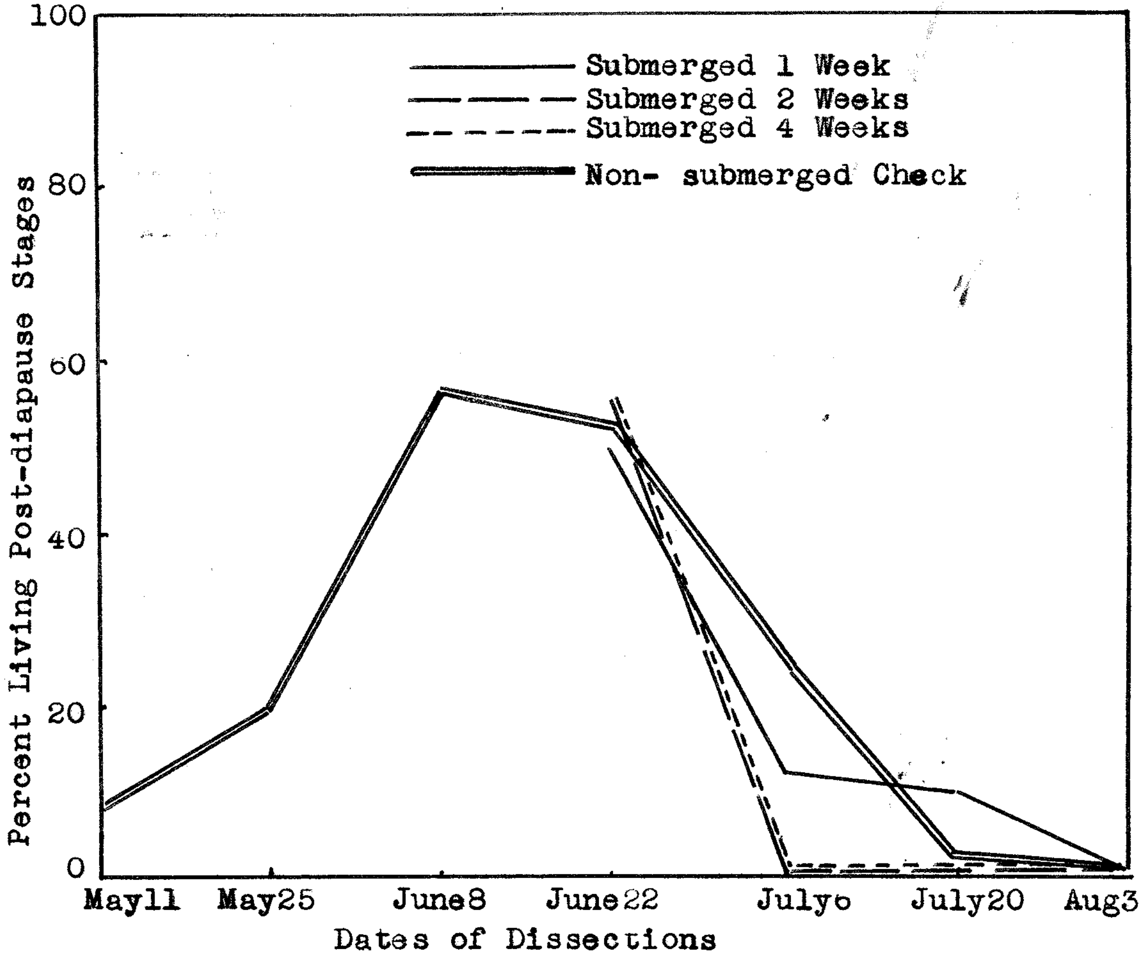


Fig. 10 Living post-diapause stages in larch sawfly cocoons when treatments begun June 22.

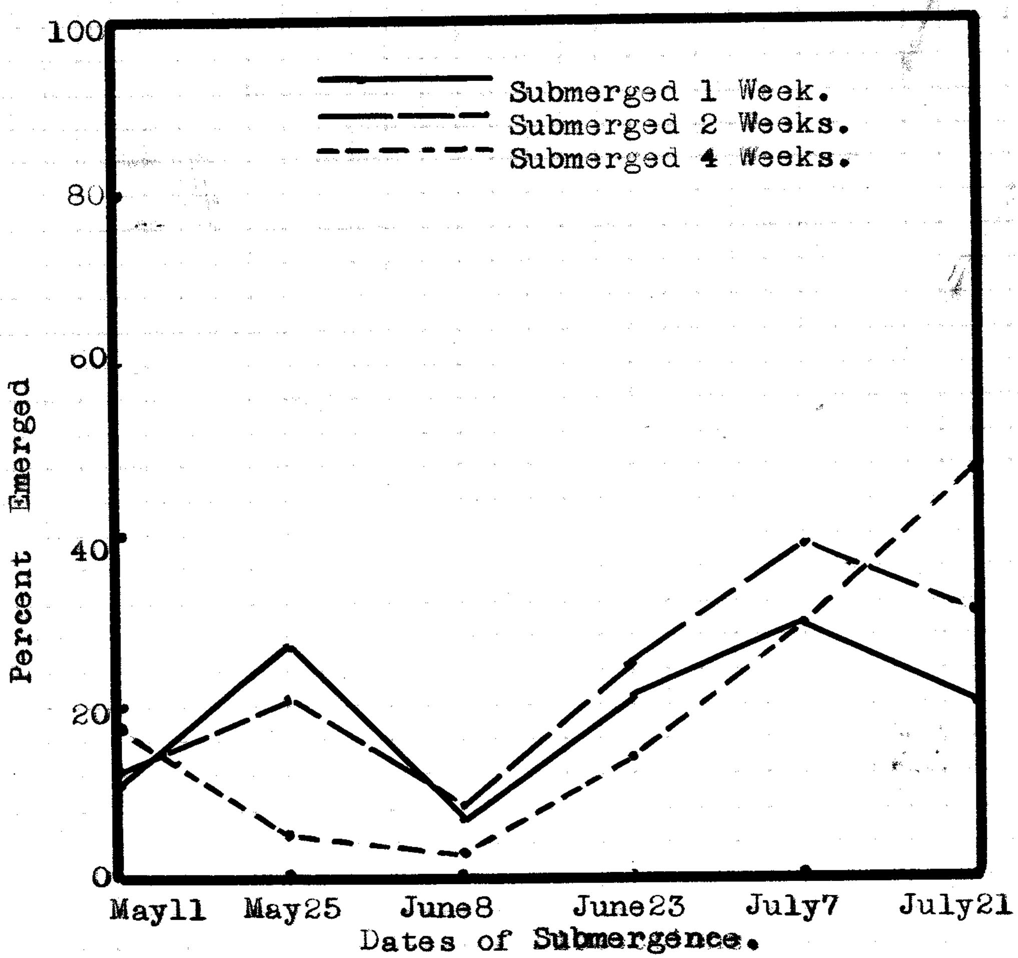


Fig. 11 Emergence of larch sawfly adults from cocoons subjected to three types of moisture treatments at various intervals.

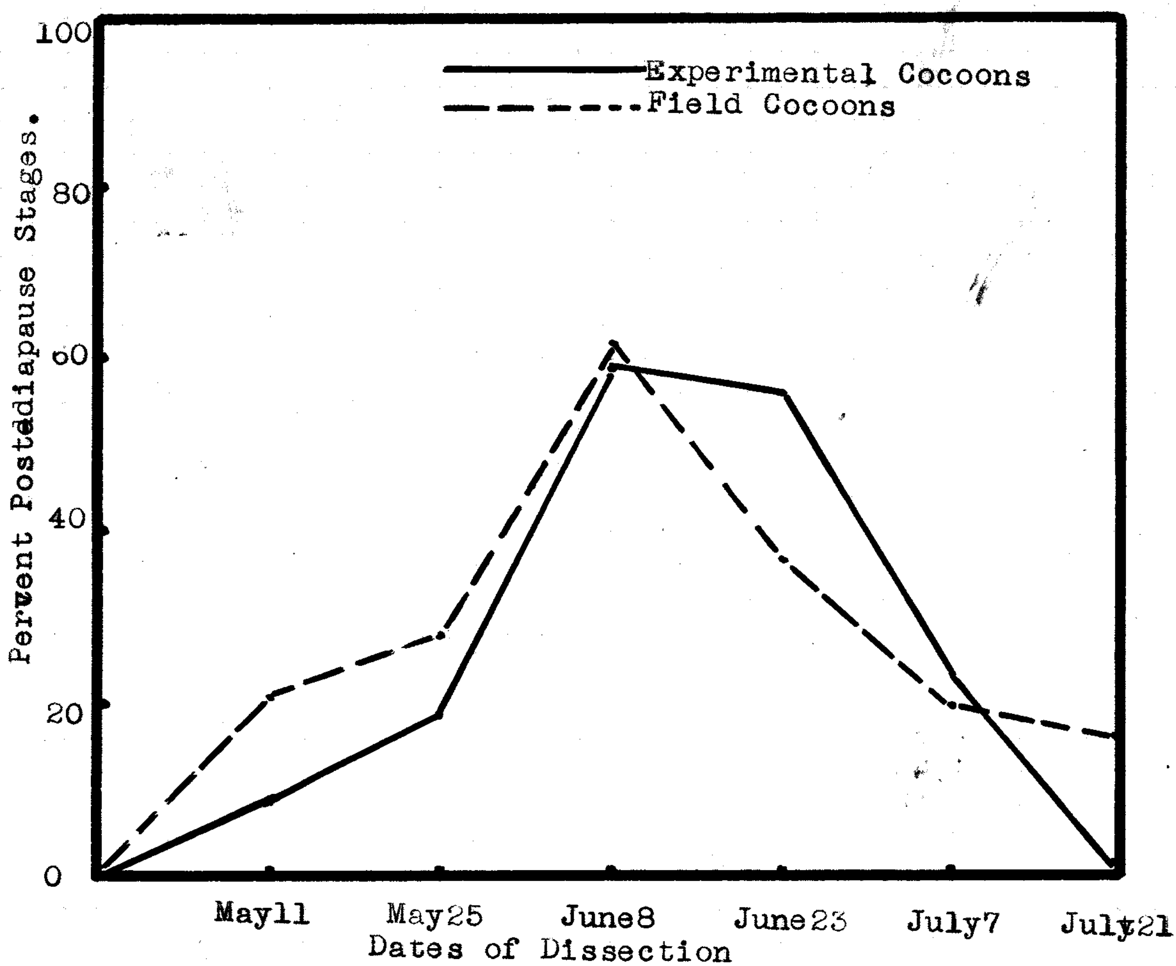


Fig. 12 Occurence of post-diapause stages in larch sawfly cocoons in experimental and field material.

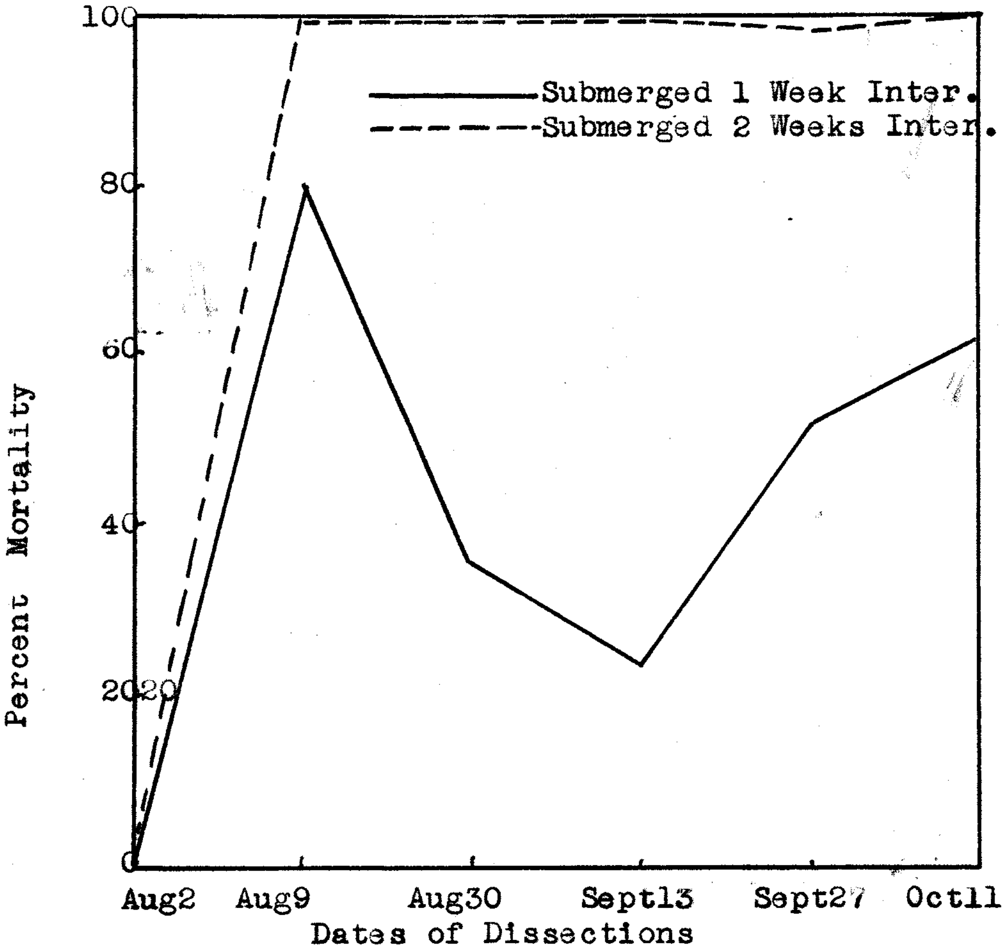


Fig. 1 Mortality in larch sawfly cocoons which had undergone intermittent periods of submergence and non-submergence.

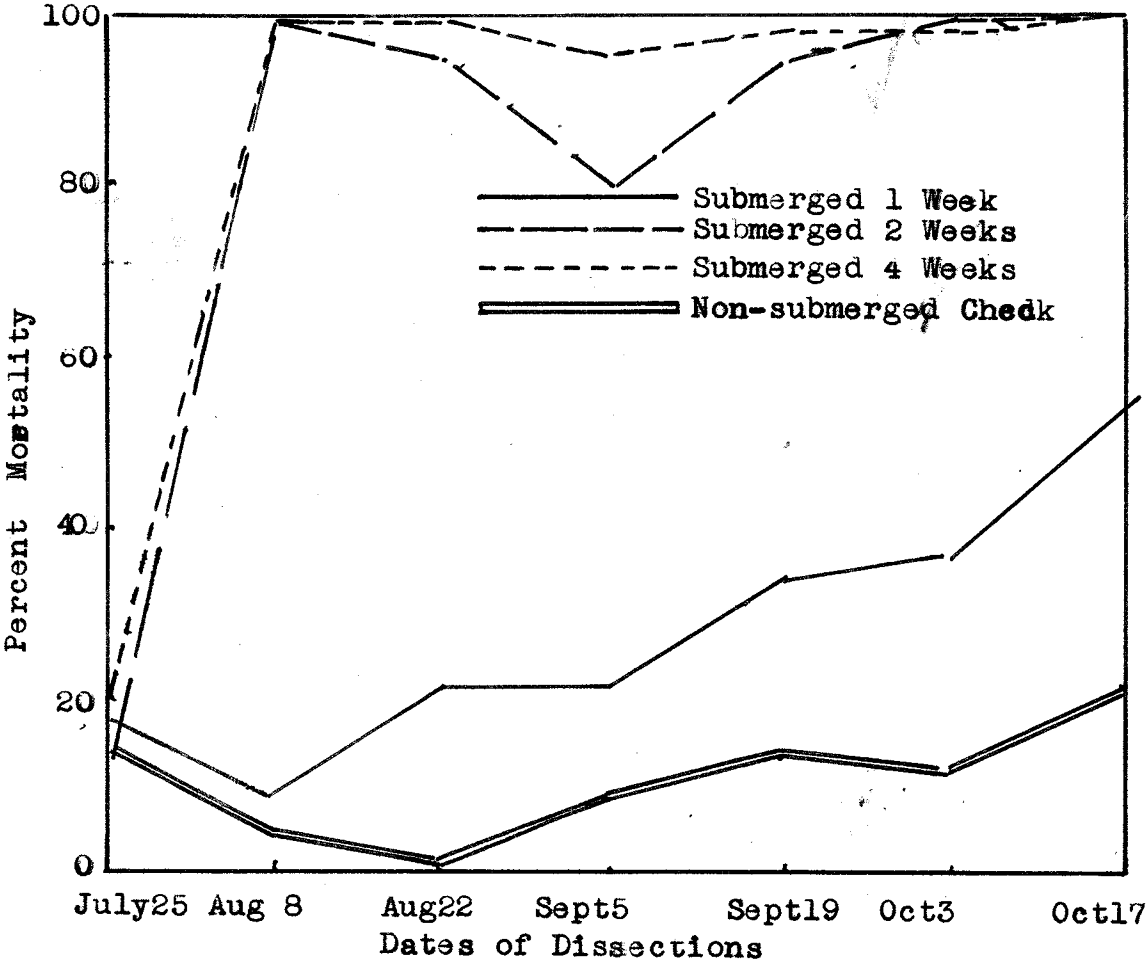


Fig. 2 Mortality in larch sawfly cocoons when treatmeents begun July 25.

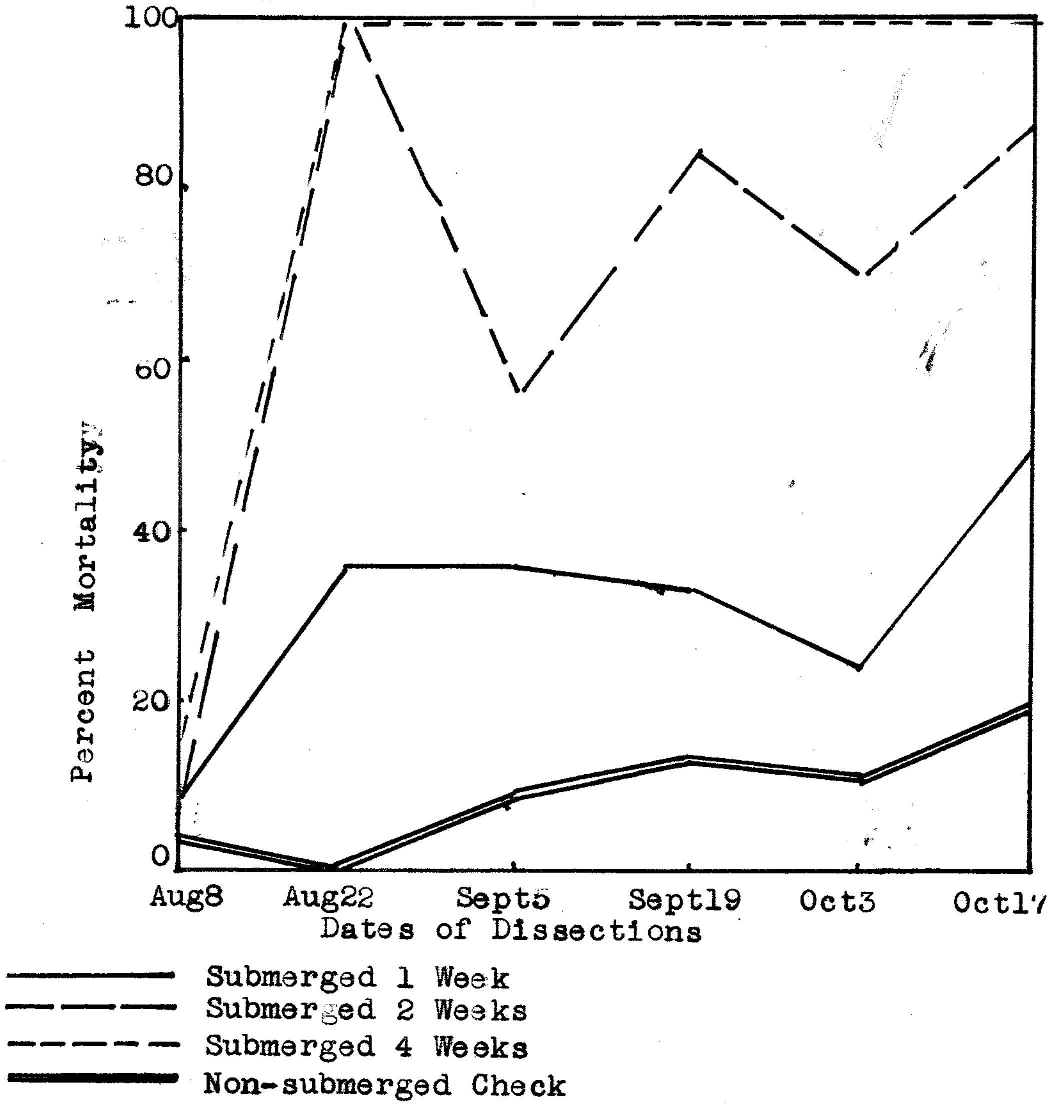


Fig. 3 Mortality in larch sawfly cocoons when treatment begun Aug 8.

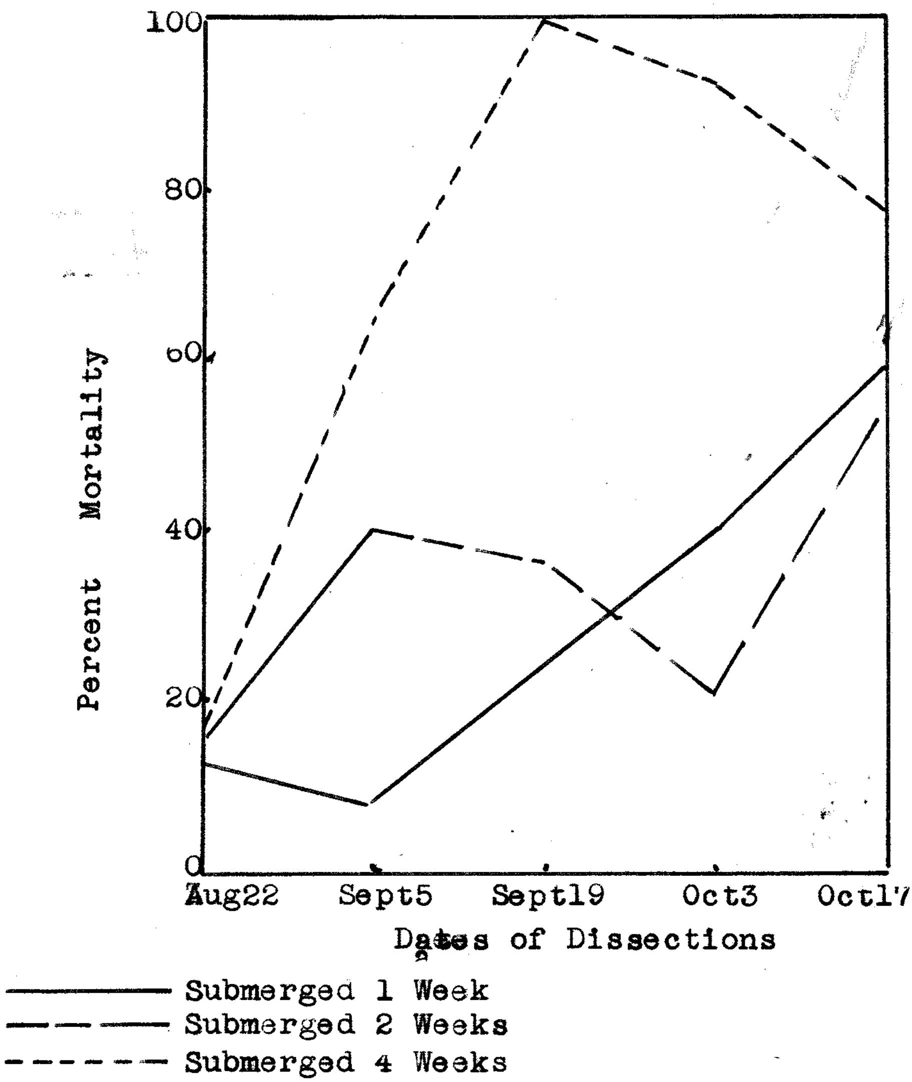


Fig. 4 Mortality in larch sawfly cocoons when treatments begun Aug 22.

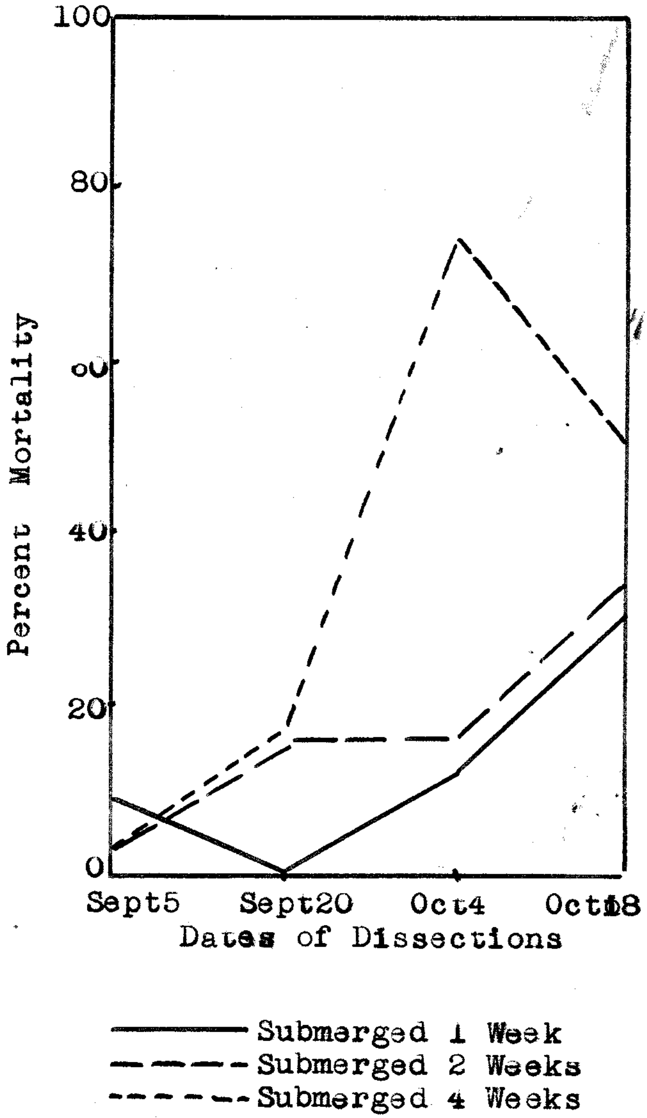


Fig. 5 Mortality in larch sawfly cocoons when treatments begun Sept 5.

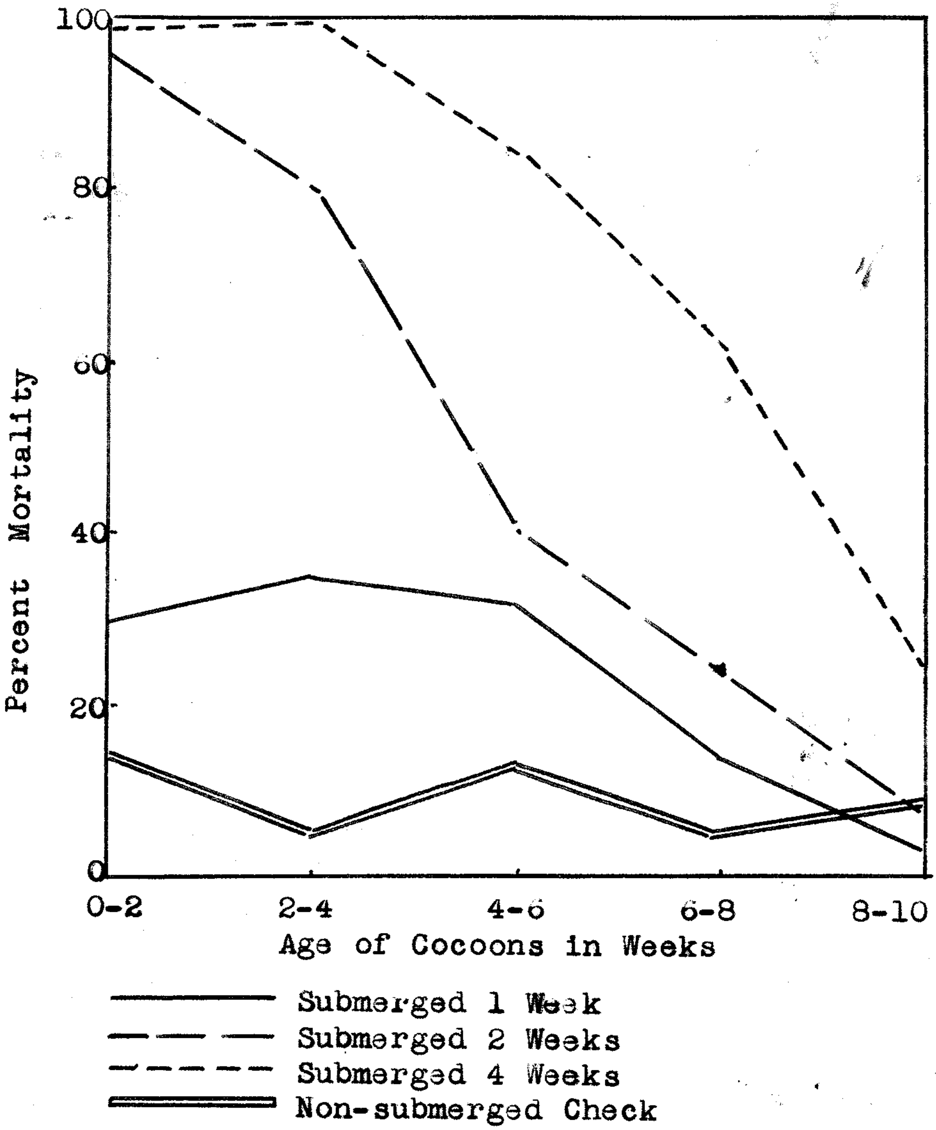


Fig.6 Mortality in larch sawfly cocoons of different ages resulting from three immmersion treatments.

PART B. STUDIES WITH NEWLY-FORMED COCOONS

(a) Object

To test the effect on newly-formed larch sawfly cocoons of submergence in natural swamp water.

(b) Procedure

The experiment was begun in late July, 1949, in a tamarack swamp at Red Rock Lake, Manitoba. The cocoons used were gathered in July during the height of the cocooning season. At the beginning of treatment the cocoons were, in general, from one-to-two-weeks old with the possible exception of a few which might have been formed the previous year. Only cocoons light in color were used as this was considered to be a criterion of freshness. They were collected from a larch swamp close to Telford, Manitoba, and were placed in screened frames as in Part A, except that only sphagnum moss was used in the replications. When not undergoing treatment, the frames and cocoons were kept in well-drained and presumably normal locations. During treatment they were submerged in water in pits dug in the swamp. Every two weeks, 20 cocoons were dissected from frames which were undergoing or had undergone treatment. These dissections were suspended at freeze-up and will be resumed after the spring thaw. Enough cocoons were placed in each frame to allow for fortnightly dissections until August, 1950.

The procedure of dissection and methods of recording were similar to those described in Part A. No post-diapause insects were found during the fall. Moribund larvae were left on moist blotting paper at room temperature until they revived or showed definite signs of death. In some cases, half the sample for dissection was left in cocoons for a day at normal conditions but no difference in percentage survival was noted between these and larvae which had been dissected immediately on removal from treatment. The general impression at the end of the fall was that moribund larvae had not been retained long enough for signs of life to become apparent. High mortality recorded for the initial dissections of cocoons from some frames was followed by a drop in later dissections, indicating that at first many larvae were inactive due to recent removal from water while not actually dead. As in Part A, the cause of death was obscured at times by the decomposition of the insect.

All larvae were shipped to the Dominion Parasite Laboratory at Belleville where Mr. L. G. Montieth was to rear those which had survived to obtain the percentage of parasitism. Many eggs, larvae and puparia of a dipterous fly were found in cocoons; these were possibly the main cause of natural mortality. Eggs of a hymenopterous fly were also common but the effect of these may be more apparent in the spring.

The following is an outline of treatments:

(i) Non-submerged check

Two frames were set up with 400 cocoons in each, to be left untreated above the swamp water level, as a check on normal sawfly development and mortality. The moss in the frames was kept fairly moist. Twenty cocoons were dissected every two weeks except during the winter.

(ii) Continuous subermgence

Two frames were set up with 400 cocoons in each to be continuously submerged during the entire experiment. The treatment was begun on July 25 when the cocoons were up to two weeks old.

(iii) Intermittent submergence

Four frames were set up with 400 cocoons in each. Two frames were treated at intermittent weekly intervals of submergence and non-submergence while the other two were treated for two-week intervals. The treatments were begun August 2 and were suspended during the winter. Dissections were made from each frame prior to treatment and every two weeks thereafter.

(iv) Submergence by series

Five series were set up (each with two frames) to be submerged one week, two to be submerged two weeks and two to be submerged four weeks. These treatments were carried out consecutively with the series at two-week intervals; Treatment on Series I commenced July 25 and on Series V, September 21. Twenty cocoons were dissected from each frame at the beginning of treatments and every two weeks thereafter except during the winter. Enough cocoons were included in each frame to carry the dissections up to August, 1950, with the exception of Series V. This last series was an afterthought and only enough cocoons were available to allow for six dissections of 20 cocoons per frame.

(v) Submergence - Overwinter September 6 to Freeze-up

Four frames were set up with 100 cocoons in each. Two frames were submerged on September 6 and restored to non-submerged conditions at freeze-up October 25. Twenty cocoons were dissected from each frame at the beginning and at the end of treatment. The remainder will be dissected in the spring. The other two frames were submerged at freeze-up, October 25, and will be removed from the water with the spring thaw. A dissection of 20 cocoons was made from each frame before treatment began and the remainder will be dissected in the spring.

(VI) Emergence study

Three frames were set up with 100 cocoons in each. One frame was submerged one week, one for two weeks and one for three weeks. These treatments were begun August 24 and following the submergence period, the frames were left in a well-drained location. No dissections were made but the emergence of adults will be recorded in 1950.

(c) Analysis and Discussion

The following is an analysis of the results of treatments outlined previously.

(i) Non-submerged check

Dissections of these untreated cocoons began on July 25. The mortality in field cocoons was not compared to that in experimental cocoons in this experiment but the results in Part A indicate little difference between the two habitats. The mortality in the untreated cocoons was due to parasites, predators, fungus and disease and was termed natural mortality. For Frame No. 1, the mortality averaged 9.3 per cent and in Frame No. 2, it averaged 12.9 per cent, giving a mean of 11.1 per cent throughout the fall season (Table I). Between dissections, which were carried on until October 17, the mortality was fairly consistent, never rising above 20 per cent (Fig.2).

The natural mortality in the cocoons dissected as a check from frames just prior to treatment 9 was 9.52 per cent (Table I to XIX). Also, the average natural mortality counted for all cocoons dissected during the experiment, treated and untreated, stood at 9.47 per cent. The close agreement of these three determinations of natural mortality indicated their reliability as checks.

Mortality due to natural causes may be expected to increase in the spring when the effect of the hymenopterous parasite Mesoleius aulicus becomes more apparent.

(ii) Continuous Submergence

Treatment was begun on these cocoons on July 25 when they were up to two weeks old. Complete mortality resulted from the first fortnight of immersion and no live larvae were found in subsequent dissections. Mortality due to natural causes averaged 12.9 per cent, but this, of course, was superimposed on the 100 per cent mortality caused by treatment (Table II).

(iii) Intermittent submergence

The intermittent treatments were begun on August 2 when the cocoons were from one to three weeks of age.

The erratic results from the cocoons treated for one-week intervals indicated possibly poor recording procedure (Table III, Fig.1). A mortality of 80 per cent was noted on the first dissections after treatment followed by a drop to 22.5 per cent on the third. After this a continuous rise in mortality was apparent ending on October 11 with an average of 62.5 per cent of the population. The high mortality in the initial dissections may have been due to faulty recording of moribund larvae just removed from the water. On later dissections, the cocoons had been out of water for a week and so moribund larvae had time to revive. The average mortality of all dissections was 52 per cent and this may rise when treatments are resumed in the spring.

Complete mortality resulted from the first two-week treatment of cocoons subjected to two-week intervals of submergence and non-submergence (Table IV, Fig.1). With the exception of one live larva found on September 29, which was probably a 1948-1949 larva still in diapause, mortality was complete in the following dissections.

(iv) Series submergence

Series I: Treatment was begun on July 25 on cocoons in this series when they were up to two weeks' of age. (Fig.2) Almost complete mortality was effected by four-week treatment (Table VII), except for a few live larvae which may have been diapausing from former years. Cocoons treated two weeks (Table VI) showed almost as high mortality, especially a month after treatment. In this case it was difficult to say whether surviving larvae were young or old. Two weeks of treatment elsewhere, however, proved fatal on cocoons two weeks of age (i.e. continuously and intermittently submerged cocoons).

Cocoons submerged for one week showed an average mortality of 31.7 per cent (Table V) with a fairly steady increase with each dissection (Fig.2). This mortality was substantially above that found in unsubmerged cocoons which in no frame exceeded 20 per cent. There was also an indication that the mortality increased some time after treatment. Spring dissections should confirm or refute this trend. Water was found in many cocoons long after the cocoons were removed from moisture and this may be the main cause of delayed mortality.

Series 2: Cocoons in this series were two to four weeks of age when treatment began August 8. Compared to cocoons in Series 1, mortality for the one-week treatment was unaccountably higher at 35 per cent. (Table VIII). There is, however, a much wider variation between Frames 1 and 2, indicating some experimental error. On the other hand, there was less variation between subsequent dissections (Fig.3).

The per cent mortality resulting from two weeks of submergence dropped in cocoons two to four weeks old to an average of 80.5 per cent (Table IX). There was, in this case, a wide variation in per cent mortality between dissections (Fig.3) and the high initial mortality may have been due to hurried recording before all live larvae had revived, as in other cases. Cocoons of this age continued to be completely ususceptible to a month of submergence (Table X).

Series 3: Treatment of this series was begun on August 23 when the cocoons were four to six weeks old. The one-week treatment caused little or no mortality on the first dissections (Fig.4), but a steady rise followed terminating on October 18 at 55 per cent. The average mortality was 31 per cent (Table XI) similar to that in cocoons in Series 1 and 2. The effect of two-week treatment was rather erratic (Fig.4) but the average mortality had dropped to 40.8 per cent of the population (Table XII).

Cocoons of this age showed some resistance to a month of treatment as the average mortality hopped to 90 per cent (Table XIII, Fig.4). The first dissection revealed 100 per cent mortality but this, as before may have been due to an error in recording.

Series 4: Cocoons in this series were from six to eight weeks old at commencement of treatment on September 6. In cocoons treated for one week the mortality found in the initial dissections was lower than that expected from natural causes (Table XIV). In the final dissection, mortality averaged 32.5 per cent and a further rise may occur in the spring (Fig.5). The average mortality from all dissections stood at 15 per cent, much below that caused in younger cocoons by similar treatments. The mortality caused in cocoons treated two weeks also showed a drop from previous series being only 24.2 per cent of the population (Table XV, Fig.5). However, cocoons treated four weeks showed the most substantial gain in resistance with age. The average mortality in those cocoons was 62.5 per cent (Table XVI) and inaccurate recording in initial dissections may have overestimated this figure somewhat (Fig.5). Very little mortality in this series of cocoons was caused by natural agents (parasites, etc.) as will be seen from the Tables.

Series 5: Treatment commenced on September 21 for this series, the cocoons being approximately eight to ten weeks of age at that time. The one and two-week treatments had virtually no effect on these cocoons. Mortality stood at 7.5 per cent for cocoons treated one week (Table XVII) and at 11.25 per cent for those submerged two weeks (Table XVIII). Little of this mortality appeared due to treatment. Only 22.5 per cent of the cocoons which were submerged four weeks were killed (Table XIX); thus the effect of this treatment had also dwindled considerably as compared to that for younger cocoons. However, the small number of cocoons dissected did not allow any great certainty on the effect of treatment but this may be more definitely established in the spring of 1950.

(v) The age of cocoons as compared to mortality in various treatments

The age of cocoons as compared to the mortality caused by one-week, two-week and four-week treatments is presented in Fig. 6. It will be seen that cocoons treated one week show a low but fairly steady mortality substantially above that in untreated cocoons, until they reached six to eight weeks of age. The rise in mortality from 30 to 35 per cent between cocoons up to two weeks old compared to those two to four weeks old is difficult to explain but it is evident that one week's submergence causes considerable mortality on these new cocoons.

The two-week treatment on the other hand, caused almost complete mortality in young cocoons up to two weeks old and mortality fell off sharply as older cocoons were treated. The treatment had little or no effect by the time cocoons were eight weeks of age. Immersion for four weeks continued to cause complete mortality when cocoons were two to four weeks of age. Then mortality fell off sharply and almost complete resistance was attained by cocoons eight to ten weeks old, only 24.2 per cent succumbing to the combined effect of treatment and natural agents.

From this graph therefore, it appeared that resistance was proportional to the age of the cocoon up to the point where a maximum was reached at the age of ten weeks or more.

Analysis of Variance

A statistical analysis was carried out using the per cent mortality values for the first, second and final dissections after treatment for Series 1 - 4 in all three treatments. The sums of squares of these values were calculated for the series, the treatments and the dissections, and for the double and triple interactions between these three. The sums of squares of the replications (i.e. Frames 1 and 2) were also calculated. The variances of these were calculated and the F value found for the Series, treatments, etc., by dividing by the variance of replications (Table XX).

The F value of the Series was very highly significant as would be expected due to the variance in mortality with age of cocoons when treated. The difference in the severity of treatments was also clearly indicated by a lower but still significant F value for treatments. The F value for the dissections was highly significant but much lower than the preceding values. That it is significant may indicate that the effect of treatment may become more apparent some time after treatment. There was generally quite a time lapse between first and last dissections.

Except for the interaction of Series and dissections which was not significant, the interactions were all highly significant above the 1 per cent point. The triple interaction was especially significant, almost as much as the variance for the series.

(vi) Cocoons submerged September 6 - Freeze-up Overwinter.

In those cocoons submerged on September 6 the mortality due to natural agents was zero in Frame 1 and 15 per cent in Frame 2 at beginning of treatment. On restoration to non-submerged conditions at freeze-up, October 25, the mortality was 100 per cent in both Frames. This might have been expected as the period of submergence was about seven weeks, enough to kill most overwintered, diapausing larvae in Part A of this experiment.

In cocoons submerged over the winter, the natural mortality was 5 per cent in Frame 1 and 15 per cent in Frame 2 at the commencement of treatment, October 25.

Explanation of Tables

Due to the difficulty in some cases in distinguishing between natural (parasites and disease) mortality and experimental (due to treatment) mortality, it was decided that total mortality was the most accurate figure. Also, experimental mortality may be superimposed on natural mortality, especially in cases of 100% mortality. In cases where natural mortality was high, however, due importance should be ascribed to it.

It will be noted that in the case of cocoons treated 4 weeks, two dissections were made before full treatment was completed.

TABLE 1

PER CENT MORTALITY IN NON-SUBMERGED COCOONS

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	FM	TM	NM	FM
July 25	10	10	0	20	20	0
Aug. 8	10	10	0	0	0	0
22	0	0	0	0	0	0
Sept. 5	10	10	0	10	10	0
19	5	5	0	25	25	0
Oct. 3	15	15	0	10	10	0
17	15	15	0	25	25	0
Mean	9.3	9.3	0	12.9	12.9	0

Mean of Total Mortality was 11.1 % of the population.

TABLE II

PER CENT MORTALITY IN COCOONS CONTINUOUSLY SUBMERGED
(Treatment begun July 25; Age of Cocoons 0 - 2 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	FM
July 25 check	5	5	0	0	0	0
Aug. 8	100	5	95	100	15	85
22	100	5	95	100	0	100
Sept. 5	100	10	90	100	25	75
19	100	10	90	100	10	90
Oct. 3	100	30	70	100	20	80
17	100	20	80	100	5	95
Mean	100	13.3	87.7	100	12.5	87.5

NB: TM = Total Mortality
NM = Natural Mortality (Parasites, fungus, disease, predators)
EM = Experimental Mortality (due to treatment)

TABLE III

PER CENT MORTALITY IN COCOONS TREATED TO INTERMITTENT WEEKLY INTERVALS OF SUBMERGENCE AND NON-SUBMERGENCE
(Treatment Begun Aug.2: Age of Cocoons 1 - 3 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Aug. 2 Check	0	0	0	0	0	0
Aug. 9	70	5	65	90	10	80
30	35	0	35	40	0	40
Sept.13	20	0	20	25	0	25
27	65	0	65	50	25	25
Oct. 11	65	10	55	60	5	55
Mean	51	3	48	53	8	45

TABLE IV

PER CENT MORTALITY IN COCOONS TREATED TO INTERMITTENT TWO-WEEK INTERVALS OF SUBMERGENCE AND NON-SUBMERGENCE
(Treatment begun Aug.2: Age of Cocoons 1 - 3 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Aug. 2 Check	5	5	0	10	10	0
Aug. 9	100	10	90	100	10	90
30	100	10	90	100	0	100
Sept.13	100	35	65	100	20	80
29	95	5	90	100	15	85
Oct. 11	100	5	95	100	5	95
Mean	99	19	80	100	10	90

NB: TM - Total Mortality
NM - Natural Mortality
EM - Experimental Mortality

TABLE V

SERIES I - PER CENT MORTALITY IN COCOONS SUBMERGED 1 WEEK
(Treatment Begun July 25: Age of Cocoons 0 - 2 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
July 25 Check	30	30	0	5	5	0
Aug. 8	10	10	0	5	5	0
22	15	15	0	30	15	15
Sept. 5	25	25	0	20	20	0
19	30	0	30	40	35	5
Oct. 3	40	15	25	35	10	25
17	75	45	30	40	30	10
Nov. 8	35	25	10	45	5	40
Mean	33.4	18.7	14.7	30.7	17.1	13.6

TABLE VI

SERIES I - PER CENT MORTALITY IN COCOONS SUBMERGED 2 WEEKS
(Treatment Begun July 25: Age of Cocoons 1 - 2 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
July 25 Check	15	15	0	10	10	0
Aug. 8	100	20	80	100	15	85
22	95	15	80	95	5	90
Sept. 5	85	20	65	75	10	65
19	90	25	65	100	15	85
Oct. 3	100	15	85	100	5	95
17	100	30	70	100	20	80
Nov. 8	100	15	85	100	10	90
Mean	95.7	20.0	75.7	95.7	11.4	84.3

NB: TM - Total Mortality
NM - Natural Mortality
EM - Experimental Mortality

TABLE VII

SERIES I - PER CENT MORTALITY IN COCOONS SUBMERGED 4 WEEKS
(Treatment Begun July 25: Age of Cocoons 1 - 2 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
July 25 Check	20	20	0	20	20	0
Aug. 8	100	10	90	100	5	95
22	100	5	95	100	10	90
Sept. 5	90	25	65	100	5	95
19	95	0	95	100	5	95
Oct. 3	100	10	90	95	5	90
17	100	30	70	100	10	90
Nov. 8	100	10	90	95	10	85
Mean	97.9	12.9	85.0	98.6	7.1	91.5

TABLE VIII

SERIES 2 - PER CENT MORTALITY IN COCOONS SUBMERGED 1 WEEK
(Treatment Begun Aug. 8: Age of Cocoons 2 - 4 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Aug. 8 Check	0	0	0	5	5	0
Aug. 22	35	15	20	35	5	30
Sept. 5	45	0	45	25	0	25
19	35	0	35	30	5	25
Oct. 3	35	5	30	10	5	5
17	65	20	45	35	0	35
Mean	43	8	35	27	3	24

NB: TM - Total Mortality
NM - Natural Mortality
EM - Experimental Mortality.

TABLE IX

SERIES 2 - PER CENT MORTALITY IN COCOONS SUBMERGED 2 WEEKS
(Treatment Begun Aug. 8: Age of Cocoons - 2-4 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Aug. 8 Check	15	15	0	10	10	0
22	100	5	95	100	10	90
Sept. 5	75	0	75	45	0	45
19	95	25	70	75	5	70
Oct. 3	75	5	70	65	5	60
17	90	25	65	85	5	80
Mean	87	12	75	74	5	69

TABLE X

SERIES 2 - PER CENT MORTALITY IN COCOONS SUBMERGED 4 WEEKS
(Treatment Begun Aug. 8: Age of Cocoons - 2-4 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Aug.8 Check	5	5	0	5	5	0
Aug.22	100	10	90	100	0	100
Sept.5	100	10	90	100	0	100
19	100	5	95	100	20	80
Oct. 3	100	10	90	100	0	100
17	100	5	95	100	10	80
Mean	100	8	92	100	6	94

NB: TM - Total Mortality
NM - Natural Mortality
EM - Experimental Mortality.

TABLE XI

SERIES 3 - PER CENT MORTALITY IN COCOONS SUBMERGED 1 WEEK
(Treatment Begun Aug.23: Age of Cocoons 4 - 6 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Aug. 23 Check	15	15	0	15	15	0
Sept. 6	0	0	0	15	10	5
20	20	15	5	30	20	10
Oct. 4	35	15	20	45	15	30
18	55	15	40	55	0	55
Mean	26.3	11.3	15.0	36.3	11.3	25.0

TABLE XII

SERIES 3 - PER CENT MORTALITY OF COCOONS SUBMERGED 2 WEEKS
(Treatment Begun Aug.23: Age of Cocoons 4 - 6 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Aug. 23 Check	20	20	0	10	10	0
Sept. 6	35	15	20	45	25	20
20	45	5	40	30	25	5
Oct. 4	20	5	15	35	5	30
18	70	10	60	45	10	35
Mean	42.5	8.8	33.7	38.8	16.3	22.5

NB: TM - Total Mortality
NM - Natural Mortality
EM - Experimental Mortality

TABLE XIII

SERIES 3 - PER CENT MORTALITY IN COCOONS SUBMERGED 4 WEEKS
(Treatment Begun Aug.23: Age of Cocoons 4 - 6 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Aug. 23	15	15	0	10	10	0
Sept. 6	50	15	35	80	10	70
Checks						
Sept.20	100	10	90	100	10	90
Oct. 4	95	30	65	90	15	75
8	85	25	60	70	5	65
Mean	93.4	21.7	71.7	86.7	10	76.7

TABLE XIV

SERIES 4 - PER CENT MORTALITY OF COCOONS SUBMERGED 1 WEEK
(Treatment Begun Sept.6: Age of Cocoons 6 - 8 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Sept. 6	15	15	0	5	5	0
Check						
Sept.20	0	0	0	0	0	0
Oct. 4	15	10	5	10	0	10
18	30	20	10	35	20	15
Mean	15.0	10.0	5.0	15.0	6.7	8.3

NB: TM ≠ Total Mortality
NM ≠ Natural Mortality
EM ≠ Experimental Mortality

TABLE XV

SERIES 4 - PER CENT MORTALITY IN COCOONS SUBMERGED 2 WEEKS
(Treatment Begun Sept. 6; Age of Cocoons 6 - 8 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Sept. 6 Check	0	0	0	10	10	0
Sept.20	15	10	5	20	15	5
Oct. 4	25	5	20	10	5	5
18	35	15	20	40	25	15
Mean	25	10	15	23.3	15	8.3

TABLE XVI

SERIES 4 - PER CENT MORTALITY IN COCOONS SUBMERGED 4 WEEKS
(Treatment Begun Sept. 6; Age of Cocoons 6 - 8 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Sept. 6	5	5	0	5	5	0
Sept.20 Checks	25	15	10	10	0	10
Oct.4	80	10	70	70	0	70
18	60	0	60	40	0	40
Mean	70.0	5.0	65.0	55.0	0	55.0

NB: TM - Total Mortality
NM - Natural Mortality
EM - Experimental Mortality

TABLE XVII

SERIES 5 - PER CENT MORTALITY IN COCOONS SUBMERGED 1 WEEK
(Treatment Begun Sept.21: Age of Cocoons, 8 - 10 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Sept.21 Check	10	10	0	15	15	0
Oct. 4	15	15	0	0	0	0
19	5	5	0	10	5	5
Mean	10.0	10.0	0	5.0	2.5	2.5

TABLE XVIII

SERIES 5 - PER CENT MORTALITY IN COCOONS SUBMERGED 2 WEEKS
(Treatment Begun Sept.21: Age of Cocoons, 8 - 10 Weeks

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Sept.21 Check	15	15	0	5	5	0
Oct. 5	15	10	5	0	0	0
19	15	10	15	15	5	10
Mean	15	10	5	7.5	2.5	5.0

TABLE XIX

SERIES 5 - PER CENT MORTALITY IN COCOONS SUBMERGED 4 WEEKS
(Treatment Begun Sept.21: Age of Cocoons 8 - 10 weeks)

Date Dissected	FRAME 1			FRAME 2		
	TM	NM	EM	TM	NM	EM
Sept. 21	10	10	0	5	5	0
Oct. 5 Checks	5	0	5	10	5	5
Oct.19	20	0	20	25	0	25
Mean	20.0	0	20.0	25.0		25.0

NB: TM - Total Mortality
NM - Natural Mortality
EM - Experimental Mortality

TABLE XX

ANALYSIS OF VARIANCE IN SERIES, TREATMENTS AND DISSECTIONS FROM SERIES 1 - 6 WATER LEVEL Ex B.

	SUM OF SQUARES	DF	VARIANCE	F $\frac{V}{E}$	5%	1%
Series	19658.48	3	6552.8	91.1	2.86	4.38
Treatments	45129.94	2	22564.8	31.4	3.26	5.25
Dissections	2052.85	2	1026.4	14.3	3.26	5.25
S x T	8623.58	6	1437.2	20.0	2.36	3.35
S x D	708.37	6	118.1	1.6	2.36	3.35
T x D	3899.21	4	974.8	13.6	2.63	3.89
S x T x D	78493.13	12	6541.1	91.0	2.03	2.72
Replications	2587.5	36	71.9			

PART C. CONCLUSIONS - PARTS A & B

PART A - Overwintered Cocoons

Cocooning larvae which had survived the winter but were still in diapause at the beginning of treatment, were able to withstand up to 2 months of submergence in swamp water before complete mortality became apparent. After one month of submergence, a small portion of cocoons being treated were dead but until 6 weeks had passed, no extensive mortality appeared. It seemed, therefore, that diapausing larvae had a very high resistance to excessive moisture. Periods of immersion, which were insufficient to cause the death of a larva, had no more effect than to delay its final development into the adult stage. The delay was, in general, proportional to the length of the treatment.

Those larvae which had broken diapause and were in more active stages, pronymphs, pupae and teneral adults, at the time of treatment, were far more susceptible. In general, 2 weeks of submergence was fatal to the majority of developing stages and frequently 1 week was sufficient to kill the pupae. By submerging sets of cocoons at different times during the season of metamorphosis it was found that the sawfly population was most susceptible to treatment when the greatest proportion was in the pronymph or pupal stages. This period was found to be between June 8 and June 23 approximately; when from 50 to 60 per cent of the insects were in post-diapause stages. Treatments of 2 weeks' submergence at this time resulted in a final emergence of only 8.1 per cent of the sawflies compared to an emergence of 29 per cent from untreated cocoons. Immersion for a month reduced the final emergence to 3 per cent. The effect of treatment before the aforementioned dates was wasted on diapausing eonymphs, while treatment any later missed the main body of adults which emerged.

Intermittent treatments in which wet and dry conditions were alternated weekly on cocoons, demonstrated the ability of the larvae to recover from a short submergence to break diapause and develop in less than a week at non-submerged conditions. Another point cleared up was that there was no evidence of the water treatment inducing larvae to remain in diapause for another year. It had been thought that overwintered larvae encountering unsuitable conditions such as excess water, might remain in hibernation another year. However, the per cent of larvae showing this characteristic was lower in treated cocoons than in untreated cocoons.

PART B - Fresh Cocoons

New cocoons which were immersed in the fall were resistant to immersion in proportion to their age until at least 10 weeks after formation. New cocoons up to 2 weeks of age proved almost completely susceptible to 2 weeks of submergence. Submergence for 1 month was completely fatal until cocoons had passed 4 weeks of age. Thereafter the resistance of the population increased rapidly until at 10 weeks of age, all cocoons were able to survive 2 weeks of immersion and only a very small portion were killed by a month of treatment. It was apparent that freshly-cocooned larvae, while very susceptible at first, gradually built up a resistance to environmental extremes which culminated when they had reached the stage in which the winter is passed.

From the results of treatments on both overwintered and new cocoons, it might be possible to predict the time of year in which heavy rainfall and flooding of the swamps would most effect sawfly populations. From the spring thaw until after the end of May, when most insects have not broken diapause and when their resistance is at its peak, floods would have to be quite extensive and lengthy to have much effect. Heavy rains in mid-June, however, should flood swamps at a time when the largest portion of the cocoons contain insects in developing stages. These insects are apparently very susceptible to moisture and a high mortality should result, reducing the season's infestation quite extensively. The time at which flooding would be most lethal would be when the mature larvae are dropping to cocoon or have freshly cocooned. Heavy precipitation in the latter weeks of July and in early August would be fatal to most freshly-cocooned larvae as their resistance was seen to be very low. Susceptibility to water decreases slowly after this time as the larvae build up a resistance. Thence by the middle of September, maximum resistance to moisture is attained and heavy fall rains after this should have little effect on the sawfly infestation of the following spring.

Artificial control of water levels should be equally effective if begun in mid-June or in late July. Two or 3 weeks of such, at the time when investigations show the largest numbers of susceptible insects present, should reduce the sawfly population sharply.

Several suggestions have been advanced to explain the swift mortality caused by water to freshly-cocooned larvae and metamorphosing stages, as compared with the high resistance of larvae in diapause.

1. The high temperatures prevailing in the experimental swamp water during late June and July were thought to have some adverse effect on the larvae, etc. Perhaps a rise in temperature caused an increase in the metabolic rate, followed by an increase in absorption of air and drowning. This theory does not do much to explain the marked difference between the resistance of eonymphs in diapause and developing stages. It may be that the rise in temperature prompts the breaking of diapause, and a resultant increase in air absorption. Experiments are to be carried out to determine how long diapausing larvae can stand submergence in water above the average summer temperatures.

2. It was thought that the reason for high mortality in freshly-cocooned larvae might be that fresh cocoons are more permeable to water than those which have aged a bit. Cocoons darken in color with age but no other evidence pointed to a change of structure. In addition, many larvae were found alive and in conjunction with water in their cocoons long after treatment, indicating the weakness would be with the larvae rather than with the cocoon.

3. The most satisfactory explanation was that in freshly-cocooned larvae and in developing stages, the respiratory rate, or oxygen consumption, is much higher than that in diapausing or resting eonymphs. It would seem that the reactions in progress in an insect's body during metamorphosis would require much more oxygen than do those of resting, inactive larvae. Also, it would seem that the active, crawling larvae, freshly cocooned, would have a high oxygen consumption and that the resting state would take some time to achieve, if done so by reducing the amount of O^2 required by the body. It follows that insects respiring heavily would be much more susceptible to excess moisture than would resting larvae, which acquire immunity to environmental rigours by reducing their O^2 requirements.

Experiments conducted on the various life stages with a respirometer have shown that pupae and pronymphs need much more oxygen than do eonymphs, hence their lower resistance to moisture. Plans are now afoot to see if the same is true of freshly-cocooned larvae. These experiments have also indicated that an increase in respiratory rate may be due, to some extent, to a rise in temperature, so summer water temperatures may have something to do with lowered resistance.

PART D. RECOMMENDATIONS - PARTS A & B

As time is to be spent on the foregoing project in the coming season, it would be wise to mention some errors and ommissions made in this work and some points for future investigations.

Treatments in 1949 established rather broadly the limits of resistance to moisture of the various stages. Using the knowledge gained, and with the aid of more frequent dissections--perhaps daily, it should be possible to determine more exactly, how long each life stage can withstand submergence. For instance, by virtue of fortnightly dissections, it was found that the majority of overwintered, diapausing eonymphs succumb to from one to two months of treatment. A series of daily dissections on larvae undergoing continuous submergence should furnish the particulars omitted from the above. Similarly, much more intensive work on new cocoons and insects in metamorphosis should be rewarding. With regard to the latter, a method of deciding which stage a cocooned insect is in would be a great help. Some promise of this has been shown in experiments with an insect respirometer where it was found possible to identify between eonymphs, pronymphs and pupae 75 per cent of the time without opening the cocoons.

With regard to the termination of Part B on which dissections were to be carried out in the spring, it might be advisable to make only one or two dissections to determine whether mortality had increased over the winter. The remainder of the cocoons should then be left until after the emergence of adults was complete. In that way the effect of treatments on the final emergence would be available for a much larger population and the final mortality could be observed on the basis of this and on which cocoons remained in diapause on the frames. Thus no periodic removal of cocoons would reduce the accuracy of the final results. There would be little point, at any rate, in continuing periodic dissections so long after treatment was over.

In the case of new cocoons, some effort must be made to determine more closely the age of cocoons.

One suggestion is to suspend moss-filled trays under severely-infested trees. A search through the moss daily would yield those larvae which had cocooned that day. Another method is that of beating trees and allowing the mature larvae which fall to cocoon in the laboratory. However, this method is known to result in poor cocoons by forcing not-quite-mature larvae to cocoon.

The very noticeable discrepancy between the emerged cocoons found in the Natural Diapause Study and the number of adults removed indicates that the latter was not done often enough or with sufficient care. In the remainder of Experiment B or in any other such experiments, the frames should be thoroughly inspected at least daily during the season of emergence. These data would provide a curve of emergence and may show the effect of weather and other factors on rate of emergence.

The season of cocooning should be fully investigated. If the majority of larvae cocoon in a short period, say two or three weeks, any treatment at that time would be quite effective. However, if there is a long season in which cocoons are formed, treatment would probably have to be impractically long to kill the majority of the larvae. It is also suspected that larvae falling in a partially flooded swamp, cocoon at a level that only an extensive rise in the water might reach. Therefore partial flooding at the beginning of the cocooning season would useless.

Those cocoons removed from frames undergoing treatment or in which treatment has just ended, should be kept for at least four days before dissection. This period at normal conditions of temperature and moisture, should allow all moribund insects time to revive and should eliminate the excessive mortality found in samples dissected immediately after immersion.in 1949. Those cocoons which are not in danger of breaking diapause and recommencing development may be left longer.

Attempts should be made with the various stages of development to find out the contributing causes of the death due to treatments. How larvae and other stages react to water of different temperatures should be studied and also the difference in permeability to water of new and old cocoons. The respiration rate or consumption of O^2 of freshly-cocooned larvae should be studied with an insect respirometer. In conjunction with the experiment with water temperatures, a record should be kept of the temperature of the swamp water through the summer.

With regard to the habitat in which the cocoons are kept during the experiment, conditions might simulate normal cocoon sites better if the moss in the frames was changed regularly through the experiment. Even when not submerged, the uprooted moss generally dies quickly and the resulting decomposition may affect the cocoons. In Part B of this experiment to be continued in 1950, the moss might be changed in the spring and a couple of times thereafter.

PART E - NATURAL DIAPAUSE STUDY

(a) Object

To determine the number of sawflies remaining in diapause in the second season in untreated cocoons kept under normal non-submerged conditions.

(b) Procedure

Two frames were set up on May 26, 1949, with 180 cocoons in each; one with sphagnum moss and the other with non-sphagnum moss. They were placed in a sphagnum swamp and covered with moss to keep the cocoons moist but not wet. During the season of emergence, the adults appearing on the screened tops of the frames were removed and recorded. On August 11, when emergence was considered over, all the cocoons were removed, dissected, and recorded as to condition.

TABLE I - ADULTS REMOVED FROM NATURAL DIAPAUSE FRAMES

Date	Frame 1	Frame 2
June 3	10	4
16	12	5
27	22	22
July 5	3	8
6	2	4
11	8	8
13	1	
15		1
16	1	
26		1
Total	59	53

% of Population

No.1 31.72 %
2 27.89 %

No. 1 - Sphagnum
2 - Non-sphagnum

TABLE II

CONDITION OF COCOONS ON AUGUST 11, 1949

Condition	Frame 1		Frame 2	
	No.	%	No.	%
Live Eonymphs	4	2.15	17	8.95
Diseased Eonymphs	1	.54		
Pupae dead	19	10.22	5	2.63
Diseased Decomposed	21	11.28	20	10.53
Parasites & Predators	43	23.12	48	25.26
Appar. Emerged	98	52.69	100	52.63
Total	186	100.00	190	100.00

(c) Observations and Conclusions

Assuming that those eonymphs still alive by August 11 were going into a second year of diapause, the percentage of the whole population exhibiting this characteristic was 5.5 per cent. This figure was above that found in treated populations in Part A of the water level studies (Table II).

The difference between the apparently emerged cocoons (Table II) and the number of adults found in the frames (Table I) may have been due to a loss of adults through cracks in the frame, or their death and decomposition in the tightly packed moss above the cocoons. Much more frequent inspections for adults should have been made during the season of emergence. Also, lighter moss should have been used as it will be seen that the emergence was somewhat greater from the frames containing the loose sphagnum moss. The discrepancy between the number of cocoons from which larvae had apparently emerged and the count of adults removed may also have been present in the treated cocoons in Part A. of the water-level studies causing the emergence to be underestimated.

TERMINAL GROWTH STUDY

(a) Object

1. To determine the effect of sawfly defoliation on the incidence and vigour of terminal shoots of larch.

2. To determine the role of terminal shoots as disclosed by this study, on sawfly infestation.

(b) Plan of Study

Sample plots of different age classes were laid out in dense and open stands on both wet and dry sites. The height, diameter, per cent defoliation and mortality of all trees in the sample plots were measured. Sample trees were selected as were sample branches on the sample trees. All the terminal shoots on the sample branches were measured and recorded. The sample plots cover a wide variety of growing conditions and are located in the general vicinity of the field station at Red Rock Lake, Manitoba. The study is to cover a period of five years.

(c) Details of procedure

The sample plots, each one chain square, were marked with four white corner posts and a centre post. The corner post was marked with the date and the number of the plot. The distance was chained and a trail blazed and painted from each plot to a suitable landmark on a road or other easily accessible place.

The diameter, height and per cent defoliation of all trees were recorded and all dead trees and stubs removed from the plots. Each tree was marked with a metal tag attached to the tree by a loose wire. The diameter was measured at breast height, marked with white paint. The measurements were taken to the nearest one-tenth inch with a steel diameter tape. The height measurements were obtained in the case of the shorter trees, with a long, measured pole. In the case of the taller trees height was measured ocularly and checked by several readings with the Abney hand level.

The per cent defoliation was obtained by careful ocular estimates in the following manner. A low estimate was made of the per cent defoliation and gradually increased by five per cent intervals until it was felt that the correct estimate was reached. The estimate of the per cent foliage remaining was obtained in a similar manner and subtracted from one hundred to give another estimate of the per cent defoliation. The average of the two estimates to the nearest five per cent was regarded as the per cent defoliation.

Sample trees were selected having the same per cent defoliation as the sample plot average and approximately the same diameter and height. With the smaller trees, four sample trees were selected inside the plot. Six sample branches per tree were selected and tagged, two in each third of the crown. With the larger trees, one sample tree was selected at least fifteen feet outside the plot and twelve sample branches removed, four from each third of the crown. The terminal shoots were measured with a steel ruler, to the nearest millimeter, and the defoliation estimated on all branches. The number of healthy and curled shoots were recorded.

The age of the sample plots, containing the larger trees, was considered the age of the sample tree. The age of the sample plots, containing the smaller trees, was obtained by finding the age of surrounding trees of the same height as the sample trees. This method was considered to be close enough as the larch is an intolerant tree and practically always occurs in one-age stands.

(d) Tabulation of Data and Observations

The sample plot records for 703 trees in the eight plots were tabulated in the following form:

TABLE I
SAMPLE PLOT RECORDS

PLOT: No.1 DATE: Sept.1949; LOCATION: Jessica Lake Swamp

Tree No.	Height					Diameter					Defoliation					Mortality					Remarks
	Year					Year					Year					Year					
	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
670	8					1.1					60										
671	9					1.0					70										
672	6					0.5					10										
673	7					0.6					10										
674	10					1.4					10										
675	7					0.7					60										
676	6					0.6					10										
677	6					0.4					80										
678	6					0.4					90										
679	6					0.4					50										
680	5					0.4					60										
681	4					0.2					10										
682	11					1.5					30										
683	10					0.8					10										
684	14					2.0					60										
685	8					1.0					20										
686	7					0.6					30										
687	8					0.8					80										
688	9					0.9					95										
689	7					0.4					50										
690	8					0.8					20										
691	10					1.2					40										
692	6					0.4					90										
693	8					0.8					30										
694	5					0.3					30										
695	8					1.0					80										
696	7					0.7					10										
697	9					1.1					20										
698	10					1.7					30										
699	6					0.7					90										
700	4					0.4					20										
701	8					0.9					70										
702	10					1.4					50										

TABLE I (cont'd)

PLOT: No.1	DATE: Sept.1949					LOCATION: Jessica Lake Swamp															
Tree No.	Height Year					Diameter Year					Defoliation Year					Mortality Year					Remarks
	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
703	6					0.4					10										
704	6					0.5					20										
705	7					0.8					20										
706	7					0.9					20										
707	5					0.4					80										
708	9					1.3					70										
709	6					0.6					50										
710	6					0.6					70										
711	6					0.5					70										
712	5					0.3					5										
713	4					0.2					90										
714	7					0.7					80										
715	7					0.6					5										
716	9					1.2					10										
717	7					0.5					100										
718	10					1.5					10										
719	5					0.3					5										
720	5					0.2					50										
721	15					2.5					20										
722	11					2.1					30										
723	13					1.9					40										
724	14					2.6					40										
725	12					2.0					90										
726	8					0.9					60										
727	10					1.3					40										
728	8					0.8					90										
729	7					0.5					70										
730	7					0.8					40										
731	8					0.8					50										
732	7					0.6					40										
733	11					1.4					40										
734	10					1.7					80										
735	5					0.3					90										

TABLE I

PLOT: No.8 DATE: Sept., 1949 LOCATION: Star Lake Swamp

Tree	Height Year					Diameter Year					Defoliation Year					Mortality Year					
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	Remarks
462	45					4.9					80										
463	30					3.0					90										
464	45					4.3					50										
465	35					3.2					30										
466	40					3.1					80										
467	45					4.9					70										
468	55					6.6					80										
469	55					3.7					90										
470	20					2.5					90										
471	45					5.3					60										
472	45					3.6					80										
473	22					1.7					90										
474	35					3.3					90										
475	50					6.2					80										
476	45					4.4					80										
477	45					4.1					80										
478	45					3.6					90										
479	30					2.7					90										
480	40					4.1					80										
481	50					5.0					90										
482	35					3.1					90										
483	45					4.8					50										
484	50					5.8					80										
485	45					5.2					80										
486	55					7.2					70										
487	55					6.3					80										
488	55					6.9					80										
489	45					4.1					60										
490	35					4.0					70										
491	55					7.3					60										
492	35					3.6					80										
Avge	41					4.3					70										

TABLE I, PLOT NO. 8.

Directions for locating plot. 0.4 miles west on No. 1 Highway from junction of Falcon Lake road and No. 1 Highway; 100 feet south of road to plot centre.

Plot Description. Dense, pure stand. One age class. Average height 41 feet. Average defoliation, 70%. Dry site. Ground cover, sphagnum moss.

The terminal shoot records for the 17 sample trees were tabulated as is shown in Table II.

TABLE II

SAMPLE TREE RECORDS

PLOT: No.1 DATE: Aug. 1949 LOCATION: Jessica Lake Swamp

TREE NO.1 - 10 ft. W. of centre post Defoliation: 60%
Height: 10' Diameter: 1.0" Length of Live Crown: 7'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	0/3	90	5.1 3.4 4.0
2	0/4	90	4.0 1.5 4.5 4.0
3	1/1	10	
4	1/5	50	1.7 4.5 5.5 3.7
5	0/6	100	5.0 3.7 6.2 4.7 1.8 2.6
6	0/0	5	

TREE No.2 - 20 ft. S. of centre post Defoliation: 50%
Height: 12' Diameter: 1.5" Length of Live Crown: 8'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	0/5	40	2.3 3.2 2.4 2.4 2.1
2	0/6	50	1.9 1.8 1.6 2.8 3.7 3.3
3	0/3	90	2.2 2.4 1.9
4	1/6	70	1.8 1.9 2.6 2.3 3.2
5	0/1	60	0.9
6	0/2	10	2.3 2.0

TREE No.3 - 15 ft E. of centre post. Defoliation: 40%
Height: 8' Diameter: 1.0" Length of Live Crown: 4'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	0/8	70	1.8 3.0 3.4 4.2 4.0 3.2 2.0 2.6
2	1/4	80	3.6 3.6 4.6
3	0/4	10	1.4 3.0 4.0 3.1
4	1/4	0	1.3 3.1 2.2
5	1/5	90	2.7 3.0 3.1 2.0
6	0/2	10	1.8 2.0

TREE No. 4 - 35 ft N. of centre post Defoliation: 25%
Height: 10' Diameter: 1.5" Length of Live Crown: 7'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	0/2	90	2.0 1.8
2	2/8	50	1.4 2.0 2.4 2.3 2.2 2.5
3	1/3	10	2.0 2.5
4	1/3	20	1.1 2.1
5	1/2	30	2.0
6	0/0	0	

% Curled Shoots
11/87: 13% Average: 47% Average 214.9/76: 2.8 cm.

TABLE II
SAMPLE TREE RECORDS

PLOT: No.2 DATE: Aug. 1949 LOCATION: Whiteshell Lake Swamp

TREE No.1 - 35 ft. N. of centre post Defoliation: 50%
Height: 15' Diameter: 2.0" Length of Live Crown: 12'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	0/7	70	1.4 2.6 2.7 4.6 4.7 5.0 2.6
2	1/6	80	3.0 2.8 2.6 1.6 4.2
3	2/23	70	1.3 1.9 2.4 3.0 2.1 2.8 2.6
			3.1 3.5 4.2 3.5 3.0 3.4 1.9
			1.8 1.9 1.6 3.2 3.5 3.3 3.3
4	0/5	40	2.4 3.4 1.0 1.4 2.8
5	0/0	5	
6	6/13	50	2.9 3.9 3.8 3.6 3.4 2.2 3.4

TREE No.2 - 30 ft. W. of centre post Defoliation: 100%
Height: 12' Diameter: 1.3" Length of Live Crown: 12'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	5/10	90	2.3 3.9 4.3 4.5 5.3
2	0/7	100	1.9 1.9 2.4 3.5 3.6 4.0 4.6
3	0/1	100	3.6
4	1/3	95	2.6 2.6
5	0/0	100	
6	0/1	95	2.3

TREE No.3 - 30 ft. S. of centre post. Defoliation: 40%
Height: 12' Diameter: 1.3" Length of Live Crown: 7'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	1/5	40	1.4 2.4 2.4 2.7
2	2/8	60	2.3 3.6 2.8 3.3 3.4 3.0
3	0/0	40	
4	0/1	70	1.1
5	1/1	5	
6	1/1	20	

TREE No. 4 - 40 ft. E. of centre post Defoliation: 70%
Height: 14' Diameter: 1.8" Length of Live Crown: 11'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	2/5	95	2.9 4.5 4.0
2	0/5	95	3.2 2.6 2.5 4.2 4.8
3	0/11	90	1.5 2.6 2.7 1.6 2.9 3.0 2.1
			2.4 2.4 2.6 2.3
4	0/6	85	1.2 3.1 1.6 2.0 2.8 2.9
5	0/0	70	
6	0/0	5	
% Curled shoots 22/119: 19%		Average: 65%	Average 278.1/97: 2.9 cm.

TABLE II
SAMPLE TREE RECORDS

PLOT: No.3 DATE: Sept. 1949 LOCATION: Whiteshell Lake Swamp

TREE No. 1 Taken outside N.E. corner Defoliation: 70%
Height: 21' Diameter: 2.9" Length of Live Crown: 18'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	1/12	90	3.7 4.2 2.1. 2.4 2.5 4.0 2.9 3.3 3.0 3.4 2.2
2	0/1	100	2.0
3	0/11	80	3.7 3.6 2.5 3.7 2.6 2.5 3.5 2.6 2.2 2.6 3.0
4	8/23	90	3.0 2.1 2.6 2.5 3.3 2.9 3.9 2.5 3.0 3.3 2.4 2.8 5.2 3.2 1.9
5	1/23	70	1.7 3.0 1.8 2.7 2.0 3.9 4.9 3.1 4.0 2.4 3.5 4.1 3.0 4.4 4.4 1.8 2.0 2.4 3.2 4.0 1.6 4.4
6	3/29	80	3.6 0.6 0.8 1.6 1.9 2.3 2.4 2.2 1.7 3.4 4.0 3.5 2.8 2.3 2.4 1.7 2.4 2.6 3.5 2.3 3.2 3.1 4.9 5.0 3.9 3.1
7	7/21	95	2.7 3.1 3.5 3.5 2.7 1.0 2.9 3.9 5.4 1.9 2.3 2.5 1.9 1.8
8	1/17	20	3.5 2.4 3.0 3.3 3.7 4.8 1.5 3.1 2.4 2.5 3.5 3.0 3.1 2.4 2.9 5.2
9	1/9	30	3.1 2.9 2.8 2.5 1.8 2.8 2.9 2.9
10	3/6	40	2.1 3.8 0.9
11	1/7	90	1.9 3.1 3.0 2.8 3.3 3.6
12	4/8	70	1.1 1.1 1.6 0.9

% Curled shoots
30/167: 18% Average: 71% Average: 392.4/137: 2.8 cm.

TABLE II
SAMPLE TREE RECORDS

PLOT: No.4 DATE: Sept. 1949 LOCATION: Jean Lake Swamp

TREE No.1 - 35 ft. N. of centre post Defoliation; 85%
Height; 10' Diameter; 1.4" Length of Live Crown: 8'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	3/14	90	1.1 1.8 1.9 1.8 1.6 2.0 2.1 2.8 3.0 3.1 1.4
2	3/23	90	2.3 2.4 2.3 2.9 3.4 1.9 1.8 2.1 2.0 2.1 2.5 2.8 1.8 3.2 1.8 2.8 3.1 3.6 3.7
3	0/4	85	2.0 3.2 2.9 3.0
4	0/2	85	1.6 1.7
5	4/15	90	1.8 2.2 2.7 1.7 2.5 1.5 2.0 2.4 3.1 1.9 1.8
6	1/20	90	1.5 1.7 1.8 1.7 1.6 1.8 3.2 2.4 2.7 2.7 2.5 3.0 2.0 2.2 2.7 2.1 2.7 3.0 2.6

TREE No.2 - 35 ft. W. of sentre post Defoliation: 95%
Height; 11' Diameter 1.7" Length of Live Crown: 8'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	6/10	95	3.6 3.9 4.6 4.8
2	4/11	90	3.4 3.9 4.9 4.9 5.0 5.7 5.3
3	1/8	100	3.4 2.7 3.4 3.3 2.7 4.1 2.8
4	5/10	100	2.1 2.1 2.6 1.1 4.1
5	1/10	100	3.7 2.0 2.0 2.8 1.6 3.3 3.1 2.3 2.8
6	1/4	100	2.5 3.6 2.7

TREE No.3 - 30 ft. S. of centre post Defoliation: 80%
Height; 11' Diameter;1.4" Length of Live Crown; 8'

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	0/1	95	1.8 (Numerous Cones)
2	0/5	100	1.2 1.9 1.8 1.6 1.7
3	1/7	95	1.8 1.9 1.8 3.0 0.7 3.2
4	1/5	95	3.3 1.4 1.3 1.7
5	0/0	60	
6	0/0	0	

TREE No.4 - 30 ft. E. of centre post Defoliation; 95%
Height; 12' Diameter: 1.8" Length of Live Crown; 8'

1	3/6	100	3.7 2.3 3.6
2	4/14	95	3.1 3.0 3.4 3.8 1.0 2.4 3.7 3.8 3.8 3.5
3	1/6	100	2.6 2.1 1.8 3.5 2.5
4	7/18	100	3.0 2.2 2.6 3.4 2.5 3.0 3.3 3.3 2.4 0.8 3.0

TABLE II
SAMPLE TREE RECORDS

PLOT NO. 4,
TREE NO. 4 (cont'd)

Branch Number	Curled shoots / Total shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
5	17/27	95	4.1 4.6 3.5 3.7 3.5 2.7 3.0 2.2 5.2 1.9
6	4/7	95	3.6 4.7 3.1
% Curled Shoots 36/78: 46%		Average: 89%	Average: 429.3/160: 2.7 cm.

TABLE II
SAMPLE TREE RECORDS

PLOT No.5 DATE: Sept. 1949 LOCATION: Jean Lake Swamp

TREE NO. 1 - Taken at N.E. corner of plot Defoliation: 80%
Height: 25' Diameter: 4.3" Length of Live Crown: 20'

Branch Number	Curled Shoots / Total Shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	3/17	60	4.0 5.5 6.7 5.4 6.4 5.2 7.0 6.2 8.1 7.6
			8.6 7.6 8.4 8.9
2	8/27	80	2.8 2.4 3.3 2.8 1.1 3.2 3.8 4.3 4.1 4.0
			1.7 3.0 4.4 4.1 3.8 4.4 6.6 5.7 7.8
3	0/12	90	2.3 2.4 3.8 1.7 3.2 2.5 4.8 3.8 4.2 4.3
			5.8 5.2
4	11/47	80	1.0 2.5 5.1 3.9 2.6 1.0 2.7 3.5 3.4 3.9
			3.0 4.2 6.0 7.0 1.5 3.3 3.0 1.7 3.1 4.4
			4.5 5.4 2.3 0.9 4.3 3.4 2.4 0.7 0.8 4.8
			4.5 4.8 5.2 6.2 4.9 4.8
5	6/50	90	3.3 2.5 2.9 3.4 3.9 3.9 3.3 4.2 1.4 2.9
			1.6 3.9 1.2 3.0 2.5 2.5 3.7 2.6 2.4 3.5
			1.9 4.3 4.2 4.3 2.7 2.6 4.0 2.8 3.0 3.3
			2.9 3.8 4.7 4.8 3.5 3.9 3.4 3.7 4.6 5.0
			4.7 6.3 5.8 6.2
6	3/79	80	4.9 2.5 2.8 3.7 2.8 2.0 6.0 2.8 3.3 5.5
			2.6 2.1 3.0 3.6 2.1 3.0 2.1 2.0 2.9 3.5
			3.0 2.3 4.0 2.9 1.6 4.0 2.8 1.9 3.6 3.4
			3.7 3.9 3.6 4.7 4.4 5.2 4.8 5.4 4.9 4.9
			4.6 3.0 3.4 3.8 3.5 5.4 3.8 4.3 3.7 3.9
			3.5 2.4 1.6 3.8 5.0 5.0 3.9 3.2 4.5 2.3
			3.6 3.9 5.2 4.9 2.4 5.2 4.2 5.9 2.9 4.5
			3.6 7.0 6.0 5.1 4.8 4.8
7	2/46	90	2.0 1.4 3.9 3.1 3.9 3.4 1.6 2.4 2.6 2.2
			2.8 4.1 3.2 3.1 3.3 1.9 1.0 3.3 3.2 3.1
			1.0 2.9 3.7 4.0 3.4 5.7 3.3 2.9 3.5 3.9
			4.9 1.7 4.8 7.1 2.6 2.6 6.9 5.9 5.8 5.4
			7.6 6.2 6.6 6.8
8	1/19	100	3.6 3.6 4.9 3.5 3.9 1.0 3.4 3.2 3.8 3.0
			3.1 2.6 3.3 3.3 3.0 3.6 4.9 4.4
9	25/104	90	7.8 3.0 2.6 2.2 2.6 2.6 2.9 5.5 1.3 3.2
			3.8 3.3 3.6 2.9 2.8 1.2 5.7 6.7 2.4 2.9
			4.8 3.4 2.8 4.8 5.4 6.1 6.4 4.3 5.2 3.9
			3.0 5.4 4.3 5.2 2.0 1.2 7.7 8.6 4.4 4.6
			5.3 6.9 3.7 4.8 5.1 3.5 2.7 4.1 4.1 4.4
			7.0 4.7 5.4 2.5 314 5.0 3.2 3.4 3.5 4.3
			3.4 3.4 2.7 4.4 6.0 7.3 5.3 5.5 5.6 2.8
			3.9 5.4 4.8 5.9 5.8 7.2 4.6 2.8 6.8

TABLE I (cont'd)

PLOT: No.1 DATE: Sept.1949 LOCATION: Jessica Lake Swamp

Tree	Height					Diameter					Defoliation					Mortality					Remarks
	Year					Year					Year					Year					
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
736	8					0.7					90										
737	9					0.8					0										
738	7					0.7					30										
739	7					0.7					70										
740	6					0.5					60										
741	5					0.3					70										
742	12					2.1					80										
743	7					0.7					20										
744	7					0.7					40										
745	8					1.1					50										
746	11					1.5					60										
747	7					0.5					70										
748	9					0.6					80										
749	10					1.2					70										
750	5					0.4					70										
751	11					1.3					70										
752	6					0.5					80										
753	13					1.8					80										
754	11					1.7					40										
755	8					1.0					40										
756	8					0.9					20										
757	5					0.4					50										
758	5					0.3					30										
759	8					0.9					80										
760	8					0.8					20										
761	9					0.9					90										
762	7					0.8					80										
763	12					2.1					30										
764	7					0.8					20										
765	4					0.2					10										
766	12					1.9					90										

TABLE I (cont'd)

PLOT: No. 1 DATE: Sept., 1949 LOCATION: Jessica Lake Swamp

Tree No.	Height Year 49	50	51	52	53	Diameter Year 49	50	51	52	53	Defoliation Year 49	50	51	52	53	Mortality Year 49	50	51	52	53	Remarks
767	6					0.4					10										
768	10					1.4					20										
769	6					0.4					60										
770	10					1.1					10										
771	9					1.0					10										
772	10					1.0					10										
773	9					1.0					60										
774	8					0.9					70										
775	8					0.7					80										
776	9					1.2					20										
777	12					1.9					50										
778	11					1.0					70										
779	13					2.0					10										
780	7					0.6					90										
781	9					1.2					50										
782	5					0.5					20										
783	5					0.4					20										
784	10					1.7					20										
785	6					0.5					50										
786	7					0.6					80										
787	9					0.9					90										
788	5					0.4					40										
789	6					0.6					90										
790	10					1.2					80										
791	6					0.6					30										
792	10					1.3					40										
793	7					0.5					40										
794	11					1.2					30										
795	10					1.0					40										
796	10					1.0					30										

TABLE I (cont'd)

PLOT: No.1 DATE: Sept.,1949 LOCATION: Jessica Lake Swamp

Tree No.	Height 49	Height 50	Height 51	Height 52	Height 53	Diameter 49	Diameter 50	Diameter 51	Diameter 52	Diameter 53	Defoliation 49	Defoliation 50	Defoliation 51	Defoliation 52	Defoliation 53	Mortality 49	Mortality 50	Mortality 51	Mortality 52	Mortality 53	Remarks
797	10					1.1					70										
798	9					0.9					40										
799	6					0.7					10										
800	8					1.0					80										
493	8					0.9					20										
494	8					0.9					10										
495	9					1.1					70										
496	9					1.2					20										
497	5					0.4					20										
498	8					1.1					20										
499	9					1.1					70										
500	10					1.3					50										
501	7					0.8					10										
502	11					1.4					40										
503	5					0.5					60										
504	9					1.2					30										
505	7					0.6					30										
506	6					0.5					40										
507	8					0.9					40										
508	7					0.7					20										
509	7					0.6					0										
510	6					0.5					10										
511	12					1.6					40										
512	6					0.5					30										
513	7					0.7					10										
514	8					1.0					20										
515	7					0.8					10										
516	5					0.4					30										
517	7					1.0					20										

TABLE I (cont'd)

PLOT: No.1 DATE: Sept.,1949 LOCATION: Jessica Lake Swamp

Tree	Height					Diameter					Defoliation					Mortality					Remarks
	Year					Year					Year					Year					
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
518	8					0.8					20										
519	8					0.7					20										
520	6					0.5					30										
521	7					1.0					40										
522	11					1.6					40										
523	6					0.6					20										
524	6					0.6					50										
525	6					0.7					90										
526	5					0.4					90										
527	9					1.0					10										
528	7					0.7					70										
529	5					0.4					60										
530	6					0.5					90										
531	5					0.3					30										
532	12					2.0					60										
533	7					0.7					40										
534	6					0.5					95										
535	7					0.7					80										
536	7					0.7					60										
537	15					2.5					70										
538	7					0.6					40										
539	9					1.3					50										
540	7					0.6					40										
541	10					1.2					20										
542	10					1.3					10										
543	6					0.9					10										
544	8					0.5					70										
545	5					0.9					10										
546	4					0.2					0										
547	4					0.2					0										
548	6					0.5					95										

TABLE I (cont'd)

PLOT: No.1 DATE: Sept., 1949 LOCATION: Jessica Lake Swamp

TREE	Height					Diameter					Defoliation					Mortality					Remarks
	Year					Year					Year					Year					
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
549	5					0.4					10										
550	8					1.1					10										
551	7					0.8					10										
552	7					1.0					30										
553	8					0.8					20										
554	10					1.0					30										
555	5					0.3					60										
556	8					0.9					10										
557	8					1.0					40										
558	5					0.5					20										
559	13					1.9					50										
560	6					0.5					20										
561	9					1.2					30										
562	10					1.4					60										
563	6					0.6					70										
564	8					1.2					10										
565	7					0.7					85										
566	6					0.6					10										
567	9					1.0					10										
568	5					0.5					60										
569	9					0.9					20										
570	5					0.3					50										
571	8					0.9					40										
572	7					0.5					30										
573	8					0.7					20										
574	6					0.5					20										
575	11					1.5					40										
576	8					1.3					30										
577	5					0.5					60										
578	6					0.5					50										
579	7					0.8					95										
580	9					1.0					50										
581	12					2.1					10										
582	9					1.0					20										

TABLE I (cont'd)

PLOT No.1 DATE: Sept., 1949 LOCATION: Jessica Lake Swamp

Tree No.	Height Year 49	50	51	52	53	Diameter Year 49	50	51	52	53	Defoliation Year 49	50	51	52	53	Mortality Year 49	50	51	52	53	Remarks
583	8					1.1					20										
584	11					1.6					10										
585	7					0.6					30										
586	6					0.4					70										
587	6					0.5					80										
588	5					0.2					100										
589	7					0.9					40										
590	8					0.9					20										
591	7					0.6					30										
592	7					0.6					10										
593	8					0.7					10										
594	6					0.5					80										
595	6					0.5					10										
596	9					1.3					40										
597	8					1.0					75										
598	10					1.0					80										
599	7					0.7					60										
600	8					0.9					10										
601	7					0.8					20										
602	8					0.9					30										
603	6					0.6					10										
604	5					0.3					30										
605	4					0.2					30										
606	5					0.4					60										
607	9					0.9					30										
608	9					1.1					60										
609	13					2.2					10										
610	5					0.3					10										
611	11					1.5					30										
612	6					0.6					30										

TABLE I (cont'd)

PLOT No.I DATE: Sept., 1949 LOCATION: Jessica Lake Swamp

Tree	Height					Diameter					Defoliation					Mortality					Remarks
	Year					Year					Year					Year					
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
613	11					1.5					40										
614	9					0.9					80										
615	7					0.6					10										
616	11					1.3					40										
617	7					0.7					20										
618	6					0.5					60										
619	9					1.0					90										
620	13					2.3					30										
621	6					0.8					70										
622	12					1.9					20										
623	7					0.6					30										
624	8					0.7					40										
625	8					0.7					10										
626	10					1.3					20										
627	7					0.7					95										
628	8					0.9					30										
629	8					0.7					80										
630	10					1.0					20										
631	7					0.7					30										
632	6					0.5					95										
633	9					0.9					10										
634	10					1.0					80										
635	7					0.8					25										
636	6					0.4					25										
637	6					0.5					20										
638	8					1.0					20										
639	9					1.1					20										
640	6					0.5					30										
641	7					0.7					30										
642	7					0.6					10										
643	13					1.7					10										

Plot:	No.1					Date: Sept., 1949					Location:					Jessica Lake Swamp					
	Height					Diameter					Defoliation					Mortality					
Tree	Year					Year					Year					Year					Remarks
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
644	7					0.7					10										
645	7					0.6					10										
646	5					0.4					20										
647	6					0.4					10										
648	7					0.8					10										
649	7					0.7					20										
650	6					0.6					10										
651	6					0.5					10										
652	6					0.5					85										
653	7					0.8					10										
654	6					0.4					10										
655	8					0.7					30										
656	11					1.5					20										
657	9					1.3					40										
Avge	8					0.9					40										

<u>Directions for Locating Plot 1</u>: One mile along road from field station towards Rennie: 6000 feet from road East along trail marked with red paint to a marked spruce tree; 800 feet north through swamp along blazed and painted trail to plot centre post.

<u>Plot Description</u>: Dense, wet site. Age class, 30-40 years; Average height - 8 feet; Average defoliation - 40%; Ground cover - sphagnum moss, grass, labrador tea.

TABLE I

PLOT: No.2 DATE: Sept.49 LOCATION: Whiteshell Lake Swamp

Tree	Height					Diameter					Defoliation					Mortality					
	Year					Year					Year					Year					Remarks
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
658	8					0.7					90										
659	20					4.8					20										
660	12					2.1					70										
661	15					2.7					20										
662	11					1.4					30										
663	7					0.8					60										
664	20					3.5					70										
665	14					3.4					25										
666	20					4.1					25										
667	22					4.6					20										
668	22					4.5					20										
669	12					2.7					70										
670	20					3.9					60										
671	14					2.3					70										
672	13					1.6					100										
673	16					4.1					20										
674	11					1.7					90										
675	5					0.1					20										
676	15					3.3					90										
Avge.	10					1.3					70										

Directions for locating plot. 11.2 miles along road from field station to Whiteshell Lake; 1.2 miles east along trail to large arrow painted on rock; 1600 feet along blazed and painted trail to plot centre post.

Plot Description. Open, pure stand. Two age classes:- 0-20 years; 20-40 years. Wet site. Average height, 0-20 years--11 feet; 20-40 years--20 feet. Average defoliage, 0-20 years - 65%; 20-40 years - 40%. Ground cover - sphagnum moss, grass.

TABLE I

PLOT: No.3 DATE: Sept., 1949 LOCATION: Whiteshell Lake Swamp

Tree No.	Height Year 49	50	51	52	53	Diameter Year 49	50	51	52	53	Defoliation Year 49	50	51	52	53	Mortality Year 49	50	51	52	53	Remarks
677	10					1.2					90										
678	7					0.6					100										
679	25					3.9					90										
680	20					4.4					40										
681	18					3.5					20										
682	16					2.3					90										
683	8					0.8					60										
684	4					0.2					80										
685	25					5.3					20										
686	18					3.0					70										
687	18					4.8					60										
688	8					1.2					70										
689	6					0.5					100										
690	25					3.9					80										
691	11					1.1					100										
692	14					2.4					100										
693	13					2.0					100										
694	8					0.9					100										
695	14					2.0					100										
696	13					1.7					100										
697	20					3.6					80										
698	12					1.9					100										
699	22					4.2					70										
700	21					3.0					90										
701	16					3.3					70										
702	5					0.4					100										
703	6					0.5					100										
Ave.	20					3.5					65										

Directions for locating plot. 200 feet North-East of plot number 2.

Plot Description. Open, pure stand. Two age classes, 0-20 years; 20-40 years. Wet site. Average height 0-20 years-9feet; 20-40 years,-20 feet; average defoliation, 0-20 years, 95%; 20-40 years, 65%. Ground cover - sphagnum moss,grass.

TABLE I

PLOT: No.4 DATE: Sept., 1949 LOCATION: Jean Lake Swamp

Tree No.	Height Year					Diameter Year					Defoliation Year					Mortality Year					Remarks
	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
468	13					1.8					100										
469	11					1.7					90										
470	13					2.5					90										
471	9					1.1					50										
472	8					1.3					60										
473	6					0.7					60										
474	7					0.9					50										
475	10					1.5					60										
476	11					1.0					90										
477	8					1.1					40										
478	7					0.8					70										
479	11					1.4					90										
480	14					2.7					90										
481	15					2.5					100										
482	12					2.2					90										
483	8					1.4					90										
484	6					0.3					90										
485	13					1.8					100										
486	12					1.6					80										
487	13					2.0					100										
Avge	8					1.5					80										

Directions for locating plot. 3100 feet south of mile post 91, on No.1 Highway, along blazed and marked trail to plot centre post.

Plot description. Open, mixed stand. One age class. Average height 8 feet. Average defoliation, 80%. Ground cover - sphagnum moss, grass.

TABLE I

PLOT: No.5 DATE: Sept., 1949 LOCATION: Jean Lake Swamp

Tree	Height Year					Diameter Year					Defoliation Year					Mortality Year					
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	Remarks
488	14					1.6					90										
489	18					2.5					50										
490	17					2.2					80										
491	10					1.2					90										
492	30					5.5					70										
493	32					5.0					90										
494	5					0.3					100										
495	25					4.3					90										
496	30					5.4					90										
497	40					6.8					90										
498	25					4.2					80										
499	25					4.0					90										
500	30					5.7					90										
501	16					2.4					100										
502	11					1.3					100										
503	15					2.2					80										
504	10					1.1					100										
505	35					6.1					90										
506	18					4.0					90										
507	20					3.5					80										
508	22					4.7					100										
509	9					0.6					90										
510	11					1.0					80										
512	7					0.5					100										
513	14					1.4					90										
514	13					1.3					100										
515	11					1.2					100										
516	12					1.3					90										
517	14					1.9					100										
518	13					2.1					60										
511	10					0.9					60										

TABLE I

Plot 5 - cont'd

PLOT: No.5	DATE: Sept. 1949				LOCATION: Jean Lake Swamp																
Tree	Height Year					Diameter Year					Defoliation Year					Mortality Year					Remarks
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
519	12					1.7					70										
520	11					1.6					100										
521	15					3.4					60										
522	14					4.1					90										
523	20					5.1					90										
524	9					0.9					90										
525	10					1.0					90										
526	9					0.9					30										
527	16					3.0					90										
528	7					0.6					100										
529	9					0.8					80										
530	13					1.6					50										
531	6					0.4					100										
532	8					0.6					30										
533	8					0.7					20										
534-	8					017					20										
535	11					1.3					5										
536	8					0.8					100										
537	13					2.0					40										
538	10					1.4					40										
539	7					0.8					60										
540	6					0.6					50										
541	5					0.4					100										
542	11					1.4					50										
543	9					1.2					20										
544	11					1.5					70										
545	6					0.4					10										
546	10					1.1					5										
547	8					0.8					5										

TABLE I

Plot 5 - cont'd

PLOT: No.5			DATE: Sept.1949						LOCATION: Jean Lake Swamp												
Tree No.	Height Year					Diameter Year					Defoliation Year					Mortality Year					Remarks
	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
548	11					1.5					20										
549	8					0.8					20										
550	8					1.2					50										
551	9					1.0					40										
552	11					1.2					40										
553	9					0.8					90										
554	8					0.9					90										
555	6					0.5					90										
556	8					1.1					10										
557	10					1.2					50										
558	5					0.5					50										
559	9					1.0					70										
560	6					0.5					50										
561	25					4.7					60										
562	8					0.8					80										
563	10					1.3					70										
564	12					1.3					80										
565	10					0.9					80										
566	14					1.8					50										
567	12					1.2					60										
568	9					0.9					40										
569	10					1.1					40										
570	6					0.6					40										
571	7					0.6					100										
572	8					0.8					70										
573	7					0.8					50										
574	14					1.6					100										
575	14					1.7					100										
576	6					0.5					100										
577	7					0.7					90										
578	10					1.3					50										

TABLE I

Plot 5 - cont'd

PLOT: No.5 DATE: Sept.1949 LOCATION: Jean Lake Swamp

Tree No.	Height Year					Diameter Year					Defoliation Year					Mortality Year					Remarks
	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
579	5					0.3					90										
580	10					0.9					30										
581	5					0.3					30										
582	7					0.7					20										
583	10					1.3					40										
584	22					4.5					50										
585	8					0.9					100										
586	7					0.6					100										
587	15					2.3					100										
588	9					0.8					100										
589	7					0.5					100										
590	6					0.6					50										
591	25					4.3					80										
592	13					1.9					90										
593	9					1.1					90										
594	25					5.0					90										
595	12					1.3					80										
596	14					2.1					100										
597	17					2.4					80										
598	13					1.8					100										
599	12					1.4					100										
600	10					1.2					30										
601	14					1.7					30										
602	14					2.4					20										
603	11					1.1					30										
604	9					0.7					20										
605	10					1.0					90										
606	22					4.5					70										
Avge	24					4.6					80										

TABLE I

PLOT No.5.

Directions for locating plot. 300 feet south along blazed and painted trail, from plot No.4 to marked Tamarack tree; 200 feet west along blazed and painted trail to plot centre post.

Plot Description. Pure open stand, dense understory. Two age classes, 20-40 years and 40-60 years. Dry site. Average height: 20-40 years, 10 feet; 40-60 years, 24 feet; average defoliation: 20-40 years, 65%; 40-60 years, 80%. Ground cover- sphagnum moss and grass.

TABLE I

PLOT: No.6					DATE: Sept. 1949						LOCATION: Picnic-ground Swamp										
	Height					Diameter					Defoliation					Mortality					
	Year					Year					Year					Year					
Tree No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	Remarks
401	25					4.2					50										
402	28					4.5					50										
403	25					3.5					80										
404	28					4.0					90										
405	33					4.8					50										
406	18					2.7					70										
407	25					4.4					40										
408	30					4.5					80										
409	32					5.0					90										
410	22					3.7					70										
411	27					3.8					40										
412	13					1.6					100										
413	25					3.4					70										
414	25					3.5					90										
415	14					2.1					80										
416	15					2.0					100										
417	30					4.1					60										
418	16					2.0					100										
419	25					3.6					30										
420	30					4.7					80										
421	15					2.5					90										
422	30					4.9					90										
423	20					2.9					40										
424	15					2.2					100										
425	28					4.1					60										
426	22					4.2					60										
427	23					3.6					30										
428	32					4.9					90										
429	20					3.0					20										

TABLE I

PLOT: No.6 DATE: Sept.1949 LOCATION: Picnic-ground Swamp

Tree	Height Year					Diameter Year					Defoliation Year					Mortality Year					Remarks
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
430	19					2.7					60										
431	28					4.1					80										
432	22					3.2					50										
433	30					5.0					80										
434	25					3.8					100										
435	20					2.5					20										
436	15					2.3					80										
437	28					4.1					90										
438	32					4.5					30										
439	13					1.6					100										
440	13					2.3					100										
441	35					5.0					20										
442	22					4.2					30										
443	27					5.4					20										
444	23					5.9					90										
445	23					3.6					90										
446	32					5.1					60										
447	27					3.8					40										
448	35					5.9					20										
449	32					4.5					80										
450	22					4.2					60										
451	20					3.3					20										
452	25					4.2					50										
453	17					2.5					100										
454	32					4.2					80										
455	17					2.6					90										
456	30					4.8					70										
457	25					3.7					40										
458	25					3.7					80										
459	28					4.3					90										
460	22					3.1					60										
461	22					4.3					40										

TABLE I

PLOT: No. 6						DATE: Sept. 1949								LOCATION: Picnic-ground Swamp							
Tree	Height Year					Diameter Year					Defoliation Year					Mortality Year					
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	Remarks
462	40					6.2					80										
463	12					1.7					80										
464	23					3.7					50										
465	25					3.6					70										
466	28					3.9					50										
467	26					3.8					80										
Avge	26					3.8					60										

Directions for locating plot. 1.5 miles from field station north on road to Jessica Lake to a large tree painted red, on right hand side of road; 500 feet east along blazed and painted trail to plot centre post.

Plot Description. Dense, pure stand. One age class, 40-60 years. Average height, 26 feet. Average defoliation, 60%. Wet site. Ground cover - sphagnum moss. Undergrowth, Alder bushes.

TABLE I

PLOT: No.7 DATE: Sept. 1949 LOCATION: Telford Swamp

Tree No.	Height Year					Diameter Year					Defoliation Year					Mortality Year					Remarks
	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
607	35					5.4					40										
608	16					2.0					20										
609	18					2.4					30										
610	45					6.1					50										
611	25					3.5					60										
612	40					6.1					80										
613	45					6.3					50										
614	10					1.4					40										
615	10					1.0					80										
616	45					7.1					70										
617	11					1.1					90										
618	35					5.6					80										
619	23					2.9					20										
620	25					3.7					50										
621	35					5.2					30										
622	20					2.6					60										
623	25					3.0					40										
624	40					6.4					20										
625	23					3.1					20										
626	9					1.0					100										
627	25					3.8					20										
628	23					3.4					20										
629	30					4.6					30										
630	35					5.4					20										
631	45					6.6					20										
632	25					3.3					40										
633	20					2.6					40										
634	15					2.5					20										
635	5					0.3					100										
636	35					4.7					50										
637	30					4.0					20										
638	10					1.0					100										
639	40					5.2					60										

TABLE I

PLOT: No.7	DATE: Sept., 1949										LOCATION: Telford Swamp										
Tree	Height Year					Diameter Year					Defoliation Year					Mortality Year					REMARKS
No.	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
640	12					1.8					70										
641	7					0.5					100										
642	16					2.6					30										
643	12					1.2					10										
644	30					3.9					20										
645	18					2.5					60										
646	9					0.8					30										
647	30					3.7					30										
648	18					1.6					50										
649	35					4.2					30										
650	35					3.7					80										
651	16					1.9					40										
652	40					4.6					80										
653	9					0.6					100										
654	12					1.7					100										
655	35					5.1					50										
656	12					1.0					90										
657	35					4.2					70										
658	35					5.1					30										
659	20					2.4					30										
660	23					2.7					50										
661	25					3.7					30										
662	40					5.6					60										
663	35					5.0					50										
664	35					4.3					30										
665	40					4.9					30										
666	18					1.7					90										
667	25					3.6					20										
668	20					2.3					90										
669	18					2.3					50										
Avge	36					4.3					40										

TABLE I, Plot No. 7.

Directions for locating plot. 7.1 miles east from Brereton Lake corner on No. 1 Highway to a telephone pole on left side of the road marked with a large white seven. 800 feet north along blazed and painted trail to plot centre post.

Plot Description. Dense, pure stand. One age class. Average height 36 feet. Average defoliation, 40%. Dry site. Ground cover, grass and sphagnum moss.

TABLE I

PLOT: No.8 DATE: Sept.1949 LOCATION: Star Lake Swamp

Tree No.	Height Year					Diameter Year					Defoliation Year					Mortality Year					Remarks
	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	49	50	51	52	53	
401	45					5.7					80										
402	30					2.8					40										
403	35					3.4					30										
404	33					3.0					50										
405	40					6.0					90										
406	50					5.3					80										
407	20					2.1					90										
408	40					3.9					80										
409	45					4.5					70										
410	30					2.8					60										
411	20					2.4					90										
412	40					3.6					30										
413	45					4.8					50										
414	23					2.4					90										
415	35					3.4					80										
416	40					3.5					80										
417	30					4.0					30										
418	35					3.5					80										
419	45					4.5					90										
420	35					3.5					40										
421	25					2.2					90										
422	25					2.4					90										
423	28					2.6					90										
424	50					6.0					80										
425	25					2.7					90										
426	30					4.4					50										
427	50					5.3					60										
428	40					4.2					80										
429	50					6.4					50										
430	20					2.2					40										
431	50					5.8					80										

TABLE I

PLOT: No.8 DATE: Sept. 1949 LOCATION: Star Lake Swamp

Tree No.	Height Year 49	50	51	52	Diameter Year 49	50	51	52	53	Defoliation Year 49	50	51	52	53	Mortality Year 49	50	51	52	53	Remarks
432	55				6.5					70										
433	35				3.3					80										
434	15				1.8					80										
435	30				2.8					70										
436	40				3.9					70										
437	35				3.5					70										
438	35				4.0					80										
439	45				5.3					90										
440	20				2.5					90										
441	45				4.2					50										
442	45				5.2					80										
443	45				5.5					60										
444	40				4.6					90										
445	45				5.6					30										
446	30				3.8					30										
447	50				6.1					90										
448	17				1.9					90										
449	45				4.2					60										
450	50				5.8					80										
451	35				3.6					80										
452	20				2.2					90										
453	35				2.8					70										
454	45				4.1					80										
455	50				4.9					80										
456	35				3.1					80										
457	25				2.8					80										
458	50				5.1					90										
459	35				3.9					70										
460	40				4.1					80										
461	40				3.8					80										

TABLE II
SAMPLE TREE RECORDS

PLOT NO. 5 (cont'd)
TREE NO. 1

Branch Number	Curled Shoots / Total Shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
10	11/63	70	3.3 4.0 3.6 3.9 5.0 4.4 6.5 4.4 4.9 4.6
			4.3 2.5 0.8 5.1 2.5 2.3 3.4 1.9 4.3 2.9
			3.4 3.8 4.6 5.1 5.4 5.3 6.7 6.1 2.0 2.5
			4.2 4.2 2.9 3.2 4.4 1.5 3.8 3.6 3.0 3.3
			6.2 4.4 4.9 5.8 6.6 5.4 2.7 2.8 4.4 4.8
			4.9 5.0
11	11/60	40	1.6 3.2 3.5 3.7 2.3 4.0 3.1 2.8 2.9 3.1
			3.3 3.2 4.6 1.9 2.9 2.6 4.0 3.5 5.3 3.6
			2.1 3.6 2.9 2.5 4.0 3.5 3.6 5.6 5.0 4.0
			3.7 3.1 3.5 2.7 3.2 4.2 3.4 2.7 4.2 3.6
			3.9 4.3 5.8 4.4 5.4 3.9 3.0 4.5 5.5
12	30/114	90	1.7 3.0 2.6 2.7 3.6 1.7 4.8 4.2 4.1 3.3
			3.7 5.3 5.4 2.3 4.1 3.8 3.0 2.9 2.6 4.3
			2.5 3.5 3.1 3.3 3.5 4.0 1.6 3.6 4.3 3.1
			4.0 4.8 5.8 5.2 4.7 5.6 4.8 4.9 5.8 4.0
			4.7 4.9 3.1 2.4 2.8 2.2 2.4 2.5 2.4 2.5
			1.8 2.9 3.2 4.0 5.1 4.2 3.1 2.7 2.7 2.9
			2.4 3.2 1.7 2.7 1.9 1.6 4.0 2.1 4.4 4.9
			5.2 4.8 1.4 2.1 1.8 2.9 3.5 3.2 5.0 5.8
			4.8 5.5 6.8 5.8

% Curled Shoots
111/638: 17% Average: 80% Average: $\frac{2028.1}{527}$ = 3.8 cm.

TABLE II
SAMPLE TREE RECORDS

PLOT: No.6 DATE: Sept. 1949 LOCATION: Picnic Swamp

TREE NO.1 - Taken at N.E. corner of plot Defoliation: 60%
Height: 28' Diameter: 3.5" Length of Live Crown: 24'

Branch Number	Curled Shoots / Total Shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	3/13	80	3.6 3.1 2.0 3.4 2.7 3.7 2.8 3.5 4.9
			5.5
2	7/29	90	2.1 4.1 1.6 2.4 3.6 2.0 2.0 3.0 4.0
			3.9 3.8 1.5 1.3 2.1 3.0 2.7 2.6 4.5
			0.8 4.0 3.7 3.6
3	8/44	90	1.5 0.7 1.5 2.8 0.6 2.2 2.6 1.8 4.0
			3.4 1.0 2.1 0.9 1.7 3.3 2.8 2.7 3.4
			4.2 3.0 2.5 2.5 2.0 4.9 1.9 1.2 3.8
			3.3 3.5 1.8 1.7 3.7 0.7 3.1 1.5 2.8
4	17/60	90	5.8 4.3 3.5 1.4 4.2 1.9 3.0 0.9 1.6
			0.6 4.0 4.2 2.3 2.7 1.2 0.4 1.6 1.7
			3.4 1.7 1.1 2.0 2.6 1.9 3.0 2.6 2.5
			2.4 2.2 1.6 2.2 4.2 3.3 2.6 3.3 2.8
			2.2 2.1 1.3 4.0 1.9 2.8 5.0
5	20/74	90	5.0 4.7 2.1 2.0 3.1 3.3 2.4 1.1 1.7
			2.2 0.8 2.9 2.6 2.8 1.5 2.4 4.0 2.6
			1.9 2.7 1.4 2.0 2.8 3.1 3.1 2.9 3.8
			2.4 2.1 2.5 1.3 2.9 1.7 2.4 1.6 2.0
			2.2 2.3 3.0 3.0 4.2 3.8 2.0 2.4 2.3
			2.5 1.5 3.1 2.8 3.1 3.6 2.9 5.1 3.6
6	0/1	30	1.8
7	19/58	40	1.9 2.5 4.8 1.8 2.2 1.9 2.0 2.1 2.9
			0.7 1.9 1.1 0.9 1.1 2.1 3.0 1.2 2.2
			1.9 1.6 3.4 1.7 0.9 2.6 2.0 2.1 3.3
			1.0 2.9 2.6 2.1 2.6 3.6 3.3 2.4 2.3
			3.1 2.0 1.3
8	20/64	40	2.6 3.3 1.0 2.5 3.4 3.2 1.3 2.5 3.9
			3.0 2.5 2.1 2.5 1.9 3.0 4.1 1.3 3.1
			1.0 3.5 2.2 2.1 3.0 1.4 1.9 2.4 1.6
			1.5 2.3 3.1 2.7 2.2 2.8 1.4 1.9 1.7
			1.2 2.2 2.3 3.3 1.9 0.9 4.3 4.5
9	21/54	50	3.0 3.1 2.8 1.6 2.7 2.5 3.5 2.3 2.2
			3.3 2.2 2.8 2.3 2.2 2.7 2.9 3.4 1.9
			2.1 1.1 1.3 3.0 1.5 1.6 2.6 1.5 1.9
			1.9 2.3 2.6 2.6 2.4 1.9
10	6/13	30	2.1 2.4 2.4 2.0 2.0 1.8 0.7
11	3/5	70	3.8 1.4
12	7/7	90	
% Curled Shoots 132/422: 31%		Average: 66%	Average: 721.1/290: 2.5 cm.

TABLE II
SAMPLE TREE RECORDS

PLOT: No. 7 DATE: Sept. 1949 LOCATION: Telford Swamp

TREE NO.1 - Taken at N.E. corner of plot Defoliation: 50%
Height: 30' Diameter: 4.0" Length of Live Crown: 25'

Branch Number	Curled Shoots / Total Shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	7/16	80	2.3 3.5 1.1 1.8 2.2 3.9 2.1 2.2 5.1
2	8/26	80	3.3 2.4 3.1 2.9 2.7 3.1 3.0 2.1 2.4
			1.1 1.5 4.0 3.3 3.6 2.9 3.5 2.1 3.2
3	8/25	70	2.4 2.1 2.7 2.2 1.1 4.9 3.3 4.0 2.1
			1.5 3.2 3.0 3.1 1.4 1.7 4.1 4.1
4	4/8	50	2.5 2.4 2.2 3.2
5	9/51	40	2.4 3.1 2.7 1.9 3.8 2.3 1.5 4.5 1.6
			0.5 2.1 2.5 2.2 1.9 2.0 2.2 3.1 2.1
			3.1 1.4 3.9 2.4 3.4 3.8 1.1 0.8 3.9
			1.2 0.9 3.2 2.6 2.9 2.2 1.9 3.1 2.7
			4.2 2.7 2.9 2.0 0.6 1.6
6	6/33	30	2.4 3.0 1.9 3.4 1.8 2.1 2.4 1.4 1.9
			1.8 0.7 2.0 2.4 2.9 3.4 1.8 2.8 0.5
			1.0 2.1 2.3 3.3 1.8 2.4 3.4 2.4 1.9
7	7/22	50	2.2 2.9 1.6 1.1 2.3 0.9 1.4 2.1 3.2
			1.1 3.4 3.1 2.0 1.1 3.5
8	13/18	10	1.2 1.3 2.4 3.7 3.8
9	13/27	40	3.1 3.0 1.6 2.0 2.4 2.9 2.3 2.3 3.1
			2.4 2.0 2.9 2.0 1.6
10	8/17	30	2.5 2.6 2.3 2.2 0.9 3.7 1.6 3.4 3.6
11	18/23	90	2.2 2.1 3.1 3.2 4.0
12	5/9	30	2.7 1.7 3.6 3.4
% Curled Shoots 106/275: 39%		Average: 50%	Average: 417.5/169: 2.5 cm.

TABLE II
SAMPLE TREE RECORDS

PLOT: No. 8 DATE: Sept. 1949 LOCATION: Star Lake Swamp

TREE NO. 1 - Taken at N.E. corner of plot Defoliation: 75%
Height: 42' Diameter: 4.4" Length of Live Crown: 16'

Branch Number	Curled Shoots / Total Shoots	Per cent Defoliation	TERMINAL SHOOT MEASUREMENTS
1	4/17	80	3.0 4.0 4.6 4.0 4.5 4.2 6.0 5.4 4.1 6.0 3.7 3.9 4.7
2	8/27	90	3.2 2.5 2.3 1.5 2.2 3.2 3.7 3.7 2.9 2.4 1.5 3.5 4.6 4.3 3.2 3.0 3.7 5.8 4.9
3	6/27	90	2.6 4.1 1.6 4.4 2.6 3.0 2.8 3.0 2.5 4.0 2.8 3.0 2.8 3.2 3.2 3.2 4.5 3.0 3.2 3.9 3.5
4	10/24	95	4.0 2.8 2.9 2.0 3.8 3.2 2.2 3.0 4.6 4.1 3.6 2.5 6.4 3.2
5	7/32	95	2.4 1.5 2.4 2.9 4.2 2.7 2.8 2.9 3.4 4.2 3.9 3.4 2.8 3.7 3.6 5.4 5.7 4.1 4.2 4.4 3.9 6.5 5.9 5.3 5.4
6	12/44	90	1.6 2.7 2.3 3.8 2.2 3.0 3.2 3.2 2.7 2.1 1.3 1.9 1.4 2.1 3.6 3.6 0.8 2.3 3.8 3.9 2.6 3.5 2.0 2.9 3.7 2.9 6.0 4.4 4.4 4.0 6.6 4.0
7	4/23	30	2.0 2.7 2.7 2.8 2.9 2.5 1.5 3.0 3.2 2.2 3.0 2.6 2.6 3.5 4.1 3.3 1.8 3.3 2.6
8	18/51	60	2.8 2.4 2.0 4.0 4.8 2.2 2.3 2.3 2.3 4.5 3.3 3.0 3.1 3.1 2.5 3.4 3.4 1.8 2.5 2.5 4.0 3.4 6.4 3.2 4.5 3.0 2.6 3.6 5.8 3.1 2.9 3.1 4.1
9	4/7	70	2.7 2.9 3.0
10	6/23	80	2.4 2.4 3.8 1.6 2.6 2.9 1.6 5.8 0.9 2.9 2.0 3.8 3.6 3.6 5.5 3.4 3.6
11	5/26	30	3.4 2.6 1.0 3.4 2.5 3.8 4.1 2.4 2.7 3.7 3.4 4.6 3.4 5.6 3.4 4.0 1.3 3.0 1.5 3.2 0.9
12	0/2	50	2.6 1.5

% Curled Shoots
84/302: 28% Average: 72% Average: 698.1/218: 3.2 cm.

(e) Analysis and Discussion

The analysis of the data collected is shown in Table III.

TABLE III

MEASUREMENTS ON SAMPLE BRANCHES

Plot No.	Sample Tree No.	DEFOLIATION						SAMPLE-BRANCH TERMINAL SHOOT MEASUREMENTS				
		Top 1/3	Mid 1/3	Lower 1/3	Branch Estimate	Sample Avge.	Tree Estimate	% of Curled Shoots	Avge Length of Shoot			
									Top 1/3	Mid 1/3	Lower 1/3	Entire Sample.
1	1	90	30	50	58		60	11	3.8	3.9	4.0	3.9
	2	45	80	35	53		50	4	2.8	2.6	1.4	2.3
	3	75	5	50	43		40	11	3.4	2.6	2.4	2.9
	4	70	15	15	33		25	28	2.1	1.9	2.0	2.0
						47	45	13				2.8
2	1	75	55	25	53		50	17	3.2	2.6	3.3	3.0
	2	95	95	95	97		100	27	3.4	2.9	2.3	3.3
	3	50	55	10	39		40	31	2.7	1.1	-	2.6
	4	95	85	35	73		70	7	3.6	2.3	-	2.7
						65	65	19				2.9
4	1	90	85	90	88		85	14	2.4	2.4	2.3	2.3
	2	90	100	100	97		95	34	4.4	2.6	2.7	3.3
	3	95	95	30	74		80	11	1.7	2.0	-	1.9
	4	95	100	95	97		95	46	3.2	2.6	3.6	3.1
						89	89	30				2.7
3	1	90	65	55	70	70	70	18	3.0	2.9	2.5	2.9
5	1	75	90	72	79	79	80	17	4.2	3.7	3.9	3.9
6	1	90	50	60	67	67	60	31	2.6	2.5	2.3	2.6
7	1	70	32	47	50	50	50	39	2.7	2.3	2.5	2.5
8	1	89	69	57	71	71	75	28	3.5	3.3	3.0	3.3

A comparison of the results of the analysis of the data is shown in the following table.

TABLE IV

COMPARISON OF SAMPLE TREE MEASUREMENTS

Plot No.	Defolia- tion %	% Curled Shoots	$\bar{L}$ cm	Crown Length Ft.	Tree Height Ft.	Age Class	Stand Conditions
1	45	13	2.8	6.5	10	20-40	dense, wet
2	65	19	2.9	10.5	13	0-20	open, wet
4	90	30	2.7	8	11	20-40	open, dry
3	70	18	2.9	18	21	20-40	open, wet
5	80	17	3.9	20	25	40-60	open, dry
6	60	31	2.6	24	28	40-60	dense, wet
7	50	39	2.5	25	30	20-40	dense, dry
8	75	28	3.3	16	42	40-60	dense, dry

The method of selecting a sample tree outside the plot is not entirely satisfactory and care must be taken to select a representative tree. A large number of trees outside the plot must be selected, tagged and the defoliation recorded from year to year. This tagging outside the plot is necessary because for the second year of study, the sample tree must have the current plot-average defoliation and also must have had the plot-average defoliation for the last year. Similarly, the sample tree for the third, fourth, and fifth years of study must have the current plus the past two, three and four years' plot-average defoliation respectively.

(f) Conclusions

No conclusions can be reached on object (1) for this year. Some observations on object (2) are considered below.

Table II shows that the sample tree from Plot No. 5 has a long average length of shoot, a low percentage of curled shoots and a high percentage of defoliation. The sample tree from Plot No. 7 has a short average length of shoot, a high percentage of curled shoots and a low percentage of defoliation. A comparison of the two trees would indicate that with a long average length of shoot, fewer curled shoots (i.e. a smaller number of oviposition sites) are necessary to produce a high degree of defoliation. However, the length of the tree crown or total foliage on the tree must be considered as it will affect the per-cent defoliation.

There should be a relationship between the initial population, measured by the average length of shoot, times the per-cent curled shoots, and the final population measured by the per-cent defoliation. Additional experiments are necessary to determine this relationship. There are a variety of factors that may influence or change this relationship. In open, dry sites high temperatures and low humidity may cause high mortality in the early larval stages. The rate of emergence from long and short shoots may differ significantly. There may be a preference for oviposition in the sunlight giving an incorrect percentage of curled shoots when the sample branches are selected at random.

(g) Summary

No information will be available on the effect of defolition on the length of the terminal shoots until the measurements are made for the next year and analyzed.

The length of the average terminal shoot, multiplied by the per-cent curled shoots, should give an index for the insect population. There should be a relationship between this index and the amount of defoliation. Further experiment is necessary to determine this relationship.

In general, the shorter the average length of terminal shoot, the higher the percentage of curled shoots.

(b) Recommendations

The study is adequate to provide the information required but it may be possible to shorten the study and increase the value of the information by obtaining additional data.

Additional data required concerns the oviposition habits of the insect, the larval mortality rate and a measurement of the tree foliage.

It may be possible to shorten the study by obtaining information from permanent sample plots in Riding Mountain National Park. Defoliation records have been maintained on these plots since 1941 and measurement of terminal shoot lengths over a five-year period should provide the information required. An increase in the number of sample plots containing short trees that enable sampling within the plot would increase the value of the information obtained from these plots. It is felt that the method of selecting the sample tree, in the case of plots containing tall trees, is not satisfactory and that better results would be obtained by measuring back at the end of the fifth year.

TECHNICAL REPORT 1949
PROJECT NO. N.30.05-4

FOREST INSECT LABORATORY, WINNIPEG

VI LARCH SAWFLY
EFFECT OF DEFOLIATION ON ANNUAL INCREMENT

Report by A. W. Dew

Field Work by A. W. Dew

9. EFFECT OF DEFOLIATION ON ANNUAL INCREMENT

(a) Object

To observe the effect of defoliation on the annual increment of larch and to determine the years when past severe defoliation occurred.

(b) Plan

To obtain a series of increment borings from different locations in the general vicinity of the Whiteshell Forest Reserve, Manitoba. A Swedish Increment Borer was used and the holes were filled with putty. The borings were stored in large shell vials and taken into the laboratory for close examination and analysis.

(c) Procedure

The borings were taken from dominant or co-dominant trees at d.b.h. Five or six borings were taken in each stand from healthy, normal trees. When trees of another species were found in the stand, a boring was taken from one for comparison with the larch borings.

(d) Tabulation of Data and Observations

Each stand was identified by a number and its location recorded from a known landmark. Each boring was numbered and recorded with the d.b.h. and height of each tree.

(e) Analysis and Discussion

The borings were studied in the following manner. The average increment was calculated by dividing the total increment by the number of rings. Those rings having below-average increment were counted and examined with the aid of a ten-power hand lens, or in some cases with a binocular microscope. Where narrowed rings occurred in trees of different species in the same swamp, the restricted growth in the larch was considered to be due to causes other than larch sawfly.

At first an attempt was made to establish the years of past severe defoliation by comparing the narrowed rings of larch trees in the same and in adjacent swamps. This method should give good results if larch trees had "complacent growth" (i.e. approximately the same width of increment every year). This condition did not prevail among the trees in the same stand or between samples from two adjacent stands.

An attempt was made to evaluate the influence of summer rainfall on the annual increment to implement the above method. No rainfall records could be obtained for any location near enough to the sample area to be of any use. In any case, summer rainfall would have an appreciable influence on only the driest sites. It was observed that the height of the water table in a swamp had a direct effect on the width of the growth ring; trees on comparatively dry sites attaining the greatest increment. The above method was thought to be of little use in studying the effect of defoliation on the annual rings of larch.

However, close inspection of the annual rings showed that the width of the summer wood decreased sharply in some areas of narrowed rings and did not in others.

This sudden decrease in the amount of the summer wood is due to a condition of starvation in the tree. The ring indicating that condition, when followed by a ring with a sudden decrease in total width, is designated as the first or primary year of starvation. The borings were re-examined bo find the years showing this condition and the results are shown in the following table.

TABLE I

A. NARROWED RINGS SHOWING STARVATION EFFECT

Location	Tree Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
A*										
B*										
C	1	6.73	41	.16	1949-1936	yes	1934-33	no	1920-18	no
					1915-12	no				
	2	7.89	40	.20	1949-1946	yes	1941-36	yes	1933-30	no
					1920-19	no	1916-10	no		
	3	9.16	40	.23	1944	no	1940-39	no	1937	yes
					1933	no	1922-10	no		
	4	6.66	41	.16	1948	no	1946	no	1944	no
					1940-39	no	1933-31	no	1920-10	no
	5	5.40	35	.15	1949-1948	yes	1942-39	no	1934-30	no
					1921-12	yes				
	X	9.48	40	.24	1949-1948		1942-39		1936	
					1933-32		1922-19		1915-10	
D	1	4.12	66	.06	1949-1943	yes	1936	yes	1931-28	no
					1926-13	no	1908-07	no	1903-01	yes
					1889-88	yes				
	2	4.21	55	.08	1949-1945	yes	1932-28	no	1923-00	no
	3	5.16	65	.08	1945	yes	1931-30	no	1924-22	no
					1920-10	no	1908-07	no	1902-99	no
					1889-84	no				
	4	5.62	63	.09	1949-1944	yes	1937	no	1934-29	no
					1925-23	yes	1922-21	no	1920-14	yes
					1912-11	no	1905	no	1895-86	no
	5	5.71	63	.09	1949-1944	yes	1932-29	no	1926-13	no
							1894-90	no		

TABLE I - cont'd.

Location	Tree No.	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
E	1	7.38	50	.15	1944-1943	yes	1938-36	yes	1925-18	no
					1914-09	no				
	2	6.59	50	.13	1940	yes	1936	no	1931-30	no
					1926-15	no	1906-99	no		
	3	9.26	46	.20	1949-1948	yes	1939-36	yes	1927-18	no
					1916-13	no				
	4	8.54	44	.19	1949-1946	yes	1939	no	1936	no
					1934-33	no	1923-18	yes	1913-08	no
	5	9.02	48	.19	1949-1946	yes	1944-42	no	1940	yes
					1936	no	1934	yes	1924-18	no
					1915-09	no				
F	1	5.64	25	.23	1949-1944	yes	1932-25	no		
	2	8.83	25	.35	1949-1948	yes	1932-25	no		
	3	6.32	27	.23	1949-1946	yes	1932-29	no	1923	no
	4	7.05	30	.24	1949-1945	yes	1932-23	no		
	5	5.64	31	.18	1949-1947	yes	1936	yes	1923-19	no
	6	6.82	26	.26	1949-1947	yes	1931-23	no		
	X	6.90	34	.20	1939-1930		1926-18			
G	1	7.22	46	.16	1949-1944	yes	1931-27	no	1925-24	no
					1921-07	yes				
	2	8.55	70	.12	1949-1948	yes	1931-25	no	1924-10	yes
					1904	no				
	3	7.98	66	.12	1949-1944	yes	1927-03	yes	1903-98	no
	4	7.98	72	.11	1949-1944	yes	1927-10	yes	1904-98	no
	5	4.60	56	.08	1949-1947	yes	1944	no	1939	no
					1936	no	1931-14	yes	1903-98	no
	6	5.63	63	.09	1949-1940	yes	1930-27	no	1920-11	yes

TABLE I - cont'd

Location	Tree Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
H	1	6.94	51	.14	1949	yes	1939-36	yes	1929-24	no
					1921-08	no	1906-04	yes	1902-98	no
	2	5.97	24	.25	1949	yes	1940-38	yes	1930-26	no
	3	8.10	52	.16	1949	no	1940-38	no	1929	no
					1927-23	no	1921-18	yes	1916-06	no
					1901-98	no				
	4	4.56	48	.10	1949-1948	yes	1945-44	no	1942-39	yes
					1937-25	no	1922-09	yes		
	5	6.90	48	.14	1949-1947	yes	1939-38	yes	1931-24	no
					1920-17	yes	1915-08	yes	1906-02	no
	6	5.79	42	.14	1949-1947	yes	1939-38	no	1931-26	yes
					1925-24	no	1921-08	no		
I	1	7.78	56	.14	1949-1942	no	1939	no	1936-32	yes
					1930-28	no	1925-07	yes		
	2	9.34	62	.15	1949-1942	yes	1939-33	yes	1931-29	no
					1927-09	no	1902	no		
	3	8.76	61	.15	1949-1948	no	1946-45	no	1943-41	no
					1939	no	1936-27	yes	1923-05	yes
	4	5.47	45	.12	1946-1945	yes	1934-29	yes	1924-09	yes
	5	5.53	53	.10	1945-1944	yes	1935-29	yes	1925-01	yes
	6	6.41	53	.12	1947-1944	no	1942	no	1939	no
					1936-29	yes	1925-08	yes		

TABLE I - cont'd

Location	Tree Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
J	1	5.86	24	.24	1948-1947	no	1943	no
					1940	no	1933-29	no
					1927-26	no		
	2	5.62	26	.22	1948-1947	yes	1943	no
					1937-36	no	1934-24	no
	3	8.98	37	.24	1944-1943	no	1937	no
					1931-29	no	1925-24	no
					1922-17	yes	1915-13	no
	4	6.51	27	.24	1949-1948	no	1940	no
					1934-29	no	1927-23	yes
	5	6.36	27	.24	1949-46	no	1943-42	no
					1933-23	no		
	6	8.01	29	.28	1949-1945	yes	1943	no
					1931-29	no	1927	no
					1925-21	no		
K	1	9.46	27	.32	1949-1947-	no	1942	no
					1933	no	1931-23	no
	2	6.56	27	.24	1949-1943	no	1932-23	no
	3	5.95	32	.15	1949-1947	no	1943	no
					1931-28	yes	1925-19	yes
	4	7.26	32	.23	1949	no	1943	no
					1932-18	yes		
	5	7.00	40	.18	1949-1947	yes	1943	no
					1930-27	yes	1925-24	no
					1923-18	yes	1916-20	yes

TABLE I - cont'd

Location	Tree Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
K	6	6.05	35	.17	1949-1948	Yes	1943	No
					1933-19	Yes	1916-15	Yes
	X	7.00	38	.18	1949-1948		1944	
					1938-37		1933-28	
					1922-19		1915-14	
L	1	3.28	18	.18	1949-1943	Yes	1939-38	No
					1933-32	No		
	2	2.76	19	.15	1949-1947	Yes	1944	Yes
					1939-38	No	1933-31	No
	3	2.16	19	.11	1949-1943	No	1939-38	No
					1936	No	1933-31	No
	4	4.47	19	.24	1949-1942	Yes	1939	No
					1933-31	No		
	5	3.51	18	.20	1949-1945	Yes	1940-39	No
					1935-32	No		
	6	2.67	19	.14	1949-1948	Yes	1940-38	No
					1934-31	No		
	X	1.37	17	.08	1948-1947		1942-41	
					1939		1936	
M	1	6.65	52	.13	1949-1946	no	1932-10	No
	2	5.11	82	.06	1931-1898	No	1889-86	No
					1883-76	No	1771-70	No
	3	5.94	33	.18	1949-1947	Yes	1934-24	No
					1921-18	Yes		
	4	4.58	30	.15	1949-1944	Yes	1934-25	Yes
					1923	Yes	1920	No

TABLE I - contd

Location	Tree Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
M	5	5.39	25	.22	1949-1946	no	1944	no
					1933	no	1931-23	yes
	6	5.48	51	.11	1949-1947	yes	1932-28	no
					1926-22	no	1920-17	no
					1915-08	no		
N	1	6.66	68	.10	1949-1943	yes	1940	no
					1937-30	no	1926-19	yes
					1916-13	yes		
	2	6.70	75	.09	1949-1929	no	1923-09	yes
	3	6.00	63	.10	1949-1943	yes	1934-13	yes
					1908-07	no	1897	no
	4	9.87	70	.14	1949-1943	yes	1930	no
					1926-08	yes	1904	no
					1893	no	1887	no
	5	7.03	55	.13	1949-1948	no	1946-44	no
					1932-29	no	1927-26	no
					1922-20	yes	1918-17	yes
					1915-13	yes	1910-09	yes
	6	8.78	66	.13	1949-1943	yes	1931-17	yes
					1915-10	yes	1904-03	no
					1887	no		

TABLE I - cont'd

Location	Tree Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
O	1	4.48	.68	.07	1949-1947	Yes	1937-36	No
					1930-29	No	1922-18	No
					1915-89	No	1887-83	No
	2	5.23	51	.10	1947	No	1937-36	No
					1931-29	No	1925-90	Yes
	3	8.75	50	.18	1949-1948	No	1937-36	No
					1930-29	No	1921-99	Yes
	4	5.10	27	.19	1949-1943	Yes	1933	No
					1931-29	No	1927-23	No
	5	7.24	93	.08	1949-1948	Yes	1931-77	Yes
					1874-72	No	1869	No
					1867	No		
	6	6.94	45	.15	1949-1948	Yes	1930-29	No
					1921-17	No	1915-09	Yes
	X	8.60	49	.18	1937-1936		1934	
					1930		1926-25	
					1922-21		1915	
					1909-01			
P	1	7.61	46	.17	1949-1948	No	1941	No
					1930-31	Yes	1925	No
					1922-10	No		
	2	6.01	53	.12	1949-1946	No	1942-36	No
					1931-29	No	1922-18	No
					1915-09	Yes	1902-00	No

TABLE I - cont'd

Location	TREE Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
P	3	5.80	53	.11	1949	Yes	1930-29	No
					1927-14	Yes	1912-08	No
					1901-99	No		
	4	4.48	38	.12	1949-1948	No	1942-36	No
					1931-29	No	1924	No
					1921-18	No	1915-14	No
	5	8.66	38	.24	1949-1947	No	1933	No
					1930-29	No	1927-	No
					1925-23	No	1921-18	No
					1915-12	No		
	6	6.61	51	.13	1949-1948	Yes	19[illegible]2-29	No
					1922-18	No	1915-09	No
					1902-00	No		
Q*								
R	1	4.81	32	.15	1949-1948	No	1931-25	No
					1922-18	No		
	2	3.27	22	.15	1949-1948	Yes	1943	No
					1941	No	1932-28	No
	3	7.42	52	.14	1949-1948	Yes	1932-28	Yes
					1924	Yes	1919-07	Yes
					1904-99	No		
	4	8.29	44	.19	1949-1947	No	1931-28	No
					1925	No	1920-18	Yes
					1915	Yes	1913-09	Yes
					1907	No		

TABLE I - cont'd

Location	Tree Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
R	5	7.95	41	.19	1949-1947	No	1930-29	No
					1924	No	1921-09	Yes
	6	8.09	29	.28	1949-1943	No	1929	No
					1927-21	No		
S	1	7.44	39	.19	1949-1946	No	1936-34	No
					1932-23	No		
	2	5.79	39	.15	1949-46	No	1926-25	No
					1932-11	Yes		
	3	6.65	34	.20	1949-1944	No	1927-24	No
					1921-16	Yes		
	4	5.65	44	.13	1949-1946	No	1930-29	No
					1927-14	Yes	1912-09	Yes
	5	6.23	50	.12	1949-1946	Yes	1930-24	No
					1921-18	No	1915-09	No
					1907-05	No		
	6	8.36	40	.21	1949-1945	Yes	1927-25	No
					1923-10	Yes		
	X	7.75	41	.19	1947		1939	
					1931-30		1923	
					1921-19			

TABLE I - cont'd

Location	Tree Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Effect	Narrowed Rings	Starvation Effect
T	1	8.65	21	.41	1949-1944	No	1932-28	No
	2	5.31	29	.18	1949-1947	No	1939-38	No
					1933	No	1931-26	No
					1924	No	1922	No
	3	4.70	25	.19	1949-1947	No	1933	No
					1931-26	Yes		
	4	4.12	24	.17	1949-1946	No	1931-26	No
	5	5.71	21	.27	1948	No	1946	No
					1936-35	No	1933-29	No
	6	7.05	27	.26	1949-1947	No	1936	No
					1931-29	No	1925-24	No
U	1	6.41	18	.36	1949-1943	No		
	2	5.94	20	.30	1949-1943	No	1931-30	No
	3	4.18	16	.26	1949	No	1947	No
					1945	No	1943	No
					1936	No		
	4	5.61	17	.33	1949-1946	No	1944-43	No
					1936	No		
	5	5.50	33	.16	1949-1945	No	1930-17	No
	6	6.66	20	.33	1949	No	1946	No
					1936	No	1933	No
					1931-30	No		

TABLE I - cont'd

Location	Tree Number	Total Growth	Number of Years	Average Growth	Narrowed Rings	Starvation Rings	Narrowed Rings	Starvation Effect
V	1	12.05	56	.22	1949-1947	Yes	1934	No
					1931-09	No	1906	No
					1897	No		
	2	11.17	64	.17	1949-1947	Yes	1929	No
					1927	No	1923-11	No
					1909-08	No	1903-94	No
					1893-86	No		
	3	8.30	61	.14	1949-1942	Yes	1931-09	Yes
					1906	No	1896-94	Yes
	4	8.17	60	.14	1949-1944	No	1934-10	No
					1908	No	1899-98	No
					1891-90	No		
	5	8.94	58	.15	1949-1947	No	1944	No
					1936	No	1931-27	No
					1925-10	Yes	1908-07	No
					1896-95	No		

* Discarded - Rings too small for accurate measurement.

TABLE I

B. PRIMARY YEARS OF STARVATION EFFECT

Location	Tree No	PRIMARY YEARS OF STARVATION EFFECT				
		1950-1941	1940-1931	1930-1921	1920-1911	1910-1901
A*						
B*						
C	1		1939,1936			
	2	1945	1939			
	3					
	4					
	5	1948			1919,1913	
D	1	1943				
	2	1945				
	3	1945				
	4	1944			1913	
	5	1944				
E	1	1942	1935			
	2		1939			
	3	1948	1935			
	4	1945			1917	
	5		1939,1933			
F	1	1945				
	2	1948				
	3	1946				
	4	1945				
	5		1935			
	6	1947				
G	1	1945			1913	1906
	2	1947				1909
	3	1948			1915	
	4	1948			1915	1908
	5	1947			1914	
	6	1948			1914	1907,1904
H	1	1948	1935			1904
	2	1948	1937			
	3				1917	
	4	1948	1939			1909
	5	1948			1918	1909
	6	1948		1926		
I	1	1942	1934			
	2		1932			1906
	3		1931		1915,1913	1904
	4	1945	1933		1914	1909
	5		1933			1905
	6					1907

TABLE I (B) Cont'd

Location	Tree No.	PRIMARY YEARS OF STARVATION EFFECT				
		1950-1941	1940-1931	1930-1921	1920-1911	1910-1901
J	1					
	2	1946				
	3				1918	
	4			1923		
	5					
	6					
K	1					
	2					
	3				1919	
	4			1929	1919	
	5	1947		1926	1919,1912	
	6	1947			1919,1915	
L	1	1948				
	2	1947,1943				
	3					
	4	1948,1946				
	5	1945				
	6	1948				
M	1					
	2					
	3	1947			1918	
	4	1944		1924,1922		
	5			1929		
	6	1946		[illegible]		
N	1	1948,1943			1920,1912	
	2					1907
	3	1948,1943			1912	
	4	1948,1944			1914	1908
	5				1919,1916 1913	1909
	6	1947,1943			1918	1909
O	1	1947				
	2					
	3					1909
	4	1948				
	5	1948				1909
	6	1948				1909

TABLE I (B) Cont'd

Location	Tree No.	PRIMARY YEARS OF STARVATION EFFECT				
		1950-1941	1940-1931	1930-1921	1920-1911	1910-1901
P	1					
	2					1908
	3	1948			1917	
	4					
	5					
	6	1947				
Q*						
R	1					
	2	1948				
	3	1947		1927,1923		1908
	4			1927	1917,1914	1908
	5				1917	1909
	6					
S	1					
	2				1914	
	3				1917	
	4				1914	1909
	5	1946				
	6	1945			1917	
T	1					
	2					
	3			1926		
	4					
	5					
	6					
U	1					
	2					
	3					
	4					
	5					
	6					
V	1	1946				
	2	1947				
	3	1942				1909
	4					
	5					1910

* - Discarded, rings too small for accurate measurement.

In most cases this starvation can be attributed to the effect of defoliation. However, in one instance, a series of borings from one larch stand indicated a condition of starvation existed in various years from 1930 to 1948. A boring from a spruce tree in the same stand showed a condition paralleling that shown in the other larch. These borings indicate that dry weather or other adverse factors may produce the same apparent effect as defoliation on trees located on a dry site.

The borings were taken from adjacent trees of approximately the same height in each stand so that a severe infestation in the stand should show a starvation effect in a majority of the borings. Where the starvation effect did not appear in a majority of the borings from a stand, the effect was considered due to causes other than severe defoliation.

The primary years of starvation-effect in Table IA show a large number in the ten-year periods 1901-1910, 1911-1920 and 1941-1950. There is no evidence of starvation-effect in a majority of the borings in any stand for the period 1921 to 1930. There is evidence of starvation-effect during the period 1931 to 1940, in a majority of borings, in only four of the nineteen stands examined. These stands (C, E. H, and I) are on the driest sites of all those stands examined. There is little or no sphagnum moss present, the vegetation being mainly grass. There is little possibility that an epidemic could build up under these conditions so the starvation effect is considered to be due to dry weather. The ten-year periods, 1901-1910, 1911-1920 and 1941-1950, are considered the only ones during which any severe defoliation occurred.

The study of the borings was aided by having available several large cross-sections from larch from Bear River, Manitoba, and three sets of cross-sections from a permanent plot in Riding Mountain National Park, for which defoliation records have been maintained since 1941. The large cross-sections from Bear River showed that the width of the annual ring may vary considerably around the circumference of the tree. Also, that the summer wood of a very narrow ring may be hardly distinguishable or absent for the part of its circumference. The cross-sections taken from Riding Mountain National Park in 1948, together with their defoliation records, were useful in in observing the effects of defoliation on the annual increment at different levels in the stem of the tree.

The cross-sections from the permanent plot in the Riding Mountain National Park were from the top, center and basal portions of the trees. The top section from one of the trees could not be located so that there are complete measurements for only two trees. No record was available of the height or crown length of the trees, the density of the stand or whether the trees were on a wet or dry site. However, a photograph of the plot and the diameter of the section indicate that the trees were on a comparatively dry, open site, were about twenty to twenty-five feet in height and the foliage extended the whole length of the tree.

The ring area for each section for the years 1939 to 1948 was calculated from the formula:

$$\pi R_1^2 - \pi R_2^2 = \text{AREA (Cm.}^2\text{)}$$

Where R_1 = outer radius of ring in Cm.
R_2 = inner radius of ring in Cm

The measurements were made in the following manner. Two lines were drawn across each section passing through the growth center of the tree. The first at the point of greatest diameter and the second at right angles to the first. Each recorded ring-width is the average of four measurements along these lines. The outermost radius was calculated by dividing by four the sum of the lengths of the two measured diameters inside bark. The inner radii were calculated by subtracting the average ring-width from the outer radii. All measurements were made with a micrometer to the nearest one-tenth millimeter.

The per cent summer wood in each ring, for the three basal sections for the year 1939 to 1948 was calculated. The recorded width of summer wood and the width of the entire ring were the averages of four measurements made along the diameter lines. The measurements were made to the nearest 0.0035 millimeter with an ocular micrometer.

The results of the measurements made on the three trees are shown in the following Table.

TABLE II

TREE NO.1470 ANNUAL RING MEASUREMENTS

Year	Bottom Section 1	2	3	4	Avge	Center Section 1	2	3	4	Avge	Top Section 1	2	3	4	Avge
1948	.05	.05	.06	.10	.06	.05	.05	.04	.05	.05					
1947	.05	.03	.03	.06	.04	.04	.05	.03	.04	.04					
1946	.03	.01	.02	.03	.02	.03	.03	.02	.03	.03					
1945	.02	.02	.01	.02	.02	.02	.02	.02	.02	.02					
*	.01	.01	.01	.02		.01	.01	.01	.01						
1944	.02	.03	.03	.03	.04	.04	.04	.02	.03	.04					
1943	.13	.12	.17	.18	.15	.15	.13	.09	.15	.13					
1942	.18	.18	.17	.18	.18	.21	.18	.12	.17	.17					
1941	.21	.20	.20	.17	.20	.22	.24	.15	.18	.20					
1940	.21	.25	.22	.18	.21	.24	.22	.16	.15	.19					
1939	.15	.17	.18	.20	.18	.23	.18	.13	.15	.17					

* Double Ring for Year 1944

***SUMMER WOOD MEASUREMENTS**

Year	Ocular Microscope Units, Each Unit - .0035 Cm. R	S	R	S	R	S	R	S	Total R	Total S	Per cent Summer Wood	Per Cent Defoliation
1948	15	5	12	4	20	10	25	10	72	29	40	5
1947	15	4	6	1	7	2	18	5	46	12	26	•
1946	10	4	4	1	5	1	10	3	29	9	31	5
1945	7	2	5	1	3	1	8	2	23	6	26	75
1944	11	3	12	3	11	3	16	5	50	14	28	85
1943	35	10	36	8	50	18	50	25	171	61	36	90
1942	46	11	55	10	52	12	50	18	203	51	25	90
1941	70	25	57	20	55	15	48	18	230	78	34	10
1940	43	15	70	25	68	23	52	20	235	83	36	•
1939	55	15	50	16	50	14	55	15	210	60	29	•

R: Width of Entire Ring   * Bottom Section Only
S: Width of Summer Wood   • No Measurements Taken

AREA OF INDIVIDUAL RINGS

Year	Bottom Section Outside Radius	Bottom Section Ring Area $Cm.^2$	Center Section Outside Radius	Center Section Ring Area $cm.^2$	Top Section Outside Radius	Top Section Ring Area $Cm.^2$
1948	5.62	2.11	3.48	1.08		
1947	5.56	1.39	3.43	.86		
1946	5.52	.69	3.39	.64		
1945	5.50	.69	3.36	.42		
1944	5.48	1.37	3.34	.83		
1943	5.44	5.05	3.30	2.64		
1942	5.29	5.38	3.17	3.29		
1941	5.11	6.29	3.00	3.64		
1940	4.91	6.34	2.80	3.23		
1939	4.70	5.21	2.61	2.70		
1938	4.52		2.44			

TABLE II

TREE NO. 1495 ANNUAL RING MEASUREMENTS

Year	Bottom Section 1	2	3	4	Avge	Center Section 1	2	3	4	Avge	Top Section 1	2	3	4	Avge
1948	.03	.04	.06	.04	.04	.08	.05	.05	.05	.06	.05	.04	.05	●	.05
1947	.02	.02	.01	.02	.02	.03	.02	.02	.02	.02	.02	.02	.02	●	.02
1946	.00	.00	.01	.01	*	.01	.01	.01	.01	.01	.03	.03	.03	●	.03
1945	.01	.01	.03	.01	.01	.01	.01	.01	.01	.01	.02	.02	.02	●	.02
1944	.03	.03	.07	.04	.04	.08	.06	.05	.05	.06	.06	.05	.05	●	.05
1943	.06	.07	.12	.10	.09	.12	.11	.09	.11	.11	.18	.20	.19	●	.19
1942	.05	.06	.11	.10	.08	.14	.12	.10	.11	.12	.16	.15	.14	●	.15
1941	.10	.12	.14	.11	.12	.17	.15	.11	.11	.13	.15	.16	.14	●	.15
1940	.10	.11	.13	.10	.11	.17	.14	.13	.14	.14	.25	.25	.20	●	.23
1939	.10	.10	.16	.09	.11	.15	.12	.11	.13	.13	.23	.21	.22	●	.22

* Ring width too small to measure accurately

*SUMMER WOOD MEASUREMENTS

Year	Ocular Microscope Units Each Unit : .0035 Cm. R	S	R	S	R	S	R	S	Total R	S	Per cent Summer Wood	Per cent Defoliation
1948	10	4	12	5	16	8	12	5	51	22	43	10
1947	6	2	7	2	5	1	5	1	23	6	26	●
1946	0	0	0	0	0	0	0	0	0	0	0	25
1945	3	1	4	1	10	3	3	1	20	6	39	55
1944	8	2	10	3	20	8	11	3	49	16	33	90
1943	16	4	20	5	30	9	28	9	94	27	37	90
1942	15	3	20	4	30	9	26	6	91	22	26	75
1941	30	9	33	12	40	16	28	10	131	47	36	0
1940	29	8	32	11	38	18	30	10	129	48	38	●
1939	28	7	30	10	46	15	25	10	129	52	39	●

R: Width of Entire Ring *Bottom Section only
S: Width of Summer Wood ●No Measurements Taken

AREA OF INDIVIDUAL RINGS

Year	Bottom Section Outside Radius	Ring Area Cm.²	Center Section Outside Radius	Ring Area Cm.²	Top Section Outside Radius	Ring Area Cm.²
1948	4.00	1.00	2.82	1.05	1.44	.44
1947	3.96	.50	2.76	.35	1.39	.17
1946	3.94	*	2.74	.17	1.37	.26
1945	3.94	.25	2.73	.17	1.34	.17
1944	3.93	.74	2.72	1.01	1.32	.41
1943	3.90	2.18	2.66	1.80	1.27	1.40
1942	3.81	1.89	2.55	1.88	1.08	.95
1941	3.73	2.77	2.43	1.93	.93	.81
1940	3.61	2.46	2.30	1.96	.78	.96
1939	3.50	2.38	2.16	1.84	.55	.61
1938	3.39		2.02		.33	

* Ring too small for accurate measurement.

TABLE II

TREE NO. 1547 ANNUAL RING MEASUREMENTS

	Bottom Section					Center Section					Top Section				
Year	1	2	3	4	Avge	1	2	3	4	Avge	1	2	3	4	Avge
1948	.05	.05	.05	.03	.05	.05	.03	.03	.04	.04	.02	.02	.02	.02	.02
1947	.03	.03	.03	.02	.03	.04	.03	.02	.04	.03	.02	.02	.02	.02	.02
1946	.01	.01	.01	.01	.01	.02	.02	.01	.02	.02	.02	.02	.02	.02	.02
1945	.01	.02	.02	.01	.02	.03	.02	.01	.02	.02	.02	.01	.01	.01	.01
*	.01	.02	.02	.01		.02	.01	.01	.02		.01	.02	.02	.02	.0
1944	.03	.02	.03	.02	.04	.03	.04	.02	.04	.05	.03	.04	.04	.04	.07
1943	.06	.06	.06	.07	.06	.09	.07	.05	.10	.08	.12	.11	.10	.10	.11
1942	.09	.08	.07	.09	.08	.09	.09	.06	.10	.08	.11	.11	.11	.10	.11
1941	.10	.10	.10	.11	.10	.10	.08	.08	.11	.09	.10	.12	.10	.08	.10
1940	.12	.10	.11	.10	.11	.13	.10	.09	.11	.11	.16	.17	.16	.16	.16
1939	.11	.10	.08	.14	.11	.10	.08	.09	.10	.09	.15	.15	.14	.13	.14

* Double Ring for Year 1944

*SUMMER WOOD MEASUREMENTS

	Ocular Microscope Units Each Unit : .0035 Cm.								Total		Per cent Summer Wood	Per cent Defoliation
Year	R	S	R	S	R	S	R	S	R	S		
1948	10	4	15	5	13	5	10	4	54	18	33	20
1947	10	2	9	2	8	2	5	1	32	7	22	●
1946	4	1	4	1	3	1	2	1	13	4	31	20
1945	4	1	4	1	7	2	4	1	19	5	26	75
1944	11	3	10	3	12	3	10	3	43	112	28	90
1943	18	6	15	4	16	5	19	5	68	20	30	90
1942	24	5	20	4	20	4	25	5	89	18	20	85
1941	30	10	27	7	26	9	32	9	115	35	30	5
1940	32	10	30	10	31	10	26	7	119	39	33	●
1939	29	9	26	10	23	7	40	11	118	37	31	●

R: Width of Entire Ring
S: Width of Summer Wood
* Bottom Section Only
● No Measurements Taken

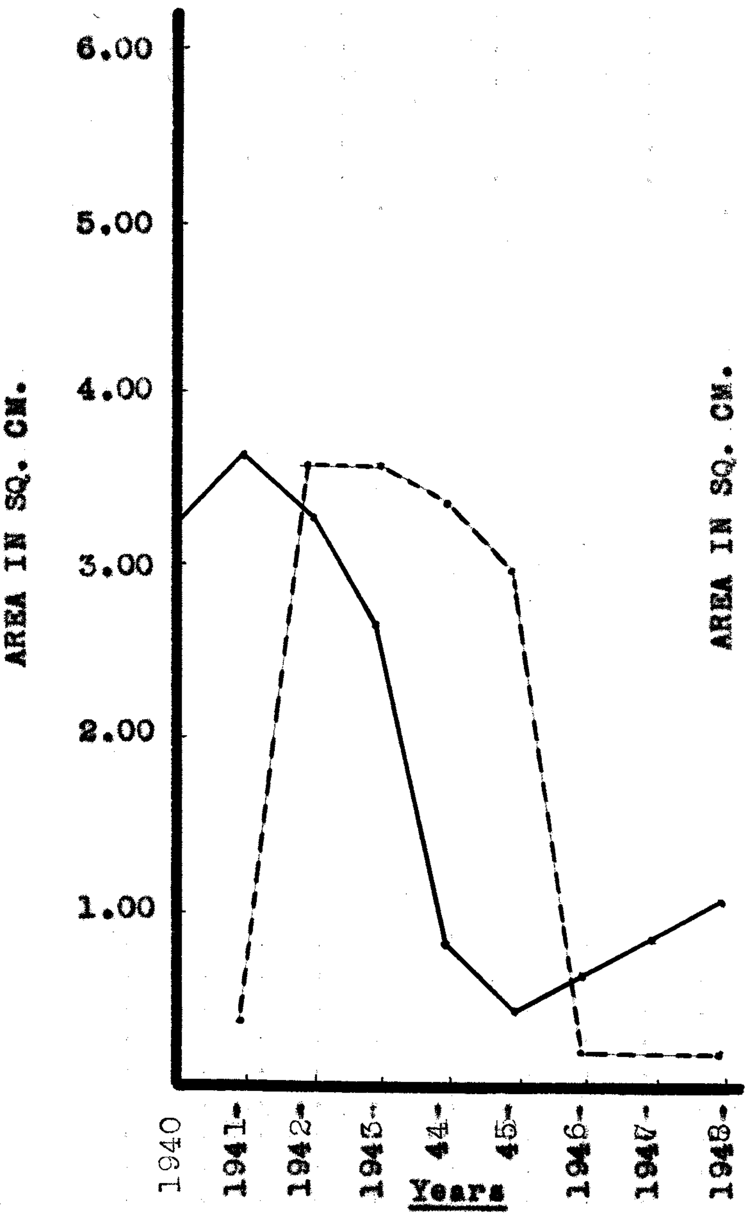
AREA OF INDIVIDUAL RINGS

	Bottom Section Outside Ring		Center Section Outside Ring		Top Section Outside Ring	
Year	Radius	Area Cm.^{2}	Radius	Area Cm.^{2}	Radius	Area Cm.^{2}
1948	5.37	1.68	3.45	.86	1.54	.19
1947	5.32	1.00	3.41	.64	1.52	.19
1946	5.29	.33	3.38	.42	1.50	.19
1945	5.28	.66	3.36	.42	1.48	.09
1944	5.26	1.32	3.34	2.04	1.47	.63
1943	5.22	1.96	3.29	1.63	1.40	.93
1942	5.16	2.57	3.21	1.59	1.29	.85
1941	5.08	3.16	3.13	1.74	1.18	.71
1940	4.98	3.40	3.04	2.06	1.08	1.00
1939	4.87	3.33	2.93	1.63	.92	.75
1938	4.76		2.84		.78	

According to the plot records, 1942 was the first year of heavy defoliation. This year was taken as the ring just prior to the attack which showed a sharp decrease in the per cent summer wood. This ring shows up fairly readily in the basal cross-sections. However, it shows up in the eighth ring from the outside in two of the cross-sections and in the seventh ring from the outside in the third cross-section. This difference means that either the two cross-sections have a double ring for one year or the one cross-section has missed laying down a growth ring. The former is thought more likely to be the case because of the small size of the trees and because the foliage extended practically the whole length of the trees. This double growth ring must have occurred during a year of severe defoliation when the foliage was stripped from the trees well before the growing season had ended. The years of severe defoliation were from 1942 to 1945. The measurements in Table II indicate that 1944 was the most likely year in which the double ring occurred. The following graphs are based on the above assumption.

TREE 1470

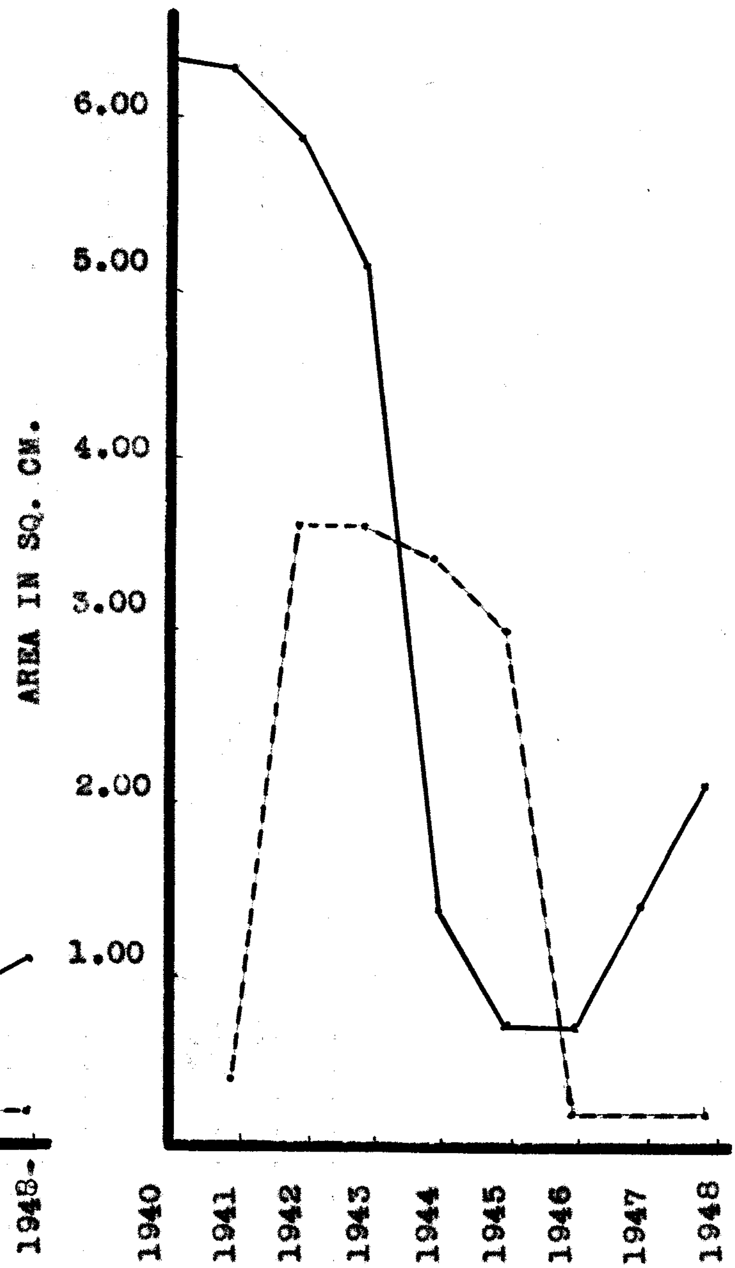
Graph(a)



Center Section

Top Section

Graph(d)

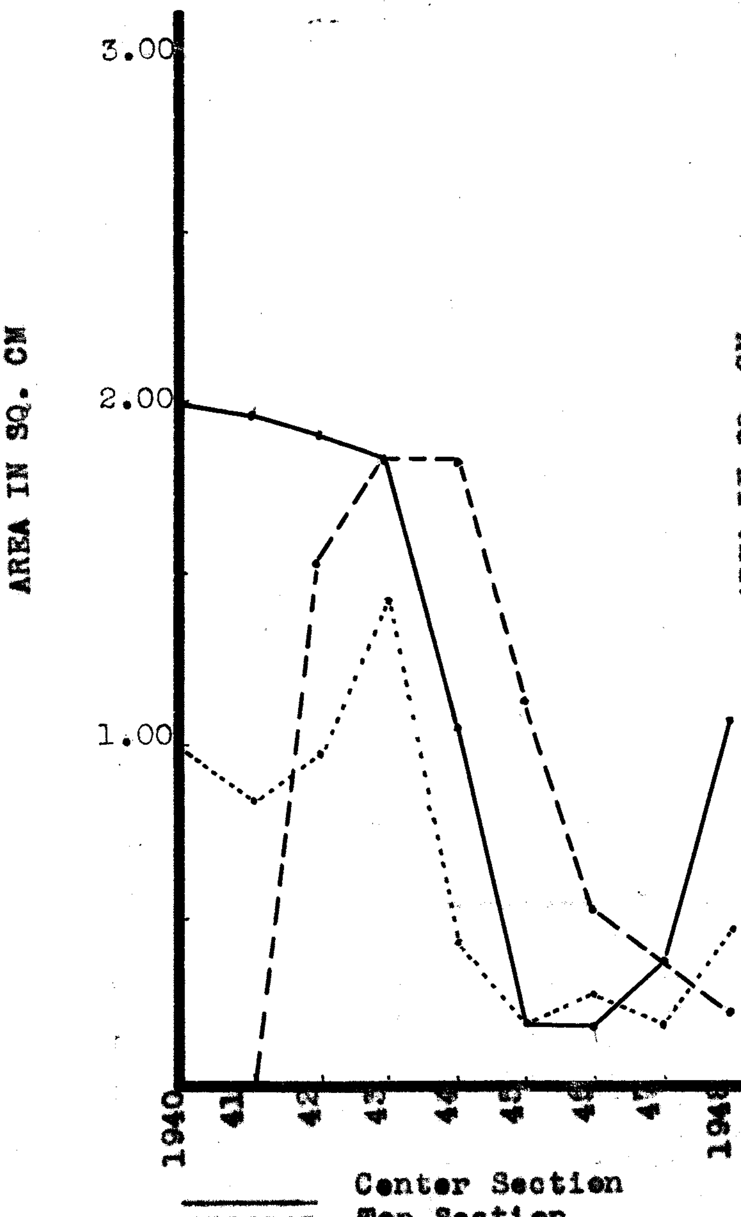


Bottom Section

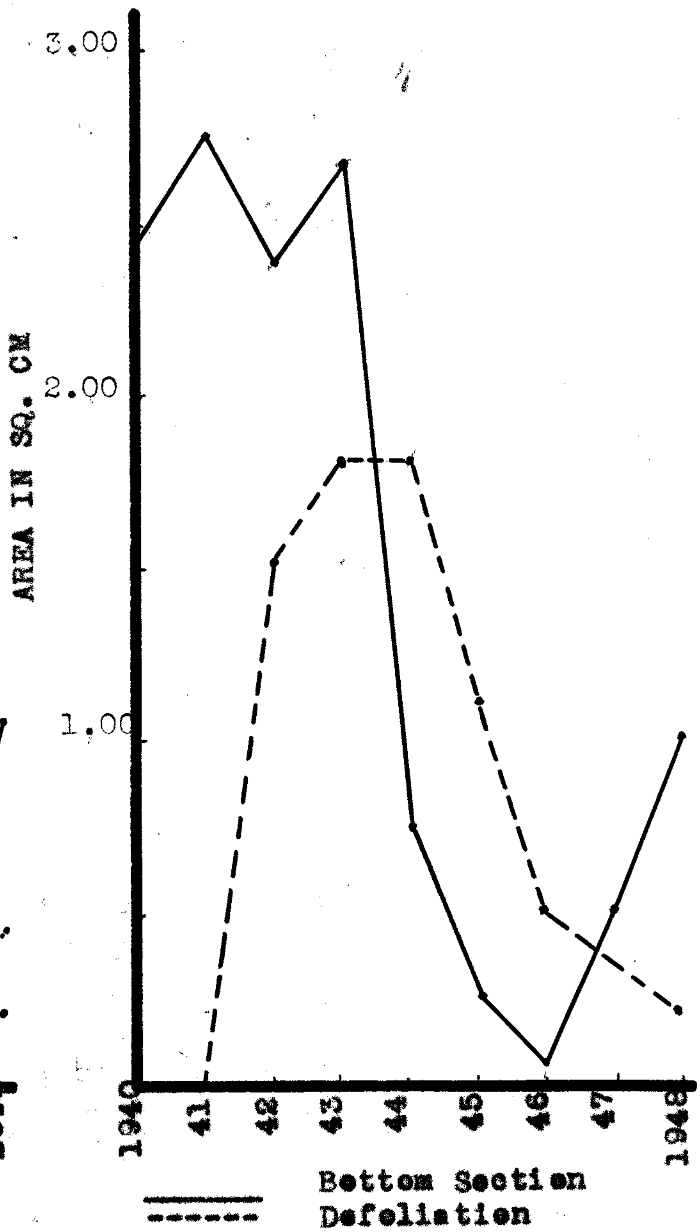
Defoliation

TREE NO. 1495

Graph(c)

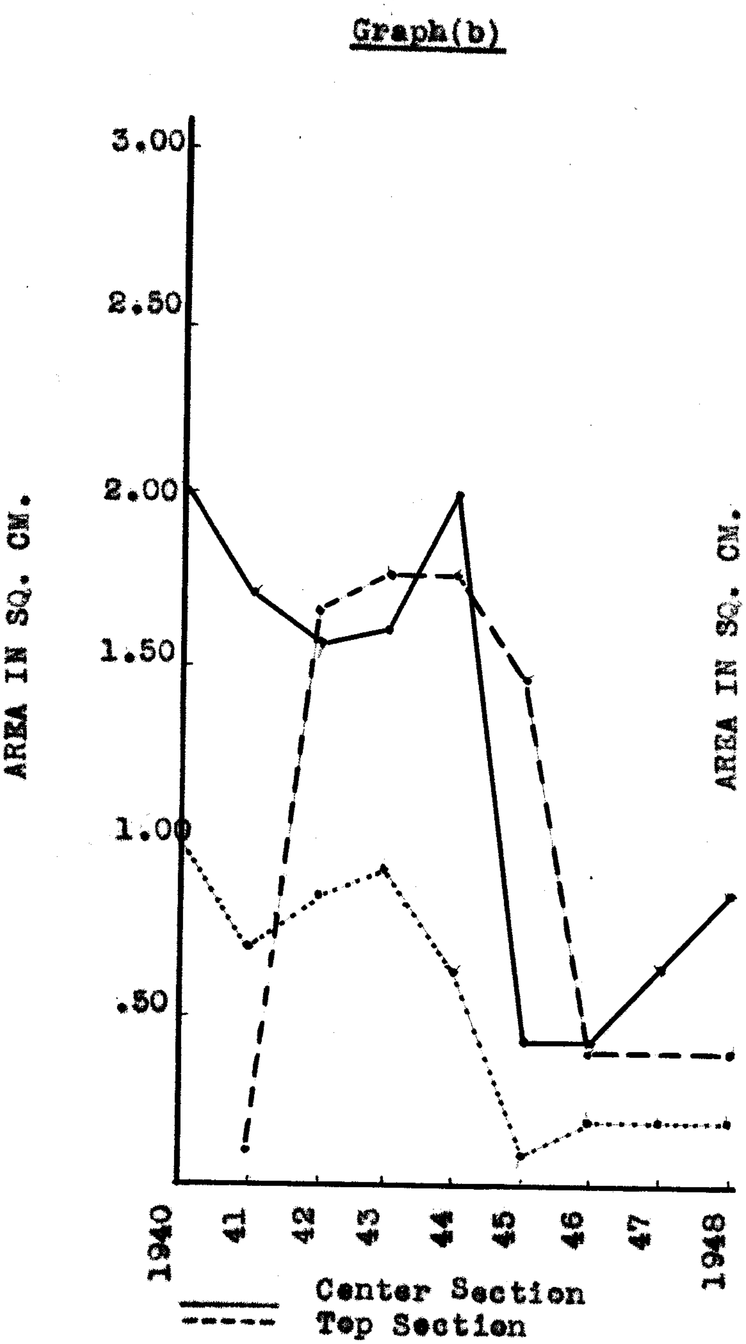


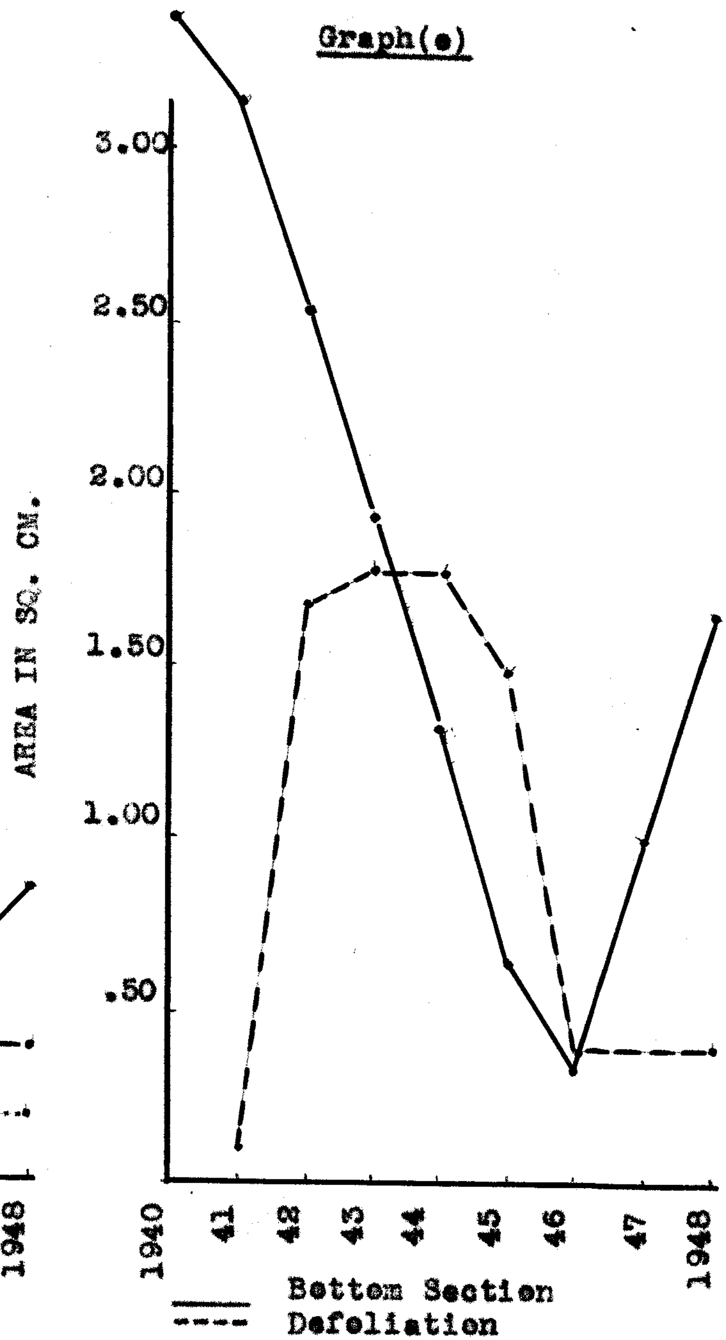
Graph(f)



Defoliation measurement missing for 1947.

TREE NO. 1547





Defoliation measurement missing for 1947.

The effect of defoliation on the area of the annual rings at different levels in the tree is shown in the foregoing graphs.

Table II shows a sharp decrease in the per cent summer wood for the year 1942 which was the first year of heavy attack. The growth rings for the years 1945-1947 are quite narrow so that with such small measurements, the error in measurement may be quite high. The figure for per cent summer wood may not be accurate for these very narrow rings. Defoliation has a varied effect on the extent of growth in the crown section of the tree (Graphs a, b, and c) but has a direct effect on the amount of growth in the basal section of the tree (Graphs d, e, and f). In other words, the cross-section from the base of the tree is the best indicator of the amount of defoliation in young, healthy trees. The graphs also show that young, healthy trees can withstand four years of severe defoliation and still show an abrupt recovery.

(f) Conclusions

The borings show that severe defoliation occurred in the Whiteshell Forest Reserve area from 1904 to 1909, from 1912 to 1920 and from 1942 to 1948. The exact dating of the rings cannot be accomplished by using the increment borings alone as partial rings may occur. The first year of severe defoliation is indicated by a growth ring having a sharp decrease in the percentage of summer wood. This growth ring may or may not be followed by a ring showing a sharp decrease in total width, depending on the vigour of the tree.

The study of the cross-sections from Riding Mountain National Park show that young, vigorous trees may survive four years of severe defoliation. There is no evidence to show that the tree can miss an entire ring for one year and still survive. However, the tree may have a ring missing for over half its circumference and still lay down a complete ring the next year. The effect of defoliation varies in cross-sections at different levels in the tree. The effect of defoliation in the crown, during any year, is often obscured by the resumption of growth after early severe defoliation, due to a second flush of needles appearing the same year. The basal section of the tree is the most reliable indicator of the amount of defoliation.

No satisfactory method has been determined to differentiate between the effect of severe defoliation and the effect of dry weather. However, defoliation generally occurs over a four-or-five-year period once the infestation has reached epidemic proportions and very dry weather rarely occurs for more than two consecutive summers. When the starvation effect occurs in a stand on a dry site and does not appear in an adjacent stand on a moist site, it is concluded that the starvation effect is due entirely to dry weather. At present, a boring from another species in the same stand used for comparative purposes is the best means of differentiating between the two effects.

(g) Summary

The material for this study consisted of 111 larch borings from the Whiteshell Forest Reserve and cross-sections from 3 larch trees from a permanent plot in the Riding Mountain National Park.

The study shows that past severe larch sawfly attacks occurred in the Whiteshell Forest Reserve from 1904 to 1909, from 1912 to 1920 and from 1942 to 1948.

The cross-sections from Riding Mountain National Park show that young, vigorous trees may survive four years of severe defoliation. A cross-section from the base of the tree gives the best indication of the length and severity of the attack. There is no evidence to show that a tree can miss laying down a ring during a year of severe defoliation. A tree may miss laying down over half of a growth ring for one year and still lay down the full circumference of the succeeding ring. The effect of defoliation in the growth rings in the crown of the tree is varied due to the fact that during a year of early severe defoliation, the tree may put forth a new flush of leaves and continue widening the growth ring or lay down a second growth ring for that year.

(h) Recommendations

The study so far has proven to be of considerable value. For further study, basal cross-sections are recommended instead of increment borings as cross-sections prevent errors in ring dating due to the presence of partial rings and are easier to study.

A further study of cross-sections is necessary to produce a reliable method of distinguishing between the effect of severe defoliation and the effect of dry weather on the growth rings. A study of dead larch trees may shed some light on the exact cause of their death. A further study of cross-sections from selected trees from plots in Riding Mountain National Park is necessary to confirm the work already done. The three trees already studied are not considered an adequate sample on which to base any firm conclusions.

A further study of cross-sections from stands in the 50-60 year class across Manitoba and Saskatchewan should show the rapidity of spread of the primary epidemic.

TECHNICAL REPORT 1949
PROJECT NO. E.20.07-1

FOREST INSECT LABORATORY, WINNIPEG

VII STUDIES ON THE BIOLOGICAL CONTROL OF THE SPRUCE BUDWORM

Report by E. A. Liscombe

Field Work by E. A. Liscombe, G. L. Warren, and A. W. Dow

Time Spent on Project

E. A. Liscombe - ½
G. L. Warren - 3/8
A. W. Dow - 1/8

Location of Work - Spruce Woods Forest Reserve, Manitoba

Object

The objectives of the biological control project on the spruce budworm, <u>Choristoneura fumiferana</u> (Clem.), are to determine the natural control factors operating in this area, their qualitative and quantitative distribution, and the effect of new parasite liberations on the spruce budworm population.

Method

In carrying out a project of this nature, the problem was divided into its component parts and each factor studied individually. These sub-projects are discussed separately in this report.

A. Phenological Study

1. Object

This study was initiated in 1949 to determine the relationship between bud development and budworm populations.

2. Methods

The experiment was carried out in the field in two separate areas; Area A was heavily infested and situated near the parasite liberation area, Area B was lightly infested and situated several miles past Speer's Ranch towards the sand hills.

In the "A", or infested area, four separate clumps of trees were used, while in the "B" or so-called, non-infested area, only three clumps of trees were available. Each clump constituted a replication.

From each clump 20 trees were selected giving a total of 80 trees in Area A and 60 trees in Area B. Following selection they were examined daily, when time permitted, and the per cent bud emergence was determined.

An open bud was defined as one which had broken the bud cap and was showing green tissue. A series of random samples taken with extension tree pruners from all four quadrats in the middle third of the tree was collected, and 100 of these terminals were examined. The number of buds showing green tissue were counted, and from this the per cent bud emergence for the tree was calculated. When at least 50 per cent of the terminals in any one daily sample showed green tissue, the tree was said to have 'emerged' and bud sampling was discontinued.

When the 140 trees had emerged, classes based on emergence dates were drawn up. Seven classes were established and each tree was placed in its proper class.

Throughout the season larval populations of the budworm were estimated and although the data are necessary for this study, methods of estimating and analyzing populations will be discussed in detail later in this report.

After feeding for the season was completed defoliation was estimated on the 140 trees. From each tree, two 50 terminal samples were taken from opposite sides of the crown by extension tree pruners in the middle third of the tree. Defoliation for any one terminal was divided into five groups, namely; none, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and complete. The defoliation for each terminal was determined and the average of the 100 sample terminals provided an estimate of the defoliation for the tree.

3. Analysis of Data and Discussion

From the bud emergence data classes I to VII inclusive were established as follows:

Class	Range in Emergence Dates
I	May 6 - 10 inclusive
II	May 11 - 15 inclusive
III	May 16 - 20 inclusive
IV	May 21 - 25 inclusive
V	May 26 - 30 inclusive
VI	May 31 - June 4 inclusive
VII	June 5 - 9 inclusive

The following graph shows the percentage of trees in each phenological class in Areas A and B.

(Insert Fig. 1. here)

It was found that early in the season Area A was 6 - 10 days ahead of Area B in bud development, but by May 26 the two areas had become the same.

The following table shows the class limits and those trees which fell in each. Although no trees fell in Classes I or VII in either area, these classes were established because in another year bud development may be earlier or later.

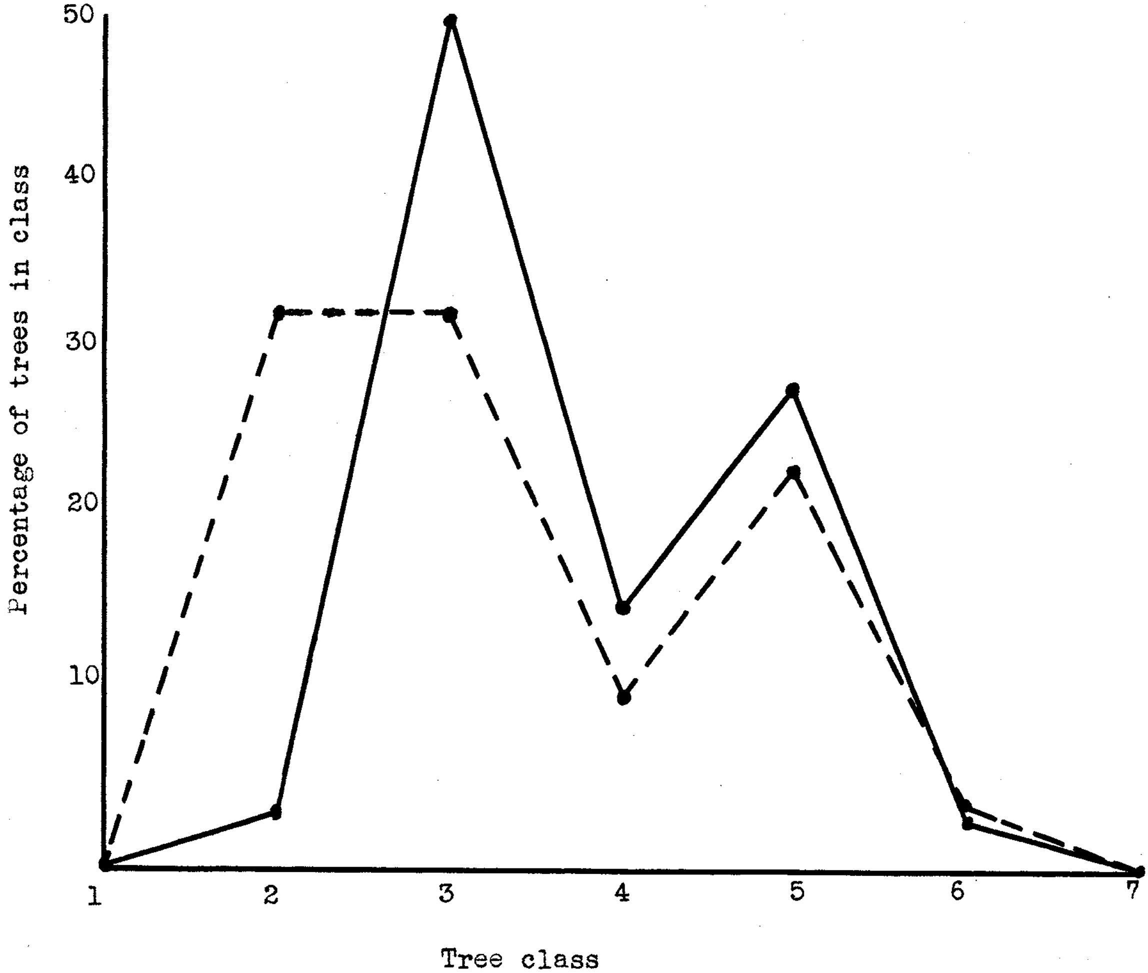


Figure 1. Percentage of trees in eack phenological class in areas A and B in Spruce Woods Forest Reserve.

TABLE I

The Range in Emergence Dates for Each Phenological Class and the Trees which Fell within Each

Area A

Class	Range in Emergence Dates	Group	Tree Number
I	May 6 - 10	---	---
II	May 11 - 15	I	2,3,5,13
		II	4,6,9,11,13,15,18
		III	1,2,4,9,10,17,18
		IV	2,3,5,6,9,10,15,16
III	May 16 - 20	I	4,6,7,8,9,10,11,18
		II	5,7,14,17,20
		III	3,6,7,11,13,14,19
		IV	1,4,7,11,17,18
IV	May 21 - 25	I	1,12,15,17,19,20
		II	---
		III	5
		IV	14
V	May 26 - 30	I	16
		II	1,2,3,8,10,12,16,19
		III	8,12,15,16,20
		IV	8,13,19
VI	May 31 - June 4	I	14
		II	---
		III	---
		IV	12,20
VII	June 5 - 9	---	---

TABLE I (continued)

AREA B

Class	Range in Emergence Dates	Group	Tree Number
I	May 6 - 10	---	---
II	May 11 - 15	I	---
		II	15
		III	11
		IV	---
III	May 16 - 20	I	2,4,5,6,9,14,16,17,20
		II	1,2,4,5,11,12,13,14,16,18,20
		III	1,2,3,6,7,9,13,14,18,20
		IV	---
IV	May 21 - 25	I	8
		II	6,7,10,17,19
		III	4,15,19
		IV	---
V	May 26 - 30	I	1,3,7,10,11,12,13,15,18
		II	3,8,9
		III	8,10,12,16,17
		IV	---
VI	May 31 - June 4	I	19
		II	---
		III	5
		IV	---
VII	June 5 - 9	---	---

The following table shows budworm populations by tree class.

TABLE II

Budworm Populations Per 100 Terminals Per Area

Area	Class	Larval Count No.1	Pupal Count No. 2	Egg Count No. 3	Total
A	II	3.0	.8	2.1	
A	III	2.9	.4	2.9	
A	IV	3.0	.8	3.5	
A	V	4.3	1.1	6.5	
A	VI	9.2	4.7	6.7	3.4
B	II	1.1	.4	4.6	
B	III	2.0	.5	0	
B	IV	1.4	.4	2.8	
B	V	1.2	.3	0	
B	VI	0	0	0	1.2

The above table shows how the budworm population increased from Class II to Class VI trees in Area A for the three counts.

In Table III the figures for larval and pupal counts found in Table II are combined.

TABLE III

Budworm Larval and Pupal Populations Per Class

Area and Class	Population Per 100 Terminals	Area and Class	Population Per 100 Terminals
A II	1.9	B II	.8
A III	1.1	B III	1.2
A IV	1.9	B IV	.9
A V	2.7	B V	.8
A IV	6.9	B VI	0

The table shows that the budworm population increased in Area A from Class II to Class VI. If one assumes that the earliest trees should have larger larval populations because of the availability of new foliage, the data do not show the true picture. It is believed by the author however, that, due to the late dates at which the counts were taken, the budworm larvae were well developed, and as there was a deficiency of new foliage on the early trees, the insects had migrated to the later, less severely defoliated trees, giving the results shown in Table III.

From estimates of defoliation from sample branches the following table was drawn up showing per cent defoliation by class for trees in this study.

TABLE IV

Per Cent Defoliation by Class

AREA A		AREA B	
Class	Per Cent Defoliation	Class	Per Cent Defoliation
II	74.7	II	19.9
III	71.5	III	10.8
IV	64.5	IV	11.1
V	67.5	V	8.6
VI	37.8	VI	5.8

It is interesting to note that the relationships in Tables III and IV are reversed, thus supporting the belief that although early trees may be most heavily attacked in spring, the picture changes as the larvae migrate later in the season.

The slight increase in defoliation in Classes A-V and B-IV is best explained by the possibility that migration onto these trees occurred earlier than the average, and the larvae therefore consumed more foliage due to the longer time interval. Only one tree fell into Class A-IV, whereas if several trees had been averaged, A-IV would probably have fallen into its proper place between A-III and A-V.

Because second-instar budworm larvae emerge from their hibernacula relatively early in the season, the buds on most trees are usually not sufficiently developed to support them. Of necessity, therefore, the insect mines old needles. Since it is felt that old needles are not preferred if new foliage is available, it is reasonable to assume that the budworm larvae would shift to the new buds as soon as possible. The writer believes that the shorter the period spent in old needles, the smaller is the mortality of the larvae. Because the young larvae prefer succulent terminals to old needles it seems reasonable to believe that early in the season the largest population would be expected to be on those trees with the earliest bud development. Due to the order in which trees are attacked, one would expect to find early trees most heavily defoliated as the season progressed. This would cause the insects to migrate to more suitable feeding places and result in larger larval populations on the late trees later in the season.

Although populations were not estimated at the beginning of the season, it is felt that Table IV, which gives the per cent defoliation per class is a reflection of the initial population.

Regardless of the fact that Area B showed no visible trend in actual population levels, the defoliation percentages followed those of Area A as shown in Fig. 1.

The defoliation of trees in each phenological class in Areas A and B was graphed and shows the following results.

(Insert Fig. 2. here)

It is believed that the phenology of Area B is quite different to that of Area A. An attempt was made to determine whether there was any difference in the water table between the two, but lack of proper equipment prevented its completion. The terrain of Area B is much drier and sandier than Area A, which might possibly explain why the bud caps of trees in Area B are thicker and harder than bud caps in Area A.

4. Conclusions

Several conclusions were derived from the foregoing data:

(a) There is a wide spread in the opening of white spruce buds and in the present study the opening dates were found to extend over a period of 22 days in Area A and 19 days in Area B.

(b) There appears to be a correlation between the opening date of the buds and the degree of defoliation. It was found that the earliest developing trees sustained the heaviest defoliation, and as the period of bud development lengthened defoliation decreased.

(c) There might possibly be a relationship between the opening of the buds and budworm populations. In the spring of the year it is believed that heaviest populations would be found on those trees which developed earliest. Later in the season however, the largest population was found on trees whose buds developed more slowly.

(d) When opening of buds began there were 6 - 10 days difference between Areas A and B. By May 26 however, the two areas had become the same.

5. Summary

The study was initiated in 1949 to determine the relationship

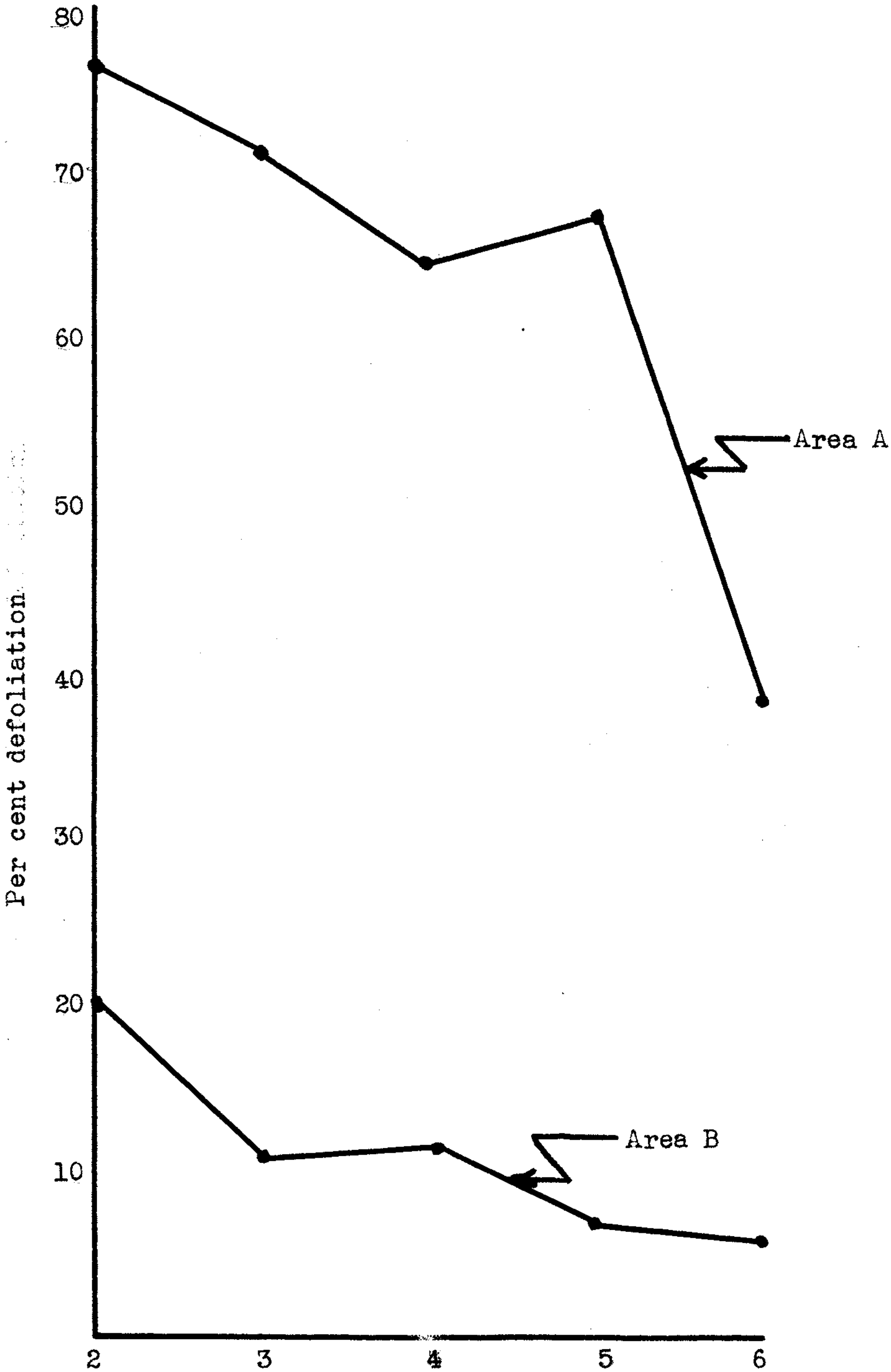


Figure 2. Defoliation of trees in each phenological class in areas A and B.

between phenological development and budworm population.

In each of two areas a large number of trees were permanently tagged, and by taking daily bud samples the percentage of open buds on each tree was determined. Phenological classes were set up when bud opening was completed, and budworm population counts were conducted throughout the season.

Later in the season defoliation was estimated for all tagged trees. This was done by sampling branches and determining defoliation for a definite number of terminals. These figures were averaged and used to determine defoliation for each class.

It was found that the two areas differed in the rate of bud development for a part of the time at least. Heaviest defoliation was found on the earliest trees, and decreased as the period of bud development lengthened.

In the spring it is believed that largest populations would be found on the earliest trees, but later in the season the heaviest population was found to be on the latest trees.

6. Recommendations

Because the bud development study was initiated in 1949, it was kept on rather a simple basis. The results obtained were very satisfactory and it is believed that the method employed in obtaining these results was correct, and will again be used when the experiment is repeated in 1950.

In addition to those experiments carried out in 1949, new work will be undertaken next year.

It has been considered possible that continual heavy defoliation might change the phenology of the tree and tend to make the buds develop earlier in the season. If this were true it might cause the budworm population to increase, as the insect could become established earlier in the season, and mortality during the needle mining stage would be reduced.

To test this hypothesis, small test trees will be examined for bud development, and then defoliated by hand. Over a period of sev- years it would probably be possible to state whether or not defoliation affects bud development.

In order to establish the relation between initial spring population and the phenological classes, early larval counts are planned for 1950. In 1949 it is believed that by the time the first larval count was made, a considerable shift had already taken place in the budworm population.

B. Population Studies on the Spruce Budworm

1. Object

Population studies on the spruce budworm have been conducted in the Spruce Woods Forest Reserve from 1946 to 1949 inclusive, with a view to obtaining both population levels and fluctuations from year to year. One of the main reasons for population studies was to determine what percentage of the population was destroyed each year by the various control factors operating in this area.

2. Methods

When the study was initiated in 1946 three separate areas (A1, A2, and B1) were used. Two consisted of pure white spruce, and the third was believed to be half white and half black spruce. The two species were used in an effort to follow the difference in populations on them. Since then, however, it has been fairly well established that no black spruce was present in those particular locations. The same areas and trees were used in 1947.

As the areas used in previous years were becoming inaccessible for regular periodic examinations and some of the sample trees had been badly damaged due to army activities, a change was made in 1948. Four areas (A1, B1, B3, and B4) consisting of pure white spruce were used.

Another change in areas was made in 1949 to provide for phenological studies. Two areas, "A" and "B", (as referred to in the previous section on Phenological Studies) were examined; one heavily infested, and the other almost free of spruce budworm larvae. From 1946 to 1948 inclusive, for each count a total of 24 trees was sampled, but in 1949 a total of 30 trees was sampled. This increase was necessary as all phenological classes (I, II, III, IV, V, VI, and VII) had to be represented in population data.

The basic method of sampling has been fairly consistent throughout the four years, but several changes have been made from time to time. In 1946 and 1947, two samples of 100 terminals each were taken from the middle third of each tree to be sampled. The early counts were conducted by obtaining the samples with an extension tree pruner. For the later counts, made when the larvae were large in size and were easily jarred from the foliage, a cloth net was attached to the top of the pruners to catch both the sample branch and any larvae jarred from it when the sample was removed.

In 1948 and 1949 a total of 400 terminals was taken from each tree to be sampled. These 400 terminals were divided so that two samples of 50 terminals each were taken from all four quadrats in the middle third of the tree. Tree pruners were again used to obtain the samples, and the net was employed to catch the sample and fallen larvae during late instars. All larvae caught in the net were recorded as were the total number of terminals in the sample, and the number of larvae per 50 terminals apportioned accordingly.

The number of counts made each year varied as the weather affected development and other work also had to be done. A number of variables were recorded each time a count was conducted, including all live and dead larvae and pupae, frozen terminals, parasite cocoons and predatorized larvae and pupae.

3. Analysis of Data and Discussion

Tables were drawn up from data on all species of larvae obtained in population counts. (See Tables I - IV on pages 338 and 339 .)

It is rather difficult to draw conclusions from these data as the counts were not taken at the same times in consecutive years. It does however, tend to show how the different insects varied in number each year. It is of interest to note that the number of black-headed budworm, red-headed budworm and unidentified larvae were very small each year, and that the spruce budworm and spruce needleworm made up the majority of the population.

The following graphs show the spruce budworm and spruce needleworm populations per count for each phenological class established in the bud development study. The populations are all based on 100 terminals.

(Insert Figs. 3 and 4 here)

It is evident from the above graphs that the increase in population from Class II to Class VI in Area A applies only to the spruce budworm. The spruce needleworm population tends to run in the opposite direction, as the class containing the largest spruce budworm populations also contains the smallest spruce needleworm population. This is rather difficult to explain. It might be due to competition although the numbers of each insect were relatively small. If this were true, the insect of the larger population would tend to inhibit the development of the other, and by feeding on different foliage classes both insects can remain at a higher level than if they were both feeding on the same trees. It is possible

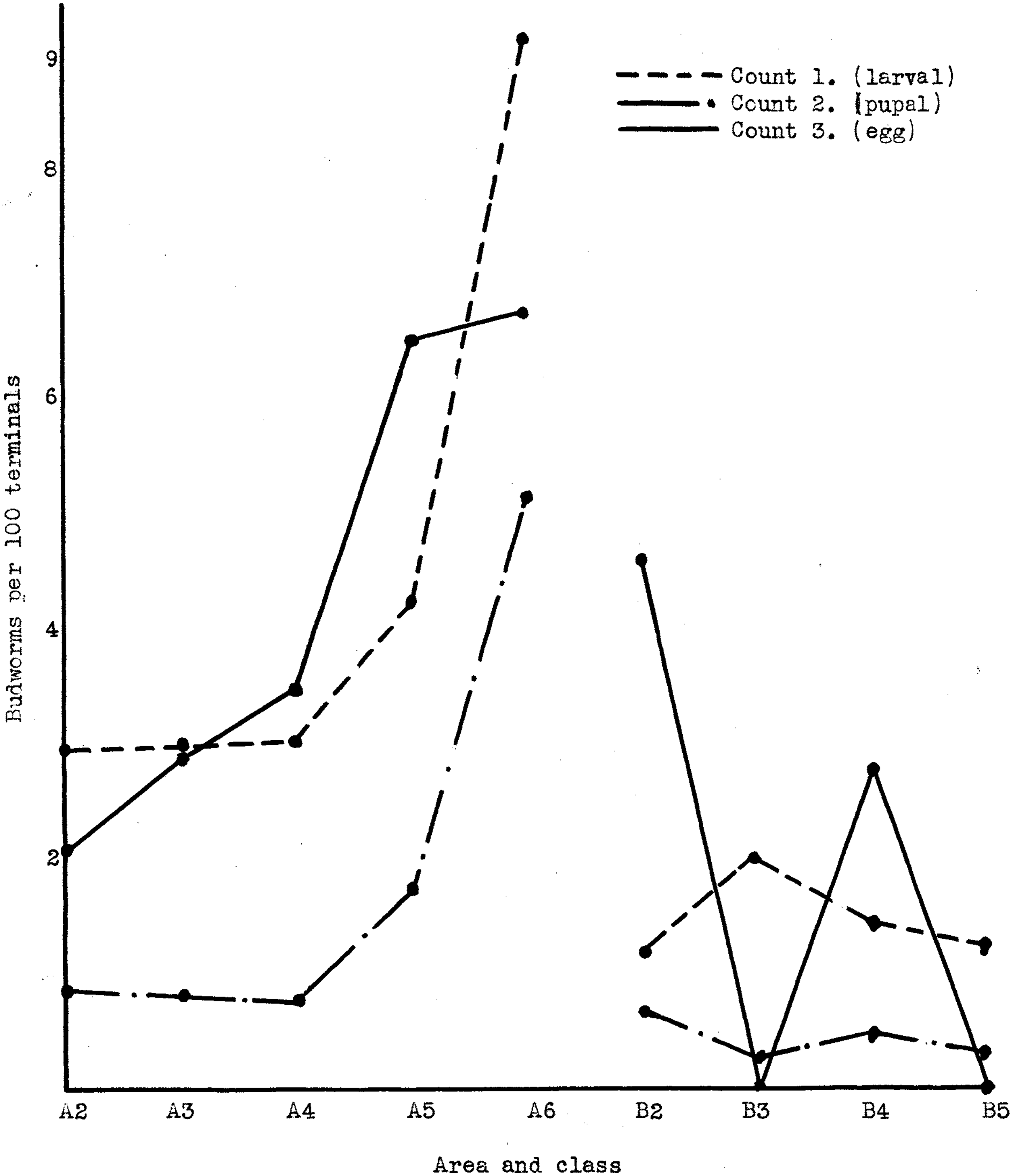


Figure 3. Spruce budworm populations per count for each phenological class in areas A and B.

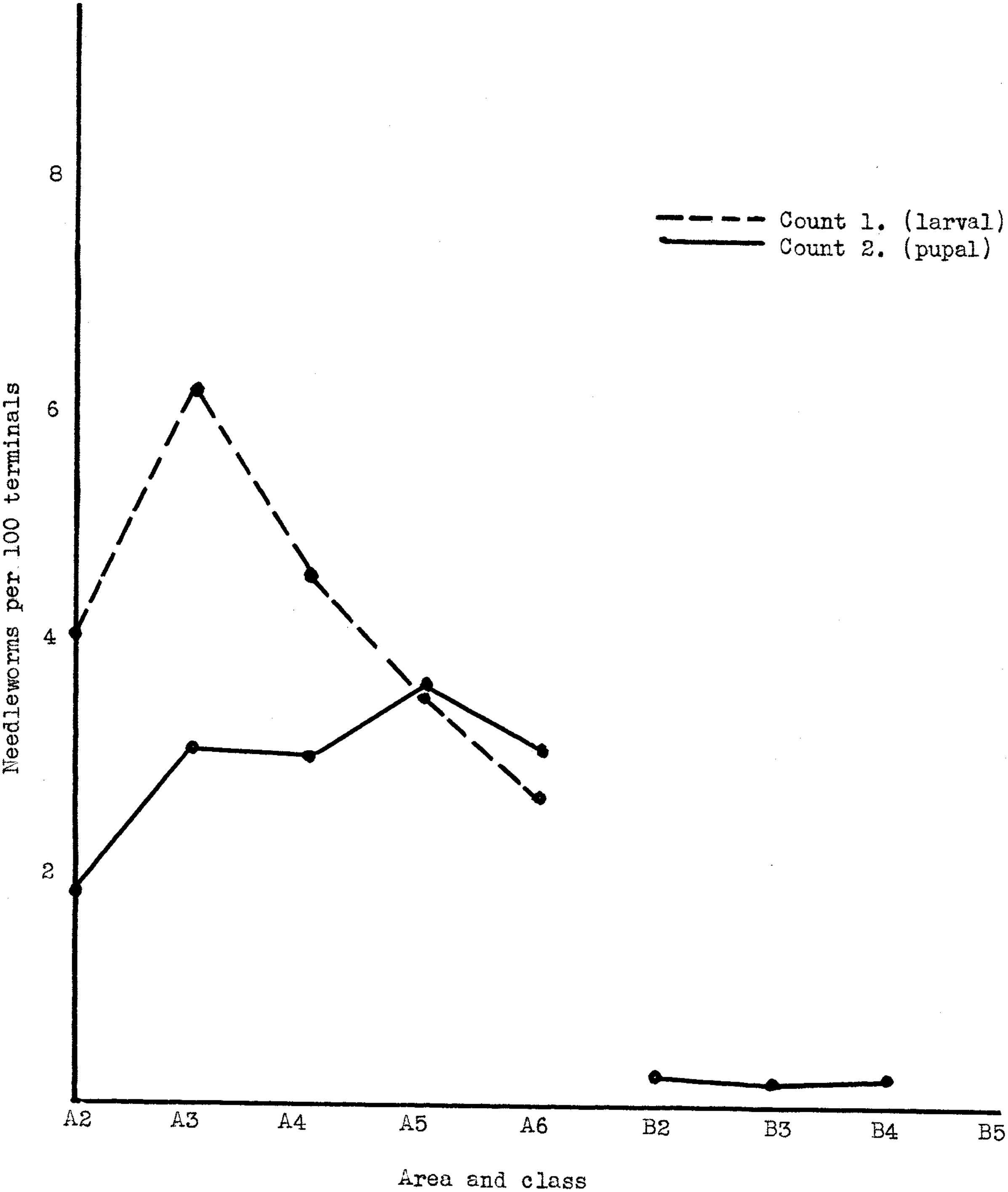


Figure 4. Spruce needleworm populations per count for each phenological class in areas A and B.

TABLE I

Relative Abundance of Several Species of Defoliators
In 1946 Expressed in Larvae Per 100 Terminals

Larvae Found in Population Counts	Area A1*				Area A2**				Area B1*				Average Per 100 Terminals
	Count No.				Count No.				Count No.				
	1	2	3	4	1	2	3	4	1	2	3	4	
spruce budworm	11.9	22.6	18.5	6.3	12.9	10.6	4.8	2.2	24.6	25.2	8.8	2.2	12.6
spruce needleworm	0	1.2	1.7	2.1	1.2	1.5	.9	.8	1.8	1.8	1.9	.5	1.3
black-headed budworm	.2	.1	0	0	.4	.2	0	0	.2	.1	.1	0	.1
red-headed budworm	.2	1.7	.9	0	1.2	1.2	.1	0	1.0	1.1	.6	0	.6
unidentified	.4	.6	.4	.2	.1	.3	.8	.2	0	.9	.6	.2	.4

* 1200 terminals for each count
** 2400 terminals for each count

TABLE II

Relative Abundance of Several Species of Defoliators
In 1947 Expressed in Larvae Per 100 Terminals

Larvae Found in Population Counts	Area A1*				Area A2**				Area B1*				Average Per 100 Terminals
	Count No.				Count No.				Count No.				
	1	2	3	4	1	2	3	4	1	2	3	4	
spruce budworm	2.0	3.6	12.2	3.4	1.5	6.9	5.2	1.6	1.6	10.3	6.6	2.4	4.8
spruce needleworm	0	0	3.8	3.2	0	.8	2.0	.5	0	.4	1.5	.2	1.1
black-headed budworm	0	.2	2.2	.8	0	.3	.5	.4	.2	.7	1.8	.5	.6
red-headed budworm	0	0	0	0	0	0	0	0	0	.1	0	0	0
unidentified	0	0	0	.4	0	0	.2	.6	.1	.2	1.4	.6	.3

* 1200 terminals for each count
** 2400 terminals for each count

TABLE III

Relative Abundance of Several Species of Defoliators
In 1948 Expressed in Larvae Per 100 Terminals

Larvae Found in Population Counts	Area A1* Count No. 1	2	3	Area B1* Count No. 1	2	3	Area B3* Count No. 1	2	3	Area B4* Count No. 1	2	3	Average Per 100 Terminals
spruce budworm	20.5	-	-	20.4	-	-	18.2	8.0	1.3	22.8	5.7	.7	12.2
spruce needleworm	0	-	-	.2	-	-	2.2	5.4	2.5	5.5	10.0	.7	3.3
black-headed budworm	0	-	-	.1	-	-	0	.1	0	.4	.1	0	.1
red-headed budworm	.2	-	-	.5	-	-	.6	1.2	.1	1.1	.5	0	.5
unidentified	0	-	-	0	-	-	0	.1	0	.2	0	0	0

* 2400 terminals for each count

TABLE IV

Relative Abundance of Several Species of Defoliators in
1949 in Area "A" Expressed in Larvae Per 100 Terminals

CLASS / Larvae Found in Population Counts	II(1) Count No. 1	2	III(1) Count No. 1	2	IV(2) Count No. 1	2	V(3) Count No. 1	2	VI(4) Count No. 1	2	Average Per 100 Terminals
spruce budworm	3.0	.4	3.1	.6	3.0	.4	4.3	1.3	9.4	4.9	3.0
spruce needleworm	4.2	1.4	6.2	2.5	4.6	2.5	3.6	2.7	2.7	1.4	3.2
black-headed budworm	.1	0	0	0	0	0	0	0	0	0	0
red-headed budworm	.1	0	.1	0	0	0	0	0	0	0	0
unidentified	.1	0	.1	0	0	0	0	0	0	0	0

(1) 1600 terminals for each count
(2) 400 terminals for each count
(3) 2000 terminals for each count
(4) 800 terminals for each count

6400

too that the insects differ in host preference and habits of migration.

Since Tables I, II, III, and IV were not based on comparable counts only, relative abundance of the two cannot be determined accurately. To correct this the following table was drawn up based only on those counts which were comparable.

TABLE V

Relative Abundance of Spruce Budworm and Spruce Needleworm Per 100 Terminals Based on Comparable Counts Only

Year	Counts	Spruce Budworm	Spruce Needleworm
1946	5 ≠ 4	7.1	1.3
1947	3 ≠ 4	5.3	1.9
1948	2 ≠ 3	3.9	4.6
1949	1 ≠ 2	3.0	3.2

The above table shows that the budworm population was 7.1 larvae per 100 terminals in 1946, 5.3 larvae in 1947, 3.9 larvae in 1948, and 3.0 larvae in 1949. This was a decline of 50 per cent over the four years.

The spruce needleworm on the other hand has increased steadily since 1946 except for a slight drop in 1949. In 1946 there were 1.3 larvae per 100 terminals, 1.9 in 1947, 4.6 in 1948, and 3.2 larvae in 1949. This was an increase of almost 300 per cent over the four years. These data are illustrated graphically in Figure 5.

(Insert Fig. 5. here)

The graph shows how the spruce budworm has steadily decreased and the spruce needleworm steadily increased. Although the spruce needleworm was much scarcer in 1946 than was the spruce budworm, the two insects were present in almost equal numbers in 1949.

Although the spruce budworm population had decreased, defoliation still seems to be as severe as in previous years. This is best explained by the fact that the population of the two insects combined has been almost constant for the four years.

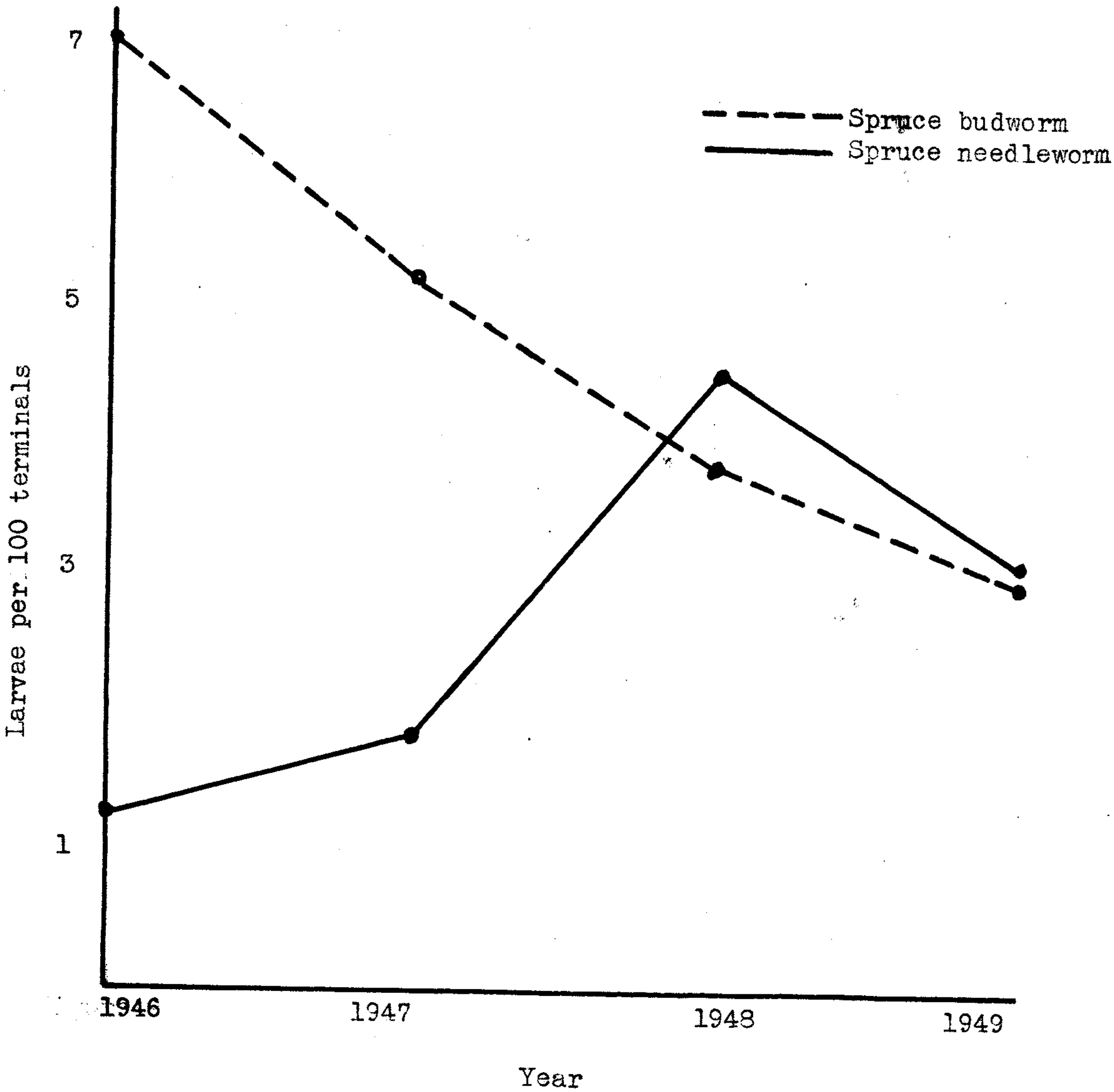


Figure 5. The relative abundance of the spruce budworm and spruce needleworm based on comperable counts only.

It is possible that the spruce needleworm could continue to increase and maintain the high level of defoliation even if the spruce budworm declines further. It might also be found that the numbers of one could have a great influence on density levels of the other.

4. Conclusions

Although population estimates may not be exact because of sampling errors which are to be discussed later, it is felt that the trends from year to year are sufficiently accurate to permit the formulation of some tentative conclusions.

(a) It has been found that the spruce budworm and the spruce needleworm constitute almost the entire larval population on white spruce in the Spruce Woods Forest Reserve.

(b) A few red-headed budworm, black-headed budworm and unidentified larvae are found every year, but the numbers of each are always small.

(c) During the four years the spruce budworm population has dropped 50 per cent, while the spruce needleworm population has increased 300 per cent.

(d) The combined population of these two species has remained constant regardless of the fluctuations in the number of the two components. Because the total population has remained the same, defoliation has also remained unchanged.

5. Summary

This study has been conducted with a view to obtaining information on insect populations and fluctuations. A number of trees in different areas were sampled each year. A definite number of terminals were examined and all population estimates obtained were based on 100 terminals. Graphs and tables were drawn up to show population changes during the last four years.

It was found that although populations of the spruce budworm had dropped, and populations of the spruce needleworm had increased, total populations and defoliation remained the same. Seemingly the budworm infestation is dying out and may or may not be replaced by the spruce needleworm.

6. Recommendations

It is believed that the sampling method is of sufficient accuracy to show wide fluctuations except for the pupal and egg counts. When egg counts are conducted the amount of foliage examined must be greatly increased.

Some work will be undertaken in 1950 to see if frass drop methods provide a better estimate of insect populations. Studies will be begun at the same time in an effort to determine the number of larvae which pupate on the ground, and are therefore missed by using the present system of sampling.

C. Spruce Budworm Population Reduction

1. Object

To determine from the population data accumulated during the past four years, the yearly population reduction and the part played by each factor in natural control of the spruce budworm.

2. Methods

This work was based on population and other counts carried out in the field.

For each of the four years the initial larval population in the spring was determined as was the final pupal population. These figures were calculated from population data gathered in the respective years, and included live and dead larvae and pupae. The final live larval figure was found merely by subtracting the dead from the live and dead total. The final live pupal figure was found by subtracting the dead and the pupal parasite percentage from the live and dead pupal total. The total for dead, diseased, and predatorized was a cumulative number, the total for each count being summed. The apparent mortality due to parasites was calculated from parasite rearings and larval dissections, and was used to determined the actual parasite percentages.

The unknown factor was the difference between the initial live and dead population and all the known mortality factors. Graphs were drawn from these data to show the annual population reduction and the mortality due to each cause.

3. Analysis of Data and Discussion

Because reliable results in this work depend mainly on the accuracy of sampling methods, it is advisable to consider critically the sampling methods employed.

The sampling technique as outlined on pages 334 and 335 of the section devoted to budworm population studies, is considered to be adequate but far from perfect.

During the early feeding stages of the larvae while they are still enclosed in a terminal, the use of extension pruners to remove foliage is considered satisfactory. Once the larvae begin to migrate, however, the system is far from satisfactory.

As previously stated on page 334, a cloth net was attached to the pruners when the larvae reach the stage where they are easily dislodged from the foliage. Due to the awkwardness of long extension pruners, branches were jarred and larvae accidentally knocked off the foliage. The accuracy of a count was therefore reduced as the origin of larvae jarred from the foliage plus those hanging from the foliage and caught in the net, was unknown.

If all larvae in the net were known to have come from the sample branch, and the sample consisted of 50 terminals only, all difficulty would be eliminated. As it is impossible to cut exactly 50 terminals these extra larvae could only be calculated on a 50 terminal basis by counting the total number of buds cut. This not only increases the time required for sampling, but adds to time of analysis. The use of a cloth net is also undesirable as it obstructs the operator's view when cutting the branch.

The present method of sampling is also inadequate during the budworm pupal stage. Although there are no hanging larvae at this time, many pupae are found on the lower foliage or on the ground, and samples taken from the middle third of the tree tend to under estimate the true population.

It has been observed in the field that most adult moths tend to congregate near the crown of the tree. It is not known definitely, whether most eggs are laid near the top of the tree or at random throughout the crown. It is believed the former is the case, however, as it was found that while making egg counts hordes of moths were seen near the top of the tree, and very few eggs were found on the middle or lower thirds.

The data on populations accumulated during the four years, 1946 - 1949, was subjected to statiscal treatment in an effort to determine the adequacy of the sampling methods.

To obtain a measure of the variability between replications, the larval counts in each area were subjected to analysis of variance. In this analysis, inter-tree variance was tested against intra-tree variance. It was reasoned that, if the former were significantly higher than the latter, the duplicate samples from each tree could be regarded as a good estimate of individual tree populations.

In 1946 it was found that inter-tree variability was significantly higher than intra-tree variability only in Area A2. In 1947 inter-tree variability was higher than intra-tree variability in two areas, B3 and B4, but in 1948 a significant difference was found only in Area B3.

In 1949 the different phenological classes within Area A were analyzed and it was found that inter-tree variability was higher in all classes except Class II and Class.VI.

From another point of view it was thought that if consecutive counts in any one year were significantly different, the sampling system reflected seasonal fluctuations.

In 1946 consecutive counts were significantly different in all areas; in 1947 they were significantly different in Areas A1 and A2; in 1948 counts were significantly different in Areas B3 and B4; in 1949 all classes showed significantly different counts.

Consecutive counts were significantly different in 11 out of 12 sets of data, and inter-tree variability was significantly higher than intra-tree variability in 6 out of 12 sets of data.

The following tables, I, II, III, and IV, show the population data for each replicate of each tree in each count. All population figures are based on 100 terminals. Areas used in these tables are as designated in the section "Population Studies on the Spruce Budworm." (See page 334.)

TABLE I

Spruce Budworm Population Per Replicate for Each Tree in All Counts by Areas in 1946

Area A1

	Tree Numbers						
1st Count	1	2	3	4	5	6	Totals
Replicate 1	42	12	13	24	13	8	112
Replicate 2	29	20	4	14	30	15	112
Total	71	32	17	38	43	23	224
Replicate Difference	13	8	9	10	17	7	64
2nd Count							
Replicate 1	35	25	19	26	22	15	142
Replicate 2	43	0	25	17	21	12	118
Total	78	25	44	43	43	27	260
Replicate Difference	8	25	6	9	1	2	51
3rd Count							
Replicate 1	9	3	17	15	14	18	76
Replicate 2	9	17	12	17	4	19	78
Total	18	20	29	32	18	37	154
Replicate Difference	0	14	5	2	10	1	32
4th Count							
Replicate 1	1	4	4	12	7	33	61
Replicate 2	13	3	9	12	5	4	46
Total	14	7	13	24	12	37	107
Replicate Difference	12	1	5	0	2	29	49
GRAND TOTALS	181	84	103	137	116	124	745

TABLE I (continued)

Area A2

	Tree Numbers												
1st Count	7	8	9	10	11	12	13	14	15	16	17	18	Totals
Replicate 1	2	3	3	7	5	11	17	36	11	12	36	28	171
Replicate 2	7	8	1	22	8	11	14	30	4	19	25	31	180
Total	9	11	4	29	13	22	31	66	15	31	61	59	351
Replicate Difference	5	5	2	15	3	0	3	6	7	7	11	3	67
2nd Count													
Replicate 1	2	2	0	4	2	3	22	8	20	12	7	14	96
Replicate 2	4	5	0	1	1	2	17	23	31	14	10	8	116
Total	6	7	0	5	3	5	39	31	51	26	17	22	212
Replicate Difference	2	3	0	3	1	1	5	15	11	2	3	6	52
3rd Count													
Replicate 1	4	3	0	6	6	4	2	4	15	2	4	8	58
Replicate 2	5	2	0	1	1	0	4	1	13	4	3	12	46
Total	9	5	0	7	7	4	6	5	28	6	7	20	104
Replicate Difference	1	1	0	5	5	4	2	3	2	2	1	4	30
4th Count													
Replicate 1	7	4	0	5	1	2	8	5	5	6	2	12	57
Replicate 2	3	6	2	1	0	0	2	9	0	6	21	1	51
Total	10	10	2	6	1	2	10	14	5	12	23	13	108
Replicate Difference	4	2	2	4	1	2	6	4	5	0	19	11	60
GRAND TOTALS	34	33	6	47	24	33	86	116	99	75	108	114	775

TABLE I (continued)

Area B1

	Tree Numbers						
1st Count	19	20	21	22	23	24	Totals
Replicate 1	19	33	17	18	16	19	122
Replicate 2	55	46	26	36	25	34	222
Total	74	79	43	54	41	53	344
Replicate Difference	36	13	9	18	9	15	100
2nd Count							
Replicate 1	20	21	10	36	14	13	114
Replicate 2	22	17	6	20	11	8	84
Total	42	38	16	56	25	21	198
Replicate Difference	2	4	4	16	3	5	34
3rd Count							
Replicate 1	8	12	17	10	19	3	69
Replicate 2	6	7	2	3	13	5	36
Total	14	19	19	13	32	8	105
Replicate Difference	2	5	15	7	6	2	37
GRAND TOTALS	130	136	78	123	98	82	647

TABLE II

Spruce Budworm Population Per Replicate for
Each Tree in All Counts by Areas in 1947

Area A1

	Tree Numbers						
1st Count	1	2	3	4	5	6	Totals
Replicate 1	0	2	8	11	4	1	26
Replicate 2	0	5	4	6	2	4	21
Total	0	7	12	17	6	5	47
Replicate Difference	0	3	4	5	2	3	17
2nd Count							
Replicate 1	9	6	12	14	3	7	51
Replicate 2	13	6	3	11	3	5	41
Total	22	12	15	25	6	12	92
Replicate Difference	4	0	9	3	0	2	18
3rd Count							
Replicate 1	13	15	9	8	12	8	65
Replicate 2	23	22	6	7	8	17	83
Total	36	37	15	15	20	25	148
Replicate Difference	10	7	3	1	4	9	34
4th Count							
Replicate 1	3	0	8	11	3	3	28
Replicate 2	8	2	0	0	0	3	13
Total	11	2	8	11	3	6	41
Replicate Difference	5	2	8	11	3	0	29
GRAND TOTALS	69	58	50	68	35	48	328

TABLE II (continued)

Area A2

	Tree Numbers												
1st Count	7	8	9	10	11	12	13	14	15	16	17	18	Totals
Replicate 1	16	7	2	1	12	7	4	4	11	6	6	13	89
Replicate 2	11	12	7	6	2	6	2	3	39	8	7	8	111
Total	27	19	9	7	14	13	6	7	50	14	13	21	200
Replicate Difference	5	5	5	5	10	1	2	1	28	2	1	5	70
2nd Count													
Replicate 1	5	27	2	4	3	4	16	18	6	12	7	8	112
Replicate 2	4	3	2	2	0	3	15	12	8	4	15	26	94
Total	9	30	4	6	3	7	31	30	14	16	22	34	206
Replicate Difference	1	24	0	2	3	1	1	6	2	8	8	18	74
3rd Count													
Replicate 1	8	11	3	9	4	4	2	11	6	3	4	4	69
Replicate 2	10	19	3	2	7	4	4	9	12	5	7	6	88
Total	18	30	6	11	11	8	6	20	18	8	11	10	157
Replicate Difference	2	8	0	7	3	0	2	2	6	2	3	2	37
4th Count													
Replicate 1	1	3	1	2	1	5	0	0	7	2	5	1	28
Replicate 2	1	3	2	1	0	1	2	3	2	0	0	1	16
Total	2	6	3	3	1	6	2	3	9	2	5	2	44
Replicate Difference	0	0	1	1	1	4	2	3	5	2	5	0	24
GRAND TOTALS	56	85	22	27	29	34	45	60	91	40	51	67	607

TABLE II (continued)

Area B1

	Tree Numbers						
1st Count	19	20	21	22	23	24	Totals
Replicate 1	16	9	4	10	8	10	57
Replicate 2	3	2	9	5	2	6	27
Total	19	11	13	15	10	16	84
Replicate Difference	13	7	5	5	6	4	40
2nd Count							
Replicate 1	12	8	10	21	8	13	72
Replicate 2	18	1	8	13	6	7	53
Total	30	9	18	34	14	20	125
Replicate Difference	6	7	2	8	2	6	31
3rd Count							
Replicate 1	9	4	11	5	2	9	40
Replicate 2	6	4	8	3	4	14	39
Total	15	8	19	8	6	23	79
Replicate Difference	3	0	3	2	2	5	15
4th Count							
Replicate 1	7	1	2	6	2	3	21
Replicate 2	3	2	1	2	1	3	12
Total	10	3	3	8	3	6	33
Replicate Difference	4	1	1	4	1	0	11
GRAND TOTALS	74	31	53	65	33	65	321

TABLE III

Spruce Budworm Population Per Replicate for Each Tree in All Counts by Areas in 1948

Area B3

	Tree Numbers						
1st Count	241	242	243	244	245	246	Totals
Replicate 1	53	18	28	37	34	14	184
Replicate 2	44	45	53	32	65	15	254
Total	97	63	81	69	99	29	438
Replicate Difference	9	27	25	5	31	1	98
2nd Count							
Replicate 1	6.17	10.18	11.01	14.47	21.96	4.10	67.89
Replicate 2	5.54	6.87	22.74	16.62	18.31	2.97	73.05
Total	11.71	17.05	33.75	31.09	40.27	7.07	140.94
Replicate Difference	.63	3.31	11.73	2.15	3.65	1.13	22.60
3rd Count							
Replicate 1	3.73	.66	2.00	6.84	2.00	.69	15.92
Replicate 2	2.45	0	2.10	7.08	3.00	4.00	18.63
Total	6.18	.66	4.10	13.92	5.00	4.69	34.55
Replicate Difference	1.28	.66	.10	.24	1.00	3.31	6.59
GRAND TOTALS	114.89	80.71	118.85	114.01	144.27	40.76	613.49

Area B4

	Tree Numbers						
1st Count	247	248	249	250	251	252	Totals
Replicate 1	67	39	31	21	43	73	274
Replicate 2	63	30	33	70	27	51	274
Total	130	69	64	91	70	124	548
Replicate Difference	4	9	2	49	16	22	102
2nd Count							
Replicate 1	11.87	4.31	45.70	1.89	11.93	2.90	78.60
Replicate 2	14.11	1.00	25.48	3.16	8.47	5.73	57.95
Total	25.98	5.31	71.18	5.05	20.40	8.63	136.55
Replicate Difference	2.24	3.31	20.22	1.27	3.46	2.83	33.33
3rd Count							
Replicate 1	1.00	.69	1.00	0	0	2	4.69
Replicate 2	2.00	0	5.80	0	4.44	1	13.24
Total	3.00	.69	6.80	0	4.44	3.00	17.93
Replicate Difference	1.00	.69	4.80	0	4.44	1.00	11.93
GRAND TOTALS	158.98	75.00	141.98	96.05	94.84	135.63	702.48

TABLE IV

Spruce Budworm Population Per Replicate for Each Tree in All Counts by Areas in 1949

Area AII

	Tree Numbers				
1st Count	10	2	9	5	Totals
Replicate 1	9.07	2.96	4.76	4.33	21.12
Replicate 2	3.63	13.31	8.80	2.49	28.23
Total	12.70	16.27	13.56	6.82	49.35
Replicate Difference	5.44	10.35	4.04	1.84	21.67
2nd Count					
Replicate 1	6	1	0	3	10.00
Replicate 2	3	1	0	.40	4.40
Total	9	2	0	3.40	14.40
Replicate Difference	3	0	0	2.60	5.60
GRAND TOTALS	21.70	18.27	13.56	10.22	63.75

Area A-III

	Tree Numbers				
1st Count	11	7	1	4	Totals
Replicate 1	3.49	5.92	9.12	3.00	21.53
Replicate 2	3.81	6.48	11.80	5.28	27.37
Total	7.30	12.40	20.92	8.28	48.90
Replicate Difference	.32	.56	2.68	2.28	5.84
2nd Count					
Replicate 1	0	0	3.00	0	3.00
Replicate 2	2	2.53	.67	0	5.20
Total	2	2.53	3.67	0	8.20
Replicate Difference	2	2.53	2.33	0	6.86
GRAND TOTALS	9.30	14.93	24.59	8.28	57.10

TABLE IV (continued)

Area A-V

1st Count	Tree Numbers 16	15	12	13	19	Totals
Replicate 1	4.74	15.20	5.73	14.28	11.07	51.02
Replicate 2	5.47	10.31	2.07	10.95	7.09	35.89
Total	10.21	25.51	7.80	25.23	18.16	86.91
Replicate Difference	.73	4.89	3.66	3.33	3.98	16.59
2nd Count						
Replicate 1	4.00	5.00	4.00	2.00	1	15.00
Replicate 2	1.00	9.00	7.00	2.75	0	19.75
Total	5.00	14.00	11.00	4.75	1	34.75
Replicate Difference	3.00	4.00	3.00	.75	1	10.75
GRAND TOTALS	15.21	39.51	18.80	29.98	19.16	121.66

Area A-VI

1st Count	Tree Numbers 12	20	Totals
Replicate 1	19.73	18.21	37.94
Replicate 2	21.93	15.29	47.22
Total	41.66	33.50	75.16
Replicate Difference	2.20	2.92	5.12
2nd Count			
Replicate 1	8.49	19.00	27.49
Replicate 2	8.01	15.00	23.01
Total	16.50	34.00	50.50
Replicate Difference	.49	4.00	4.48
GRAND TOTALS	58.16	67.50	125.66

The following tables, V, VI, VII, and VIII show the analysis of variance of the spruce budworm population data as found in Tables I, II, III, and IV.

TABLE V

Analysis of Variance of Spruce Budworm Population Data by Areas for 1946

Area A1

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	690	5	138	2.3	2.62	3.90
Counts	1192	3	394	6.5	3.01	4.72
Interaction	1584	15	105.6			
Within Trees	1458	24	60.5			
Total		47				

Area B1

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	528	5	105.6	1.9	2.60	3.90
Counts	2419	3	806.3	14.6	3.01	4.72
Interaction	828	15	55.2			
Within Trees	1426	24	55.2			
Total		47				

Area A2

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	2130.1	11	193.6	10.9	1.99	2.64
Counts	1686.2	3	562.1	31.6	2.80	4.22
Interaction	2535.7	33	76.8			
Within Trees	855.5	48	17.8			
Total		95				

TABLE VI

Analysis of Variance of Spruce Budworm Population Data by Areas for 1947

Area A1

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	105.7	5	21.1	1.3	2.62	3.90
Counts	613.5	3	204.5	13.0	3.01	4.72
Interaction	356.9	15	224.6			
Within Trees	376.5	24	15.7			
Total		47				

Area B1

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	202	5	40.4	3.2	2.62	3.90
Counts	354	3	11.8	1.0	8.64	26.6
Interaction	198	15	13.2			
Within Trees	297	24	12.4			
Total		47				

Area A2

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	682.8	11	62.1	2.5	1.99	2.64
Counts	704.5	3	234.8	9.6	2.80	4.22
Interaction	1219.2	33	36.9			
Within Trees	1170.5	48	24.4			
Total		95				

TABLE VII

Analysis of Variance of Spruce Budworm Population Data by Areas for 1948

Area B3

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	1264.0	5	252.8	3.5	2.77	4.25
Counts	7289.1	2	3644.5	50.41	3.55	6.01
Interaction	915.8	10	91.60			
Within Trees	1302.1	18	72.3			
Total		35				

Area B4

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	904.5	5	180.9	1.7	2.77	4.25
Counts	12898.3	2	6449.2	62.2	3.55	6.01
Interaction	2831.6	10	283.2			
Within Trees	1866.8	18	103.7			
Total		35				

TABLE VIII

Analysis of Variance of Spruce Budworm Population Data in Area "A" for 1949

Class II

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	19.25	3	6.42	.62	8.84	27.49
Counts	76.35	1	76.35	7.38	5.32	11.26
Interaction	24.02	3	8.01			
Within Trees	82.75	8	10.34			
Total		15				

Class III

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	41.88	3	13.73	7.67	4.07	7.59
Counts	103.53	1	103.53	57.84	5.32	11.26
Interaction	19.38	3	6.46			
Within Trees	14.31	8	1.79			
Total		15				

Class V

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	112.88	4	28.22	5.68	3.48	5.99
Counts	136.04	1	136.04	27.37	4.96	10.04
Interaction	85.39	4	21.35			
Within Trees	49.67	10	4.97			
Total		19				

Class VI

	Sums of Squares	Degrees of Freedom	Variance	F	5%	1%
Trees	10.90	1	10.90	2.95	7.71	21.20
Counts	76.01	1	76.01	20.54	7.71	21.20
Interaction	82.12	1	82.12			
Within Trees	14.81	4	3.70			
Total		7				

As inter-tree variability was significantly higher than intra-tree variability in only one half the series, it is felt that the sampling technique is not as precise as desirable although it probably gives a fair estimate of the population.

Results obtained at Sault Ste. Marie showed that unless samples were taken under similar conditions of light, exposure and temperature, the variability would tend to be increased. These factors probably contributed to the few sets of data showing significant differences since temperature, light and exposure conditions often varied greatly from one place to another on the same sample tree.

However, as it is felt that the sampling technique is of sufficient accuracy to give fair estimates of the population the population reduction data, which to be of value necessitates accurate sampling, can be discussed with the view that the figures are fairly accurate.

Before discussing the population reduction data it is necessary to define apparent and actual mortality as applied to parasitism. Apparent mortality consists of larval and pupal parasitism as determined from parasite rearings and larval and pupal dissections. The actual mortality on the other hand, represents that portion of the original spring population destroyed by the parasites or other factors under consideration.

Tables IX and X show in tabular form the annual reduction in larval and pupal populations for the four years. All figures in Table IX represent the number of spruce budworm larvae and pupae per 100 terminals.

TABLE IX

Reduction in Spruce Budworm Population by
Various Mortality Factors Per 100 Terminals

Year	Initial Population of Live & Dead Larvae	Initial Population of Live Larvae Only	Final Population of Live & Dead Pupae	Final Population of Live Pupae Only	Larval Parasitism	Pupal Parasitism	Dead, Diseased and Predatorized	Unknown Mortality
1946	19.0	18.0	4.8	1.7	5.1	1.3	3.1	7.8
1947	9.0	8.8	3.0	1.3	1.7	.7	1.8	3.5
1948	20.5	20.3	1.0	.5	.5	.3	.5	18.7
1949	3.0	2.9	.6	.3	.9	.1	.3	1.4

TABLE X

Reduction in Spruce Budworm Population
in Per Cent by Various Mortality Factors

Year	Apparent Mortality		Actual Mortality			Unknown	Population Reduction
	Larval Parasites	Pupal Parasites	Larval Parasites	Pupal Parasites	Dead, Diseased & Predatorized		
1946	45.7	45.8	26.9	6.9	16.0	41.1	90.9
1947	22.1	35.7	19.2	7.8	19.7	39.3	86.0
1948	9.5	35.6	2.8	1.3	2.0	91.5	97.6
1949	31.0	19.5	31.0	2.3	12.0	44.9	90.2

The accompanying figures, 6, 7, 8, and 9, show graphically the part played in population reduction by each factor.

(Insert Figs. 6, 7, 8, & 9 here)

From Table X it can be seen that over the four year period the decline of the budworm population from the time of larval establishment in the spring to the end of pupation varied from 86 per cent to 97.6 per cent. In 1946 the reduction was 90.9 per cent and in 1947 the reduction dropped to 86 per cent. The highest population reduction occurred in 1948 when it was 97.6 per cent. The 1949 figure had dropped back to the 1946 level and was determined to be 90.2 per cent.

Efforts were made to classify the importance of the various factors causing spruce budworm mortality. One factor which could be readily determined was parasitism. A summary of larval and pupal parasite mortality is given below in Table XI.

TABLE XI

Apparent and Actual Parasite Reduction Percentages of the Spruce Budworm Over a Four Year Period

	Larval		Pupal	
Year	Apparent Mortality	Actual Mortality	Apparent Mortality	Actual Mortality
1946	45.7%	26.9%	43.8%	6.9%
1947	22.1%	19.2%	35.7%	7.8%
1948	9.5%	2.8%	35.6%	1.3%
1949	31.0%	31.0%	19.5%	2.3%

Most of the parasite mortality was produced by two species of hymenopterous larval parasites, Apanteles fumiferanae (Vier.) and Glypta fumiferanae (Vier.), and several species of dipterous larval parasites, Zenillia caesar (Aldrich), Phorocera sp., and Phryxe pecosensis (Townsend), and an Ichneumon, Itoplectis conquisitor (Say), which attacks only pupae.

It is evident that the real larval and pupal mortalities were extremely low in 1948. This is best explained by the fact that when the degree of parasitism was determined the budworm population had already dropped greatly from the level recorded in the spring.

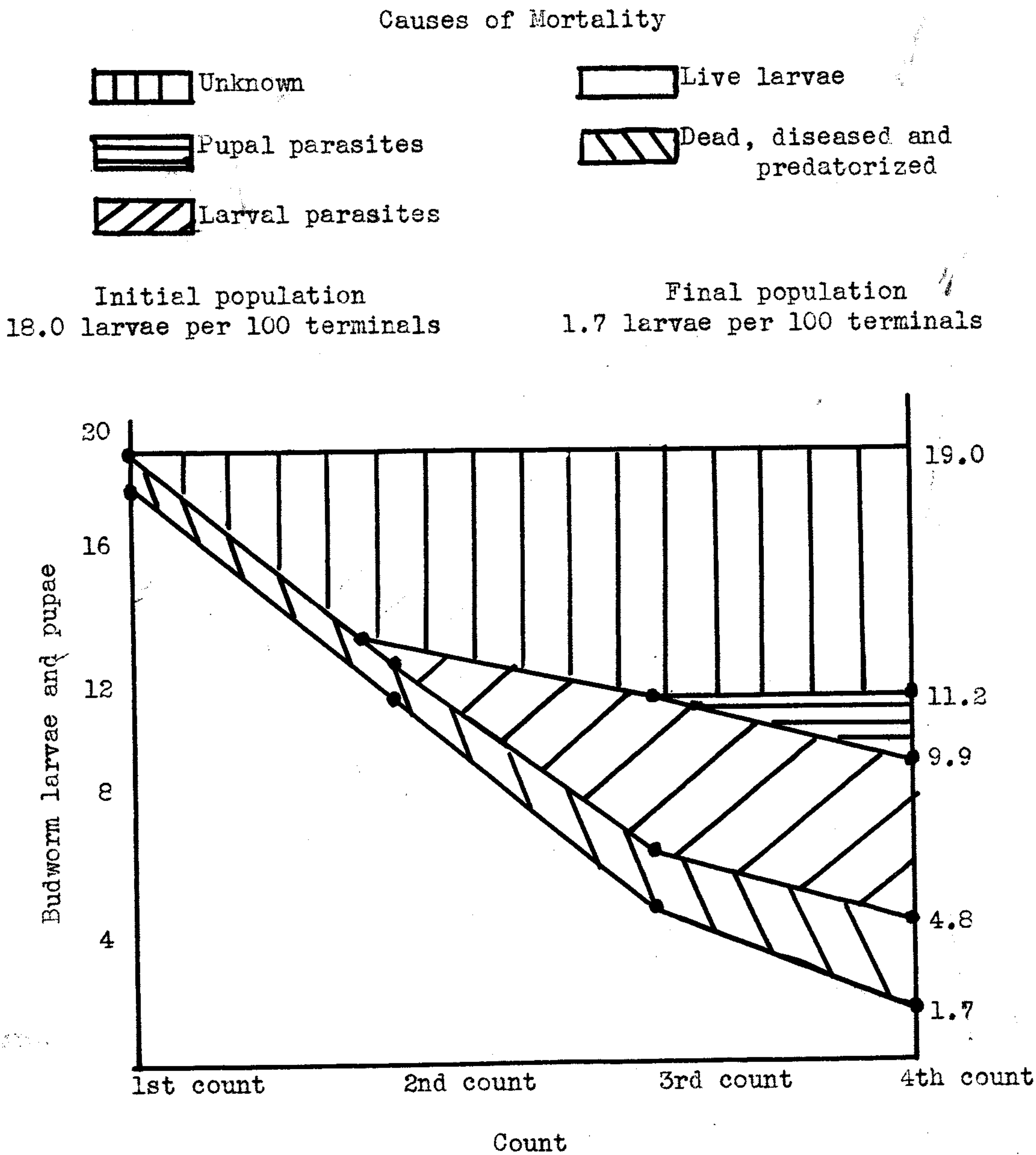


Figure 6. Graph showing reduction of spruce budworm population in 1946.

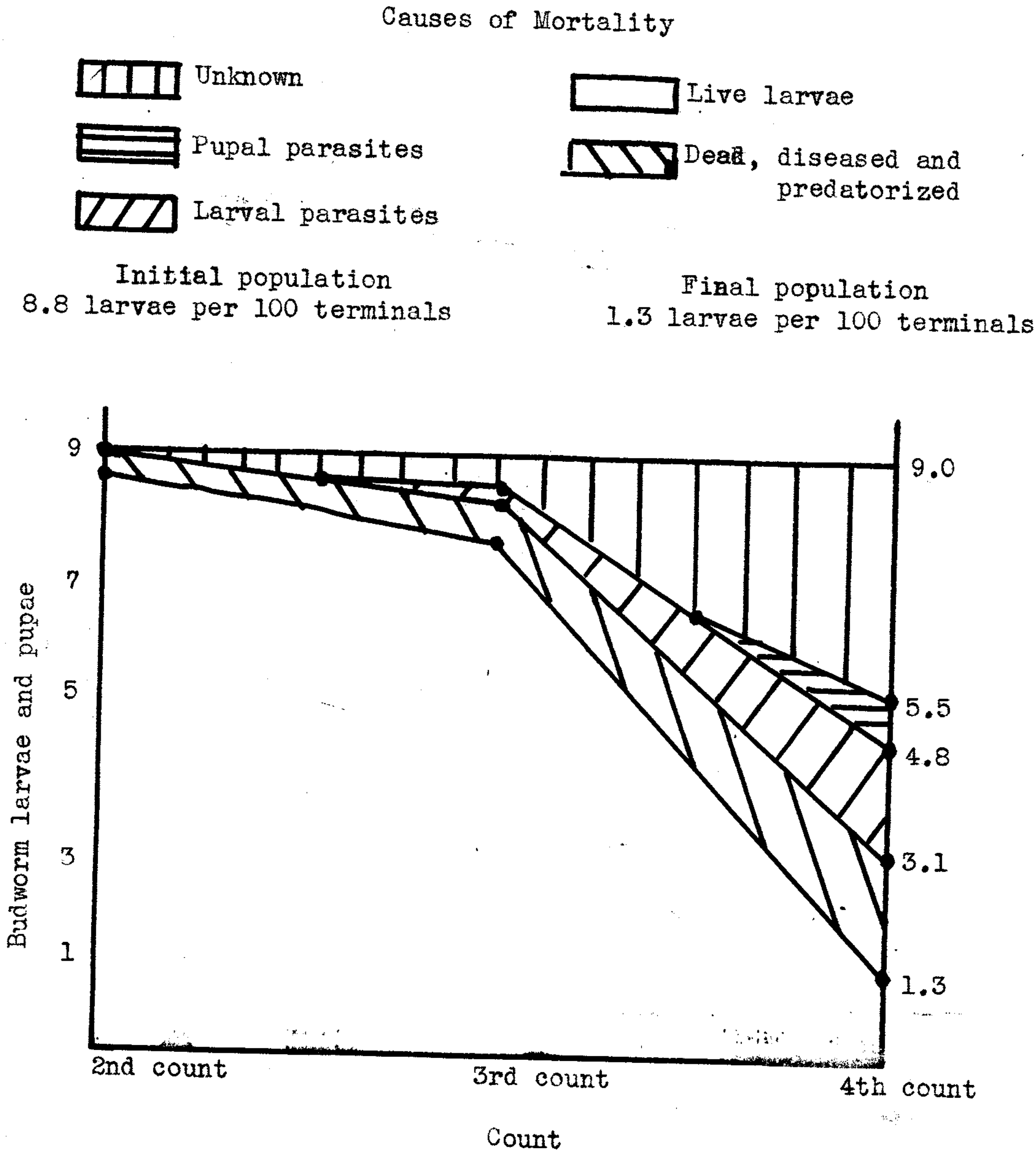


Figure 7. Graph showing reduction of spruce budworm population in 1947.

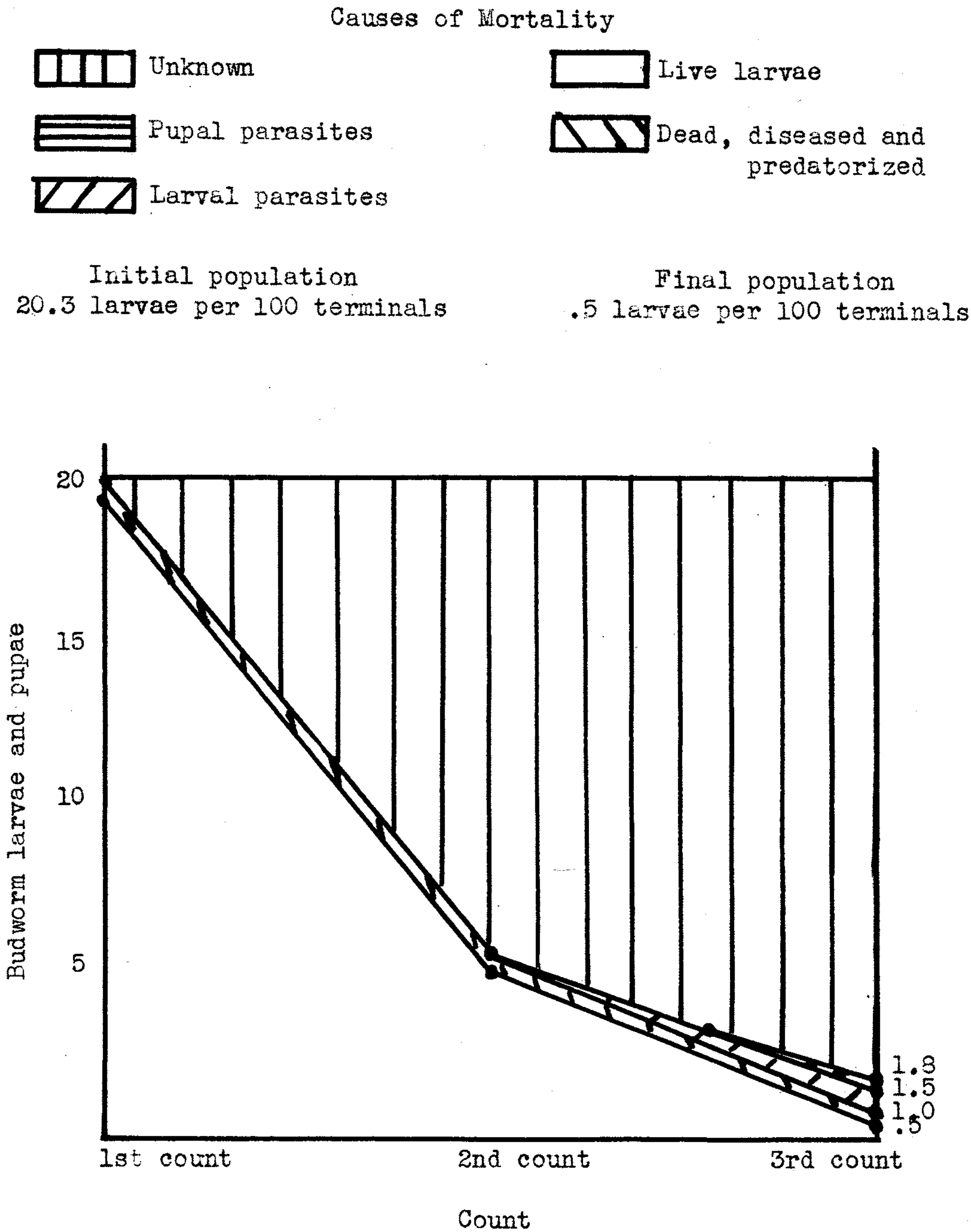


Figure 8. Graph showing reduction of spruce budworm population in 1948.

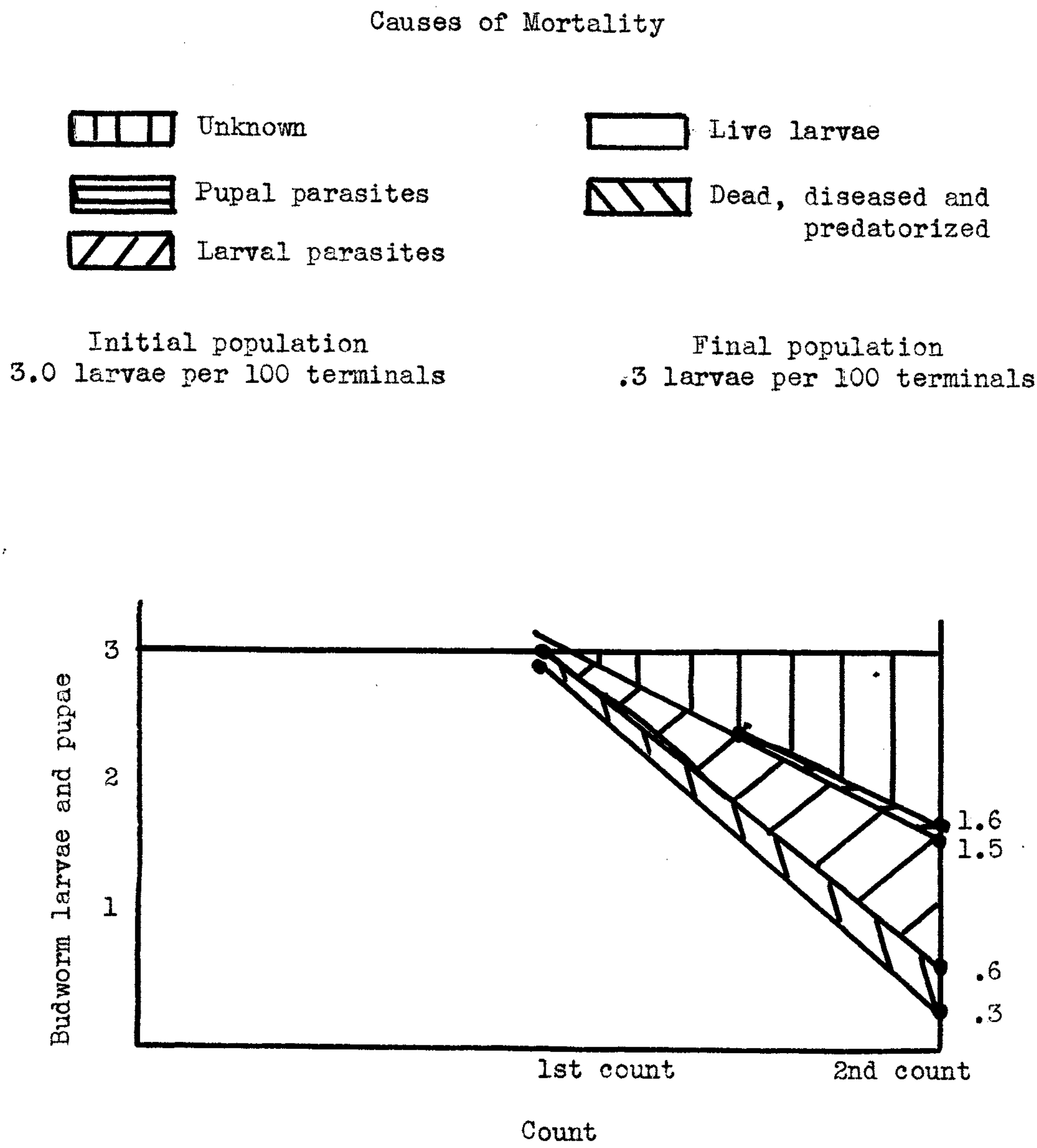


Figure 9. Graph showing reduction of spruce budworm population in 1949.

A number of dead, diseased and predatorized larvae and pupae were collected each year in population counts. Only occasional diseased larvae were found, but it is believed that the numbers are lower than they should be as dead and diseased larvae were recorded only when a count was conducted.

The spruce needleworm and dragon flies were the most important predators. Once again, the predation is thought to be greatly underestimated as predation was going on continually.

By grouping the totals for dead, diseased and predatorized together it was found that this factor accounted for 16 per cent of the total population reduction in 1946, for 19.7 per cent in 1947, for 2.0 per cent in 1948, and for 12.0 per cent in 1949. It can be seen that the figures for 1946, 1947 and 1949, were fairly constant, while the figure for 1948 was exceptionally low.

As previously stated predatorized larvae were gathered only during population counts, and since hordes of dragon flies were seen in the field in 1948, it is probable that a large number of budworm were destroyed, but only a small fraction was recorded.

Each year there is a large mortality of spruce budworm larvae and pupae which cannot be accounted for. It appears that on the average, the unknown factors are fairly constant from year to year.

In 1946 the unknown mortality amounted to 41.1 per cent of the total reduction, in 1947 for 39.5 per cent, in 1948 for 91.5 per cent and in 1949 for 44.9 per cent of the total. The large deviation from the usual in 1948 could probably be best explained by the fact that only a fraction of the predatorized larvae were recorded. As it has already been mentioned that the dragon flies were very numerous in that year, predation by them was probably extremely high, thus giving a large value for unknown mortality.

In the four years under discussion there has been a steady decline in egg populations. When egg clusters were gathered they were reared until the heads of the larvae could be seen emerging from the egg, at which time the clusters were preserved and viable eggs recorded. The following figures therefore, consist of larvae which were ready to emerge and form the initial population for the next year.

In 1946 the egg count gave a potential spring population of 135.5 larvae per 100 terminals. This number, however, was calculated on the basis of the number of eggs per cluster, and the number of clusters per sample in one area only, as only one area of the three was available for study at that time. In 1947 there was a marked decline, the figure being 29.9 larvae per 100 terminals. In 1948 the number dropped further to 28.6 per 100 terminals, and in 1949 to 6.2 larvae per 100 terminals. Because the egg populations have been steadily declining, it would appear that the infestation is either shifting or dying out in this area.

4. Conclusions

It is the author's belief that biological control factors cause a heavier mortality of spruce budworm larvae than any other factors during the period of seasonal development. Although a large portion of the decline in population each year is attributed to unknown causes, it is felt that predators and disease, especially the former, comprise the main component of this category.

Another result considered of value is that certain factors exact a fairly constant toll of the spruce budworm population. From this information it may be possible to infer or predict, under similar circumstances, that a given percentage of the larval population in the spring will be destroyed by the end of the pupal period. In this study the total mortality during this time averaged 91 per cent, and the unknown mortality was fairly constant at about 42 per cent.

5. Summary

During the four year period the population reduction data as determined from population and parasite counts has brought out the following information.

(a) The annual drop in spruce budworm population from the initial larval count in the spring to the end of pupation averages 91 per cent.

(b) Of this decline approximately 40 per cent is due to unknown causes, approximately 26 per cent is due to larval parasites and 4.5 per cent due to pupal parasites.

(c) In some years (mainly 1948) predation by dragon flies is believed to have accounted for a large percentage of the unknown factors.

(d) Predation by the spruce needleworm also was believed to have accounted for a considerable portion of the unknown factors involved in the population decline.

(e) It was found that sampling techniques now employed are not completely satisfactory, but are accurate enought to show large variations.

6. Recommendations

The population reduction material accumulated during the past four years is considered to provide not only valuable information, but, due to the consistency of some of the figures they might be applied to a similar newly infested area, to give an idea of the changes expected to t ake place during the season.

The sampling technique although not entirely desirable will be used again in 1950. Frass studies will also be explored as a possibility for increasing the accuracy of sampling methods.

D. The Predatory Habits of the Spruce Needleworm

1. Object

This study was undertaken in 1948 and 1949 in an effort to determine the predatory habits of the spruce needleworm, *Dioryctria reniculleia* Grote. Although it is considered to be a phytophagus insect, in the Spruce Woods Forest Reserve it is also a predator of the spruce budworm. These studies have attempted to gather information on its habits which might shed some light on its value as a control factor.

2. Methods

Predatory habits of the spruce needleworm were studied essentially under controlled insectary conditions. One hundred and twenty jars, each containing a larva of the spruce needleworm and a larva of the spruce budworm, were set up as follows.

(1) 20 jars were provided with white spruce with an abundance of new shoots. Foliage was changed daily. The jars were numbered as follows:

A-I: a 1-5
b 1-5
c 1-5
d 1-5

(2) 20 jars were provided with foliage as above but it was changed every second day. These jars were numbered as follows:

A-II: e 1-5
f 1-5
g 1-5
h 1-5

(3) 20 jars were provided with old foliage which was changed daily. These jars were numbered as follows:

A-III: i 1-5
j 1-5
k 1-5
l 1-5

A complete replication of the above was also set up and labelled as follows:

(1) B-IV: m 1-5
n 1-5
o 1-5
p 1-5

(2) B-V: q 1-5
r 1-5
s 1-5
t 1-5

(3) B-VI: u 1-5
v 1-5
w 1-5
x 1-5

Each larva was provided with one terminal shoot and jars were examined daily. When a budworm larva was found to be dead or chewed it was discarded and replaced with another.

Field observations indicated that prior to pupation of Dioryctria, a white silken cocoon is spun by the larva which could envelop as many as four budworm pupae, each of which was later predatorized. To test the nature of this reaction under artificial conditions, series of from 1 - 5 budworm pupae were placed in jars under the various food conditions described above. Results were unsatisfactory however, as the needleworm larvae were disturbed and webs continually broken due to handling.

As the needleworm larvae in the insectary rearings pupated, the pupae were measured. When the adults emerged they were sexed as accurately as possible, paired in jars according to their food habits during their larval life, and foliage was added upon which it was hoped the Dioryctria females would oviposit. This was done to obtain egg clusters to determine the effect of larval diet on fecundity and fertility.

When drawing up the following tables, not all Dioryctria were included as some were used only for a day or so and died before they had a chance to feed. Therefore only those larvae which survived to pupate were used.

3. Analysis of Data and Discussion

Before the results of the work are tabulated, it is advisable to consider briefly the habits of the needleworm under natural conditions.

In the spring of the year the budworm larvae mine old needles until the new buds are well enough advanced to support them. It is not known at the present time whether Dioryctria larvae have similar habits. It is known, however, that they do bore into the unopened buds as do the budworm larvae.

The two insects parallel one another very closely throughout the larval stages, although the needleworm matures somewhat later. Both insects seem to have the same foliage habits, they enclose themselves in a web when feeding in an expanding terminal, and they may gather several partly eaten terminals together with a silken web.

It has been observed that the needleworm is much hardier in the larval stage than the spruce budworm larvae. They can stand much more handling and can remain alive without food for a much longer time than can the budworm larvae.

Through experience it has been found much harder to get Dioryctria adults to mate and lay eggs than the budworm; in fact as yet no eggs have been obtained in experimental trials.

The first result to be discussed is the effect of the various types of foliage on the number of budworm consumed by the larvae of the needleworm.

TABLE I

Effect of Foliage on the Number of Budworm Larvae and Pupae Concerned when Considering all *Dioryctria* Larvae Regardless of the Type of Food they Consumed

Year	Foliage Type	No. of *Dioryctria*	No. of Budworm Larvae Chewed	No. of Budworm Pupae Chewed	No. of Larvae per *Dioryctria*	No. of Pupae per *Dioryctria*	Total Budworm Per *Dioryctria*
1948	abundant	40	12	42	.3	1.5	1.8
	scarce	40	12	68	.3	1.7	2.0
	old	40	22	104	.6	2.6	3.2
Mean					.4	1.9	2.3
1949	abundant	40	11	55	.3	1.4	1.7
	scarce	40	14	53	.4	1.3	1.7
	old	40	41	93	1.0	2.3	3.3
Mean					.6	1.7	2.2

In 1948 and 1949 the figures show the same trend. It was believed that if abundant foliage were available at all times in the field, predation would be low due to the fact that the needleworm is phytophagus by nature. As foliage was decreased, however, predation would increase out of necessity.

The above results are depicted graphically in the following figure.

(Insert Fig. 10 here)

As depicted by Figure 10, such was true in the two years of the experiment. Where abundant new foliage was available predation in 1948 amounted to 1.8 budworm per needleworm. Under scarce foliage conditions, predation increased to 2.0 budworm per needleworm, while on old foliage it had increased to 3.2 budworm per needleworm. The same trend was found in 1949.

It has been stated that Dioryctria is mainly a pupal predator and Figure 10 shows this very clearly. On the three types of foliage predation was heaviest in the budworm pupal stage although the ratio of larvae to pupae chewed in the different foliage classes in the two years varied considerably.

The following table shows the amount of predation occurring when Dioryctria larvae feed only on a single stage of the budworm.

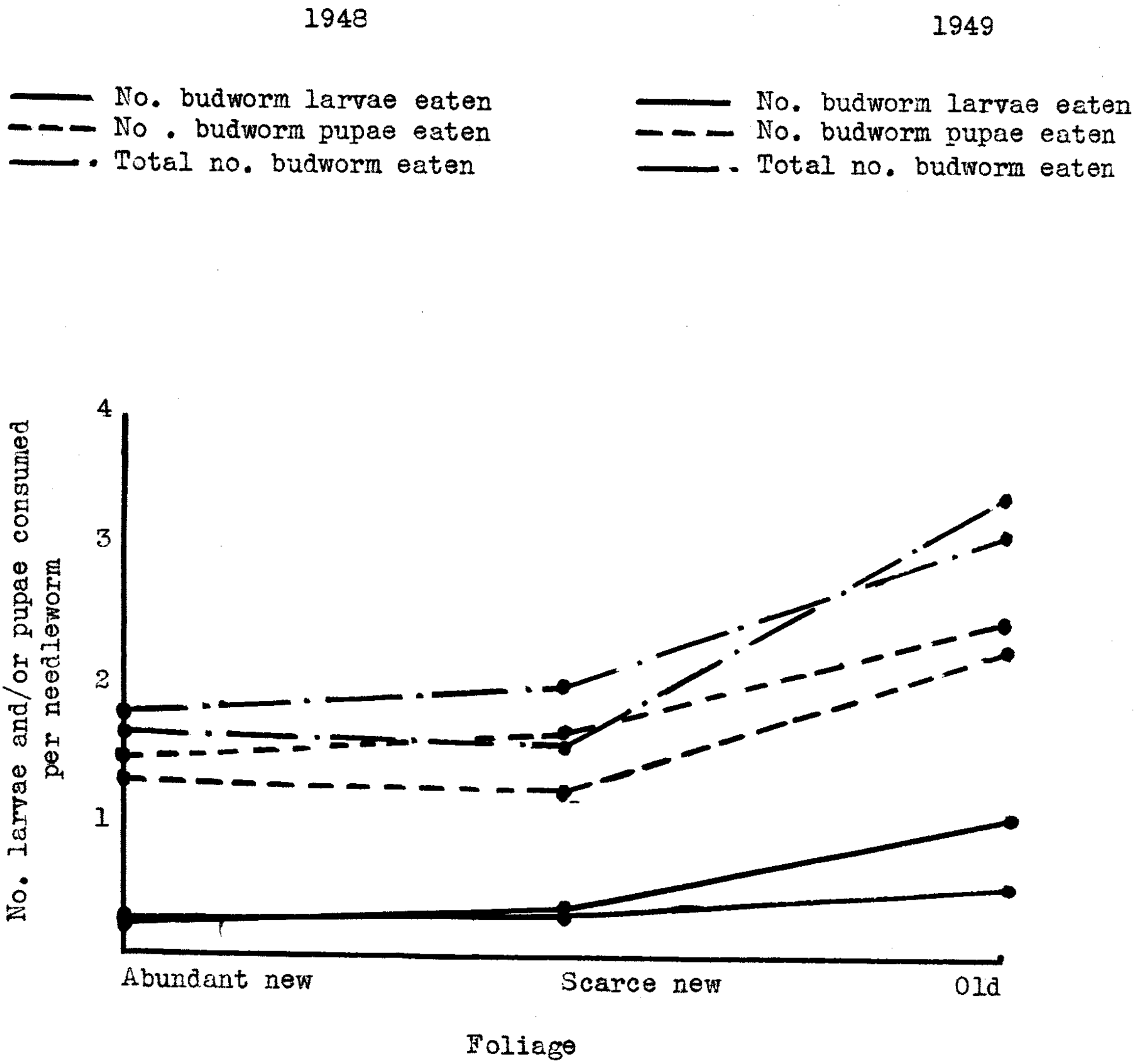


Figure 10. The affect of various types of foliage on the number of budworm consumed per spruce needleworm.

TABLE II

The Effect of the Diet of Dioryctria on the Number of Budworm Larvae or Pupae Consumed when Considering Only those Dioryctria which Fed on a Single Stage of the Budworm

Year	Foliage Type	No. of Dioryctria fed on Budworm Larvae Only	No. of Larvae Consumed	No. of Larvae per Dioryctria
1948	abundant	5*	5	1.0
	scarce	6	6	1.0
	old	4	5	1.2
Total		15	16	1.1(Mean)
1949	abundant	4	7	1.8
	scarce	7	10	1.4
	old	6	12	2.0
Total		18	29	1.6(Mean)

* Larvae fed on only budworm larvae and foliage.

Year	Foliage Type	No. of Dioryctria fed on Budworm Pupae Only	No. of Pupae Consumed	No. of Pupae per Dioryctria
1948	abundant	12*	26	2.2
	scarce	18	55	3.1
	old	16	58	3.6
Total		46	139	3.0(Mean)
1949	abundant	21	51	2.4
	scarce	22	47	2.1
	old	12	37	3.1
Total		55	135	2.6(Mean)

* Larvae fed on only budworm pupae and foliage.

It is evident from the above table that the statement referring to the needleworm being primarily a pupal predator is true as about twice as many pupae as larvae were destroyed.

The following table also refers to the effect of the diet of the needleworm larvae on the number of budworm destroyed, but in this case only Dioryctria which fed on both budworm larvae and pupae were considered.

TABLE III

The Effect of the Diet of Dioryctria on the Number of Budworm Larvae and Pupae Consumed Considering only those Dioryctria which Fed on Both Budworm Larvae and Pupae

Year	Foliage Type	No. of Dioryctria Fed on Budworm Larvae & Pupae	No. Larvae Eaten	No. Pupae Eaten	No. Larvae per Dioryctria	No. Pupae per Dioryctria
1948	abundant	5	6	16	1.2	3.2
	scarce	6	6	13	1.0	2.2
	old	14	17	46	1.2	3.3
Total		25	29	75	1.1	2.9 Mean
1949	abundant	3	4	6	1.3	2.0
	scarce	3	3	6	1.0	2.0
	old	19	31	52	1.6	2.7
Total		24	38	64	1.3	2.2 Mean

The above table seems to indicate that diet does not seem to alter predation a great deal as the numbers of larvae and pupae chewed per needleworm are very similar to those found in Tables I and II, where the needleworm larvae were subjected to diets other than that found in Table III.

Table IV is based on the preceding tables but in this case the percentage of Dioryctria preying on individual budworm stages is listed.

TABLE IV

The Percentage of Dioryctria Preying on Budworm Larvae and/or Pupae

Year	Foliage	% Dioryctria Preying on Only Budworm Larvae	% Dioryctria Preying on Only Budworm Pupae	% Dioryctria Preying on Both Larvae and Pupae	Total % Dioryctria Preying on Budworm
1948	abundant	12.5	30.0	12.5	55.0
	scarce	15.0	45.0	15.0	75.0
	old	10.0	40.0	35.0	85.0
Mean		12.5	38.3	20.8	71.7
1949	abundant	10.0	52.5	7.5	70.0
	scarce	17.5	55.0	7.5	80.0
	old	17.5	30.0	45.0	92.5
Mean		15.0	45.8	20.0	80.8

It is of interest to note that the percentages of Dioryctria preying on larvae or larvae and pupae both, are very similar, but a great deal less than the percentage of needleworms feeding on budworm pupae.

The following graph shows the results graphically and clearly indicates the prevalence of Dioryctria as a pupal predator.

(Insert Fig. 11 here)

At the time the experiment was set up it was believed that the number of budworm consumed might be greatly affected by the sex of the needleworm larva. The following table lists the number of budworm larvae and pupae consumed per male and female Dioryctria.

TABLE V

Effect of the Sex of the Dioryctria Larva on the Number of Budworm Larvae and Pupae Consumed

		Male Dioryctria				
Year	Foliage Type	No. Dioryctria	No. Budworm Larvae	No. Budworm Pupae	No. Larvae per Dioryctria	No. Pupae per Dioryctria
1948	abundant	19	4	16	.2	.8
	scarce	12	5	21	.4	1.8
	old	14	7	46	.5	3.3
Mean					.4	2.0
1949	abundant	2	0	6	0	3.0
	scarce	3	0	7	0	2.3
	old	9	13	22	1.4	2.4
Mean					.5	2.9

		Female Dioryctria				
Year	Foliage Type	No. Dioryctria	No. Budworm Larvae	No. Budworm Pupae	No. Larvae per Dioryctria	No. Pupae per Dioryctria
1948	abundant	14	6	13	.4	.9
	scarce	18	6	31	.3	1.7
	old	13	9	43	.7	3.3
Mean					.5	2.0
1949	abundant	8	0	14	0	1.8
	scarce	8	2	18	.2	2.2
	old	15	15	34	1.0	2.3
Mean					.4	2.1

The above table clearly indicates that when the three foliage

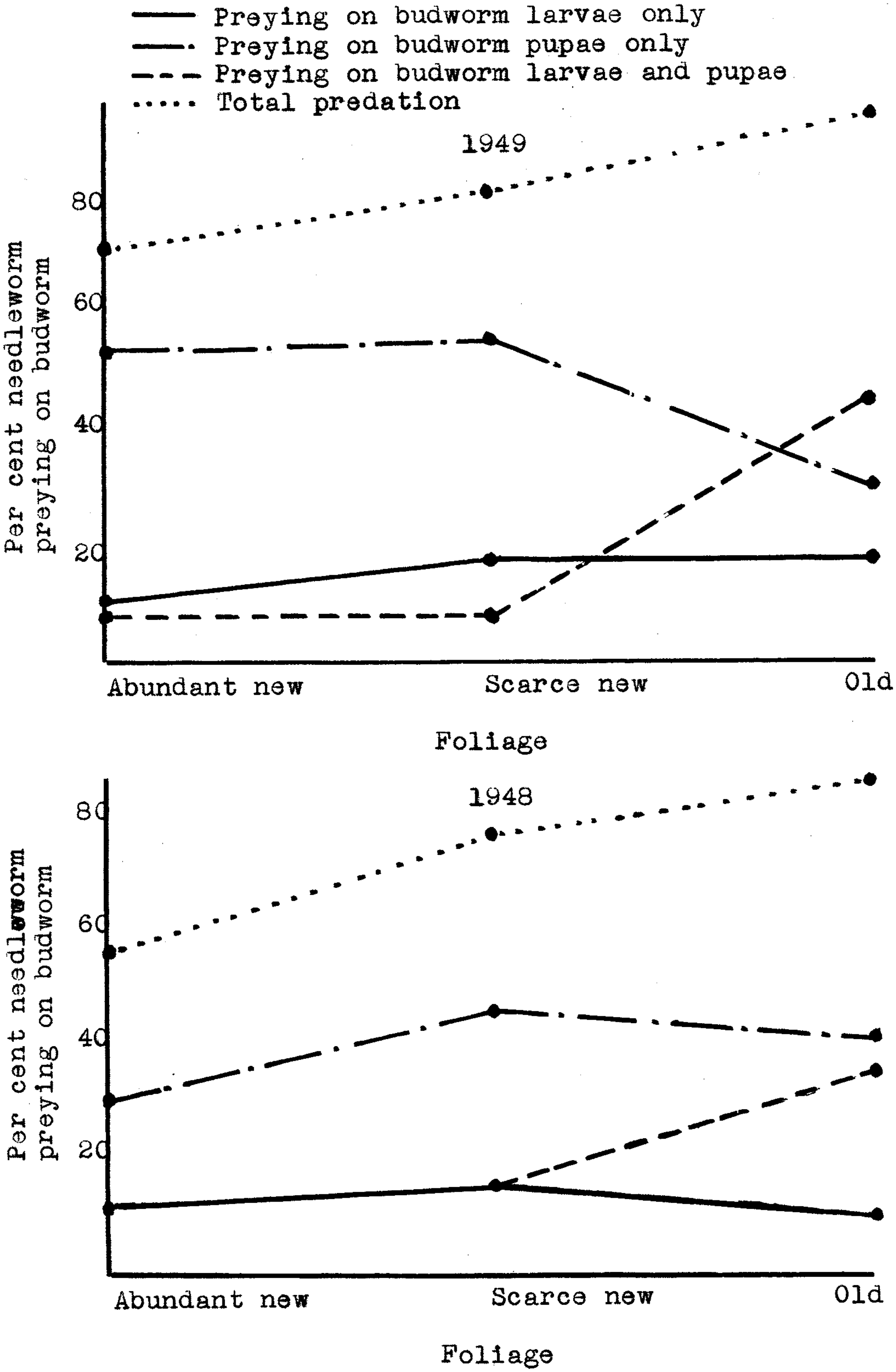


Figure 11. The effect of foliage on the prevalence of predation of the spruce budworm by the spruce needleworm.

classes are averaged the numbers of budworm larvae and pupae consumed are equal for male and female needleworm.

As stated earlier, one needleworm could envelop several budworm pupae in its web. This reaction was tested and the following data show the results obtained. The data are set out in two tables. (See pages 379 and 380 .) The first, or Table VI, gives the total figures while the second, or Table VII, is the figures per Dioryctria larva. It should be stated that the treatment number refers to the number of budworm pupae placed with each Dioryctria larva. As budworm pupae were destroyed they were replaced to keep the number up to strength at all times. It was hoped that predation would increase as the number of pupae available at any one time was increased.

It is evident from the above data however, that treatment had no apparent effect on the number of budworm consumed.

As it is known that food consumed frequently affects larval and pupal size, it was thought that pupal sizes of Dioryctria might be determined or affected by their larval diets. Table VIII, shows the results of the effects of diet on size of Dioryctria pupae. (See page 380 .)

The above table, however, shows that regardless of diet the average pupal measurements are the same.

In 1948 there was a difference of 5 mm. in length between larvae on the different diets, while the average width was the same for each type.

In 1949 the average difference in length was .3 mm. as was the average difference in width. These figures would lead one to believe, therefore, that pupal size is in no way influenced by the type of food the insects receive during their larval life.

It is interesting to note that the Dioryctria larvae which fed only on foliage had the same measurements as those which fed on one or two stages of the budworm.

TABLE VI

The Effect of Treatment on the Number of Budworm Larvae and Pupae Consumed Considering all *Dioryctria* Involved

Year	Foliage Type	No. *Dioryctria* Involved	Treatment 1		Treatment 2		Treatment 3		Treatment 4		Treatment 5		Total
			Larvae	Pupae	Larvae	Pupae	Larvae	Pupae	Larvae	Pupae	Larvae	Pupae	
1948	abundant	8	2	9	3	0	2	9	1	6	4	18	54
	scarce	8	3	15	2	20	3	14	3	7	1	12	80
	old	8	8	19	4	25	2	24	3	15	5	21	126
Total		24	13	43	9	45	7	47	7	28	10	51	260
1949	abundant	8	4	12	3	10	2	14	2	9	0	11	67
	scarce	8	4	7	3	10	2	14	4	7	1	15	67
	old	8	12	15	4	15	9	22	7	21	11	20	136
Total		24	20	34	10	35	13	50	13	37	12	46	270

TABLE VII

The Effect of Treatment on the Number of
Budworm Larvae and Pupae Consumed per *Dioryctria*

Year	Treatment	Abundant Foliage			Scarce Foliage			Old Foliage		
		No. Larvae per *Dioryctria*	No. Pupae per *Dioryctria*	Total Budworm per *Dioryctria*	No. Larvae per *Dioryctria*	No. Pupae per *Dioryctria*	Total Budworm per *Dioryctria*	No. Larvae per *Dioryctria*	No. Pupae per *Dioryctria*	Total Budworm per *Dioryctria*
1948	1	.2	1.1	1.4	.4	1.9	2.3	1.0	2.4	3.4
	2	.4	0	.4	.2	2.5	2.8	.5	3.1	3.6
	3	.2	1.1	1.4	.4	1.8	2.1	.2	3.0	3.2
	4	.1	.8	.9	.4	.9	1.3	.4	1.9	2.3
	5	.5	2.3	2.8	.1	1.5	1.6	.6	2.6	3.3
Total		1.5	5.3	6.9	1.5	8.6	10.1	2.7	13.0	15.8
1949	1	.5	1.5	2.0	.5	.9	1.4	1.5	1.9	3.4
	2	.4	1.2	1.6	.4	1.2	1.6	.5	1.9	2.4
	3	.2	1.8	2.0	.2	1.8	2.0	1.1	2.8	3.4
	4	.2	1.1	1.4	.5	.9	1.4	.9	2.6	3.5
	5	0	1.4	1.4	.1	1.9	2.0	1.4	2.5	3.9
Total		1.3	7.0	8.4	1.7	6.7	8.4	5.4	11.7	16.6

TABLE VIII

Effect of Diet on Pupal Sizes of *Dioryctria* in mm.

Year	Foliage Type	*Dioryctria* Fed on Budworm Larvae						*Dioryctria* Fed on Budworm Pupae					
		Minimum Length	Minimum Width	Maximum Length	Maximum Width	Average Length	Average Width	Minimum Length	Minimum Width	Maximum Length	Maximum Width	Average Length	Average Width
1948	abundant	11.2	2.7	12.6	3.0	12.1	2.9	10.9	2.6	13.0	3.0	12.1	2.9
	scarce	11.0	2.6	12.3	3.0	11.6	2.8	11.4	2.7	14.0	3.6	12.7	3.0
	old	12.5	2.8	13.0	3.0	12.8	2.9	9.7	2.8	13.0	3.0	12.2	2.9
Mean						12.2	2.9					12.4	2.9
1949	abundant	11.5	2.5	12.8	3.5	12.1	2.9	10.5	2.6	13.5	3.5	12.3	3.1
	scarce	10.6	2.5	14.0	3.5	11.7	2.8	10.5	2.5	13.5	3.5	11.9	3.1
	old	10.5	2.7	12.8	3.3	11.7	3.0	10.4	2.6	13.5	3.5	11.6	3.0
Mean						11.8	2.8					11.9	3.1

Year	Foliage Type	*Dioryctria* Fed on Neither						*Dioryctria* Fed on Both					
		Minimum Length	Minimum Width	Maximum Length	Maximum Width	Average Length	Average Width	Minimum Length	Minimum Width	Maximum Length	Maximum Width	Average Length	Average Width
1948	abundant	11.3	2.7	13.5	3.7	12.2	3.0	11.7	2.7	14.0	3.5	13.0	3.0
	scarce	10.7	2.4	12.4	3.0	11.7	2.8	11.6	2.6	13.2	3.0	12.6	2.7
	old	12.0	2.6	12.5	2.9	12.3	2.8	11.9	2.7	13.2	3.2	12.6	3.0
Mean						12.1	2.9					12.7	2.9
1949	abundant	11.5	2.6	13.0	3.3	12.2	3.0	12.5	3.1	12.5	3.1	13.5	3.1
	scarce	11.5	2.8	11.5	2.8	11.5	2.8	12.5	2.7	12.5	3.1	12.5	2.9
	old	11.6	2.7	12.3	3.1	12.0	2.9	10.5	2.6	12.9	3.3	11.7	2.9
Mean						11.9	2.8					12.2	2.9

4. Conclusions

From the two year's data it is possible to draw some definite conclusions. The first and most apparent result is that as the amount of palatable foliage decreases, predation by the needleworm increases.

Under natural conditions there is competition for food and shelter between the spruce budworm and the spruce needleworm. If adequate foliage was present, predation would be greatly reduced. Since both species are heavy defoliators, however, new foliage is rapidly destroyed. It is evident that old foliage is distasteful to the *Dioryctria* larvae as the increase in predation between abundant and scarce foliage is only a fraction of the increase in predation from scarce to old foliage. If old foliage is as undesirable to the spruce budworm as it is to the spruce needleworm, mass migrations could be expected in areas of heavy defoliation.

Not only does the number of budworm consumed increase from abundant to scarce to old foliage, but the percentage of *Dioryctria* larvae involved in predation also increases. The best explanation for this increase is that as palatable foliage decreases, the needleworm larvae must increase their consumption of budworm to supplement their diet and remain alive. It can be expected, therefore, that in areas of heavy defoliation where all new foliage is quickly consumed, predation would, if an adequate number of needleworm larvae were present, rapidly increase and greatly reduce the number of budworms able to migrate to new, lesser defoliated trees.

The number of budworm consumed when the needleworm fed on larval and pupal stages was somewhat lower than the numbers destroyed when the needleworm larvae fed on only one stage. This is to be expected however, as more of one stage must be consumed to equalize the amount consumed when two stages are available.

The number of budworm pupae consumed is a great deal higher than the number of larvae or larvae and pupae consumed. This is to be expected, however, if the needleworm is considered to be mainly a pupal predator.

The number of budworm consumed does not seem to be at all influenced by the sex of the needleworm, as it has been shown that the numbers consumed by male and female *Dioryctria* are similar.

Although it was noticed in the field that frequently several budworm pupae were enveloped by the web of a single *Dioryctria* larva, under artificial conditions predation was not increased as the number of budworm pupae per jar was increased. It is presumed that several pupae may be eaten whether they occur singly or in groups.

It was also shown that the pupal size of the needleworm is not affected by diet as studied in this experiment.

5. Summary

The project was initiated to study the habits of *Dioryctria reniculleia* and mainly to determine its value as a predator of the spruce budworm.

By setting up in duplicate a series of jars, the habits of the needleworm were studied under several types of foliage conditions.

The following is a list of the results obtained.

(a) Predation is low when new foliage is abundant and increases as palatability of the foliage decreases.
(b) The needleworm is mainly a pupal predator.
(c) Sex of the needleworm larva seems to have no effect on predation.
(d) Under experimental conditions, the number of budworm pupae predatorized is in no way connected with the number of pupae availalbe at any one time.
(e) Predation has no visible effect on the size of the *Dioryctria* pupae.

6. Recommendations

It is felt that this study is of use in determining the value of the spruce needleworm as a predator. It does not, however, give any indication of the damage the insect does as a defoliator. It might be advantageous to compare relative defoliation caused by the spruce needleworm and the spruce budworm.

The experimental techniques are believed to be adequate although it might help to leave scarce foliage for three days instead of two. This may accentuate differences between scarce and abundant foliage.

One phase of the work which must be improved is the rearing and mating of moths. It is felt that valuable information could be obtained if successful matings and normal oviposition could be accomplished under experimental conditions. Several methods of rearing have been tried, but it is believed that small screen cages may provide a solution.

If the early larval stages of the spruce budworm and spruce needleworm could be separated, more complete information could be obtained on the habits of the needleworm and its value as a predator. More infomation is needed on the general biology of the needleworm to appraise properly the environmental factors influencing its abundance.

E. Parasites as a Natural Control Factor of the Spruce Budworm

1. Object

Parasite surveys have been conducted for a number of years in the Spruce Woods Forest Reserve for two main reasons. The first was to determine the species and their abundance. The second was to determine whether any of the several species of parasites which have been liberated in the area had become established, and to what extent they had spread through the Reserve.

2. Methods

To determine larval parasitism a large number of branches were gathered at random and all foliage was carefully scrutinized. All budworm larvae obtained from this examination were placed in individual vials along with fresh foliage and reared. The vials were checked daily for parasite emergence and fresh foliage was added. To supplement information on rearing, all larvae gathered from population counts before parasites emerged in the field were preserved and dissected for parasites during the winter months.

Budworm pupae were collected and reared to determine species and abundance of pupal parasites. All pupae collected were placed in individual vials and reared until either a parasite or an adult moth emerged. These vials were checked daily and all findings were recorded.

3. Analysis of Data and Discussion

Over the four year period the percentage of larval parasitism varied considerably as shown in the following table.

TABLE I

Percentage of Larval Parasites

Year	% Apanteles sp. Parasites	% Glypta sp. Parasites	% Hymenopterous Parasites	% Dipterous Parasites	Total % Parasites
1946	16.1	29.2	45.4	.3	45.7
1947	8.5	5.2	13.7	.04	13.7
1948	4.0	5.3	9.2	.3	9.5
1949	13.8	9.3	23.1	7.9	31.0

In 1946 larval parasitism amounted to 45.7 per cent. Of this total 16.1 per cent was due to Apanteles fumiferanae (Vier.), and 29.2 per cent due to Glypta fumiferanae (Vier.) giving a total of 45.4 per cent due to hymenopterous parasites. The percentage of Diptera was very low, being only 0.3 per cent.

In 1947 a great drop was found in the number of larval parasites. Hymenopterous parasitism amounted to 13.7 per cent of which 8.5 per cent was due to Apanteles fumiferanae (Vier.), and 5.2 per cent due to Glypta fumiferanae (Vier.). Dipterous parasitism dropped to an insignificant .04 per cent.

The parasite population continued to drop in 1948, at which time hymenopterous species accounted for 9.2 per cent of the total. Apanteles fumiferanae (Vier.) accounted for 4.0 per cent, and Glypta fumiferanae (Vier.) constituted the remainder of 5.3 per cent. Dipterous parasitism amounted to 0.3 per cent.

In 1949 the parasite percentage increased considerably and was almost back to the 1946 level. In that year Apanteles fumiferanae (Vier.) amounted to 13.8 per cent, and Glypta fumiferanae (Vier.) to 9.3 per cent giving a total of 23.2 per cent for hymenopterous species. Dipterous parasites destroyed 7.9 per cent of the budworm larvae.

The following graph shows the trend of larval parasitism over the four year period.

(Insert Fig. 12 here)

From the accompanying graph it is of interest to note that as the budworm population declined so did the larval parasites, until 1948. In 1949, however, the considerable increase in larval parasites cannot be fully explained, but may be attributed to one of several causes. It might possibly be that the 1949 budworm population was underestimated, or the parasite percentage itself may not be accurate. It is believed, however, that neither of the above is

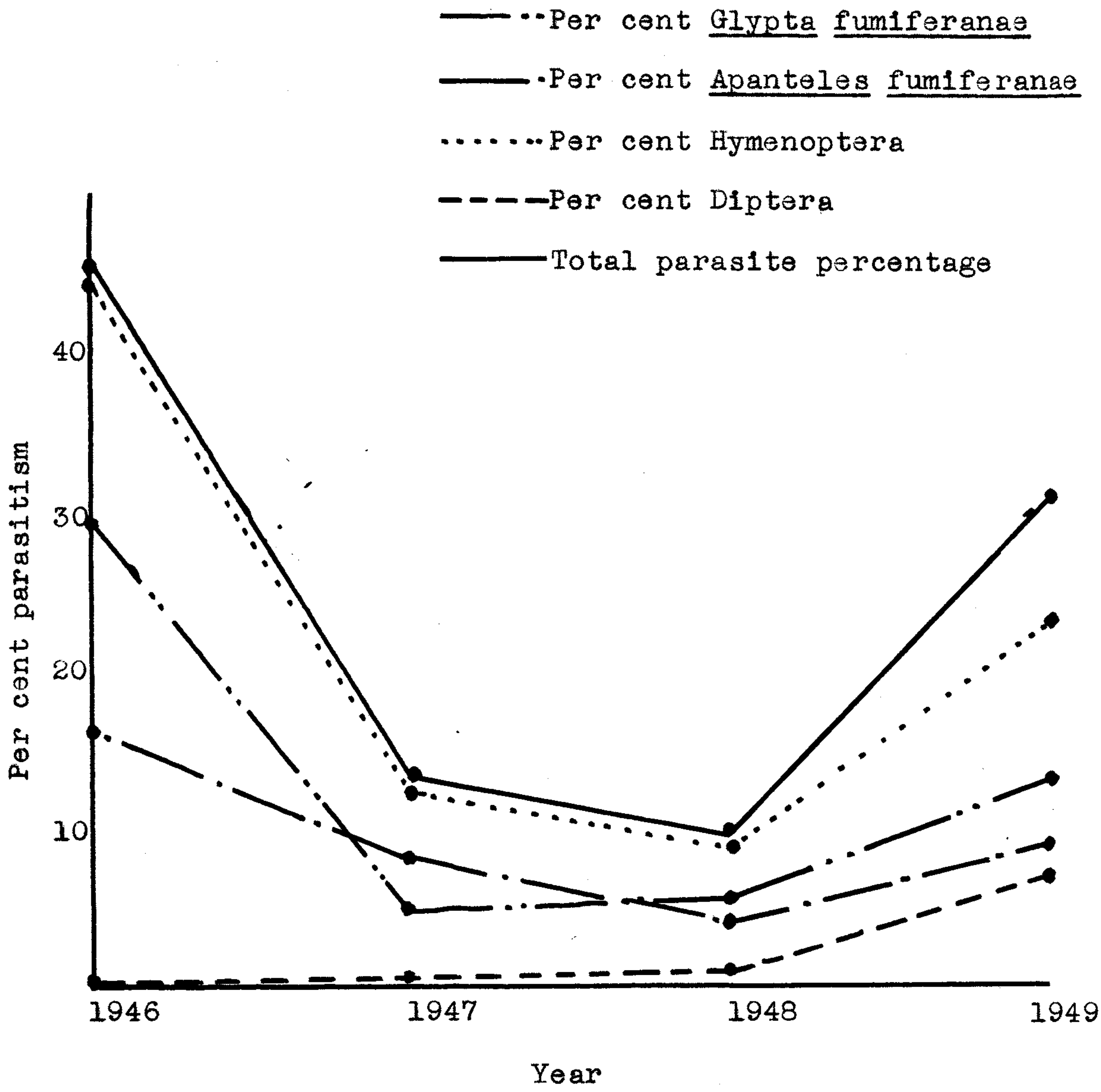


Figure 12. Graph showing the various components of larval parasitism from 1946 to 1949.

the correct answer, but that the per cent parasitism simply increased for reasons unknown. In the past four years sampling or rearing methods have not changed sufficiently to permit such a large sampling error, and it was also observed in the field that parasites were more numerous than in previous years.

Although the yearly percentages of Apanteles fumiferanae (Vier.) and Glypta fumiferanae (Vier.) varied considerably, over the four year period the average percentages of the two are very similar, being 10.6 per cent for Apanteles and 12.2 per cent for Glypta. Diptera averaged 2.1 per cent. It should be noted, however, that only a portion of the Dipterous parasites are recovered from larvae. Most Dipterous parasites emerge from budworm pupae.

Hymenopterous parasite recoveries since 1946 have continually brought forth the same species. Only Apanteles and Glypta have been recovered. In 1946 and 1948 Glypta was the most abundant, while in 1947 and 1949 Apanteles was the most prevalent.

The per cent pupal parasitism has varied little in the past four years except for 1949, as shown in the following table.

TABLE II

Percentage of Budworm Pupal Parasites

Year	% Itoplectis conquisitor	% Phaeogenes hariolus	% Chalcids	% Hymenopterous	% Dipterous	Total % Parasites
1946	29.1	1.2	1.4	31.7	12.1	43.8
1947	23.9	.2	.9	25.0	10.7	35.7
1948	20.2	2.3	.4	22.9	12.7	35.6
1949	1.2	.7	0	1.9	17.6	19.5

In 1946 the total parasite percentage was found to be 43.8 per cent, and was composed of 31.7 per cent Hymenoptera and 12.1 per cent Diptera.

In 1947 the total had dropped to 35.7 per cent of which 25.0 per cent were Hymenopterous species and 10.7 per cent were Dipterous species.

A very slight drop was noted in 1948 when a total parasite percentage of 35.6 per cent was obtained. Hymenopterous species constituted 22.9 per cent of this total, and the remainder of 12.7 per cent was attributed to Dipterous parasites.

In 1949 parasitism declined about 50 per cent because of unusual and almost complete disappearance of the Hymenopterous parasites. Hymenopterous species had dropped to 1.9 per cent, while the Dipterous parasites increased to 17.7 per cent.

It is interesting to note that each year *Itoplectis conquisitor* was the main constituent of the Hymenopterous species and that *Phaeogenes* sp. and Chalcids were scarce.

The following graph shows how the pupal parasite species have varied in the last four years.

(Insert Fig. 13 here)

From the above graph it is interesting to note how the total parasite percentages gradually dropped until 1948. This conforms with budworm population trends. The large drop in 1949 was attributed to the fact that the budworm population was low and larval parasitism was heavy, thus greatly reducing the number of budworm available for attack by the strictly pupal parasites *Itoplectis*, *Phaeogenes*, and Chalcids.

Over the last four years the Hymenopterous portion of the parasite complex has dropped fairly gradually until the end of 1948. In 1949, however, Hymenopterous species were very low in number. The Dipterous species on the other hand have varied very little and only showed a difference of 5 per cent over the four year period.

Over the four years all species collected have been recorded and the following lists them in order of abundance.

1946 Hymenoptera

Glypta fumiferanae (Vier.)
Apanteles fumiferanae (Vier.)

Diptera

Madremyia saundersii (Will.)
Zenillia caesar (Aldrich)
Phryxe pecosensis (Townsend)

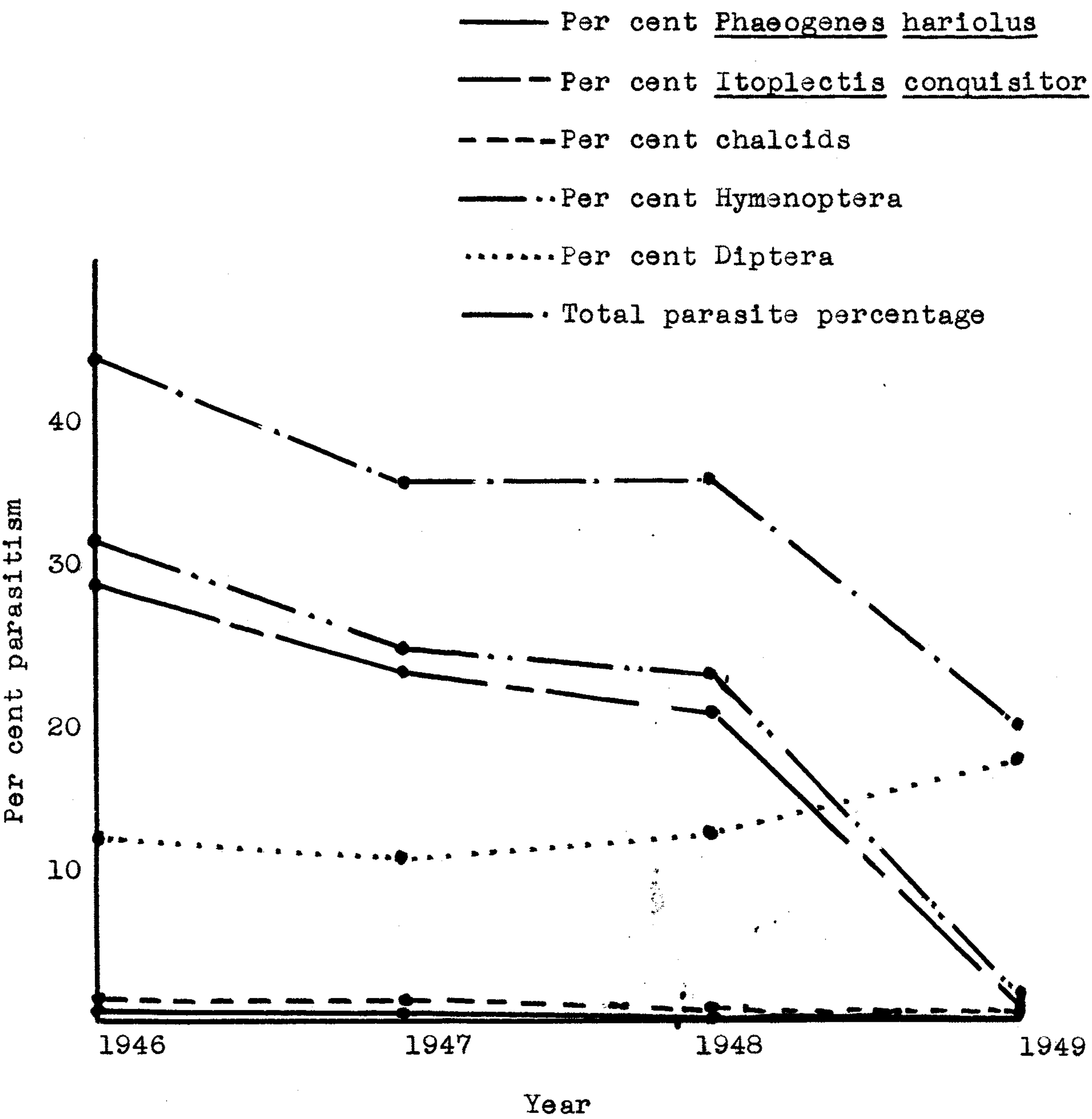


Figure 13. Graph showing the various components of Pupal parasitism from 1946 to 1949.

1947 — Hymenoptera

larval
Apanteles fumiferanae (Vier.)
Glypta fumiferanae (Vier.)

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

Diptera

Madremyia saundersii (Will.)
Zenillia caesar (Aldrich)
Phryxe pecosensis (Townsend)
Nemorilla pyste (Walker)

1948 — Hymenoptera

larval
Glypta fumiferanae (Vier.)
Apanteles fumiferanae (Vier.)

pupal
Itoplectis conquisitor (Say)
Phaeogenes hariolus (Cress.)
Amblymerus verditer (Nort.)

Diptera

Zenillia caesar (Aldrich)
Phorocera sp.
Phryxe pecosensis (Townsend)

1949 — Hymenoptera

larval
Apanteles fumiferanae (Vier.)
Glypta fumiferanae (Vier.)

pupal
Itoplectis conquisitor (Say)
Phaeogenes hariolus (Cress.)

Diptera

Zenillia caesar (Aldrich)
Phorocera sp.
Phryxe pecosensis (Townsend)
Madremyia saundersii (Will.)

From these results it is evident that the same few species are found each year. None of the species liberated in the past four years have been recovered as yet. Since 1946 several parasite liberations have been made. In 1946 850 Phytodietus fumiferana and 640 Ceromasia auricaudata were released. Phytodietus has not yet been recovered. Ceromasia was liberated too late to find a suitable host that year so its chances of eventual establishment are poor. In 1947 three parasite liberations were made. On June 10, 296 Phytodietus fumiferanae and 483 Pseudosarcophaga affinis were released. At the time of liberation, the parasites were in a good condition but there was a heavy wind from the northwest. On June 18 another 576 Phytodietus were released under better conditions as the wind was from the southeast at only 15 M.P.H.

No liberations were made in 1948 but in 1949 a liberation of 474 Pseudosarcophaga affinis was made. It is hoped that these will become established and be recovered in 1950.

In an endeavour to determine the relationship of other insect species to spruce budworm, a number of insect species obtained in the Spruce Woods Forest Reserve in 1946 were sent to Mr. G. Stuart Walley for identification.

The following is a list of idenficiations and Mr. Walley's comments on each.

*1. Cremastus sp. near epagoges Cush. The latter species has not been reported previously as a parasite of spruce budworm, but it has been reported from the related host Archips cerasivorana.

*2. Apanteles sp. Species name unavailable for this unique male. In some respects it is near A. polychrosides Vier. rather than A. fumiferanae.

3. Attractodes sp. Habits unknown but probably a parasite of Diptera.

4. Meteorus vulgaris. A common parasite of various species of cutworms pertaining to the family Phalaenidae.

5. Pemphredon sp. Wasps of this genus nest in decaying wood and provide their nests with aphids as food for the larvae.

6. Smicroplectrus velox Wly. Host sawflies of the genus Pachynematus.

7. Sphex sp.

8. Podalonia sp. Members of this genus and the preceeding nest in the ground and provision their burrows with caterpillars of various kinds.

* These specimens were obtained from the 1946 budworm larval rearings, while the remainder were collected as adults.

4. Conclusions

It was found that no introduced species have yet been recovered although species native to the area are of considerable value.

On the average pupal parasites are more effective than are larval parasites in destroying the spruce budworm.

5. Summary

By rearing large numbers of budworm larvae and pupae in individual vials, the per cent reduction in budworm population caused by the various species can be determined.

It was found that larval parasites averaged 25 per cent over a four year period. Over the same period the pupal parasites averaged 33.6 per cent.

The main species of Hymenoptera found were Apanteles fumiferanae (Vier.) and Glypta fumiferanae (Vier.) in the case of larval parasites, and Itoplectis conquisitor (Say) and Phaeogenes hariolus (Cress.) in the case of pupal parasites.

The main Dipterous parasites were:

Zenillia caesar (Aldrich)
Phorocera sp.
Phryxe pecosensis (Townsend)
Madremyia saundersii (Will.)

6. Recommendations

This parasite determination study is of extreme importance in a biological control project.

It is suggested that more liberations of new species should be made and that the timing of liberations could be improved. The writer feels that the release of one or two shipments which may not become established is not conclusive evidence that the parasite cannot exist in its new location. Many factors must be taken into account and adverse weather might easily destroy or scatter colonies which otherwise would have become established. Parasites play an important role in budworm control, and to obtain results which might be more accurate, it is suggested that the numbers of larvae and pupae reared to estimate parasitism be increased.

TECHNICAL REPORT 1949
PROJECT NO. E.30.22-4

FOREST INSECT LABORATORY, WINNIPEG

VIII DETERIORATION OF FIRE-KILLED TIMBER IN NORTHERN SASKATCHEWAN

Report by E. A. Liscombe

Field Work by E. A. Liscombe
G. L. Warren
L. L. McDowell
J. J. Lawrence
A. E. Campbell

Time Spent on Project

E. A. Liscombe - 1/4
G. L. Warren - 1/5
L. L. McDowell - 1/24
J. J. Lawrence - 1/24
A. E. Campbell - 1/14

1. Object

This study conducted from 1947 to 1949 inclusive was undertaken to determine the extent of damage caused by wood boring insects attacking fire-killed and injured jack pine and white spruce.

2. Method

When the study was initiated in 1947, only one area was observed. This area was situated 1.3 miles east of Fort House along the new fort road in the Fort á la Corne Provincial Forest, Saskatchewan, and consisted of pure jack pine. The same area was studied in 1948 to determine population changes over a period of one year.

The fire, reportedly driven by a high velocity wind swept through the area on the night of June 13, 1947, and caused varying degrees of burn i.e., from a severe crown burn to a light, rather harmless ground burn. Hence all burn types were available in a comparatively small area.

The burn was first inspected approximately 2 months after the fire, and again approximately 12 months later.

Burn types were classified according to those employed in "The Deterioration of Fire Killed White Spruce by Wood Boring Insects in Northern Saskatchewan", by H. A. Richmond and R. R. Lejeune.

All trees falling into a given burn type have the characteristics contained in the description of that burn type in common. Five major types were described in the white spruce study, and the characteristics of each were interpreted in relation to jack pine. The five major burn types for jack pine are defined below:

<u>Burn Type 1</u> - Most severe type of burn. Bark has been burnt through or bark scales have subsequently dried and fallen. Cambium may be cooked and dry, and in this condition it is usually brown in color, or cambium may be moist but not sticky and greyish-black in appearance. A bluish-green mould is usually associated with the latter condition.

<u>Burn Type 2</u> - A less severe burn than Type 1. The bark is badly charred and does not peel readily; cambium badly scorched, dry and black, due to excessive heat; may be mottled tan to brown in color. Inner and outer bark may be separated, the former peeling readily in strips.

<u>Burn Type 3</u> - Less severe burn than Type 2. The bark is scorched but not necessarily charred, and is readily removed whole; cambium usually mottled tan to brown with sticky surface.

<u>Burn Type 4</u> - Bark obviously subjected to intense heat but appears undamaged by flames or, more infrequently, bark lightly charred on opposite side of sampling area; cambium white, moist and sticky, and in some instances a slight discoloration may be apparent.

<u>Burn Type 5</u> - Tree has suffered only a mild coat burn, and foliage on the upper portion of the tree may be undamaged; cambium white, moist and sticky; appears similar to that of a tree unaffected by fire burn.

A measured area of bark was removed from the basal region of 50 trees of each burn type. The d.b.h., tree height and insect population per square foot were recorded.

Study in the Fort á la Corne area was discontinued in 1949 and was replaced by two areas near Big River, Saskatchewan. One was a white spruce area situated approximately 29 miles north of Big River on the Meadow Lake Road. The other, a jack-pine burn, was situated approximately 7 miles from Big River on the road leading to Camp 15 in the Big River Provincial Forest. A third area was located about 12 miles north of Snowdon on the Torch River Road and consisted of pure jack pine.

The three areas were burnt at approximately the same time, in late April and early May, 1949.

Two examinations were made in the latter half of 1949, one in late August and the other in late October. In August only the two Big River areas were examined and 50 trees of each burn type were sampled at that time. In the October inspection the three areas were examined, but only 25 trees of each burn type were sampled in each location.

3. Analysis of Data and Discussion

Tables 1 and 2, following, list the findings in the Fort á la Corne jack pine in 1947 and 1948.

TABLE 1

Year Host and Place	Burn Type	No. of Trees Examined	Mean d.b.h.	No.of *Monochamus* Larvae per Square Foot	No.of *Stenocorus* Larvae per Square Foot	No.of Clerid Larvae per Square Foot	No.of *Monochamus* Entrance Holes per Square Foot	Mean Depth of Penetration in Inches	No.of *Monochamus* Emergence Holes per Square Foot	Per Cent *Monochamus* Emergence
1947	1	50	7.0	5.3	22.6	.1	1.9	1.2	---	----
Jack Pine	2	50	6.7	4.8	24.9	.6	1.0	1.4	---	----
Fort a la Corne	3	50	6.2	1.7	5.5	--	---	---	---	----
	4	50	6.5	.1	.5	--	---	---	---	----
Provincial	5	50	6.9	---	----	--	---	---	---	----
Forest										

TABLE II

1948	1	50	6.2	.4	.1	.1	2.9	2.1	1.3	45.6
Jack Pine	2	50	5.3	.2	.3	.0	.9	2.3	.0	4.36
Fort a la Corne	3	50	6.2	.4	.6	.1	1.8	2.5	.2	9.8
Provincial	4	50	5.4	.2	1.0	.0	.5	2.6	---	----
Forest	5	50	6.5	---	----	--	---	---	---	-----

In 1947 and 1948 the most destructive insect was *Monochamus scutellatus* Say.

As no *Monochamus* larvae were found between the bark and the wood in 1948, all numbers in the column "Number of *Monochamus* larvae per square foot", refer to larvae actually in larval tunnels. The mean depth of penetration was fairly uniform each year although the 1948 results showed the larvae to have attained a much deeper penetration level. While the holes in Burn Types 1 and 2 were 100 per cent deeper in 1948 than in 1947, holes in Types 3 and 4 were found to be 250 per cent deeper in 1948 than in the previous year. Regarding penetration, it is of interest to note that although in 1947 there were no tunnels constructed in Type 3 and 4 trees, by 1948 these tunnels were deeper than those started in Types 1 and 2 in 1947.

In 1947 the depth of penetration increased from Burn Type 1 to Burn Type 2, the only types containing larval tunnels. Because no larval tunnels were found in Types 3, 4 and 5, it is believed that trees of Type 3 and 4 had only recently become susceptible to attack and that the larvae had not had time to tunnel into the wood when the examination was made.

In 1947 the highest population was found to be on Type 1 trees with a continual decrease to Type 4. As Type 5 trees were still alive they were not susceptible to attack and therefore did not contain borers. As Type 1 trees were the most severely burnt, they would contain less moisture than would trees of other burn types. From the number of larvae obtained from trees in this category, it is evident that the amount of moisture present in these trees made them susceptible to attack almost immediately after the fire, but the lesser burnt trees were still too moist and the population gradually decreased due to the fact that susceptibility to attack decreased.

In 1948 however, considerable changes had taken place. In trees of Types 1, 2 and 3, the population had dropped considerably due to mortality and also because many of the larvae had matured and emerged before the second examination was conducted. (The fact that emergence had taken place is very unusual, as it means the insect had completed its life cycle in one year instead of the two or three years usually required. It may be that development in jack pine is considerably faster than in white spruce, as it has been found that no emergence takes place the first year in infested white spruce stands.) Populations of Type 4 trees had increased in 1948 because they had become susceptible to attack after the first examination was completed in 1947, when no larvae were found in trees of this Type.

The per cent emergence dropped from Type 1 to Type 5 trees following somewhat the trend of larval populations for trees of the same types.

In 1947 the largest number of entrance holes was found in Type 1 trees, lending support to the theory that up till the time of examination they were the most susceptible to attack. A few holes were found in Type 2 trees, but none in the later burn types.

In 1948 Type 1 trees still contained the largest number of entrance holes, but it is believed that most of those holes represented larvae which were well along in development. The number of holes in Burn Type 2 was constant from 1947 to 1948, but the largest increase over 1947 was found in Type 3 trees. Entrance holes were also on the increase in Type 4 trees indicating that trees of Types 3 and 4 had become susceptible to attack after the 1947 examination. It is of interest to note that Type 5 trees were still free of attack 14 months after the fire, and it is assumed that these trees will recover.

The Stenocorus sp. populations fluctuated considerably in the two years under study. In 1947 trees of Types 1 and 2 contained the majority of the population, although a few were found in Type 3 and 4 trees.

In 1948, however, conditions had altered and the Stenocorus sp. population gradually increased from Type 1 to Type 4 trees. The population trend in both years conformed fairly closely to that of the Monochamus populations, as it is believed that as the types become susceptible to Monochamus larvae they also become susceptible to Stenocorus sp. larvae.

Clerid sp. a predator of Monochamus larvae, also fluctuated in numbers and although they increased from Types 1 to 2 in 1947, they followed the same pattern as did the Monochamus larvae in 1948.

For the two years a considerable number of Ips pini were found and the bark was noted to be heavily scored.

The difference found in the susceptibility to round-headed borer attack of the different Burn Types in jack pine and white spruce is worthy of attention. The data for the Carrot River burn was taken from the report by H. A. Richmond and R. R. Lejeune. In both instances the burn took place in June, so that the interval between the occurrence of the fire and the examination of trees was very similar.

The following table illustrates the differences in the two burns. It must be understood, however, that the populations for the Carrot River study did not consist entirely of Monochamus and so the differences on similar burn types are not as great as is apparent. The data from the Fort á la Corne study consist entirely of Monochamus larvae.

TABLE III

Differences in Wood Borer Populations on the Various Burn Types in Jack Pine and White Spruce

Burn Type	Carrot River, September, 1942 Populations of Round-Headed Borers Per Square Foot on White Spruce	Fort á la Corne, August, 1947 Populations of Monochamus Larvae Per Square Foot on Jack Pine
1	nil	5.3
2	1.0	4.8
3	1.8	1.7
4	3.1	.1
5	5.2	nil

Figures for 1943 are not available for the Carrot River study thus preventing a comparison of data obtained in the second year of each study.

It will be observed that Burn Types 1 and 2 in white spruce were largely unaffected by borers, while these were the most attractive in jack pine. On white spruce the borer population increased with the lighter burn types, even when round-headed borers other than Monochamus were disregarded, while on jack pine the population decreased.

Tables 4, 5, and 6, following, list the findings on jack pine in August and October of 1949 in the Big River area burned in the spring of that year.

TABLE IV

Year Host and Place	No. of Trees Examined	Mean d.b.h.	No. of *Monochamus* Larvae per Square Foot	No. of *Stenocorus* Larvae per Square Foot	No. of *Clerid* Larvae per Square Foot	No. of *Monochamus* Entrance Holes per Square Foot	Mean Depth of Penetration	No. of *Monochamus* Emergence Holes per Square Foot	Per Cent Emergence	Burn Type
1949	50	6.2	.1	3.5	.0	—	—	—	—	1
(August)	50	5.9	.2	4.8	.1	—	—	—	—	2
Jack Pine	50	7.1	.3	2.9	.2	—	—	—	—	3
Big River	50	8.1	.1	.5	—	.0	.5	—	—	4
Prov. Forest	50	9.0	—	—	—	—	—	—	—	5

TABLE V

1949	25	6.7	.4	.1	—	—	—	—	—	1
(October)	25	7.2	.3	.5	—	.2	1.1	—	—	2
Jack Pine	25	7.3	.2	—	.1	.3	2.7	—	—	3
Big River	25	8.8	1.2	.2	.2	1.2	1.2	—	—	4
Prov. Forest	25	8.4	—	—	—	—	—	—	—	5

TABLE VI

1949	25	5.8	—	—	—	—	—	—	—	1
(October)	25	6.0	.6	.4	—	1.2	1.8	—	—	2
Jack Pine	25	6.2	.8	.4	.1	1.4	1.8	—	—	3
Snowdon	25	6.2	2.5	.0	—	2.5	2.0	—	—	4
	25	5.4	—	—	—	—	—	—	—	5

When considering the jack-pine stand found in the Big River Provincial Forest, the August data show that the population increased from Burn Type 1 to Burn Type 3, and that the Type 4 population had dropped back to the Type 1 level as shown by Table 4. This was the exact opposite of the initial findings in the Fort á la Corne jack pine, but it is believed the low populations in Type 1 and 2 trees were due to the fact that the trees were very badly charred and rendered unsuitable for heavy insect attack. This explanation is strengthened by the fact that Monochamus entrance holes were found only in Type 4 trees, whereas in 1947 entrance holes were found only in Type 1 and 2 trees. The first examination of the jack pine in the Big River Provincial Forest yielded results somewhat similar to the second examination of the jack pine in the Fort á la Corne Provincial Forest. The data seem to indicate that the Big River fire was of greater intensity than the one in Fort á la Corne, thus rendering badly burnt trees too dry to be susceptible to attack for any length of time. The belief that the Big River fire was of severe intensity also helps to explain the lack of Monochamus entrance holes in trees of Type 1, as enough time had elapsed from the date of the burn to allow larvae to be well enough along in development to begin tunneling into the wood, had the trees at the outset not been too dry to be susceptible to attack.

Table 5 gives the data for the same area in October. In a period of two months noticeable changes had taken place. Trees of Types 1 and 2 were susceptible to attack for a short time after the August examination as the population had increased slightly. Type 3 populations had remained almost constant, but Type 4 populations had increased tremendously indicating that trees of this Type became susceptible after the August examination had been completed. In October the number of entrance holes increased from Type 2 to Type 4 trees indicating that Type 4 trees were the most susceptible.

The mean depth of penetration was greatest in Type 3 trees but it is believed that Type 4 trees had not been susceptible long enough for the larvae to obtain their maximum depth.

When the stand was examined in August, Stenocorus sp. larvae greatly outnumbered Monochamus larvae. The trend found in the different burn types corresponded to that found in Fort á la Corne in 1947, although the 1949 figures were considerably lower. There appeared to be no correlation between burn type and Stenocorus abundance.

The number of Clerids varied considerably, the larvae being found in Burn Types 1 and 2 in 1947, in Types 1, 2 and 3 in August of 1949, and in Types 3 and 4 in October of 1949. It is evident from these figures that as time goes on susceptibility gradually shifts to the more lightly burned trees.

The jack-pine stand near Snowdon when examined in October showed some rather puzzling results. The Monochamus population increased from Type 2 to Type 4 trees indicating that Type 4 trees were the most susceptible to attack. The number of Monochamus entrance holes and the mean depth of penetration also increased from Type 2 to Type 4 trees, strengthening the belief that Type 4 trees were most susceptible to attack. This corresponds to results found in October at Big River.

The data seem to show that the fire was of severe intensity rendering Type 1 trees too dry to be susceptible to attack. The fire, however, was actually very light and swept almost entirely through the tops of the trees. Type 4 trees still showed some green foliage and why trees of this type contained the heaviest population and the deepest penetration is a mystery. Type 1 trees would not have been found at all had there not been a severe blow down of trees before the fire occurred, as the fire went through too quickly to char the trees very badly. The blow down, however, tended to cause intense fires in small areas, resulting in these trees being very badly charred. Due to the conditions under which the examination was made, it is felt that the results obtained are not as accurate as those from other areas.

The Stenocorus sp. population fluctuated as in the other areas, but Clerid larvae were found only in Burn Type 3.

Tables 7 and 8 on the following page list the findings in the white spruce stand north of Big River, for the August and October examinations of 1949.

Due to the thin bark found on white spruce it is natural to assume that no Monochamus larvae would be found on severely burned trees as they would be too dry to be susceptible to attack. The tables show this clearly.

Table 7, depicting the August data, shows that Type 3 trees were the most susceptible to attack at that time, as they contained the largest number of larvae. Type 2 and 4 trees contained almost equal numbers of larvae but were a great deal less susceptible to attack than Type 3. This is coupled with the fact that few tunnels were found in Type 4 trees and none in Type 5. There were no

TABLE VII

Year Host and Place	Burn Type	No. of Trees Examined	Mean d.b.h.	No. of *Monochamus* Larvae per Square Foot	No. of *Stenocorus* Larvae per Square Foot	No. of *Clerid* Larvae per Square Foot	No. of *Monochamus* Entrance Holes per Square Foot	Mean Depth of Penetration in Inches	No. of *Monochamus* Emergence Holes per Square Foot	Per Cent *Monochamus* Emergence
1949	1	50	6.9	—	.0	—	—	—	—	—
(August)	2	50	5.6	.1	.5	—	.1	1.0	—	—
White Spruce	3	50	7.5	1.0	2.6	.1	.2	1.7	—	—
Halfway House	4	50	7.0	.2	.2	.0	.1	1.4	—	—
	5	50	6.3	—	.1	—	—	—	—	—

TABLE VIII

1949	1	25	8.2	—	—	—	—	—	—	—
(October)	2	25	6.2	.1	.1	—	.0	1.8	—	—
White Spruce	3	25	5.1	1.0	.2	—	.3	1.8	—	—
Halfway House	4	25	6.3	2.5	.4	—	.6	1.9	—	—
	5	25	6.8	—	—	—	—	—	—	—

tunnels found in Type 1 trees but this was probably due to the fact that the trees were too dry to be susceptible to attack. The largest number of entrance holes was found in Type 3 trees as was the largest number of larvae, indicating that trees of this Type had reached the level where they were very susceptible to borer attack. Type 2 trees contained a few entrance holes suggesting that they were susceptible for a short time after the fire.

It can be seen that the greatest mean depth of penetration was found in trees containing the largest population. This is as expected as these trees were among the first to become susceptible and therefore, the larvae had a longer period of time in which to construct their larval tunnels. The mean depth of penetration in Type 2 and Type 4 trees was very similar.

IX PUBLICATIONS

IX PUBLICATIONS

Burbidge, D., and R. R. Lejeune. The Effects of Moisture on Larch Sawfly. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 6, No. 1, January - February, 1950.

Hildahl, V. Larch Sawfly Survey. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 5, No. 2, March - April, 1950.

Hildahl, V. Spruce and Jack-Pine Budworms. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 5, No. 4, July - August, 1949.

Hildahl, V. Larch Sawfly Parasites. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 6, No. 2, March - April, 1950.

Lejeune, R. R. Larch Sawfly Parasites. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 5, No. 2, March - April, 1949.

Lejeune, R. R. Forest Insect Survey. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 5, No. 3, May - June, 1949.

Lejeune, R. R. Field Accommodation. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 5, No. 3, May - June, 1949.

Lejeune, R. R., and H. R. Wong. Distribution of the Larch Sawfly in Manitoba and Saskatchewan. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 5, No. 6, November - December, 1949.

Liscombe, E. A. R., and R. R. Lejeune. Natural Control of the Spruce Budworm. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 5, No. 6, November - December, 1949.

Turnock, W. J. The Birch Sawfly. Forest Insect Investigations. Bi-Monthly Progress Report, Ottawa, Canada. Vol. 5, No. 5, September - October, 1949.

Wong, H. R., and W. J. Turnock. Forest Insect Survey. Forest Insect Investigations, Bi-Monthly Progress Report, Ottawa, Canada. Vol. 5, No. 4, July - August, 1949.

FINANCIAL STATEMENT

1949 - 1950

BUILDING & LANDS:		
Upkeep..................	$ 356.48	
Acquisition.............	2,375.00	$ 2,731.48
SALARIES:		
Temporary..............	42,562.15	42,562.15
WAGES:		
Temporary.............	624.20	624.20
EQUIPMENT:		
General................	9,996.53	
Scientific............	1,329.00	11,325.53
Upkeep................	1,186.57	1,186.57
EXPRESS, FREIGHT & CARTAGE:		145.08
MISCELLANEOUS:		188.18
SUPPLIES:		
General................	938.01	
Scientific............	422.18	
Subsistence...........	1,476.16	
Photographic..........	14.19	2,850.54
COMMUNICATIONS:		
Telegraph.............	59.28	
Telephone.............	118.71	177.99
TRAVEL:		
		7,030.70
TOTAL		68,822.42

Northern 1949 Winnipeg Insect and Disease Species Index