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(Excluding Part 1, Jack pine deterioration study.)

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INTRODUCTION.

Work of the Forest Insect Laboratory for the year 1939 was again carried on under the disadvantage of no permanent headquarters in Winnipeg. For this reason all research was conducted in the field with headquarters at Hawk Lake, Ontario.

The field work was of two types: (1) the organization and instruction of field officers of the Saskatchewan and Manitoba forest services in relation to the forest insect survey, and (2) biological investigations. Biological investigations were concerned primarily with the Jack pine budworm but considerable attention was also directed toward the European larch sawfly, the lecanium scale on pine, sawyer beetles and bark beetles.

In the report that follows the majority of space is devoted to the budworm problem. This work is divided into three phases as follows: (1) a study of the effect of defoliation of Jack pine and the future growth of the tree as influenced by such variables as site, age-class, mixture, density, etc.; (2) an analysis of the biological control operating throughout the range of budworm in central Canada; and (3) a biological study of the budworm with emphasis on its development and fecundity as influenced by controlled food and growing conditions.

THE JACK PINE BUDWORM

PUPAL PARASITE SURVEY

By R. R. Lejeune

I. INTRODUCTION

Preliminary investigations of the parasitism of the Jack pine budworm were conducted during 1937 and 1938 by the Winnipeg laboratory of the Forest Insect Investigations. From data procured it was evident that the majority of parasitism occurred during the pupal stage and that the percentage mortality of the host and the species of parasite varied with the age of the infestation. A comprehensive pupal parasite survey was undertaken in 1939 embracing northwestern Ontario, Manitoba and Saskatchewan. Fundamentally this survey represents a specialized application of the Forest Insect Survey and was possible only through the co-operation of the provincial forest services and private contributors.

Essentially, the survey consists of the collection of budworm pupae from several representative districts and a determination of sex ratios and the degree and type of mortality caused by natural control factors. The organization and technique of handling is based on experience gained from similar studies conducted in previous years.

From this study it is hoped to disclose methods for the successful manipulation of important parasites and elucidate qualitative and quantitative parasitic fluctuations correlated with the age of the infestation.

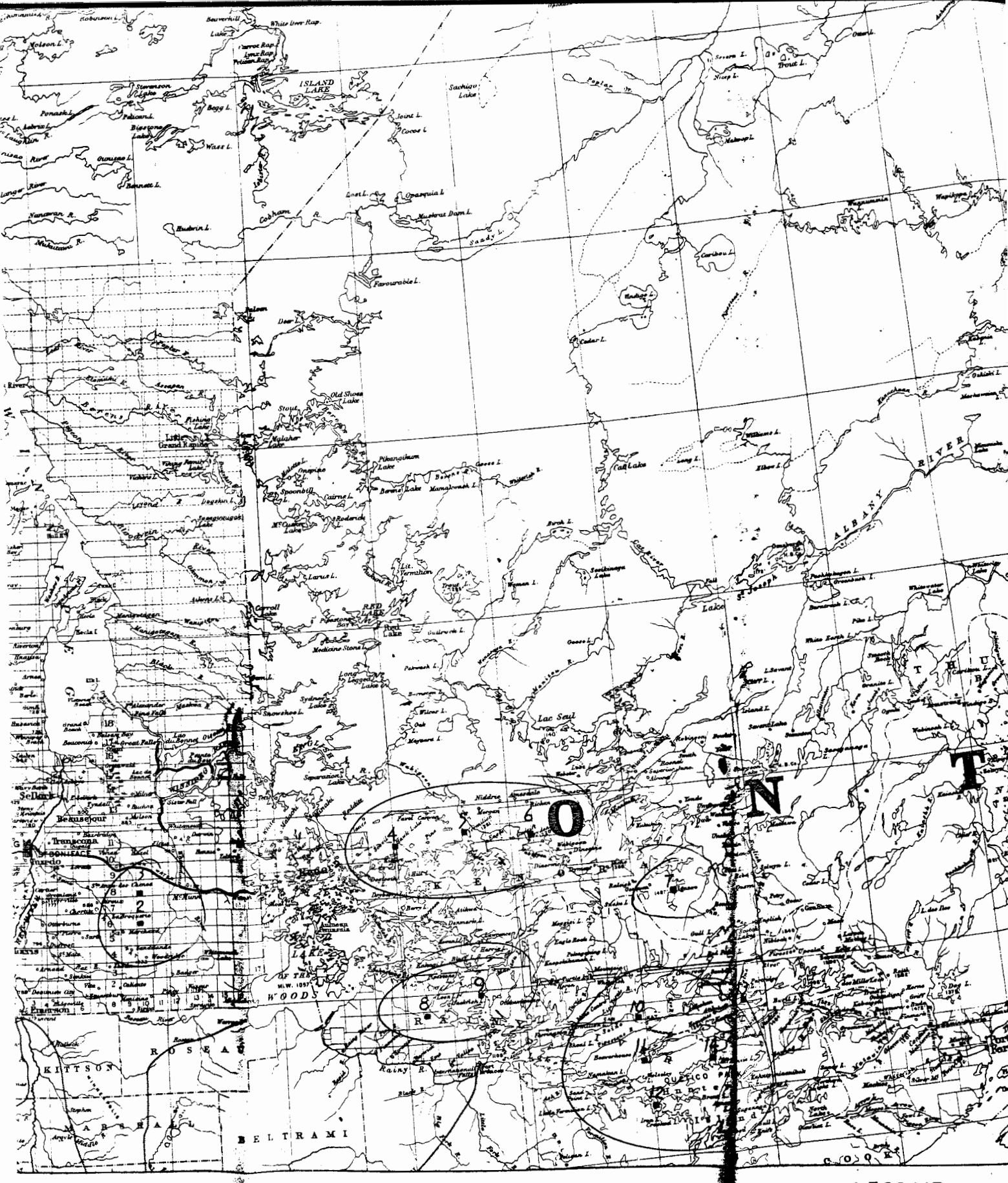
In addition, the existence of a correlation between the sex ratio of the budworm and its epidemiology has been suspected and the information pertaining thereto is easily obtained from this survey. The necessity then for a long term inclusive project to guage fluctuations in natural control factors and host sex ratios is obvious.

From a survey of this nature certain immediate valuable results are also available. The determination of parasitic species, some possibly new, and their incidence and spread, coupled with liberations of species in areas where they are lacking, is considered of prime importance.

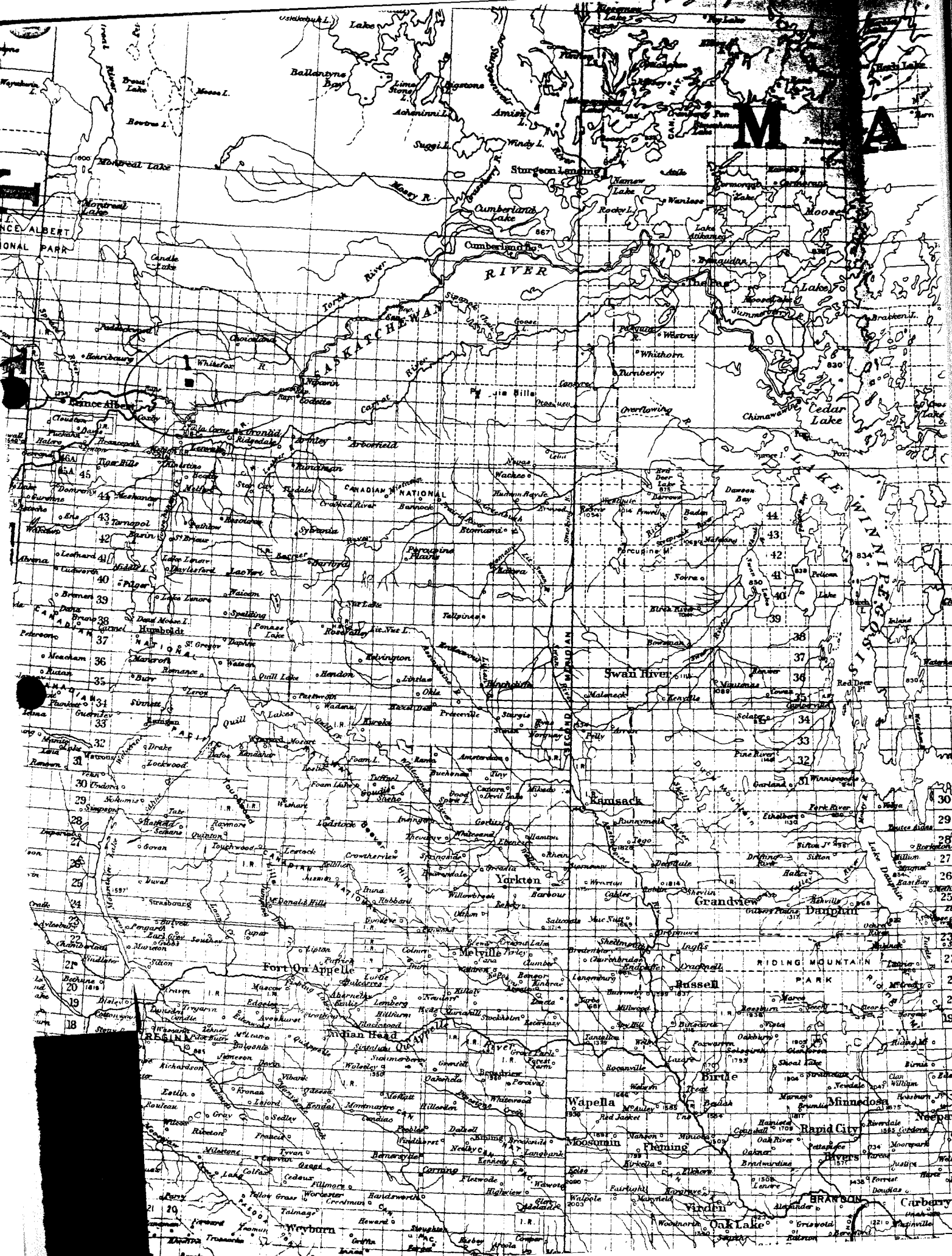
To assure the fulfilment of the original plans of the survey, it was essential to contact and procure the enthusiastic co-operation of the provincial forestry services of the provinces concerned and the Dryden Paper Company. This was not only forthcoming, but contributions far exceeded expectations, thereby appreciably increasing the benefits to the interested organizations and the Winnipeg Laboratory. It should be emphasised that these organizations are seriously concerned over the alarming possibilities of decimation of Jack pine by the budworm and willingly provide any assistance at their disposal.

II. AREAS CONTRIBUTING

A total of 15 areas was studied in this project, each characterized by certain peculiar epidemiological features. Ignace, Ontario, the most easterly area sampled, first reported the infestation in 1937, indicating a fairly recent attack. Budworm has been extant at Dryden, Vermilion Bay and Hawk Lake, Ontario, since at least 1935 and parasitism there should have reached or passed its maximum now. In the Fort Frances district the outbreak is believed to have originated from the southeast corner in the vicinity of Basswood in 1936. For rearing purposes pupae from 8 strategically located ranger stations were grouped into four areas of gradually increasing distances from the focal point. It has been impossible, however, to ascertain accurately the growth of the outbreak in this district and the groupings are based primarily on the consensus of opinion of the foresters and rangers in the area. Conditions at the Sandilands Forest Reserve are much the same as at Hawk Lake and parasitism here is also expected to be at its maximum. The history of the Fort a la Corne infestation in Saskatchewan is obscure. Moreover, it is far removed from the Manitoba and Ontario outbreak; therefore, a different biological and climatic environment may influence the host and parasite.



E BUDWORM PUPAL PARASITE SURVEY IN 1939


Montreal Lake
Cumberland Lake
Cumberland House
RIVER
Sturgeon Landing
Moose
Cedar Lake
LAKE WINNIPEGOSIS
Prince Albert
Canadian National
Swan River
Kamsack
Yorkton
Grandview
Dauphin
Melville
Fort Qu'Appelle
Russell
Indian Head
REGINA
Birtle
Wapella
Minnedosa
Rapid City
Moosomin
Virden
Oak Lake
Carberry
Weyburn
RIDING MOUNTAIN PARK
SASKATCHEWAN
MANITOBA

III. ORGANIZATION OF THE SURVEY

A. Collection & Shipment

Forest rangers or other suitable persons were contacted in each region and the necessary arrangements made and instructions given to ensure that daily collections would be made of the budworm pupae during the pupal period of some 10 days. As far as possible daily collections of 100 to 200 pupae were made from each area. Forest Insect Survey boxes were used as containers and not more than 250 pupae per box packed in slightly moist moss produced the best results. To prevent the development of unfavourable environmental conditions and excessive emergence of parasites and moths, pupae were shipped immediately after collection to the Forest Insect field station at Hawk Lake, Ontario, or retained in a cool place until shipment was possible. In the remote regions these collections were picked up by airplane and mailed from the nearest point.

B. Handling and Rearing

Complete arrangements for receiving, handling and rearing of pupae and parasites required much preparation and organization. Upon arrival at Hawk Lake, the boxes were immediately opened, pupae counted and sexed and confined in specially constructed cages, segregated according to sex and locality. These cages are of wood construction, approximately 14 inches square and

with one side detachable. The centre of this removal section contains a circular opening 2½ inches in diameter into which a pint size rearing jar is screwed. The interior of each cage is fitted up with two full length screen shelves on which the pupae are placed. As the parasites emerge, they are attracted by the light into the jars, which are then removed and the daily emergence recorded. This method is not suitable for the emergence of moths as they are not attracted to light. Their emergence, however, occurs prior to that of the parasites; thus, the cages may be entered daily to record moth emergence until such time as parasites make their appearance. Complete operations required the use of 22 cages.

IV. SOME INSECTS RECEIVED

The locality, name, service in which employed, number of boxes and the number of pupae shipped by each contributor is shown in Table 1.

TABLE 1

LOCALITY	COLLECTOR	SERVICE OR COMPANY	NO. OF BOXES	NO. OF PUPAE
Ft. a la Corne, Sask.	E.P.Bilquist	Nat.For.Program No. 4	12	5,026
Sandilands For. Res.				
Camp I	L.Verrault	Nat.For.Program	13	5,486
Camp III	J.H.Wells	Nat.For.Program	16	7,169
Ft.Frances District,Ont.				
Basswood Lake	R.Cowan	Ont.For.Branch	4	916
Beaverhouse L.	A.F.Parker	Ont.For.Branch	3	728
Calm Lake	F.Clark	Ont.For.Branch	5	2,719
Crooked Pine Lake	P.Pettier	Ont.For.Branch	3	593
La Croix Lake	E.A.Melin	Ont.For.Branch	3	428
Off Lake	R.H.Pattison	Ont.For.Branch	8	1,092
Sphene Lake	C.J.Dahlin	Ont.For.Branch	6	508
Sturgeon Narrows	G.C.Buckingham	Ont.For.Branch	5	974
Hawk Lake, Ont.	Officers of Lab.	For.Ins.Investigations	--	1,635
Vermilion Bay,Ont.	W.Coppard	Ont.For.Branch	3	352
Dryden,Ont.	O.Jackson and E.C.Macdonald	Dryden Paper Co.	12	2,420
Ignace, Ont.	J.M.Horn	Ont.For.Branch	13	2,981
TOTAL			107	31,027

As indicated above, a total of 31,027 pupae were received during the ten-day collection period from 15 contributing areas.

V. PRESENTATION OF DATA AND DISCUSSION

A. Parasites Reared

Parasite emergence commenced on July 18th, reached a peak in the first week of August and then slowly decreased into the first week of September.

The following is a complete list of parasites reared from Jack pine budworm pupae in 1939. While subsequent tables make no attempt to differentiate between those species of little significance, all known species are presented below to make the information complete.

DIPTERA

Nemorilla maculosa Meigh.
Miscellaneous (not determined)

HYMENOPTERA

Ichneumonoidea

Phaeogenes hariolus Cress.
Ephialtes conquisitor Say.
Exolurus sp. possibly innominatus Vier.
Atrometus clavipes Davis
Sagaritis sp.
Atrometus sp.
Labrorychus sp.

Chalcidoidea

Amblymerus verditor Nort.
Syntomosphyrum esurus Riley
Tetrastichys sp.
Dibrachys cavus Walk.
Pachyneuron altiscuta Ksw.
Brachymeria compsilurae (Cwfd.)
Perilampus sp.
Habrocytus phycidis (Ashm.)

Table 2 shows in percentages the mortality of budworm pupae due to parasites and other unspecified causes, such as vitiation of the strain, fungal and bacterial infection or injury received through handling and shipping. While no reliance or special significance should be attached to the figures in the column "Other Causes" and admittedly it would be desirable to be able to allocate specific causes to this category, it does not detract from the main topic under consideration, namely pupal parasites. All Diptera, consisting chiefly of Nemorilla maculosa have been placed under one heading. Miscellaneous Ichneumons and Chalcids played such a minor role that they have all been grouped under "Miscellaneous Hymenoptera".

As a rule, a budworm pupa parasitised by Chalcids harbours several individuals, the number depending on the species. Therefore, actual figures showing Chalcid emergence are not shown, but, based on 1938 determinations, an effort has been made to give an approximation of the number of pupae parasitised.

It should be noted in Table 2 that, as previously mentioned (P. 369), several St. Frances stations have been grouped.

TABLE 2

Locality No.	LOCALITY	PERCENT MORTALITY TO BUDWORM PUPAE								
		Diptera	E. conquisitor	P. harrisolus	Miscellaneous Hymenoptera	S.esurus & Tetrastichys sp.	A. verditor & D.cavus	Total Parasitism	Mortality from other Causes	Total Mortality
1	Hawk Lake, Ont.	1.34	14.25	20.24	0.45	.80	1.33	38.59	18.29	56.88
2	Vermilion Bay	.85	12.50	22.16	0.00	.57	.57	36.65	50.85	87.50
3	Dryden	6.03	12.56	16.82	0.62	.83	2.11	38.97	28.63	67.60
4	Sandilands, Camp I	1.95	6.17	12.65	0.50	.69	2.28	24.24	49.00	73.24
5	Sandilands, Camp III	1.41	5.40	10.27	0.20	.46	2.00	19.74	63.01	82.75
6	Basswood L., Ft. Frances	4.04	1.96	14.41	0.23	.33	.54	21.51	48.37	69.88
7	Ignace	.67	7.71	12.48	0.10	.77	.97	22.70	60.30	83.00
8	Sphene & Off Lakes	6.56	4.25	18.31	0.62	.31	1.31	31.36	42.37	73.73
9	Calm and Crooked Pine Lakes	4.28	2.51	13.98	0.39	.48	2.05	23.69	48.94	72.63
10	La Croix, Sturgeon Narrows and Beaverhouse Lake	1.27	4.18	11.88	0.05	.19	.37	17.94	41.64	59.58
11	Fort a la Corne, Sask.	5.30	1.15	2.04	0.36	.85	.14	9.84	61.25	71.09

It is apparent that the Fort a la Corne infestation, probably the most recent and distinctly isolated from the other areas, is notably deficient in parasites. Diptera are in the majority here, while usually being of lesser importance in the other areas. The reported abundance of the forest tent and the ugly nest caterpillars may have affected a considerable absorption in numbers of Ephialtes and Phaeogenes, conceivably accounting for the obvious scarcity of these two species. In an attempt to alleviate this condition, a large number of the two species was released there.

As in previous years, Phaeogenes and Ephialtes are again the major parasites at Sandilands. It will be noted in a succeeding section, however, that these two species are present in markedly different ratios than in 1938.

Compared to the other Ontario areas, Ephialtes is of relatively minor importance in the Fort Frances district. This may be an indication that the infestation in that area is on the downgrade, with the result that Ephialtes is declining in the face of more vigorous competition from Phaeogenes. The underlying theory of this fluctuation is amply elucidated in the next section. Diptera are most abundant in material received from Dogwood, Calm, Crooked Pine, Off and Sphene Lakes, the highest parasitism of 0.56% occurring in the last

two mentioned.

Basswood Lake is believed to be the focal point of the infestation in the Fort Frances district. In view of this, progressive changes in parasite population with increasing distances from the focal point are to be expected. There is, however, no apparent correlation between incidence of parasitism and proximity to the supposed source of the outbreak.

Parasitism at Hawk Lake for 1939 shows a slight drop from 1938 with Phaeogenes becoming increasingly important. This would seem to indicate that parasitism here reached its maximum in 1938 and apparently both host and parasites are now slowly on the wane.

Similar conditions obtain at Dryden and Vermilion Bay, both within sixty miles east of Hawk Lake and also in the original severe budworm area. An interesting feature at Dryden is the large number of Diptera obtained.

Phaeogenes and Ophialtes are the only parasites of any consequence obtained from the Ignace collections, Ophialtes being the lesser of the two.

Considering the pupal survey as a whole, it is manifest that the three major parasites are Diptera, Phaeogenes harioluS and Ophialtes conquisitor. Since the inception of these parasite investigations in 1937 it has become increasingly evident from the limited

number of areas sampled that Ephialtes and Phaeogenes would eventually prove to be the most valuable parasites offering possibilities of natural control. The pupal survey conducted in 1938, embracing a large number of areas, has amply justified this premise in that these two species have, with a single exception, contributed a major share of parasitic insect mortality to budworm pupae.

D. Parasitic Population Fluctuations

The significance of the figures as given in Table 2 cannot be fully appreciated until a comparison is made with the 1938 records. The preliminary investigations previously mentioned indicated fluctuations in the population of species according to the age of the infestation in definite regions. The correlation of the oscillations of the host and parasite abundance, therefore, constitutes a fundamental study in arriving at the contribution of various species in establishing natural control.

The following table presents a comparison of the four main parasites in the 3 areas sampled in 1938.

TABLE 3

PARASITE	SANDILANDS, MAN.		HAWK LAKE, ONT.		IGNACE, ONT.	
	1938	1939	1938	1939	1938	1939
N. maculosa	2.87	1.68	1.25	1.34	3.12	.67
E. conquisitor	11.50	5.78	18.1	14.25	16.6	7.71
P. hariolus	1.04	11.46	18.5	20.24	4.6	12.48
A. verditor	1.36	2.14	2.0	1.53	.52	.97

The most significant point arising from Table 3 is that Ephialtes conquisitor seems capable of building up its population early in an outbreak but incapable of maintaining it in the face of certain opposition or, being a more general parasite, is possibly absorbed by other alternate hosts. Ephialtes has dropped in effectiveness in 1939. Phaeogenes, on the other hand, has increased. The same condition is encountered in all the remaining areas in Table 2, and is particularly pronounced in the older areas, such as Basswood (6).

Refering back to Table 2, what the previous population of Ephialtes might have been in areas 8-10 cannot be surmised as no data was procured before 1939. Notwithstanding, in view of the fact that the Jack pine budworm has been active in that country for 2 years before reaching its climax in 1939, it is possible that the balance of the population has already switched from Ephialtes in favour of Phaeogenes. According to those areas in which we have this data for 2 years, Sandilands, Hawk Lake and Ignace (Table 3)

we should expect to find Phaeogenes in the majority after 3 years of intensive budworm activity, or otherwise this change of balance would not apply.

A further point which may contribute toward an abundance of Phaeogenes in the newer areas might be its ability to disseminate through a newly infested region to greater advantage than Ephialtes.

All other parasites considered, Phaeogenes appears to be the most important and capable of the greatest destruction of budworm pupae.

Despite the increase of Phaeogenes and the decrease of Ephialtes, there appears to be a certain stability of the total percentage mortality inflicted upon the host between 1938 and 1939, although it cannot be said how high this percentage might be. Indications are that there is a certain effective maximum balance between the two and as one increases the other decreases. This point is illustrated in Table 4, showing the combined parasitism of Ephialtes and Phaeogenes in the 3 areas sampled in both 1938 and 1939.

TABLE 4

SANDILANDS F.R.		HAWK LAKE, ONT.		IGNACE, ONT.	
1938	1939	1938	1939	1938	1939
12.54	17.24	36.40	34.49	21.20	20.19

Note:- A discrepancy occurs in the Sandilands Forest

Reserve but the ratio is consistent at Hawk Lake and Ignace. However, before any definite conclusions can be formulated on this phase additional investigation is required.

C. Sex-Ratio Correlations between Host & Parasite

Detailed rearings in 1938 indicated the probable existence of a correlation between the sex-ratio of the host and sex-ratios of Ephialtes and Phaeogenes. However, to ensure accurate results in a study of this nature, a large sampling such as obtained in the 1939 pupal parasite survey was essential. The ensuing discussion, then, is concerned chiefly with the demonstration and interpretation of these correlations and their potentialities as evinced in this survey.

TABLE 5

AREA	SEX RATIOS		
	C.fumiferana	P.hariolus	E.conquisitor
Vermilion Bay	.321	.359	.318
Ignace	.356	.223	.335
Off & Sphene Lakes	.428	.430	.456
Basswood	.431	.346	.500
La Croix, Sturgeon Narrows & Beaverhouse Lake	.456	.391	.534
Hawk Lake	.493	.547	.551
Calm & Crooked Pine L	.504	.520	.475
Dryden	.522	.472	.500
Fort a la Corne	.545	.456	.569
Sandilands III	.586	.508	.620
Sandilands I	.589	.541	.605

That a correlation between sex-ratio of parasite and the host exists is evident from Table 5. These correlations

are graphically illustrated for clarity in Charts 1 and 2. In these charts the sex-ratio of each parasite has been plotted against the sex ratio of the host. The regression line has been fitted on the basis of statistical calculations as outlined in "Methods of Statistical Analysis" by C.H. Goulden of the Dominion Rust Research Laboratory, Winnipeg.

The regression lines plotted in Charts 1 and 2 are derived from regression coefficients computed from sex-ratios of Ephialtes and Cacoecia in Chart 1 and Phaeogenus and Cacoecia in Chart 2. These lines are fitted so that the sum of squares of the deviations of the points in the graph from a straight line is a minimum. The regression coefficient expresses the increase or decrease in the dependent variable (sex-ratio of parasite) for one unit increase in the independent variable (sex-ratio of C. fumiferana)

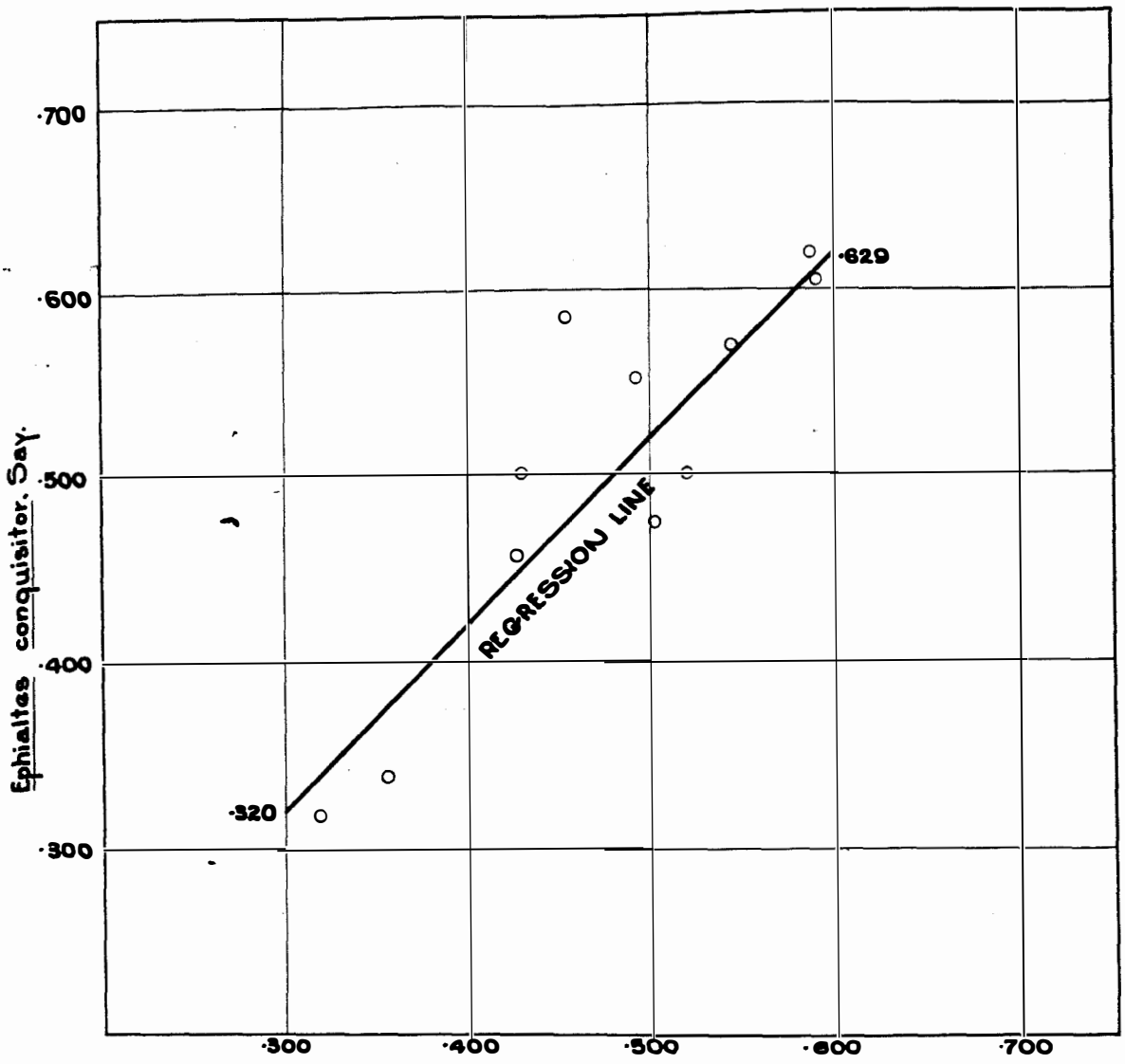


CHART I.

REGRESSION CHART for SEX-RATIO of *EPHIALTES CONQUISITOR*, SAY. ON SEX-RATIO of *CACOECIA FUMIFERANA*, CLEM.

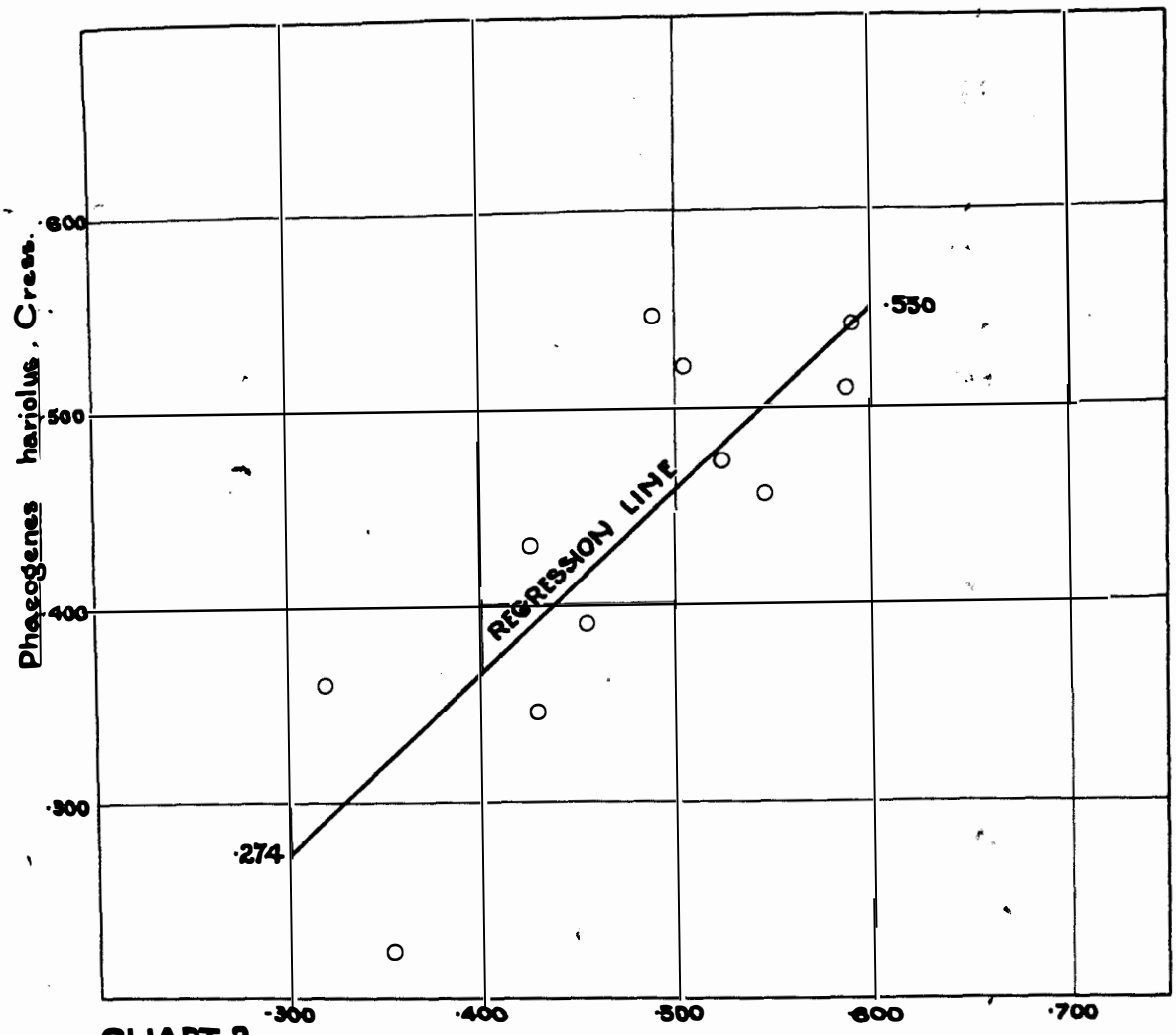


CHART 2.

REGRESSION CHART for SEX-RATIO of *PHAEOGENES HARIOLUS*. CRESS. ON SEX-RATIO of *CACOECIA FUMIFERANA*. CLEM.

Regression of Ephialtes on Cacoecia

The regression coefficient when tested is shown to be highly significant. On this basis it is apparent that there is a definite correlation between the sex-ratio of Ephialtes and the sex-ratio of Cacoecia. The regression equation shows that for every rise of 0.100 in the sex ratio of the budworm pupae a corresponding increase of .103 in the sex-ratio of Ephialtes is predicted. This is almost a perfect direct correlation.

Regression of Phaeogenes on Cacoecia

The regression coefficient when tested comes so close to being significant that it cannot be ignored. Actually it is suspected that the host-parasite ra tios here are more intimately linked than in the case of Ephialtes. The variations from the regression line, however, are more erratic, doubtless accounting for the slightly less significant coefficient. From the regression equation, an increase of 0.092 in the sex-ratio of Phaeogenes may be expected for an increase of 0.100 in sex-ratio of the host.

To appreciate fully the import of these correlations, we must go a step further and examine the sex-ratios of each parasite in (1) female budworm pupae and (2) for male budworm pupae in all the areas contributing to the survey. These data are presented in Table 6.

TABLE 6

LOCALITY	Sex-Ratio of *E. conquisitor*		Sex-Ratio of *P. harielus*	
	♀Pupae	♂Pupae	♀Pupae	♂Pupae
Vermilion Bay	.562	.178	.688	.150
Ignace	.411	.286	.491	.108
Off & Sphene Lakes	.737	.347	.714	.314
Basswood	.600	.462	.608	.302
La Croix, Sturgeon Narrows & Beaverhouse	.741	.516	.796	.135
Hawk Lake	.515	.403	.805	.293
Calm & Crooked Pine L.	.640	.404	.756	.414
Dryden	.608	.398	.798	.243
Fort a la Corne	.650	.389	.691	.188
Sandilands I	.744	.411	.728	.276
Sandilands III	.771	.457	.724	.298

It is obvious from Table 6 that the sex of the host plays a major role in affecting the subsequent sex of the parasite (*Ephialtes* or *Phaeogenes*) developing therein, particularly as regards *Phaeogenes*. Without exception there is an unmistakable bias towards the development of male parasites in male host pupae and female parasites in female pupae. The origin of the correlations disclosed in Charts 1 and 2 is also explained, as it is patent that the higher the sex-ratio of the host pupae, the higher will be the sex-ratio of *Ephialtes* and *Phaeogenes* developing in them. It would seem that these parasites have some ability to predetermine the sex of the progeny by controlled fertilization or other means, and that they are possibly influenced in this respect by certain inherent qualities of the host, such as size, odour or nutritive considerations related to sex.

Table 7 presents data again closely related to sex ratios in that it gives the mortality to male and female pupae as a consequence of insect parasitism of all kinds and other causes in all the areas sampled.

TABLE V

PERCENT PARASITISM OF MALE AND FEMALE BUDWORM PUPAE

Locality No.	1		2		3		4		5		6		7		8		9		10		11		
Locality → / Parasites ↓	Hawk Lake		Vermilion Bay		Dryden		Sandilands Camp I		S.F.R. Camp III		Basswood		Ignace		Sphene and Off Lake		Galm and Crooked Pine Lakes		La Croix Sturgeon R. Beaverhouse L.		Fort a la Corne		All Localities	
	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀	B.W. ♂	Pupae ♀
APANTELES FLAVIPES	1.45	1.24	.82	.80	4.67	7.20	2.22	2.26	1.38	1.67	5.18	2.53	.36	1.22	6.99	5.99	4.51	4.51	1.64	.82	2.80	7.45	2.66	3.47
APANTELES FUMIFERANAE	18.18	18.28	11.71	14.16	13.93	11.31	6.28	6.13	6.28	4.78	2.49	1.87	7.28	8.46	5.35	2.78	3.53	1.68	5.35	2.78	.79	1.46	6.23	4.96
APANTELES SP.	20.14	20.35	19.25	22.20	18.51	15.27	12.64	12.26	12.59	8.63	16.16	12.91	13.52	10.53	22.39	12.87	10.41	7.66	13.37	10.09	2.10	2.01	13.69	9.66
MISCELLANEOUS DIPTERA	.26	.50	.00	.00	.26	.40	.26	.23	.27	.14	.19	.25	.10	.09	.66	.58	.36	.42	.08	.00	.48	.26	.34	.29
EPHORUS AND PARASITOIDS SP.	.81	.83	.42	.26	.21	1.39	.70	.69	.38	.51	.19	.51	.55	1.16	.32	.14	.56	.39	.18	.21	.61	1.06	.46	.71
PREDITOR	1.19	1.91	.42	.26	2.47	1.74	2.79	1.69	1.67	2.22	.38	.76	1.02	.91	1.16	.74	1.89	1.20	.38	.32	.11	.16	1.45	1.36
TOTAL PARASITISM	40.11	37.11	32.64	45.12	40.65	37.39	23.41	25.83	22.51	17.75	23.59	18.23	22.83	22.37	36.87	23.10	32.26	15.66	21.00	14.22	6.89	12.40	24.81	20.43
DEATH FROM OTHER CAUSES	18.81	17.75	54.81	42.48	30.18	27.21	58.72	45.96	62.13	63.64	52.77	42.53	58.86	63.06	41.82	43.12	49.60	48.29	50.82	29.97	62.41	60.26	52.40	50.08
TOTAL MORTALITY	58.92	54.86	87.45	87.60	70.83	64.60	81.13	67.79	84.64	81.39	76.36	60.76	81.69	85.45	78.69	66.22	81.86	63.96	71.82	44.19	69.30	72.66	77.21	70.51

It is to be observed that, with the exception of Fort a la Corne and Vermilion Bay, total insect parasitism destroyed a greater percentage of male than female pupae. In areas 8, 9 and 10 these differences are very evident, being brought about primarily by Phaeogenes and Ephialtes, although the same general preference for male pupae to a lesser degree is evinced by the other parasites. This disparity is not so marked, although quite distinct, in the remaining areas. Here again Phaeogenes and Ephialtes have discriminated against male host pupae.

Considering the total insect parasitism in all areas, 4.38% more male than female pupae were killed by parasitism. Phaeogenes, Ephialtes, Amblymerus yerditor and miscellaneous Hymenoptera killed a higher percentage of males while the reverse condition obtained for Diptera and smaller Chalcids.

The whole picture relative to sex-ratios and selectivity of the host and parasites as it stands at present has now been presented. By considering as a unit the data from Tables 5, 6 and 7 and Charts 1 and 2, certain possible methods of manipulation which may eventually produce a natural control are suggested. First, the parasites have been shown to destroy a greater percentage of males. Then, any artificial or mechanical measures, such as trapping, designed to further reduce the

number of males should effect a material reduction in the budworm population if carried on in a large scale over a period of years.

In connection with this, records show that as budworm pupation progresses the sex-ratio of pupae present in the field increases, due to the later pupation of female larvae. A stock of parasites reared and maintained in the laboratory could then be liberated in the field when the budworm sex-ratio has reached a high level but a considerable period of pupation still remains. As the sex ratios of the host and parasite are apparently in direct correlation, this would result in a greater production of female parasites. These, believed to be polygamous, would then be potentially in a better position to increase their numbers in the following year.

In association with the above, it is interesting to note the oscillations in sex-ratios of Ephialtes and Phaeogenes for the last two years at Sandilands and Hawk Lake. This information is presented in Table 8.

TABLE 8

Species	Sandilands F.R.		Hawk Lake	
	1938	1939	1938	1939
E. conquisitor	.590	.615	.456	.551
P. hariolus	.347	.520	.259	.547

What these ratios were previous to 1938 cannot be surmised, but it is apparent that the ratios of both species show marked increases, particularly in the case of Phaeogenes. It may be that at the beginning of an outbreak the sex-ratio of Phaeogenes is low, increasing as the infestation becomes more severe and the host becomes more abundant. In accordance with the theory presented, as the sex-ratio of Phaeogenes increases, the potentialities of the parasite also multiply. If the increase in the sex-ratio of Phaeogenes from 1938 to 1939 is the continuation of a trend existing prior to that time, this may conceivably account for its present position of preeminence.

D. Parasite Overwintering Study

1. Aims and Methods

The following study was undertaken to determine if Phaeogenes and Ephialtes overwinter as adults and, if so, in what manner hibernation takes place. Parasites reared from the pupal survey material were used for this project and confined in a cotton covered cage 6 feet square, specially constructed for this purpose. The floor of the cage was left open and placed on the ground in this manner over a number of seedlings, thereby providing as nearly as possible a natural environment.

Parasites were introduced into the cage through

a removable tightly fitting trap door 2 feet square built into one of the lower corners. In all, some 200 adults of Phaeogenes and Ephialtes were released in the cage during the period of emergence. A pint of thin sugar syrup was provided daily by allowing it to trickle through the top of the cage, thereby maintaining the humidity in the cage and at the same time supplying food and moisture for the parasites.

In November, when all activity had ceased, the top was removed to allow the normal fall of snow to cover the ground, in this manner simulating natural conditions encountered in the field.

E. Results to Date

No results, of course, are available at this early date. In the spring, however, the top of the cage will be replaced and observations continued throughout the summer of 1940 for the appearance of either Phaeogenes or Ephialtes.

Although it has not been demonstrated that these parasites overwinter as adults, certain deductions based on investigations to date indicate this to be possible. Moreover, in the same token it is probable that the budworm in this particular case may be a more or less specific host, although Ephialtes is known to have many other hosts. It has been shown with other similar parasites that neither eggs, larvae or pupae can long withstand severe

winter temperatures. This leaves only adults for overwintering. If in the following spring either parasite passed through an alternate host to produce the budworm generation of parasites early in July, this would necessitate an attack on the first host in the beginning of June. This, in turn, requires the presence of a host overwintering as a mature larva, since the parasites can only oviposit on pupae less than a day or two old. Not many of these are known to exist.

In addition, parasite fluctuations seem to vary directly with the age of the infestation and abundance of the host. This implies the existence of a situation which is possible only if the budworm is a specific host. It is conceivable that these parasites, although essentially general, have over a period of years developed a certain host specificity through close association and continual synchronization of events in their respective life histories.

E. Parasite Liberations

One of the original aims of the pupal survey was to locate budworm infested areas in which parasites were lacking either in abundance or species, and to rectify such undesirable trends, whenever possible. All the major species were obtained from all the areas sampled. Incidence of parasitism, on the other hand, varied considerably with locality. The parasitism at Fort a la

Corne for example was far below that encountered in any other area. In an attempt to alleviate this situation, a large series of Phaeogenes and Ephialtes obtained from the survey collections was liberated there. In addition, parasites were released in the Port Arthur District, the eastern limit of the infestation, Taebo, Ontario and Clear Lake, Manitoba.

Table 9 lists the species and number of parasites released in the areas mentioned.

TABLE 9

Date	Locality	Species	Males	Females
July 28	Taebo, Ontario	Ephialtes	138	145
Aug. 1	Port Arthur, Ont.	Phaeogenes	395	280
Aug. 1	Port Arthur, Ont.	Ephialtes	160	150
Aug. 1	Fort a la Corne, Sask.	Phaeogenes	265	275
Aug. 1	Fort a la Corne, Sask.	Ephialtes	50	50
Aug. 1	Clear Lake, Man.	Phaeogenes	170	130
Aug. 1	Clear Lake, Man.	Ephialtes	50	50
TOTAL FOR ALL AREAS			1228	1080
GRAND TOTAL				2308

F. Summary

A total of 31,027 budworm pupae were handled and reared at the central field laboratory at Hawk Lake, Ontario, in 1939. The localities contributing and the

total insect parasitism for each area is listed in the following tabulation:

Area No.	Locality	Percent Parasitism
1	Hawk Lake, Ontario	38.59
2	Vermilion Bay, Ont.	36.65
3	Dryden, Ontario	38.97
4	Sandilands, Man., Camp I	24.24
5	Sandilands, Man., Camp III	19.74
6	Basswood Lake, Ont.	21.51
7	Ignace, Ontario	28.70
8	Sphene & Off Lakes, Ont.	31.36
9	Calm & Crooked Pine Lake, Ont.	23.69
10	La Croix, Sturgeon Narrows and Beaverhouse Lake, Ont.	17.94
11	Fort a la Corne, Sask.	9.84

Parasitism is highest in areas 1, 2 and 3 where the infestation is oldest. The infestation in areas 4 to 9 inclusive is generally believed to be more recent and parasitism is, on the whole, correspondingly lower. The most recent outbreak has been reported from Fort a la Corne and parasitism there is by far the lowest in all the areas sampled.

The major parasites obtained, in their order of importance, were two Ichneumons, Phaeogenes hariolus and Ephialtes conquisitor, and Diptera, comprising chiefly Hemorilla maculosa. These three accounted for over 90%

of the total insect parasitism while miscellaneous Hymenoptera were responsible for the remaining 10%.

Records for two years from Sandilands, Hawk Lake and Ignace indicate that Ephialtes seems capable of building up its population early in an outbreak, but incapable of maintaining it in the face of certain opposition or, being a more general parasite, is possibly absorbed by other alternate hosts. Ephialtes has dropped in effectiveness in 1939. Phaeogenes, on the other hand, has increased. If the above holds true, the data at hand implies that intensive budworm activity has been extant in the Ft. Frances District for at least three years, as the balance there has already switched in favour of Phaeogenes.

A statistical analysis of survey material from 11 areas discloses the existence of a direct correlation between the sex-ratios of Cacoecia and sex-ratios of Phaeogenes and Ephialtes. Moreover, it is clear that these correlations have been brought about by an obvious tendency for male parasites to develop in male host pupae and vice versa for females.

There is apparent a rather small but marked parasitic discrimination against male budworm pupae, mainly by Ephialtes and Phaeogenes.

These findings suggest the initiation and development of several possible methods of control. In

the first place it has already been shown that a greater percentage of male pupae are destroyed by parasitism.

Then, any successful artificial or mechanical measures such as trapping applied towards a further reduction in the number of males should effect a material decrease in the budworm population if carried out on a large scale over a period of years.

Moreover, records show that as budworm pupation proceeds the sex-ratio of pupae in the field increases, due to the later pupation of female larvae. A stock of parasites maintained in the laboratory could be released in the field when the host sex-ratio has reached a high level, but with a considerable portion of the pupal period still remaining. As the sex-ratios of host and parasite are apparently in direct correlation, this operation should result in the production of a greater number of female parasites. These, believed to be polygamous, would then be potentially in a more favourable position to increase their numbers in the following year.

Records available from Sandilands and Hawk Lake show a marked increase in 1939 of the sex-ratios of Phaeogenes and Ephialtes. In connection with the above, this indicates that, other things being equal, higher parasitism can be expected in these areas in 1941.

A parasite overwintering study is in the process of completion in conjunction with the pupal survey. A series of approximately 200 adults of Ophialtes and Phaogenes were confined in a 6 foot square cotton covered cage placed on the ground at Hawk Lake in the fall of 1939. If overwintering occurs in the adult stage, recoveries should be made in 1940.

A large series of some 2300 individuals of Phaogenes and Ophialtes obtained from the survey collections were liberated at Port Arthur and Tache, Ontario; Clear Lake, Manitoba; and Port a la Corne, Saskatchewan. It is believed that these are areas which will derive the most benefit from such liberations.

6. Recommendations

This paper has attempted to point out the value and importance of continuing and extending this survey to Dominion-wide proportions. It has also demonstrated that qualitative and quantitative studies on host-parasite and inter-parasite relationships should eventually make possible the accurate determination of the condition of an infestation and accurate forecasts of its future course. The Ophialtes-Phaogenes relationship has been used to illustrate this point. Moreover, the value of the survey in discerning where and what species of parasite are lacking is obvious.

In view of the evidence obtained to date, the

solution of the following problems is essential for a more complete understanding of the jack pine budworm complex:

(1) Development of a practical technique for handling and producing parasites in quantity in the laboratory. On the basis of our present knowledge, it appears that special emphasis should be attached to the solution of this phase.

(2) Natural control factors operating against budworm larvae and eggs.

(3) Establish biotic potentials of the parasites and host.

(4) Controlled parasitism of male and female pupae by Ephialtes and Phaeogenes to corroborate the sex-ratio correlations disclosed above.

(5) Method of overwintering of Ephialtes and Phaeogenes.

(6) Settle definitely the question of polygamy in Ephialtes and Phaeogenes.

In conclusion, it cannot be too strongly stressed that a Dominion-wide application of this pupal survey would greatly enhance the possibility of ultimately producing an effective natural control. With the probable discovery of other valuable parasites or predators in various parts of the country, reciprocal transfers from one area to another could be conducted with increased hope of ultimate success.

VI. INSECT PARASITISM OF LARVAE OF C. fumiferana

During the course of investigations conducted at Hawk Lake in 1939, 357 budworm larvae were reared individually for instar development. Of this number 12 or 3.36% were killed by Apanteles fumiferanae Vier., a Braconid parasite.

All larvae were removed from exposure to parasitism in the 2nd or 3rd instars; therefore all parasitism occurred prior to the 4th instar. A remarkable feature is that 11 parasites emerged from female larvae and 1 from a male.

Details regarding emergence of parasites are presented in the following tabulation:

Sex of larva Parasitised	Instar in which Parasite Emerged	No. of Parasites Emerged
Male	4th	1
Female	3rd	1
Female	4th	8
Female	5th	2
	Total	12

The presence of this parasite at Hawk Lake is important in view of the fact that it was not recorded from this area in 1937 and 1938. This species is reputed to be a useful budworm parasite (Doane et al.) and there is a possibility that its appearance in this area in 1939 is the prelude to the building up of a

population which might well be the deciding factor in producing a natural control. If specific in its host selection, the budworm population in 1938 was of sufficient quantity to afford a considerable increase in numbers of the parasite, other things being equal. In addition, if the selection of female larvae is consistent, its effectiveness is thereby appreciably amplified.

Meteorus trachynotus, another braconid reared from budworm larvae in this locality in 1937 and 1938, was not recovered in 1939.

FEEDING AND GROWTH OF BUDWORM LARVAE

By F. B. Rabkin

FEEDING AND GROWTH OF BUDWORM LARVAE

I. INTRODUCTION

Previous studies on the biology of the spruce budworm (cf. 1937 and 1938 report) elucidated the fact that budworm larvae show a dietary preference for staminate cones of Jack pine food. Large counts made at Willard Lake, Ontario, in 1938 showed that at the beginning of the year most of the larval (budworm) population exhibited a decided tendency to migrate to staminate cones, in the early part of the year. After approximately two weeks' feeding, another "migration" occurred to the terminal buds on the Jack pine. Some larvae completed their development on terminal buds alone. The data obtained from this and other projects indicated further studies on the biology of the budworm to ascertain the effect of the different food types on survival of larvae, sex-ratio, etc.

This study was concerned with two main features:

(a) To determine the role of staminate cones and terminal buds in the growth and development of budworm larvae.

(b) To determine the number of instars in larvae fed on each food type.

The interrelation of these two parts includes such points as: The effect of the different foods upon:- Mortality of the developing larvae; retardation in growth; larval and pupal sex-ratios; fertility and fecundity of adult female moths, etc.

II. METHOD

The study was based on the separate rearing of 200 second instar budworm larvae. A large series of such larvae were collected immediately following their emergence in the spring and before any feeding had taken place. Shell vials (3½" x 1") were used as cages in which to rear the larvae. Placing 2 larvae in each vial, 50 vials of staminate-feeding larvae and 50 vials of terminal-feeding larvae were started, thus beginning with 100 larvae in each category.

Larvae were liberated onto a freshly picked staminate-cone or terminal-bud in the vial which was then corked. This was essential in order to keep the small larvae from escaping; however, this resulted in a fairly high humidity within the vial. In order to maintain normal conditions, the corks were replaced by cotton plugs in a few days. Despite extreme care, some larvae succeeded in wriggling their way out of the vial and escaping.

All the vials were examined once each week and new food added when necessary. Records were kept as to condition of larvae, change of food, moult, etc. Head capsules occurring from larval moults were preserved for winter examination. Due to the manner in which the second instar larvae fed, it was impossible in many cases to avoid inadvertent introduction of larvae into the vials. However,

such introduced larvae were feeding on the requisite food type and thus did not influence the experiment inasmuch as food types were concerned. Some difficulty was experienced in segregating the various head capsules found in the vials and, thus, determination of instars was made more difficult.

III. FEEDING

A. Staminate Cones

Jack pine budworm larvae were first noted in the field, at Hawk Lake, Ontario, on May 28, 1939. At this time the staminate cones on the Jack pine were fully "swollen" but very few had started to ripen--the majority being "green". This study was in full operation by June 1939.

It was found that the larvae readily fed on these slightly greenish cones by boring right into the centre of the cone. Within a short time the larvae were entirely concealed from view and all traces of their presence were quite impossible to find.

Usually no difficulty was experienced in maintaining the larvae on the staminate cones. In a number of cases it was difficult to determine whether the larva had moulted or not, since an early third instar larva closely resembles a second instar one, etc. Further, due to the small size of the second instar capsule--about 0.2 mm. long and 0.2 mm. wide--a microscopic examination of the food and contents of the vial was necessary. In some

cases this necessitated the disturbance of the larva.

From previous observations it was found that the larva did not return to terminal buds until the latter part of June when they were approximately in the fourth instar. In order to start staminate-fed larvae feeding on terminal buds, the latter were merely introduced into the vial, about June 12th. In this manner larvae went over to the buds voluntarily. This occurred about June 19th. In nearly all cases the larvae preferred to remain in the cones as long as possible, continuing to feed in them even when the cones had become covered with mold. Feeding on the terminals took place in the usual manner, the larvae spinning their web and chewing off the needles at the base. During the last two instars the larvae had voracious appetites, 1 larva alone consuming about 3-3" terminals in entirety.

B. Terminal Buds

In most cases the second instar budworm larvae practically refused to feed on the terminal buds provided in the vials. For the first few days of their being confined (in the vial) the larvae kept crawling about inside the vial continuously. In a few cases the larvae remained in their second instar almost to the end of June without feeding. Those larvae that did settle down to feed appeared to do so in a "haphazard manner", alternating

between periods of feeding and periods of wandering about (during the second and third instars). In their early stages of feeding the second instar larvae always bored right into the terminal--usually the central axis of the bud on the needles--practically no "external" feeding occurred. This would tend to destroy the bud completely, even if none of the needles were harmed. During the fourth instar the larvae settled down and developed in a more or less normal manner.

Various possibilities suggest themselves in explanation of the larvae not feeding on terminals. One important factor would be the matter of the terminals at the time the larvae commence to feed. During the latter part of May and early June the terminals are not yet fully opened and in many cases are covered with a resinous exudation. This would tend to inhibit any feeding activity on the part of the budworm. Another factor worthy of consideration is the relative food values in terminal buds as compared to staminate cones. The former would not contain nearly the amount of nutritive elements that the latter would.

IV. GROWTH AND DEVELOPMENT

In addition to the various relationships indicated under the separate feeding types, no especial features were noted in the development of the larvae. In general, growth was apparently similar between male and

female larvae feeding under similar conditions up until the fourth instar, at which time the male usually developed more rapidly.

A. Instars

On the basis of head capsules collected from the individual vials, there is thought to be 6 larval instars in the budworm, exclusive of the prepupal and pupal stage. Due to the difficulty in locating head capsules and also additional larvae being inadvertently introduced with the change of food, it is not possible at this time to make any definite statements in regard to the number of instars. In most cases, the data available seem to indicate 6 instars.

1. Head Capsule Measurements

On the weekly examinations the larvae and food were examined for cast-off capsules. The presence of a capsule was taken as an indication of change of instar, since no appreciable external changes occurred in the early instars to signify such changes. It is interesting to note, at this point, that up until the last instar no other portion of the exuviae could be found except the head capsule.

A series of head capsules were measured under the binocular microscope and the sizes of head capsule for the various instars determined. The data are presented in Tables 1 and 2. In these tables the length

and width (in millimetres) of the capsules are presented for each instar. The number of capsules in each category is included. Due to various capsules not recovered, and death of larvae at various instars, the number of head capsule measurements presented for each instar is not constant.

Table 1 presents the measurements of head capsules from larvae fed on staminate cones. The variation in size for each instar is readily observed. This is not due to sex-differences in size of capsule, since studies during 1938 (See Annual Report for 1938.) showed no appreciable differences in size between male and female capsules. Observations and measurements from this study (Feeding and Growth) show similar results. The range in size of head capsule for each instar may be due to feeding and general "vigour" of the individual larva.

Table 2 presents the measurements of head capsules from larvae fed on terminal buds. Here again there is noted considerable variation in size for capsules in the same instar.

TABLE 1

LARVAL (BUDWORM) HEAD CAPSULE MEASUREMENTS-STAMINATE FED

2nd INSTAR			3rd INSTAR			4th INSTAR			5th INSTAR		
Lgth. Mm.	Width Mm.	No.of Cap-sules	Lgth. Mm.	Width Mm.	No.of Cap-sules	Lgth. Mm.	Width Mm.	No.of Cap-sules	Lgth. Mm.	Width Mm.	No.of Cap-sules
.21	.21	4	.42	.37	2	.64	.64	4	1.06	.95	1
.23	.23	13	.41	.41	2	.67	.67	1	1.06	1.01	2
.25	.25	1	.42	.41	1	.74	.74	2	1.06	1.06	2
.27	.27	16	.42	.42	6	.80	.74	1	1.17	1.11	5
.32	.32	12	.48	.48	2	.80	.80	2	1.17	1.17	3
.37	.32	1	.53	.48	2	.85	.80	4	1.22	1.11	1
.37	.37	26	.53	.53	14	.85	.85	7	1.22	1.17	1
.40	.37	2	.58	.53	2	.90	.85	2	1.27	1.17	2
.40	.40	3	.58	.58	15	.95	.85	2	1.27	1.22	3
.42	.37	5	.61	.61	1	.95	.90	2	1.27	1.27	2
.42	.42	2	.64	.58	7	.99	.90	2	1.33	1.27	1
			.64	.61	4	.99	.95	3	1.33	1.33	1
			.64	.64	10	1.01	.90	1	1.38	1.27	2
			.67	.64	1	1.01	.95	3	1.38	1.33	3
			.69	.69	2	1.01	1.01	3	1.38	1.38	1
			.74	.64	1	1.06	.95	2	1.43	1.27	1
			.74	.74	1	1.06	1.01	1	1.43	1.38	1
			.80	.80	1	1.06	1.06	3	1.48	1.27	1
									1.48	1.33	1
									1.48	1.38	4
									1.48	1.43	1
									1.48	1.48	3
									1.54	1.48	1
									1.59	1.48	1
									1.64	1.48	1

TABLE 2

LARVAL (BUDWORM) HEAD CAPSULE
MEASUREMENTS-TERMINAL FED

2nd INSTAR			3rd INSTAR			4th INSTAR			5th INSTAR		
Lgth. Mm.	Width Mm.	No.of Cap-sules	Lgth. Mm.	Width Mm.	No.of Cap-sules	Lgth. Mm.	Width Mm.	No.of Cap-sules	Lgth. Mm.	Width Mm.	
.23	.23	3	.42	.42	1	.74	.74	1	1.17	1.17	
.26	.26	3	.53	.53	5	.80	.80	3	1.22	1.06	
.27	.27	7	.58	.58	6	.82	.82	1	1.22	1.17	
.32	.32	5				.85	.80	1	1.27	1.17	
.37	.32	1				.85	.85	3	1.27	1.22	
.37	.37	8				.90	.85	1	1.30	1.22	
						.90	.90	1	1.33	1.27	
						.95	.86	1	1.38	1.27	
						.95	.90	3	1.43	1.29	
						.95	.95	1	1.43	1.38	
									1.48	1.38	

TABLE 3

SUMMARY OF HEAD CAPSULE MEASUREMENTS
OF STAMINATE FED BUDWORM LARVAE

INSTAR	MINIMUM		MAXIMUM		MEAN	
	LENGTH	WIDTH	LENGTH	WIDTH	LENGTH	WIDTH
SECOND	.21	.21	.42	.42	.32	.31
THIRD	.42	.37	.80	.80	.57	.56
FOURTH	.64	.64	1.06	1.06	.90	.86
FIFTH	1.06	.95	1.64	1.48	1.32	1.26

TABLE 4

SUMMARY OF HEAD CAPSULE MEASUREMENTS
OF TERMINAL FED BUDWORM LARVAE

INSTAR	MINIMUM		MAXIMUM		MEAN	
	LENGTH	WIDTH	LENGTH	WIDTH	LENGTH	WIDTH
SECOND	.23	.23	.37	.37	.31	.31
THIRD	.42	.42	.58	.58	.55	.55
FOURTH	.74	.74	.95	.95	.87	.85
FIFTH	1.17	1.17	1.48	1.38	1.32	1.24

A summary of Tables 1 and 2 is contained in Tables 3 and 4, presenting the minimum, maximum and mean length and width of head capsules for each instar. In general, no appreciable differences in mean size of head capsule is noted between staminate-fed and terminal-fed larvae, although the capsules from terminal-fed larvae appear to be a trifle smaller. It is interesting to note that the minimum sizes of head capsules were always greater amongst terminal-fed larvae than amongst staminate fed.

The data presented leads to several interesting considerations. Apparently type of food does not seriously influence the size of the larva, as depicted by the head capsule measurements. Since the food-type does exert some influence on the larva (as will be indicated later) it must affect the vigour. Examination of Tables 1 and 2 indicates a more uniform development of larvae feeding on terminal buds. The differences (in millimeters) between the smallest and largest head capsules in each instar are presented below:

	STAMINATE-FED		TERMINAL-FED	
	LENGTH	WIDTH	LENGTH	WIDTH
2nd Instar	.21	.21	.14	.14
3rd Instar	.38	.43	.16	.16
4th Instar	.42	.42	.21	.21
5th Instar	.53	.53	.31	.21

Thus, it is observed that the size ranges of head capsules from terminal-fed larvae exhibit greater uniformity than capsules from staminate-fed larvae.

The increase in mean head capsule size through successive instars for staminate- and terminal-fed larvae was computed as follows:

	STAMINATE		TERMINAL	
	LENGTH	WIDTH	LENGTH	WIDTH
2nd-3rd Instar	.25	.25	.24	.24
3rd-4th Instar	.23	.30	.32	.30
4th-5th Instar	.42	.40	.45	.39

(Figures are given in millimetres)

The indications from the above are that in both staminate- and terminal-fed larvae the increase in size of head capsule is fairly uniform up to the 4th instar. In both cases the greatest increase in size took place on the 4th instar moult. The greatest diversity in size of head capsule occurred in the fifth instar. This might be the result of the accumulated effect of the type of feeding upon the larval growth. In general, the larvae

appeared to put on their maximum growth during the fifth and sixth instars.

For purposes of comparison, a complete series of head capsules from each of one male and female larva--staminate- and terminal-fed--were recorded in Table 5.

TABLE 5

SIZE OF HEAD CAPSULE IN THE LARVAL INSTARS FROM STAMINATE- AND TERMINAL-FED LARVAE

	STAMINATE-FED				TERMINAL-FED			
	MALE		FEMALE		MALE		FEMALE	
	LENGTH	WIDTH	LENGTH	WIDTH	LENGTH	WIDTH	LENGTH	WIDT
2nd Instar	.32	.32	.40	.37	.27	.27	.37	.3
3rd Instar	.53	.53	.61	.60	.53	.53	.58	.5
4th Instar	.85	.80	.95	.85	.85	.80	.90	.9
5th Instar	1.22	1.17	1.38	1.33	1.33	1.27	1.33	1.2

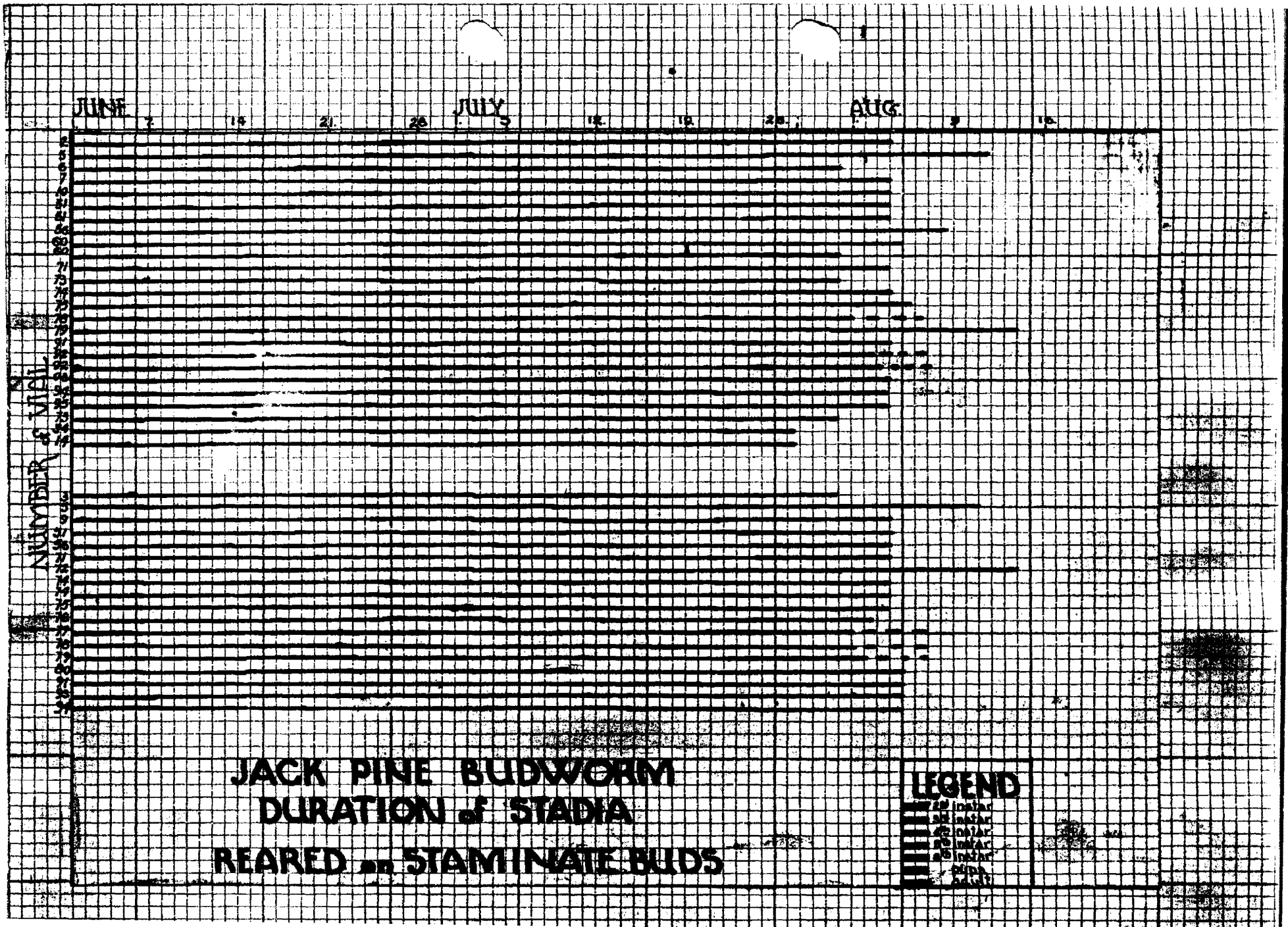
It is evident, from Table 5, that no appreciable differences in size of head capsule exist between larvae of the same sex, regardless of the food type. Head capsules from female larvae appear to be somewhat larger. It is interesting to note that the head capsules of male larvae (Table 5) are nearly equal or somewhat lower than the average sizes recorded in Tables 3 and 4 for similar food types. Similarly, head capsules from female larvae were consistently larger than the mean sizes recorded in Tables 3 and 4.

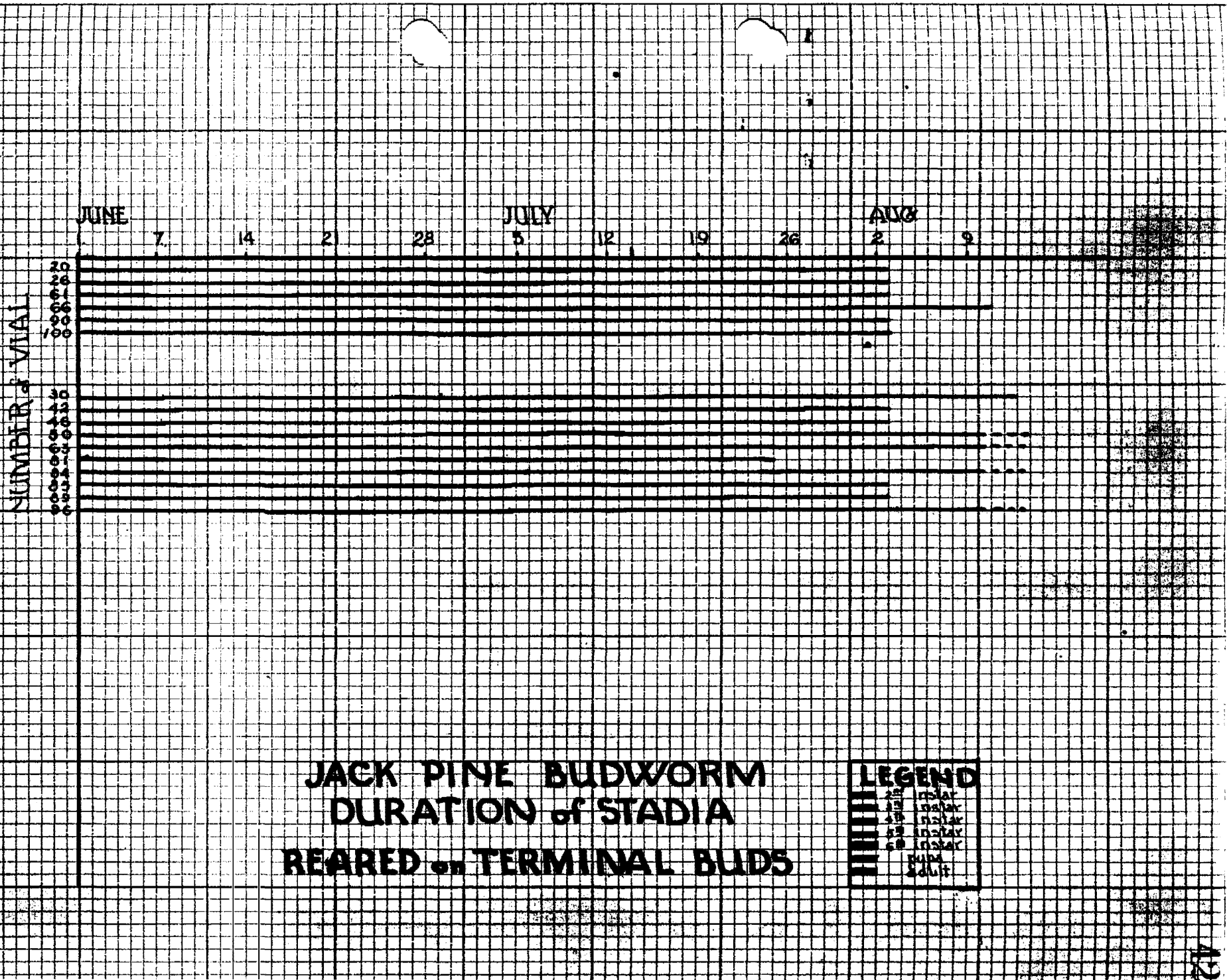
B. Larval Development

Two charts were prepared illustrating the development of budworm larvae on staminate cones and terminal buds. Only those larvae that completed their development and emerged as moths were depicted in these charts. Due to the fact that the larvae were examined once (or twice) per week, in many cases, the date of change of instar was based on the state or condition of the larvae. In the compilation of the charts the stage of the larva at the time of examination was taken in most cases. The development of the larvae is based on the presence of six instars, as seemed to be indicated by head capsule measurements. Female larvae are presented in the upper portion of the charts, separated from male larvae (in the lower portion) by a blank space.

1. Staminate-fed Larvae

Examination of Fig. 1 did not show any appreciable advance of male larvae over female ones. The males completed their development only a short interval ahead of the females. This chart further indicated that for the last two days of June 76% of the female larvae were in the fifth instar, 20% in the sixth instar and 4% in the fourth instar. Pupation was started practically in all cases by July 12th and fairly well completed by July 24th. By July 26th 92% of the female larvae had emerged as moths. Male larvae feeding on staminate cones showed more variation


JUNE
7
14
21
28
JULY
5
12
19
26
AUG.
2
9
16
NUMBER of LARVAE
JACK PINE BUDWORM
DURATION of STADIA
REARED on STAMINATE BUDS
LEGEND


JUNE
7
14
21
28
JULY
5
12
19
26
AUG
2
9
NUMBER of VIAL
20
26
61
66
90
100
30
42
46
60
63
81
84
83
85
90
JACK PINE BUDWORM
DURATION of STADIA
REARED on TERMINAL BUDS
LEGEND
2nd instar
3rd instar
4th instar
5th instar
6th instar
pupa
adult

in their duration of instars. For the last two days of June 66.67% of the male larvae were in the fifth instar, 22.2% were in the sixth instar and 11% in the fourth instar. Pupation amongst the male larvae preceded female pupation by one to two days, on the average, and was fairly well completed in the former by July 23rd.

2. Terminal-fed Larvae

Development amongst larvae reared on terminal buds (Fig.2) was somewhat retarded. There appeared to be considerable variation amongst both male and female larvae in change of instar. Amongst female larvae (reared on terminal buds), on June 28-30, 33.3% were in their fourth instar and 66.6% were in the fifth. Pupation was under way by July 12th and fairly well completed by July 26th. The males reared on terminal buds developed somewhat more slowly. By the end of June 50% of the larvae were in the fourth instar, 40% in the fifth instar and 10% in the sixth instar. Pupation was well under way by July 15th and fairly well completed by July 24th

3. Stadial Duration

The charts (Figs. 1 and 2) were summarized on the basis of the number of days spent in each stadium by the larv The total number of days was computed and averages obtained. The results are presented in Tables 6 and 7. These tables present the minimum number of days, maximum number of days and average number of days spent by male and female larvae (in each food category) in each stadium.

TABLE 6

DURATION OF STADIA AMONGST STAMINATE FED LARVAE

STADIUM	MALE			FEMALE		
	MINIMUM DAYS	MAXIMUM DAYS	AVERAGE DAYS	MINIMUM DAYS	MAXIMUM DAYS	AVERAGE DAYS
2nd Instar	7	14	7.7	6	14	7.9
3rd Instar	7	15	9.3	7	11	8.8
4th Instar	7	14	10.3	7	15	10.6
5th Instar	7	12	9.1	7	13	9.2
6th Instar	7	12	9.1	6	16	9.8
Pupa	11	14	12.3	11	14	12.8
Moth	11	22	16.0	6	18	11.9

TABLE 7

DURATION OF STADIA AMONGST TERMINAL FED LARVAE

STADIUM	MALE			FEMALE		
	MINIMUM DAYS	MAXIMUM DAYS	AVERAGE DAYS	MINIMUM DAYS	MAXIMUM DAYS	AVERAGE DAYS
2nd Instar	7	20	9.8	7	11	8.0
3rd Instar	9	19	12.6	9	21	12.8
4th Instar	7	13	9.6	8	14	11.0
5th Instar	7	13	9.1	7	10	8.2
6th Instar	7	11	9.3	7	12	8.7
Pupa	10	13	11.8	12	13	12.5
Moth	5	15	10.1	8	14	11.2

The tables (6 and 7) indicate that female larvae are somewhat retarded in their early development, when feeding on terminal buds, as contrasted with staminate cones. For the second, third and fourth instars, the number of days spent in each of these stadia by terminal larvae (females) was greater than the number of days spent in similar stadia by female staminate larvae. In the remaining stadia the terminal larvae (females) developed faster than staminate female larvae. Thus, a general averaging of development was indicated. Male larvae feeding on staminate cones did not differ appreciably in their rate of development from female staminate larvae. Terminal larvae (male) were slower in their development, compared with staminate male larvae. A comparison of the adult life span showed that male larvae feeding on staminate cones lived longer than male or female larvae on other food types.

Further tables were constructed, based on the total life span of the larvae and the percentage of this time spent in each stadium. The data were segregated for male and female larvae and staminate or terminal food. The results are presented in Table 8. The total life span was computed, starting with the larval emergence in the spring of the year. Thus, the computed life span does not take into consideration the time spent in the egg stage, first instar larvae, hibernating larvae and

the first few days of second instar larvae emerging in the spring of the year. For staminate-fed larvae, the average life span for the male budworm was computed as 73.7 days, females 71 days. Terminal-fed larvae were found to have an average life span of 72.3 days for both males and females.

Table 8 indicates that the longest period of larval life occurred in the third instar for terminal-fed larvae and fourth instar for staminate-fed larvae. Staminate-fed larvae spent the shortest period of their development in the second instar. It is interesting to note that fluctuations, in the form of an increase or decrease in time spent in each stadium, occur at the same time (same instar) regardless of sex or food. This would seem to indicate definite instar characteristics, regulating the time spent in that particular instar. This is, then, further complicated through sex and feeding, which accounts for the variations from the average. In general, the budworm spends about 1/6 of its life in the pupal stage (from emergence in spring to death of adult in summer). Approximately 5/6 of the life span is spent in the larval stage.

C. Discussion

The tables presented on duration of instar (6, 7, 8) and larval development all indicate a general "averaging" effect. Where the larvae have developed very

TABLE 8

DURATION OF STADIA RELATIVE TO TOTAL LIFE SPAN AMONGST BUDWORM LARVAE

STADIUM	STAMINATE FED		TERMINAL FED	
	MALE	FEMALE	MALE	FEMALE
	% of Total Life Span	% of Total Life Span	% of Total Life Span	% of Total Life Span
2nd Instar	10.5	11.1	13.6	11.1
3rd Instar	12.6	12.5	17.4	17.7
4th Instar	14.0	14.9	13.3	15.2
5th Instar	12.3	13.0	12.5	11.3
6th Instar	12.3	13.7	12.9	12.0
Pupa	16.7	18.1	16.3	17.3
Moth	21.6	16.7	14.0	15.4
	100.0	100.0	100.0	100.0

rapidly during the early instars due to favorable conditions, an apparent retardation in growth occurs during the latter instars. This is exemplified in Table 8. Thus, it appears that there is a definitive period for larval development and, when this period is altered by feeding and environmental factors in any one portion of the period, a compensating change is generally effected in another portion.

Summation of data presented in this section of the study --growth and development--would seem to indicate a discrimination operating to the disadvantage of the male budworm larvae when they are deprived of pollen in their diet. The charts (Pages 421 & 422) indicate that male larvae reared on terminal buds were the slowest in their development, compared to female larvae on terminals or male and female larvae on staminate cones. Male larvae feeding on staminate cones were in advance of female larvae on the same food or other larvae on terminals. Female larvae feeding on terminals were slightly in advance of male larvae on the same food. In general, male larvae feeding on staminate cones develop in accordance with female larvae on the same food; male larvae feeding on terminal buds show definite retardation in their early growth and appreciable curtailment of their adult life. Thus, the data are, definitely, indicative of the effect of pollen in a larval budworm

diet and also that staminate cones are not definitely essential to the growth of budworm larvae. The indications are that pollen affects the normal development of budworm larvae, imparting a more vigorous constitution to the insect and thus equipping it to better withstand the adverse conditions of its environment. This would be further reflected in the fertility and fecundity of the adult moths and hence of direct bearing on the epidemiology of the insect.

V. MORTALITY AND SURVIVAL OF LARVAE

The results of the experiment on feeding larvae separately on staminate cones and terminal buds are presented in Tables 9 and 10. In these tables it will be noted that in each vial 2 larvae were started. In a number of cases these larvae either died or escaped from the vial, and this necessitated the addition of further larvae, to maintain the experiment. Such larvae intentionally introduced were recorded under "added" in the column, "LARVAE". Such larvae as were introduced with the food are recorded under "addit'l" in the column, "LARVAE". A number of larvae had died as a result of parasitism, incurred during the second or third instar; other larvae had died from becoming entrapped in the moisture at the sides of the vial. These larvae are recorded under the column, "Other than Experimental Mortality".

TABLE 9

MATURATION OF STABLEATE CORE-FED LARVA

VIAL	NUMBER OF LARVAE												NO. OF MOLTS	
	Started		Added		Addit'l		Dead		Escaped		Died Other Than Exp. Mortality		MALE	FEMALE
	No.	Inst.	No.	Inst.	No.	Inst.	No.	Inst.	No.	Inst.	No.	Inst.		
1	2	2	—	—	—	—	1	2	1	5	—	—	—	—
2	2	2	2	3	1	3	2	4	2	2	—	—	—	1
3	2	2	—	—	2	2	(2)1/1	3/4	1	4	—	—	1	—
4	2	2	—	—	—	—	—	—	2	3	—	—	—	—
5	2	2	—	—	—	—	—	—	—	—	—	—	1	1
6	2	2	1	3	3	3	—	—	(4)2/2	3/4	1	2	—	1
7	2	2	—	—	1	3	1	pup.	1	5	—	—	—	1
8	2	2	—	—	—	—	—	—	(2)1/1	2/4	—	—	—	—
9	2	2	—	—	—	—	1	5	—	—	—	—	1	—
10	2	2	—	—	1	3	(2)1/1	2/5	—	—	—	—	—	1
11	2	2	—	—	—	—	(2)1/1	3/5	—	—	—	—	—	—
12	2	2	—	—	—	—	1	pup.	1	2	—	—	—	—
13	2	2	1	2	1	3	1	3	1	3	(2)1/1	2/4*	—	—
14	2	2	—	—	—	—	—	—	1	4	1	4*	—	1* Abnormal
15	2	2	—	—	—	—	1	5	—	—	—	—	—	—
31	2	2	—	—	—	—	2	2	—	—	—	—	—	—
32	2	2	—	—	—	—	1	3	1	3	—	—	—	—
33	2	2	1	2	4	2	(3)2/1	3/5	4	2	—	—	—	—
34	2	2	1	2	—	—	1	5	1	3	—	—	—	1
35	2	2	—	—	—	—	—	—	—	—	(2)1/1	3/4*	—	—
36	2	2	—	—	3	2	3	2	2	5	—	—	—	—
37	2	2	—	—	—	—	2/1	2	—	—	—	—	—	—
38	2	2	—	—	—	—	2	2	—	—	—	—	—	—
39	2	2	—	—	(2)1/1	2/3	(4)1/3	2/3	—	—	—	—	—	—
40	2	2	2	2	—	—	2	3	(2)1/1	2/3	—	—	—	—
51	2	2	—	—	3	2	2	4	—	—	—	—	1	2
52	2	2	1	2	1	3	(2)1/1	5 pup.	1	4	1	4*	—	—
53	2	2	—	—	1	2	3	2	—	—	—	—	—	—
54	2	2	—	—	—	—	1	3	1	2	—	—	—	—
55	2	2	—	—	—	—	2	3	—	—	—	—	—	—
56	2	2	—	—	3	2	(2)1/1	3/5	—	—	1	4*	1	1
57	2	2	—	—	—	—	2	2	—	—	—	—	—	—
58	2	2	—	—	1	2	(3)1/2	2/3	—	—	—	—	—	—
59	2	2	—	—	—	—	1	5	1	4	—	—	—	2
60	2	2	1	2	1	3	1	4	1	2	—	—	1	1
71	2	2	—	—	2	2	1	5	1	2	—	—		
72	2	2	—	—	4	2	1	3	(3)1/1/1	2/3/4	1	4*	1	—
73	2	2	(4)2/2	2/3	4	3	(6)2/3/1	2/3/4	(2)1/1	3/4	—	—	—	2
74	2	2	—	—	(7)5/2	2/3	(2)1/1	2/3	(4)2/1/1	3/4/5	—	—	2	1
75	2	2	—	—	7	2	(4)1/1/2	3/5/6	3	2	—	—	1	1
76	2	2	(3)1/2	2/3	1	3	(5)3/2	2/3	—	—	—	—	1	—
77	2	2	(4)2/2	2/3	—	—	3	2	1	2	1	6	1	—
78	2	2	(3)1/2	2/3	1	3	4	2	—	—	—	—	1	1
79	2	2	(3)1/2	2/3	1	2	—	—	1	3	(3)2/1	2/3	1	1
80	2	2	(3)1/2	2/3	—	—	2	2	1	pup.	1	4*	1	—
91	2	2	—	—	1	3	—	—	1	5	—	—	1	1
92	2	2	—	—	(2)1/1	2/3	1	3	1	6	—	—	—	2
93	2	2	—	—	3	2	—	—	(3)1/2	4/5	—	—	1	1
94	2	2	2	3	—	—	2	2	—	—	—	—	1	1
95	2	2	—	—	—	—	—	—	1	4	—	—	—	1

NOTE: FIGURES MARKED WITH * INDICATE DEAD DUE TO PARASITISM.

TABLE 10

MATURATION OF TERMINAL BUD-FED LARVAE

VIAL	NUMBER OF LARVAE												NO. OF MOTHS	
	Started		Added		Addit'l		Dead		Escaped		Dead Other Than Exp. Mortality		MALE	FEMALE
	No.	Inst.	No.	Inst.	No.	Inst.	No.	Inst.	No.	Inst.	No.	Inst.		
16	2	2	1	2	-	-	3	2	-	-	-	-	-	-
17	2	2	1	2	-	-	2	2	1	5	-	-	-	-
18	2	2	1	2	-	-	2	2	1	2	-	-	-	-
19	2	2	-	-	-	-	1	2	1	3	-	-	-	-
20	2	2	2	2	-	-	3	2	-	-	-	-	-	1
21	2	2	-	-	-	-	1	2	1	2	-	-	-	-
22	2	2	-	-	-	-	1	2	1	2	-	-	-	-
23	2	2	2	2	1	3	2	2	(3)$\frac{2}{1}$	$\frac{3}{4}$	-	-	-	-
24	2	2	-	-	-	-	2	2	-	-	-	-	-	-
25	2	2	1	2	-	-	1	2	1	3	1	4*	-	-
26	2	2	-	-	1	2	-	-	2	3	-	-	-	1
27	2	2	-	-	-	-	(2)$\frac{1}{1}$	$\frac{2}{3}$	-	-	-	-	-	-
28	2	2	1	2	-	-	(3)$\frac{2}{1}$	$\frac{2}{3}$	-	-	-	-	-	-
29	2	2	-	-	1	2	1	2	2	3	-	-	-	-
30	2	2	-	-	2	2	2	2	1	2	-	-	1	-
41	2	2	2	2	-	-	2	2	(2)$\frac{1}{1}$	$\frac{2}{3}$	-	-	-	-
42	2	2	-	-	1	2	-	-	(2)$\frac{1}{1}$	$\frac{2}{3}$	-	-	1	-
43	2	2	1	2	-	-	(2)$\frac{1}{1}$	$\frac{2}{3}$	1	3	-	-	-	-
44	2	2	1	2	-	-	3	2	-	-	-	-	-	-
45	2	2	-	-	-	-	2	2	-	-	-	-	-	-
46	2	2	-	-	2	2	3	2	-	-	-	-	1	-
47	2	2	3	2	-	-	1	2	(4)$\frac{3}{1}$	$\frac{2}{3}$	-	-	-	-
48	2	2	1	2	-	-	-	-	3	2	-	-	-	-
49	2	2	1	2	-	-	2	2	1	2	-	-	-	-
50	2	2	1	2	2	2	(2)$\frac{1}{1}$	$\frac{2}{5}$	(2)$\frac{1}{1}$	$\frac{2}{3}$	-	-	1	-
51	2	2	-	-	-	-	1	3	-	-	-	-	-	1
62	2	2	-	-	-	-	-	-	(2)$\frac{1}{1}$	$\frac{2}{3}$	-	-	-	-
63	2	2	-	-	-	-	1	2	-	-	-	-	1	-
64	2	2	-	-	-	-	1	3	1	2	-	-	-	-
65	2	2	2	2	-	-	1	pup.	(3)$\frac{2}{1}$	$\frac{2}{3}$	-	-	-	-
66	2	2	-	-	-	-	-	-	1	2	-	-	-	1
67	2	2	-	-	1	3	-	-	(2)$\frac{1}{1}$	$\frac{3}{4}$	1	4*	-	-
68	2	2	-	-	-	-	1	3	1	2	-	-	-	-
69	2	2	-	-	-	-	2	2	-	-	-	-	-	-
70	2	2	2	2	-	-	2	3	2	2	-	-	-	-
81	2	2	1	2	-	-	1	3	1	2	-	-	1	-
82	2	2	1	2	-	-	2	2	1	2	-	-	-	-
83	2	2	1	2	-	-	(2)$\frac{1}{1}$	$\frac{2}{4}$	1	2	-	-	-	-
84	2	2	-	-	-	-	1	2	-	-	-	-	1	-
85	2	2	2	2	-	-	1	2	(2)$\frac{1}{1}$	$\frac{2}{3}$	-	-	1	-
86	2	2	-	-	-	-	-	-	(2)$\frac{1}{1}$	$\frac{2}{5}$	-	-	-	-
87	2	2	-	-	-	-	-	-	1	5	1	4*	-	-
88	2	2	1	2	-	-	2	2	1	2	-	-	-	-
89	2	2	1	2	-	-	-	-	1	2	1	5*	1	-
90	2	2	1	2	-	-	1	3	1	2	-	-	-	1
96	2	2	-	-	2	2	1	pup.	1	3	1	3*	1	-
97	2	2	-	-	1	2	3	2	-	-	-	-	-	-
98	2	2	-	-	-	-	-	-	2	2	-	-	-	-
99	2	2	-	-	-	-	2	2	-	-	-	-	-	-
100	2	2	-	-	-	-	-	-	1	2	-	-	-	1

NOTE: FIGURES MARKED WITH * INDICATE DEAD DUE TO PARASITISM.

A. Maturation & Survival of Larvae

Of the 100 larvae originally started on June 1st, 57 died and 19 escaped before reaching the adult stage. Thus, a "natural" mortality of 57% was indicated (5% was due to parasitism incurred by the larvae in the second or third instar). 32% of the larvae had died during the second instar; 11% during the third; 3% during the fifth and 6% during the sixth instar. Amongst the "escaped" larvae, 8% occurred during the second instar; 1% during the third instar; 5% during the fourth and 4% during the fifth.

Of the 100 larvae started on terminal buds, 38 had either died or escaped, only 12 reaching the adult stage. 34% of the larvae had died in the second instar; 9% in the third; 4% in the fourth (3% parasitized); 1% in the sixth instar. Thus, a total mortality of 48% occurred amongst these larvae fed on terminal buds. 40% of the larvae had escaped--31% in the second instar; 7% in the third; 2% in the fifth.

These data indicate various agencies operating against the normal development of the budworm larva. It is very likely that experimental conditions--uncontrollable humidity, lack of proper air circulation, etc.--are responsible for some proportion of the mortality. However, all larvae were subjected to the same conditions

and thus any differences would be due, in general, to the food available to the larvae.

A greater natural mortality was noted amongst larvae fed on staminate cones than larvae fed on terminal buds. In both cases the greatest mortality occurred in the early instars (second and third). Approximately twice the number of larvae escaped from terminal buds as larvae that lef t staminate cones. This indicates a greater restlessness in the former and might be the result of the food provided (terminal buds). Again, the largest number of larvae from each food-type escaped during the second and third instars.

For a more nearly complete analysis of this study, Table 11 was prepared showing the fate of all the larvae involved in this study. It will be noted that the number of larvae fed on staminate cones totalled 192, while larvae reared on terminal buds totalled 145. Of the "additional" larvae in the terminal bud category, only two were introduced in their third instar, the remainder being introduced in the second instar. It is doubtful whether these larvae had had access to sufficient pollen to influence the experiment in any way.

A comparison of the number of larvae escaped shows that a total of 27.60% had escaped from staminate food and 38.62% had escaped from terminal buds. In the

TABLE 11

SUMMARY TABLE SHOWING EFFECT OF STAMINATE & TERMINAL BUD FEEDING ON SURVIVAL OF BUDWORM LARVAE

	NO. OF LARVAE STARTED	NO. OF LARVAE ADDED		ADDIT'L		NO. OF LARVAE ESCAPED					DEAD OTHER THAN FROM DIETARY CAUSES		STADIUM LARVAE DIED						
		2nd	3rd	2nd	3rd	2nd	3rd	4th	5th	6th	Drowned	Para-sitized	2nd	3rd	4th	5th	6th	Pre-Pupa	Pupa	Moth
A	100	15	17	41	20	17	14	13	7	2	6	7 ≠ 1 destr.	38	26	6	6	5	-	3	13
B	100	31	-	12	2	33	18	2	3	-	-	5	54	10	1	1	-	1	-	16

A - represents staminate-fed larvae.

B - represents terminal-fed larvae.

second instar approximately three times the percentage of "terminal-larvae" escaped as compared to "staminate-larvae", while in the third instar approximately twice the percentage of the former type of larvae escaped compared to the latter. In the fourth, fifth and sixth instars more staminate-larvae than terminal-larvae escaped. Thus, it is plainly shown that the larvae subjected to terminal buds are decidedly restless in the early instars. This might be taken to indicate the undesirability of such food. It is difficult to explain the escaping of staminate-larvae in the fourth, fifth and sixth instars. This might be due to the vigour of the staminate-larvae, as indicated by greater desires to "wander" and migrate as compared to staminate-larvae which are putting on their maximum growth at this period. (See "Larval Development", P.420).

B. Parasitism

It is interesting to note that the parasitism among staminate and terminal larvae was very nearly the same. It would seem to indicate that budworm larvae are generally subjected to a small degree of parasitism during the second or third instars. All the parasites emerged from their larvae hosts while the latter were in the fourth or fifth instar. Of the 12 larvae parasitized, only one was a male. Whether this indicates a preference for female larvae as hosts is not known, but it does indicate a certain discrimination against the female.

C. Mortality of Larvae

A comparison of the "natural" mortality among staminate- and terminal-larvae shows that in both cases the greatest percentage occurred in the second instar. Twice the percentage of terminal-larvae died in the second instar compared to second instar staminate-larvae. There were more staminate-larvae dead in each of the second, third, fourth, fifth and sixth instars than terminal-larvae in the same stages. Three staminate-pupae failed to reach the adult condition.

In summation, Table 11 shows that 77.6% of the total number of staminate-larvae did not, for various reasons, reach the adult stage. 43.8% of the larvae had died from some unknown cause; 7.3% had died from other than dietary and experimental causes; 26.5% of the larvae had escaped. This left a total of 22.4% moths (9.4% males and 13.0% females). Of the terminal-fed larvae, 89.0% did not reach the adult stage--46.8% of the larvae had died from unknown causes; 7.5% had died from other than dietary causes; 33.6% of the larvae had escaped in various stages of development; 11% of the larvae emerged as moths.

D. Discussion

The data presented show a large decimation of budworm larvae irrespective of feeding habits. With respect to actual mortality which might directly be attributed to feeding, the results do not appear to show

any superiority of staminate cones over terminal buds. The mortality of larvae in the former was 43.8% while, on the latter, 46.9% had died. The indications were that on terminal buds a large percentage of the larvae failed to develop beyond the second instar (37.2%). Those larvae that did reach the third instar (on terminal bud food) completed their development without any further appreciable decimation. Staminate-fed larvae appear to suffer some mortality in every instar; even 3 pupae (1.6%) failed to emerge.

On staminate cone feeding 22.4% of the total number of larvae in the study emerged as adults. Of this figure 9.4% were males and 13.0% were females. 11.0% of terminal-fed larvae reached the adult condition, 6.9% being males and 4.1% females. The sex-ratio of adults reared on staminate cones was .58 while the sex-ratio of moths fed on terminal buds was .38. In the light of the data presented in the above paragraph, relative to larval mortality, it would seem that staminate cone feeding does not affect the development of budworm larvae; rather, it is an important factor in the biotic potential of the insect. That is, staminate cone feeding does not result in greater numbers of larvae maturing, but it does seem to favour the maturation of a greater number of females than males.

VI. SUMMARY

The results obtained from this study provide for a better appreciation of the complexities in the biology of the Jack pine budworm and a more comprehensive knowledge on the epidemiology of the insect. The exact role of staminate cones in the diet of the budworm has not yet been fully recognized, while the inter-relationships of staminate cone- and terminal bud-feeding on the sex-ratio and fecundity of the insect have been rather vague.

The data obtained from this study are not regarded as final and conclusive. Due to experimental difficulties and uncontrollable factors, certain phases of the study are not as complete as might be desirable. The inferences and conclusions drawn have all been based on meticulous observation and statistical results and a repetition of this study would serve to check the results included in this report.

A. Feeding

Larvae at Hawk Lake, Ontario, emerged from hibernation May 28th, 1939. Heavy migrations occurred at that time, resulting in appreciable mortality of the second instar larvae. Early feeding of the larvae in the field was predominately on staminate cones, although some terminal bud-feeding was observed. Caged larvae, whether feeding on staminate cones or terminal buds,

tunnelled into the heart of the food and became lost from sight. In most cases larvae reared on terminal buds were very restless, showing no desire to settle down and feed. This restlessness was manifested in a continual wandering of the larvae within their cage and a constant desire for escape. Many succeeded in doing so. Due to the restlessness of the larvae and not feeding on the terminal buds, some larvae retained their second instar up to June 27th and others remained in the third instar up to July 3rd. Larvae on staminate cones developed in a more normal manner and generally moulted within one week following their start of feeding.

B. Growth and Development

On the basis of observations and head capsules recovered, it was decided that there were at least six larval instars in the life of the Jack pine budworm. Measurements on a large series of head capsules did not show any appreciable differences in size of head capsule between male and female larvae. Considerable variation in size of capsule for each instar was observed and no appreciable differences in mean size of head capsule were noted for staminate- or terminal-fed larvae. Thus, it was concluded that the type of food does not directly affect the size of the larva and hence it must exert its influence in imparting general vigour and ability to

survive, etc.

The mean size of head capsule for the larval instars irrespective of food or sex were computed as follows:

	LENGTH	WIDTH
2nd Instar	.32	.31
3rd Instar	.56	.55
4th Instar	.89	.86
5th Instar	1.32	1.25

(Sizes are given in millimetres)

The growth of larvae throughout the summer was plotted on a chart. On the basis of this, it was found that male larvae feeding on terminal buds were the slowest in their development, compared to other larvae--male and female on staminate food or female larvae on terminal food. Both male and female larvae feeding on staminate cones developed in a uniform manner with the female larvae being slightly in advance of the males.

Tables were constructed to show the number of days and percentage of life span spent in each stadium. It was found that the longest period of larval life occurred in the third instar for terminal-fed larvae and fourth instar for staminate-fed larvae. The life span of the insect (based on time of emergence in spring to death of adult in the fall) was computed as 72.3 days (on the average) exclusive of sex or feeding. Variations

from this average figure caused by sex or feeding, or both, were negligible. In general, it was found that where larvae had developed more rapidly than normal in the early instars due to favourable conditions an apparent retardation in growth occurred during the latter instars (and vice versa). Further, any fluctuations in the form of an increase or decrease in time spent per stadia occurred in the same stadium for all larvae, regardless of sex or food. Thus, it was concluded that there is a definitive period for larval development and when this period is altered through feeding or environmental changes in any one portion of that period a compensating change is generally effected in another portion.

The data presented seemed to indicate a discrimination operating to the disadvantage of the male budworm when they are deprived of pollen in their diet. By forcing the male to feed only on terminal buds they show definite retardation in their early growth and appreciable curtailment of their adult life. Thus, the presence of pollen in the larval diet would seem to affect the normal development of budworm larvae, imparting a more vigorous constitution to the insect and thus equipping it to better withstand the adverse conditions of its environment. This would be further reflected in the fertility and fecundity of the adult moth.

A heavy mortality was found to occur in the development of the Jack pine budworm. Total (natural) mortality was very nearly equal for larvae reared on terminal buds or staminate cones. This is in accordance with the results found in other studies (larval development), i.e. staminate cones do not constitute a "superior" food for budworm larvae inasmuch as survival of larvae is concerned. The heaviest mortality of larvae occurred amongst second instar forms feeding on terminal buds. Staminate-fed larvae suffered considerably less in the second instar, but an appreciable mortality occurred in the third instar and slight mortalities occurred in the fourth, fifth and sixth instars.

Twice the number of moths matured from staminate food as from terminal buds. Sex-ratios appeared to be considerably affected by the different feeding. Moths matured from staminate cones showed a sex-ratio of .58, whil moths reared from terminal buds showed a sex-ratio of .38. Thus, it is concluded that pollen is an important factor in the biotic potential of the Jack pine budworm, favouring the maturation of vigorous males and a greater number of females.

FOREST INSECT SURVEY

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By D.N. Smith

MAP OF SASKATCHEWAN AND MANITOBA

SHOWING

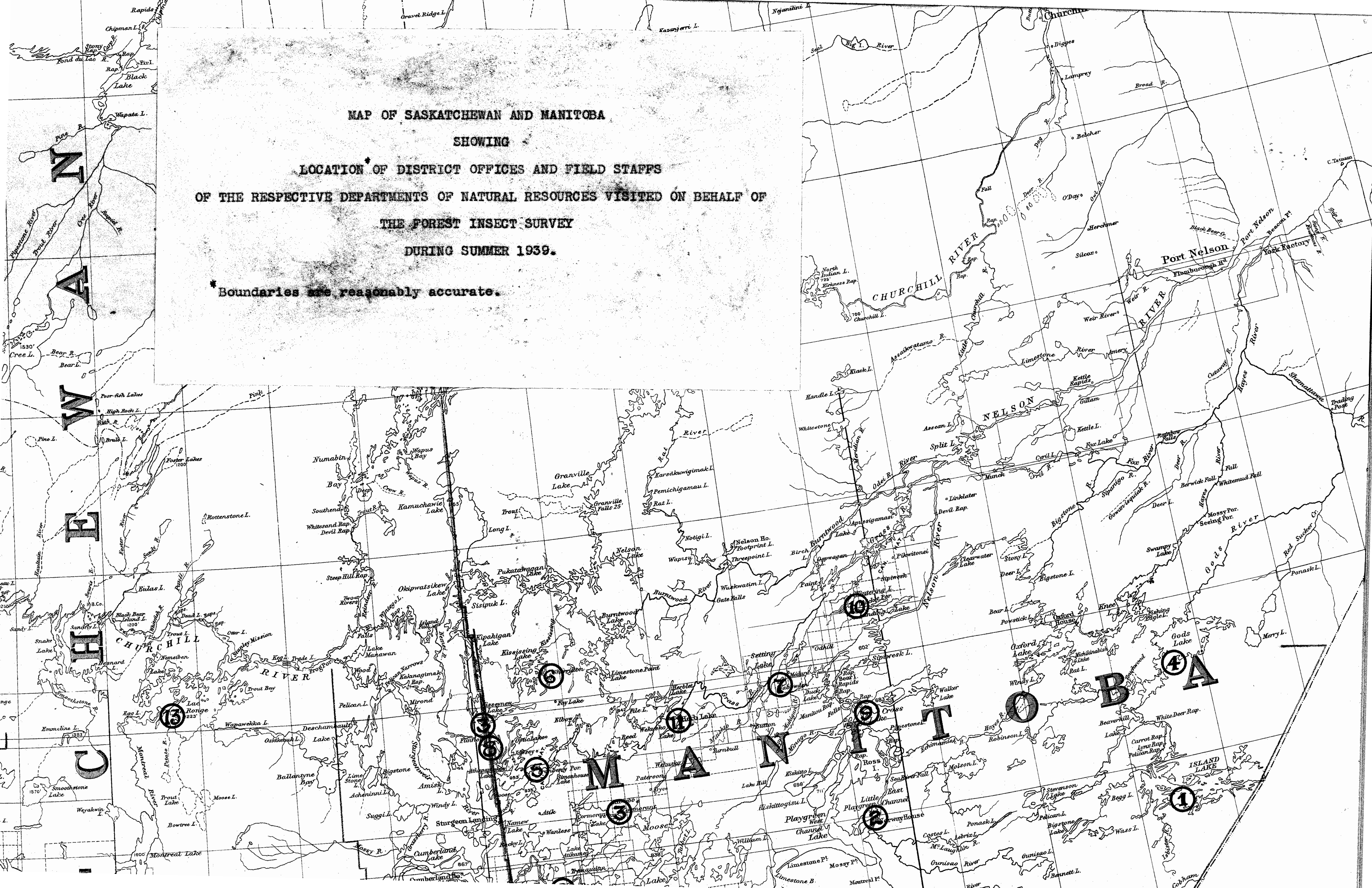
LOCATION* OF DISTRICT OFFICES AND FIELD STAFFS

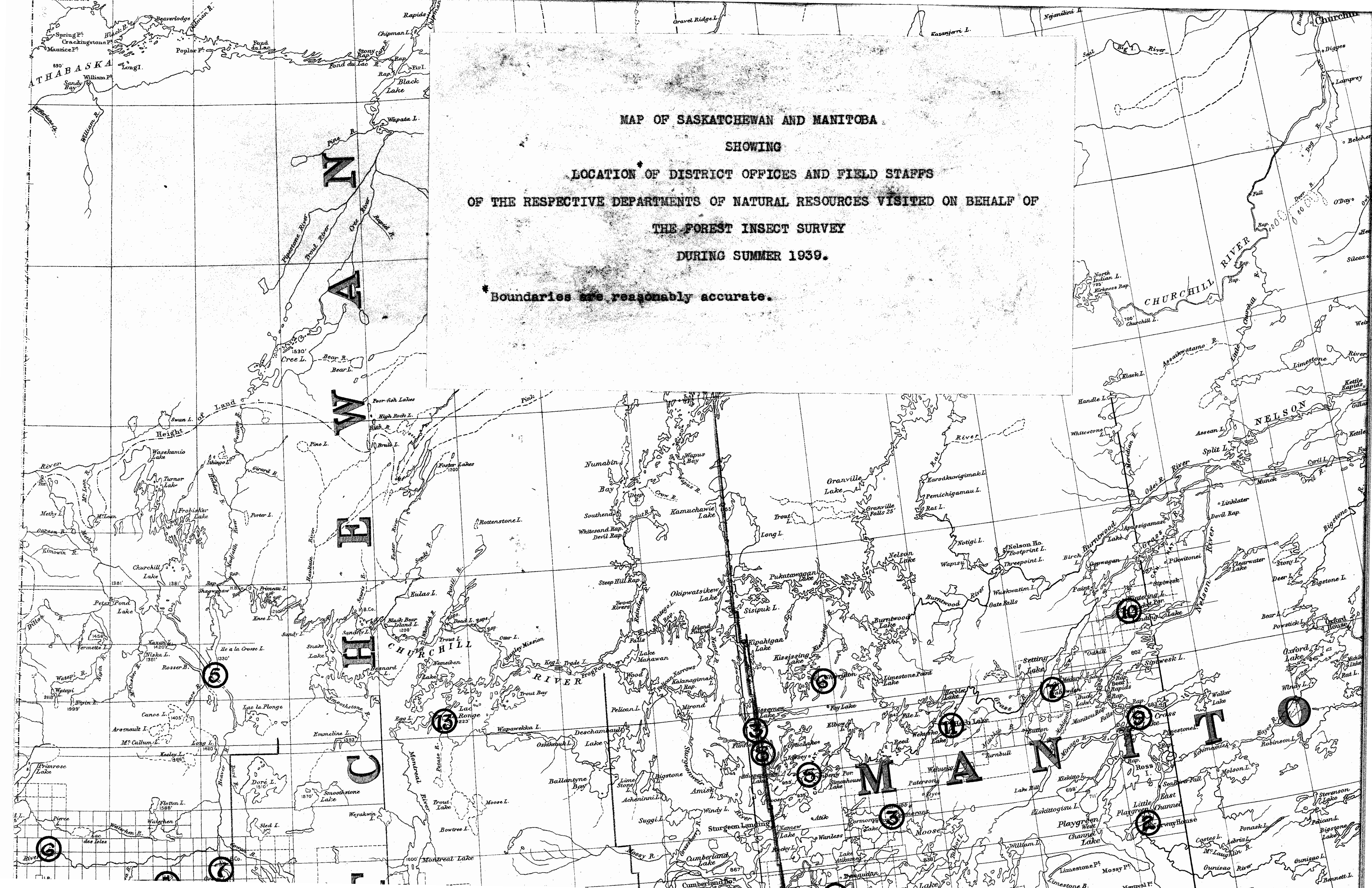
OF THE RESPECTIVE DEPARTMENTS OF NATURAL RESOURCES VISITED ON BEHALF OF

THE FOREST INSECT SURVEY

DURING SUMMER 1939.

*Boundaries are reasonably accurate.





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R. Harvey, District Forester
T. Ewings, Chief Fire Ranger

Fire Ranger	No.	P.O.
Bowman, A.	1	Island Lake
Durand P.	2	Norway House
(Erlandson, W.	3	Cormorant Lake
(Meyers, P.	4	God's Lake
Evans, G.	5	Cranberry Portage
Ferguson, G.	6	Sherridon
Hanson, C.	7	Wabowden
Hislop, W.	8	Channing
Jones, G.	9	Cross Lake
Sinclair, A.	10	Thicket Portage
Wedge, W.	11	Herb Lake
----------	12	Grand Rapids
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I. INTRODUCTORY STATEMENT

The Winnipeg Laboratory, Forest Insect Investigations, was initiated in the summer of 1937 and was eventually assigned a supervisory territory extending from the Alberta-Saskatchewan boundary to Michipicoten Harbour, Ontario, on Lake Superior. Little of this territory had previously been visited by entomological officers until the summer of 1936 when Mr. H. A. Richmond contacted officials and personnel of the Ontario Forest Branch districts in northwestern Ontario west of Schreiber, and of the Manitoba Forest Service in the southern and western districts of that province, in addition to private agencies throughout.

The province of Saskatchewan, the northern and eastern forest districts of Manitoba and the territory from Schreiber, eastwards to the divisional limit, remained unvisited.

A request had been received by Mr. Richmond from Mr. E. H. Roberts, Director of Forests, Province of Saskatchewan, asking that his forested areas be examined and his field officers contacted and instructed in the objectives of, and means of co-operating with, the Forest Insect Survey. In addition to this call from that province, Mr. C. Tunstell, officer in charge, Dominion Forest Service, Winnipeg, had indicated the importance of the bronze birch borer (Agrilus anxius) situation

in Prince Albert National Park. It was therefore proposed to comply with the requests of these gentlemen and, in addition, to undertake reconnaissance and instruction work amongst the personnel of the Manitoba Forest Service in the northern forest district.

Accordingly, on June 10th Messrs. H. A. Richmond and D. N. Smith left Winnipeg for Regina, were received by Mr. E. H. Roberts the following morning and left via Moose Jaw and Saskatoon for Prince Albert. Mr. Roberts promised the full co-operation of his department and, as will be seen from what follows, was more than generous in its provision. Many thanks are also due Mr. C. Tunstell, Chief Forest Officer, Winnipeg, and Mr. H. Knight, Superintendent, Prince Albert National Park, for facilities provided in that recreational area; and to Colonel H. I. Stevenson, Director of Forests, Manitoba, and to his northern district Forester, Mr. R. Harvey, for transportation and other facilities extended by them.

Territory at present unvisited comprises the eastern forest district of Manitoba and the area lying north and eastwards from Ft. William to Michipicoten Harbour.

II. PROVINCE OF SASKATCHEWAN

A. Administrative System

The organization adopted for the administration

of natural resources in Saskatchewan is unique in that the Department is not divided into a number of branches or separate services corresponding to the different resources, such as forests, lands, and mines, each with its own personnel; instead, all field officers of the Department are liable, at least in theory, to be called upon to deal with a wide variety of matters pertaining to all of the resources. In practice, there are a few officers with special qualifications who devote all their time to particular resources, but the duties of the majority of the staff are as above.

The main office of the Department is at Regina, and is under the personal supervision of the Deputy Minister, Mr. R. J. Hill, assisted by senior officers responsible for particular resources. Thus, Mr. E. H. Roberts is Director of Forests, assisted by Messrs. H. Eisler and W. McNeill.

District offices are located at Prince Albert, Meadow Lake and Hudson Bay Junction, each in charge of a District Superintendent (Messrs. E.C. Coursier; A.C. Macaskill; and R.T. Cook, respectively), assisted by technical foresters and non-technical assistants. Each district is subdivided into a number of smaller areas, in each of which there is a resident Field Officer. This officer administers the local application of departmental policies with regard to timber cutting and inspection, fire control, hay permits,

homestead applications, fish, fur and game, etc.

B. Districts

- Prince Albert was the focal point for the project, since from that point all others could be reached. North of Prince Albert, Highway No. 2 extends to Prince Albert National Park. From Prince Albert the more westerly District of Meadow Lake is reached, either by railroad, or by automobile. The latter alternative is roundabout, involving travel on Highway No. 3 west to Shellbrook, southwest from Shellbrook to North Battleford on Highway No. 10 and north from the latter to Meadow Lake on Highway No. 4. From Prince Albert eastward to Nipawin, and southeast to Hudson Bay Junction, travel is also possible either by rail or automobile. These will be discussed later. Before undertaking work with the Provincial bodies, the project commenced in Prince Albert National Park.

Mr. Richmond being greatly pressed for time, it was proposed to visit Prince Albert National Park first, examine the Agrilus situation on the golf course, thence Mr. Richmond would return to Winnipeg, leaving the writer to contact the remaining Park personnel and proceed over the intended districts alone.

1. Prince Albert National Park

In the Park, Mr. H. Knight, Superintendent, was called upon, and offered all possible assistance to the examination, delegating Mr. B. M. Strong, his assistant,

to accompany us to the golf course. The Park, of course, is administered by the Federal Department of Mines and Resources, but is included under the Provinde of Saskatchewan for convenience.

(a) Bronze Birch Borer

On the golf course the bronze birch borer damage affects the fringes of the fairways and in the vicinity of holes and benches. Because it is precisely in such locations that the maximum aesthetic and restful effect is given by the trees, the damage is serious. Along the fairways the trees possess a pleasing and interesting hazard value, and, realizing all this, the Park caused an appropriation to be set aside for corrective measures, if such existed, but before attempting definite work awaited the entomological opinion.

The general belief is that the bronze birch borer prefers the open growing and decadent trees--not, however, precluding the infestation of young thrifty trees. In this area all types of birch are affected, the more densely growing perhaps least. Thus, while many trees are dead or close to death, others are attacked only in part with certain limbs dead and others quite healthy. Unfortunately, due to the tunnelling habits of the larva, the actual damage to the tree itself may be greater than that apparent upon superficial examination. This indicated the inadvisability of pruning methods as

a permanent cure. In addition to this discouragement of pruning, was the lack of information at that time as to the distribution of the borer within the park. Thus, if such distribution within the park were to prove general (as it did), the possibility of re-infestation of the pruned tree would always be impending.

Conversation between Mr. Richmond and the writer, followed by report of the widespread distribution of the pest within the Park and outside it, led to formulation by Mr. Richmond of the following recommendations submitted to Mr. C. Tunstell.

(1) That all dead trees should be cut and removed.

(2) That badly injured and dying birches should also be cut.

(3) That trees only partly injured be left for the present and cut only when their disfigurement made their presence undesirable.

(4) That cutting be done in such a manner as to permit the development of a coppice growth from the stump. This would soon produce a bushy growth which might lend a certain beauty to the green fairways and from which young birch could be obtained in place of the old ones.

(5) In the event that such growth is desired, it was suggested that such cuttings be done in the fall or early next spring so as to prevent the young growth going into the winter and being subject to winter killing.

(6) That steps be taken next spring to replace these dying birch with another broadleaf species, for so long as birch exists there the trouble is apt to persist. (Choice of broadleaf left to Park authorities)

Should it be undesirable to replace birch with another broadleaf species, the removal of the majority of infected tree structures, leaving a four to six foot stub

of trunk might be undertaken. This might be enclosed in light wire mesh and planted with wild honeysuckle or Virginia creeper until such time as the coppice at the base of these stubs was well enough advanced; then the upper part of the stub could be removed. In situations of great natural charm this expedient offers the possibility of attractively replacing injured trees until they replace themselves.

(b) Personnel Contacted

While engaged in contacting personnel, some 260 miles of travel was aggregated. These distances will be itemized below.

The following is a list of Park personnel met:

Superintendent:	H. Knight	Waskesiu
Asst. Supt.:	B. M. Strong	Waskesiu
Foresters:	A. Bickerstaff	Waskesiu
	F. Hicks	Waskesiu
Chief Warden:	C. Davis	- Meridian
Wardens:	Wm. Anderson	- Silver Grove
	H. Genge	- Bittern Lake
	H. E. Harrison	- Kingsmere Lake
	G. Holden	- Meridian
	R. Hubel	- Waskesiu Lake
	F. Jervis	- Boundary Cabin
	E. L. Millard	- Rabbit Cabin
	E. C. Pocock	- Sturgeon River

Points, distances and men contacted are as follows:

Waskesiu to Montreal Lake and return	- 54 miles	- R. Hubel, H. Genge.
" " Crean Lake " "	- 26 "	- F. Russell (water)
" " Sturgeon River " "	- 150 miles	- C. Davis, G. Holden, F. Jervis, E.L. Millard, Wm. Anderson, E.C.Pocock.
" " First Narrows " "	- 30 miles	
	260 miles	

H. E. Harrison was contacted at Waskesiu, eliminating a sixty-mile return trip by water to Kingsmere Lake.

(c) General

(i) Accommodation & Communication. At Waskesiu there are a number of summer hotels; of these the Lakeview Inn is recommended, most Dominion men stopping there.

If the weather is very cold and damp, as in the early spring, this Inn maintains small bungalows, containing desk, chair, bed, stove and wood supply and toilet facilities. This accommodation is $3.00 per day and, in the Inn, $2.00 per day.

Meals can be varied between the Lakeview and Pleasant Inns.

Waskesiu being on the metallic telephone, calls or wires can be put through from either direction. Before July 1st mail is weekly from Prince Albert. There is telephonic communication throughout the park, a ground return system establishing contact between the warden's cabin and the administrative offices. The ground system line can be switched out to metallic at Meridian, where a switchboard is situated in the office of Chief Warden Davis. The long distance call is then effected by the switchboard in the Red Deer Chalet. If privacy is desired, when desiring to contact wardens by telephone from Waskesiu it is best to use the instrument in the office of R. Hubel, at Waskesiu. This is ground return alone.

(ii) Transportation. A convenient pocket Tourist Map is obtainable from the Administration Building, Waskesiu, and, if desired, one of the Topographical Survey maps for Prince Albert National Park may also be obtained.

Roads, passable under all reasonable conditions, lead from Waskesiu in the following directions:

1. Northeast shore Lake Waskesiu to Hanging Hearts Portage - 6 miles

2. Northwest shore Lake Waskesiu to First Narrows - 15 miles

3. Waskesiu to Lac la Ronge - (under construction, passable about 30 miles)

4. Waskesiu to Boundary Cabin (gives fair cross-section of the park) - 90 miles

Boat and canoe trips can be taken to any part of the park. To contact the Wardens at Crean and Kingsmere Lakes this form of transportation is necessary.

At the south end of Montreal Lake there is a Hudson's Bay Company post and an Indian Reserve, while

the Saskatchewan Department of Natural Resources maintain a fire tower and patrol man, Henri Fourmier, noted for great physical strength. He operates under Jos. Johnson of the Prince Albert district, the latter being in charge of the Emma Lake Provincial Forest and territory north of Prince Albert National Park.

(iii) Park Description. The timber in the park is largely second growth, resulting from early logging operations and from the historic fire of 1919. The difference the fire has made is readily noticeable when traversing the Hanging Heart Lakes. On their eastern shore the timber is heavy and more or less virginal, consisting of tamarack and black spruce in the low spots and white spruce and hardwoods, mixed with balsam, on the higher ground. The soils are rich, deep and peaty or humified. On the western shoreline the timber had been severely burned to the water's edge and is being replaced by second growth hardwoods, together with spruce and balsam regeneration.

The country generally is hilly and rolling, underlain by clay, gravel and sand deposits. The timber types vary with the site and also with the history as mentioned above. Large areas of the western and southern parts of the park are Jack pine and hardwoods, except in valleys and low places where tamarack and black spruce frequently are to be found. The park is studded with many small lakes, often set in deep valleys. The eastern parts of the park, to the northeastern boundary, are heavily wooded, with black and white spruce, tamarack and hardwoods, spruce attaining considerable size in places.

(iv) Insect Conditions. Other than that of the bronze birch borer, no insect damage was noted within the confines of the park. Within the park this pest is widely distributed so that local control on the golf course would not be permanent. At that time the forest tent caterpillar was located on Peterson Point, Cream Lake, and the larvae were almost full-grown. The foliage from which they were dislodged was heavily chewed but the attack appeared very limited in extent.

Bark-beetles were found at work in logs felled by contractors for the Lac La Ronge highway; and in fungus-infected balsam and spruce of overmature size on the southeast shore of Cream Lake. Beetles, therefore, appear to be entirely secondary. However, a tree was

found actively infested by bark-beetles on the grounds of the Administration Building at Waskesiu. The foliage of this tree was just becoming reddened and furnished an apparent indication of primary attack, although the tree had been rather poorly pruned.

(d) Summary, Prince Albert National Park

(i) Personnel contacted. The Superintendent, Mr. H. Knight, his assistants and chief warden, as well as the remaining eight wardens were contacted, the forest insect survey explained to them and reconnaissance made amounting to some two hundred and sixty miles within the park's boundaries.

(ii) Insect conditions. Attack on birch of the bronze birch borer was very extensive within the park and was especially destructive along the fairways of the golf course, for aesthetic reasons. Other insects were insignificant at the time of visitation.

The itinerary subsequent to the project in Prince Albert National Park was laid out in the following order:

(1) From the Park to Prince Albert. In Prince Albert telephonic contact was made with Mr. E. C. Coursier, District Superintendent for the Saskatchewan Department of Natural Resources in that district. He had made arrangements, by radio, with District Superintendent A. G. Macaskill of Meadow Lake for my arrival by train and promised to re-advise them that I would be on the next train. In addition, he had

made arrangements within his own district for his Forester, Mr. H. C. Pond, to accompany me in contacting all his available field officers. This work will be set forth in its place.

(2) From Prince Albert to Meadow Lake, thence returning to Prince Albert to cover that district.

(3) At that time it was undecided whether to proceed to the Hudson Bay Junction district and thence to the Northern Forest District of Manitoba, or the reverse.

2. Meadow Lake District

As mentioned in section B., P. above, this district may be reached by train or highway. The former was the necessary alternative in this case. This train leaves Prince Albert weekly for Meadow Lake, leaving on Mondays, returning on Fridays. Although the total distance is some 105 miles, the time consumed approximates eleven hours. The town is headquarters for the supervisory district of the Department of Natural Resources, a district extending from the Alberta boundary eastwards almost to Leoville; south to a line east and west of Glaslyn and north as far as necessity demands.

The town has a population of approximately 1200, and most of these arrived in the general exodus from the drought-stricken prairies. Consequently, the town is very new, somewhat raw and has a homestead outlook. Commercial competition within the town is very keen. About 30% of the

population are on relief and from this arises a community attitude of realism and commercialism.

Much of the land around the town has been sown to alfalfa or grain, while north of the town in the vicinity of Barne's Crossing and Waterhen Lake large scale ranch operations were formerly conducted and a good deal of beef is still shipped, it is stated. The long freight haul and high rates, together with the poor market prices of recent years have tended to impose great strain upon the standard of living.

The above is included to show that forest problems are relatively minor in importance in this district, the greater emphasis falling upon farming, fishing, etc. This is not to say that timber does not exist, but the emphasis is not placed upon it.

(a) Personnel contacted

District Superintendent: A. S. Macaskill
Forest Supervisor: A. W. Benson
Field Officers:

R. Arnold	-	Spruce Lake
R. Higman	-	Paradise Hill
S. Mitchell	-	Loon Lake
T. Pugh	-	Meadow Lake

The following field officers were not contacted, owing to weather conditions, which made roads impassable, or to inaccessibility.

J. Barnett	-	Glaslyn
F.W. Redhead	-	Isle a la Crosse
E.A. Sharman	-	Pierceland
F. Timpson	-	Green Lake

(b) General

(i) Accommodation & Communication.

Accommodation

Meadow Lake - Avenue Hotel, meals in. Clean, modern, electric light, typewriter.

Loon Lake - International or Lakeside Hotels. Restaurants not recommended.

St. Walburg - Van Norman's Hotel. Meals in. Avoid conversation with Van Norman.

Communication

Saskatchewan Provincial Telephone System

Meadow Lake District Phone line

Radio from Meadow Lake

C.N.R. telegraphs

(ii) Transportation. Several possibilities exist when organizing an itinerary to embrace the Meadow Lake and Prince Albert Districts, as well as the National Park. A Departmental map will show these at once. If the season is normal with respect to rainfall, a good plan would be to drive from Winnipeg straight through to Saskatoon, thence via North Battleford to Meadow Lake. (In wet weather the going will be difficult, especially from North Battleford.). Having covered the Meadow Lake District with the exception of Green Lake, information may be obtained as to the condition of the road to Green Lake and of the trail from Green Lake to Big River. From

Big River it is a straight run into Prince Albert. The chief advantage of this return is that new country will be visited, none repeated and six field officers contacted quite readily. These are as follows:

At Green Lake	-	F. Timpson
At Big River	-	C. E. Potter
At Big River	-	E. C. Over
At Leoville	-	D. Prechette
At Macdowall	-	H. S. Nicholson
At Holbein	-	T. H. Adams

However, it is to be noted that only a bush trail connects Green Lake with Big River and weather will be the deciding factor. In extremely wet summers, as experienced this season, it becomes impossible even to reach Green Lake from Meadow Lake. In fact, this entire district is difficult to travel in bad weather because the soil is a gumbo clay for the most part.

A map of the district can be obtained in the Department office.

Some 650 miles were covered within the district, made up as follows:

Prince Albert to Meadow Lake and return	210 miles,	C.N.R.
Meadow Lake to Flotten Lake and return	90 miles,	truck
Meadow Lake to N.P.P. #3 and return, 2 trips	160 miles,	truck
Meadow Lake to Loon Lake,	38 miles,	truck
Vicinity Loon Lake	30 miles,	truck
Loon Lake to St. Walburg	40 miles,	truck
St. Walburg to Meadow Lake	76 miles,	truck
	646	

(iii) District Description. Besides farming, fishing, hay and a small amount of fur farming and trapping, the district is said to possess potential wealth from a deposit of red and yellow ochre at Loon Lake and what are claimed to be gas and oil deposits. The latter may be regarded as near-rumors; the former exist.

Timber is concentrated in the Meadow Lake and Bronson Provincial Forests and to the north of Meadow Lake, particularly at Green Lake - the present limit of accessible timber.

Along the railway to Meadow Lake a great deal of the timber is Jack pine. On undisturbed sites there are areas of white spruce, limited in amount, while in low lands tamarack and black spruce are to be found. A great deal of the Jack pine visible from the train was seriously affected by witches' broom, in localized areas much killing being directly attributable thereto. Considerable burntover occurs in places and some areas are very sandy, particularly where the country is rolling. About Capasin, ravines and coulees are marked, and quantities of white spruce extend in groups southwards from the railway. In the vicinity of Capasin, also numerous tents of caterpillars, which proved on examination to be M. americana, were noted along the railway. These were chiefly found on short rose and willow growth. At this point also the height of land (Missouri Coteau) may be seen to the south, forming the horizon

and extending in a southeasterly-northwesterly direction. South of Meadow Lake, it forms what is known as the Divide and is 2,000 feet above sea-level. A fire tower is maintained here by the Department of Natural Resources.

(iv) Insect Conditions. The timber in the district was apparently free from serious insect menace, few species being recovered from beating spruce, larch and Jack pine. The birch showed frequent signs of Agrilus activity. On the outskirts of the town of Meadow Lake and northerly to Flotten Lake the aspen showed evidence of attack by forest tent caterpillars, heavy in some places, lighter in others. Light attack was also noted at Loon Lake where beating of spruce produced larvae of P. dimmockii.

At Green Lake it was reported over one and a quarter million feet of white spruce were blown down in swathes during a high wind in 1937. Salvage was delayed for winter scaling and by the following summer the logs were rendered worthless by borers, the tunnelling of which extended into the outer few inches of heartwood. Stumpage of $3.10 per thousand was lost to the province, involving a loss of revenue amounting to almost $4,000.

On Flotten Lake, balsam on islands was heavily infested with borers and considerable mortality was resulting. However, being confined to the islands, it is probable that the pests preferred to remain rather than migrate to the mainland and the damage thus became intensified.

(v) National Forestry Program. A two-hour lecture on general and forest entomology was given to the enrollees of N.F.P. #3 in the Meadow Lake Provincial Forest. Many of these lads had a first-hand knowledge of tree pests in their home shelterbelts and grounds and the talk was received with keen interest.

(c) Summary Meadow Lake District

(i) Personnel contacted. The District Superintendent, Mr. A. G. Macaskill was contacted, also his forest supervisor, chief field officer and three other field officers. Four field officers were beyond contact. Including transport from Prince Albert and return, some 646 miles were traversed in the district.

(ii) Insect conditions. At time of visitation forest tent caterpillar defoliation of aspen northwest of Meadow Lake was the only insect damage noted.

The remaining districts, to follow, do not lend themselves to the tabular arrangement of the foregoing and the procedure is thus discussed in more or less chronological sequence.

3. Prince Albert District

On returning from Meadow Lake (via C.N.R.) to Prince Albert, Mr. E.C. Coursier, District Superintendent for the Department of Natural Resources, was visited. He had already planned a schedule designed to provide

facilities for contacting as many as possible of his field officers, and had assigned Mr. H. P. Pond, Forester, to provide the necessary transportation and introductions.

There are seventeen field officers in the district. One of these, D. Patterson at Lac la Ronge, is inaccessible except by plane at present. The new highway to that point will overcome this difficulty in the future. Mr. D. R. Pitts of Mildred and D. Prechette of Leoville were not contacted because their areas were very lightly wooded. S. Taylor, operating from Prince Albert, was not available. The remaining thirteen field officers were contacted and in most instances a short trip into their areas was undertaken.

Mr. Pond not being immediately available, Mr. Coursier suggested a brief visit to the National Forestry Program Camp, No. 4, in the Fort a la Corne Provincial Forest. This would give a general picture of the country traversed, afford the opportunity to meet the Forester-in-charge, Mr. O. G. Horncastle, and the Camp Foreman, Mr. E. Bilquist. The trip was accordingly made in the company of Field Officer J.C. Callahan. (This and other routes taken can be seen readily from a Fire Protection map of the Prince Albert District on file in the Winnipeg Laboratory or available from that District Office.). Along the route a call was paid to Field Officer J. M. Brown. Considerable numbers of tents of Cacoecia cerasivorana were

noted at his station.

The reserve comprises approximately nine townships and is largely Jack pine in the southern and western parts. In these latter areas there have been severe fires, which have denuded the soil in some instances. Possibly as a result of these much of the tie-size timber in the reserve is said to be worthless because of red-rot. In addition, a large number of trees are seriously affected by witches' broom, from which mortality is resulting.

The soil is, generally, very sandy, while the surface is gently rolling with occasional small ravines. In the bottoms of these, and in low areas generally, small streams or lakes are to be found. In these lower areas black spruce and tamarack are to be found. None of it is of very great size. The tamarack, and Jack pine presented an appearance of freedom from insect pests. On the older, richer sites are found small quantities of white spruce and balsam.

Once more in Prince Albert, and Mr. Pond still absent on other business, a field trip was made in the company of Mr. Callahan. This lay west of Prince Albert, into the Nisbett Provincial Forest. At Holbein Field Officer T. H. Adams of that point, and also Field Officer H. S. Nicholson, of Macdowall, were contacted and all three made an excursion, beatings being undertaken and general observations called to their attention.

Mr. Nicholson reported that in the summer of 1936 considerable defoliation of Jack pine had occurred in localized areas in his district and that the damage - top killing - was extremely noticeable still. This section was accordingly visited and such found the case. Very oddly, the defoliation appears confined to a relatively narrow strip surrounding large grassy areas. The intensity of attack seems greatest on the fringes of this grassland. These grasslands incidentally are rather common in the mixedwood areas, occurring at intervals. Possibly relicts of more extensive grassland now successfully invaded by forest cover, they might also represent a seral succession following severe local burning. In any case, the trees concerned presented dead, naked tops for several feet, much as though resultant from Jack pine budworm. However, when sketches were shown to Mr. Nicholson of Jack pine budworm and pine sawfly pupae and cocoons respectively, he identified the latter. This does not preclude the possible activity of budworm as well. At that time there was no sign of current attack.

The type of cover within the Kisbey Provincial Forest varies with the site. Along the Holbein-Prince Albert highway the sides of the road show a cross-section of this cover. On the sandy and gravelly portions, Jack pine is very abundant and much regeneration of fire origin

is to be found. A very great deal of this Jack pine is attacked by and is dying from witches' broom. Even small trees 6' in height are attacked, which is somewhat unusual in the writer's observation. Some infected trees are very bushy, often from the ground-level up. The poplar had a thin appearance, especially on the outskirts of Prince Albert, apparently due to forest tent caterpillar attack. Numerous tents of M. americana were observed. Beating of spruce recovered larvae of Pikonema alaskensis.

Upon returning to Prince Albert, Mr. H. P. Pond was contacted and the itinerary suggested by Mr. Coursier and arranged by Mr. E. J. Marshall followed as closely as possible. The first trip was to Big River, 110 miles northwest of Prince Albert on Highway No. 3, to contact Field Officers C. E. Potter and H. C. Over, whose districts merge there.

Over's territory extends northward and eastward as far as commercially valuable and much of his timber is both overmature and inaccessible. A canoe trip of 20 miles was made up the eastern shore of Delaronde Lake and observation of the shoreline timber suggested no insect attack except to scattered clumps of balsam which were reddened from borer attack, as subsequent investigation showed. Beatings of larch recovered only a few loopers and Marlatt's larch sawfly and from spruce a

few yellow-headed spruce sawfly (Pikonema alaskensis) larvae were recovered, also larvae of the green-striped caterpillar (Feralia jocosa).

Potter's area comprises most of the Big River Provincial Forest and areas north of it. These areas had formerly been heavily cut over by the Big River Lumber Company and fire has taken a toll in other areas. The timber is coming back after these two adverse situations and much young growth of spruce, balsam, Jack pine and larch occurs. Cutting conditions in this district are now very poor due to the overmaturity of the timber and the high incidence of heart-rot. A small sawmill and a planing mill are all that are left of what was once a huge industry. Large quantities of sawdust are shipped from here for use as grasshopper bait on the prairies. Fish is also shipped during the winter and some farming undertaken. The rich, heavy-soiled sites bear the spruce and balsam, while the sandy areas bear Jack pine. Beatings of larch produced Harlatt's sawfly and some loopers, and of spruce, larvae of the yellow-headed and black-headed spruce sawflies, and of the green-striped caterpillar Feralia jocosa as well as various loopers and Neodiprion abietis. No recoveries were obtained from Jack pine.

Once more in Prince Albert, it was arranged to contact Field Officer Jos. Johnson at H.Q., Emma Lake

Provincial Forest, make a field trip with him and thence proceed in his company to Paddockwood to contact Field Officer, P. C. Hogan. From the latter point a trip was to be made to Candle Lake, in compliance with a request from Mr. E. J. Marshall, Forest Supervisor, Prince Albert.

At Emma Lake, dying spruce on Emerald Island were examined and found to be affected by bark-beetles, larvae being present under the bark. However, the trees so affected all bore fire-scars at their bases and were growing upon a thin - humus soil underlain by coarse gravel. Hence resistance was considered to be low.

A road follows most of the west shoreline of Emma Lake, going to McIntosh Point and Okema Beach, the Church of England Summer Camp. The Saskatchewan Summer School of Art is also located on the west shore. From Prince Albert to Emma Lake and around the west shore of Emma Lake as far at least as Okema Beach the forest tent caterpillar damage to aspen was noted to be of medium intensity. A trip north of Emma Lake to Anglin Lakes* traversed excellent Jack pine stands of considerable density with much regeneration to the westward, all apparently vigorously healthy. Fire has been successfully kept out of this area since seeding and no complicating factors seem to

* These lakes were formerly used to control water level of the Red River, used by the Prince Albert Lumber Company to drive logs from what is now Prince Albert National Park to the Saskatchewan River.

be in operation. There are occasional spruce admixtures, while in low areas much larch and black spruce regeneration is to be found, the latter producing large cone-baskets. Beating of larch recovered Marlatt's larch sawfly, but spruce seemed free of pests.

Between Emma Lake and Paddockwood, little of note was encountered, although the forest tent caterpillar showed signs of activity at intervals.

F. C. Hogan was contacted, but being on holidays was unable to take a field trip owing to other responsibilities. Mr. H. P. Pond rejoined me here and we proceeded to Candle Lake, some 31 miles northeast.* A boat trip of 12 miles on the lake took in the northwest and southeast parts of timber berth 1212 B. The summary of conditions on this berth, and in the Big River area is appended (Appendix A) below and may be typical of over-mature spruce in general. Pikonema alaskensis and P. dimmockii were recovered from spruce beating.

After returning to Prince Albert from Candle Lake, another trip was undertaken, in Mr. Pond's company, to the National Forestry Program camp previously mentioned, some 60 miles to the east. On the outskirts of Prince Albert,

* The country is very rolling, being of glacial origin with clay soil on the low spots, supporting spruce and hardwoods and sandy, stony or gravelly deposits on the rougher country bearing Jack pine and hardwoods. The swampy areas are quite extensive in places bearing tamarack and black spruce, while sandy ridges just a few feet above the swamp bear Jack pine. On level, dry areas with a heavy ground covering and a thick topsoil it is possible to see tamarack, black spruce, Jack pine, poplar and birch all growing close together on same site.

near its Sanitorium, Mr. Pond had noted a localized outbreak of the Jack pine budworm on Jack pine and so this area was examined. A few trees were noted to be red and dying and peeling of the bark revealed Ips at work. However, there was no sign of defoliation in the area although a single larva of the budworm was obtained. Just what factors brought this small infestation under control are unknown. Tents of Cacoecia cerasivorana were noted in the vicinity and it is possible that parasitism may have resulted, they providing the reservoir. Considerable injury by Petrova albicapitana was noted, but this pest is not abundant enough to cause damage and appears very widespread.

At the camp, through the kind offices of Messrs. Horncastle and Bilquist, accommodation was very generously extended. On July 13th larvae of the Jack pine budworm were discovered in slash resulting from a trail-widening operation. The boys were made available on request and a large series of larvae collected and preserved. Examination showed that pupation had just commenced and the whole camp was made available for pupal collections.

At the end of each day's collections the pupae were segregated into sexes and counted, the sexes separately boxed in Survey boxes with suitable packing material and shipped as early as possible to Hawk Lake, Ontario, where they were confined in special boxes for parasite emergence (See Biological Studies, P.). The following table

presents the information relating to these collections:

Date	No. Male Pupae	No. Female Pupae	Total	No. Man-Hours
14	274	125	399	46
15	235	217	452	48
17	590	662	1,252	58
18	700	903	1,603	54
19	149	236	385	94
20) 21)	392	636	1,028	106
TOTAL	2,340	2,779	5,119	406

During the course of these collections miscellaneous insect material was collected, including larvae of Cacoecia cerasivorana, Ellopia fiscellaria, Notolophus antiqua, Olene plagiata, Petrova albicapitana, Semiothisa sexmaculata, Neodiprion abietis, N. dubiosus, N. nanulus, and Pikonema dimmockii. South of the camp, and extending to the Saskatchewan River, the aspen was reported to be severely defoliated by forest tent caterpillars; numbers of cocoons of this insect were gathered along with the above. Occasionally larvae of the budworm would be found dead and limp, apparently the result of diseases of micro-organic cause; while dipterous parasitism of larvae was noted in some instances. Subsequent results obtained from rearing material at Hawk Lake, Ontario, indicate that parasitism by Diptera is common and relatively higher in this Fort a la Corne

Forest epidemic than in those in southeastern Manitoba and northwestern Ontario. A possibility of parasite interchanges arises from these observations.

While in the camp, L. S. Horne, Field Officer, Kinistino, and J. M. Brown, Strong Pine, visited the writer and field trips were undertaken with each. As in all contacts, the aims, methods and aspirations of the Forest Insect Survey were explained and illustrated wherever possible by beatings of trees.

A three-hour lecture, illustrated by samples of insect damage, was given to the enrollees of this camp, N.F.P. #4, the subject being general and forest entomology.

Leaving the camp and proceeding eastwards through this Reserve, the extent of infestation was noted to extend for about six miles. A few miles east of the camp an area was observed in which the tops of tall, mature Jack pine were dead, for several feet in some instances. It was concluded that budworm damage was the cause and hence infestations in this Reserve are not of particularly recent occurrence. A later report from E. Bilquist, foreman of the camp, as above-mentioned, shows that the present infestation extends about 8 miles north of the camp, thus covering an area of at least 60 square miles.

The office of the next field officer to be contacted, B. A. Matheson, was at Beaver House, twenty-six

miles east of the National Forestry Camp and some twelve miles west of Nipawin. On arrival there, Field Officer A. W. May, of Nipawin, was also present and field trips were arranged which would include each of these men separately.

The first of these was with A. W. May, who being on holiday could spare little time and was therefore confined to the outskirts of Nipawin. The bulk of the timber in his area lay to the east of Nipawin in an area the writer expected soon to traverse in any event, as will be seen below. The forest tent caterpillar has been fairly severe in this area again this year, the fourth consecutive season, so that Nipawin would seem to be a focal point for epidemics of this pest. May believes that attack would have been much greater than this had not the extreme rainfall occurred that did occur, for on May 10th he noted "considerable" numbers of young larvae which later diminished greatly. Growing conditions in this district seem to be excellent for the host and no unusual mortality was observable after these prolonged attacks. To the west of Nipawin, on the southern bank of the Saskatchewan River, an area of balsam and spruce was examined and beatings made. Agrilus damage was noted to birch, while several balsam were noted dying or dead from twig- and trunk-borer attack. To the east of the town, on its very outskirts, a few pupae of the Jack pine budworm were found but no notice-

able damage was observable. This appears to be merely an endemic situation. The presence of budworm so lightly here, and on the outskirts of Prince Albert to the west, together with the relatively heavy infestation in the vicinity of N.F.P. #4, seems to indicate the probable centre of infestation for the whole area as lying in the central portion of the Fort a la Corne Provincial Forest. The evidence of former attack therein points to its having been the case at some more remote date. If this conclusion is valid, the Reserve might act as a focal point from which dispersion could take place to other areas.

The second field trip, in the company of D. A. Matheson, was undertaken north and west of Beaver House to White Fox, Fernview, Love Siding and Botany P.O. The timber in this area is chiefly white spruce and balsam, of considerable size and extent. About one million feet have been cut here annually for several seasons. Beatings produced no serious pests but the following were recovered: Nepytia canosaria, Anoplonyx laricis, Cephaleia sp., Pikonema alaskensis and P. dimmockii. The aspen showed occasional signs of forest tent caterpillar.

Being rejoined by Mr. Pond who had temporarily left me at the camp, we proceeded to the Torch River Provincial Forest headquarters, to contact Field Officer G. M. Parker. This reserve is straight north of Nipawin and contains several hundred million feet of spruce, of

good quality and ready for the saw. However, it is more or less economically inaccessible and was relinquished by the Pas Lumber Company in favour of berths on to Carrot River. Beatings in this area located Marlatt's larch sawfly and Semiothisa sexmaculata on larch and larvae of the yellow-headed and green-headed spruce sawflies on spruce. There was slight evidence of forest tent caterpillar at Grassy Lake, but attack was medium from Nipawin to the Reserve itself.

At Grassy Lake, there being two-way radio communication available, arrangements were made with Field Officer C. Otterbein at Three Rivers Cabin for water transport to The Pas, Manitoba. Mr. Otterbein is located about 70 miles east of Nipawin on the Saskatchewan River and he is a member of the personnel of the Hudson Bay Junction District. To reach his cabin the wooded areas of A. W. May's district must be traversed, as mentioned above. The reason for undertaking water transport to The Pas, rather than proceeding directly by rail to Hudson Bay Junction, arose from a suggestion by Mr. E. J. Marshall, who was formerly District Superintendent of that District and is now Forest Supervisor at Prince Albert. The trip would involve travel down the Sipanok Channel to the Carrot River and thence to The Pas, Manitoba. Insofar as the Pas Lumber Company have been cutting in this area for many years, he felt the trip would be more advantageous than going by

rail, which took one through settled areas. The Company cut some 40,000,000 feet of spruce this last year and it was decided to follow Mr. Marshall's suggestion.

Leaving Grassy Lake Cabin we proceeded to Carrot River to contact Field Officer P. R. Rafuse. Two trips were made in his Company, the first being undertaken to The Pas Bridge, over the Carrot River, and just inside the western border of the Pasquia Forest Reserve. On the way, the trail is through spruce and tamarack regeneration growing on what was a swampy muskeg, the soil being a rich, deep humus. At present, this area is undergoing drainage and is being ruthlessly burned over to produce homestead land. Beating larch in this swamp produced Marlatt's sawfly and larvae of Semiothisa sexmaculata, S. granitata and Cephaleia sp. Beating of white spruce produced larvae of Pikonema alaskensis and P. dimmockii. Where present, the aspen showed forest tent caterpillar varying from light to medium. Within the reserve the chief cover is white spruce and balsam, poplar, both black and white, and birch; while along the Carrot River may be found Manitoba maple, American elm and ash. The second trip with Mr. Rafuse was to Connell Creek, just within the Settlement and outside the Reserve. Forest tent caterpillar damage was noted to be medium-heavy in Jordan River Valley, Arborfield, Connell Creek P.O., Megan P.O., and Hackett's P.O. This season it was

noticeably less severe in the western part of the Reserve than in the Settlement. At Moosedale P.O. beating of larch resulted in great numbers of larvae of the European-larch sawfly being recovered. One tree thirty-five feet in height yielded 500 larvae. Larch is relatively scarce in this area which may account for the heavy larval concentration upon limited material. A dozen or so similar trees in the area were examined and also found to be infested.

This contact with Mr. Refuse concluded survey in the Prince Albert District, and, as previously mentioned, it was planned to reach The Pas, Manitoba, and visit the Northern Forest District of that province before working the Hudson Bay Junction District of Saskatchewan.

Mr. Pond conveyed me to Three Rivers Cabin, on the Saskatchewan River by truck and we followed the old Pas Trail from Nipawin east. Between these two points Agrilus was noted, even in densely wooded stands, in the birch, and the forest tent caterpillar attack on aspen appeared medium to heavy, being heaviest around Three Rivers Tower. This intervening country is very sandy and somewhat rolling for about 20 miles east of Nipawin, after which it becomes more heavily timbered by spruce and hardwoods. The cover varies according to its history, as to fire, homestead, or cutover regeneration. Conifers are, generally, rather sparse, because the area was heavily

logged by the The Pas Lumber Company years before. No damage was observed to spruce, Jack pine or larch by insect attack. At Three Rivers Cabin, small black spruce were noted infected with the leaf-rust, Chrysomyxa sp. This was the first record made of this disease by the writer.

From Three Rivers Cabin by canoe, down the Saskatchewan River to the Sipanok Channel and thence to the Carrot River and eventually The Pas, some 200 miles, revealed very little insect damage. The aspen showed signs of forest tent caterpillar damage, but lightly; Agrilus damage to birch was occasionally noted, and clumps of balsam were reddened, presumably by borers, from place to place. No defoliation of spruce or tamarack was observed. Beatings at Sipanok Cabin almost at the union of the Sipanok Channel and Carrot River produced Pikonema alaskensis and P. dimmockii from spruce and Anoplonyx laricis and Semiothisa sexmaculata larvae from larch. At Mountain Cabin on the Carrot River, L. Simmons, Game Officer, was contacted.

The The Pas Lumber Company drove some 40,000,000 feet of white spruce down the Carrot River this past season and since the drive was still boomed in for the most part it was necessary to abandon the river and reach The Pas by a truck of the The Pas Lumber Company, kindly supplied by Mr. Kennedy, Woods Manager.

(a) Summary, Prince Albert District

(i) Personnel contacted. The District Superintendent, Mr. E. C. Coursier, his executive associates and foresters, and thirteen of his seventeen field officers contacted, involving travel amounting to almost 1300 miles within the district. Numerous field trips, beatings and explanations on behalf of the survey were undertaken.

(ii) Insect conditions. The forest tent caterpillar was found to be widespread, varying greatly in intensity from place to place. A small but medium intensity infestation of Jack pine budworm was found in the central portion of the Fort a la Corne Provincial Forest, while the same insect is present on the outskirts of Prince Albert and Nipawin in very small numbers. The European larch sawfly was recovered at Moosedale P.O.

(iii) National Forestry Program. The N.F.P. #4 camp in the Fort a la Corne Provincial Forest was visited and a three-hour lecture on entomology given. The finding of Jack pine budworm in the area resulted in the collection and shipment of 5,119 pupae to Hawk Lake, Ontario, for parasite emergence studies. These collections were made by enrollees under personal supervision.

(iv) Accommodation and Communication

Accommodation:

Prince Albert, Empress Hotel, meals in or out.
Big River, Lakeview Hotel, table d'hote.
Paddockwood, Paddockwood Hotel, meals in.
Carrot River, Empress Hotel, meals in.

Communication:

Saskatchewan Provincial Telephones
District Office telephones
Radio
C.N.R. Telegraphs

Although the last section of the above has begun work with the Manitoba Forest Service at The Pas, that section will be displaced chronologically and the Hudson Bay Junction District discussed next in order to maintain all Districtsof the Province of Saskatchewan under one grouping.

4. Hudson Bay Junction District

The following executive officers of this district were contacted:

R. T. Cook, District Superintendent

C. R. Christie, Forest Supervisor

F. H. Hewitt, Forester

and in addition the following members of the office personnel:

D. Thompson, Radio operator and Timber Permits

C. Soules, Cruiser

Messrs. Christie and Hewitt are graduates of the University of New Brunswick and have had field experience with the spruce budworm in that province, thus appreciating the role of insects in forestry.

Mr. Cook assigned C. Soules to accompany me in

his district but before the latter became available a trip was made to N.F.P. #5 on the Fir River. Hearty co-operation was extended there by J. Derbishire, foreman, resulting in the collection by the enrollees of a large number of cocoons of the Forest tent caterpillar. Numbers of these were reported by the Survey, to whom they were shipped, as being parasitized. A two-hour lecture on general and forest entomology was given the enrollees of this camp. Forest tent caterpillar attack on aspen is apparent and heavy from the Junction to this camp, even birch being attacked. West of the camp, in the vicinity of 13-Mile Tower, a number of mature Jack pine were observed to bear red crowns. Investigation showed an apparently primary attack by Ips sp. About twelve trees appear affected and in some cases girdling is not complete, giving the tree an alternation of reddened and natural green boughs.

Travel within this district is almost entirely confined to the railway, either by train or gasoar. It is essential to acquire a C.N.R. gasoar permit before one can travel in this manner and much inconvenience resulted before same was obtained. After C. Soules became available, an itinerary was drawn up which relied upon rail travel and the fact that the Hudson Bay Junction District field officers are placed at towns along the railway line, which takes the shape of a huge oval. Thus, by

starting at the Junction one can, going west, contact the field officers at Prairie River and Crooked River, thence southeast to Chelan, still farther east to Somme and hence back to the Junction. The contacts and observations made by approximation to this arrangement are given below.

Taking the train for Crooked River, a stopover was made at Prairie River to contact Field Officer L. Moulton, and a field trip was taken with him. Along the railway, from the Junction to Greenbush, damage by forest tent caterpillar was light to medium, but from Greenbush to Prairie River appeared of more medium intensity, which, at times, became heavy, as far as Mistatim. From Mistatim to Crooked River attack was light and patchy.

At Prairie River beating produced larvae of Pikonema alaskensis and P. dimmockii, Hydriomena divisaria and Olene plagiata from spruce; and from larch, Marlatt's sawfly and the loopers, Semiothisa sexmaculata and S. granitata. Agrilus was frequently noted on birch.

Continuing to Crooked River beatings were made of larch, resulting in the recovery of larvae of Marlatt's sawfly and Semiothisa sexmaculata; of spruce, green- and yellow-headed spruce sawflies. Rust was present on white spruce. Dr. M. H. Horwill, Field Officer, at that point, was contacted and in his company I proceeded to Chelan in anticipation of meeting C. Abra, Field Officer there. Forest tent caterpillar attack very light and patchy

between Crooked River and Chelan. Mr. Abra had gone on land work to a remote part of his district and so it was necessary to continue to Somme, to meet Field Officer T. Shannon. Between Chelan and Somme attack of aspen by the forest tent caterpillar was medium in intensity, but in the immediate vicinity of Somme was very heavy. The trees had releafed but were very thin and the underbrush was a tangled mass of leaves united by silken cocoons. Beating of larch recovered larvae of Marlatt's sawfly, Semiothisa sexmaculata, and of spruce, Pikonema alaskensis, Olene plagiata and Caripeta divisata. Larvae of Archips conflidens were present on aspen leaves, sometimes inhabiting abandoned cocoons of the forest tent caterpillar.

Returning to the Junction via Prairie River, it was found that a gascar permit had been issued and, in the company of C. Soules, travel down the south line (R.R.) was undertaken to meet Field Officer K. O. Sanders at Ushta Siding. South of Reserve Junction on this south line the forest tent caterpillar had inflicted very severe attack on aspen as far as Tallpines; between Tallpines and Endeavour attack was medium heavy. At Ushta Chrysomyxa rust was noted on black spruce. Beating of spruce produced larvae of Caripeta divisata and Pikonema alaskensis and of larch, Semiothisa sexmaculata and Marlatt's sawfly. Agrilus was occasionally noted on birch.

After leaving Mr. Sanders, it remained to contact the field officer at Pelly, to the southeast, thus completing the work within the District. This point is reached by gascar and is on the Swan River, Manitoba,-- Sturgis, Saskatchewan, line, some twenty miles south of the Porcupine Mountains. The Department maintains a Ranger Station (Maloneck) in the mountains and it was found that Mr. C. Schell was at that point. Contacting Mr. Schell, a field trip was undertaken, on which spruce and larch trees were beaten. On the latter, larvae of Protoboarmia porcelaria, Semiothisa sexmaculata, S. granitata and Anoplonyx laricis were found. Chrysomyxa rust was present on both black and white spruce regeneration. Although he has been in this districttwenty years, Mr. Schell has never seen forest tent caterpillar attack and no evidence of such was noted at the time.

(a) Summary, Hudson Bay Junction District

(i) Personnel contacted. The District Superintendent, Mr. R. T. Cook, his executive officers and foresters and nine of his field officers were contacted, involving travel of some 400 miles.

(ii) Insect conditions. The most destructive insect in this district at the present time is the forest tent caterpillar which is widespread throughout the majority of the areas traversed. Severest damage occurs north and south of Hudson Bay Junction, and at Somme. The European

larch sawfly was discovered at Beaver Lake, west of Flin Flon, Manitoba.

(iii) National Forestry Program. The N.F.P. #5 camp on the Fir River was visited and a three-hour lecture on entomology undertaken. The enrollees collected a large number of cocoons of the forest tent caterpillar, a great many of which proved parasitized.

(iv) Accommodation and Communication.

Accommodation

Hudson Bay Junction, Hudson Bay Hotel, Meals at Hudson Bay Cafe.

Crooked River, Modern Hotel, meals in.

Prairie River, Mrs. Gill's Boarding House, meals.

Chelan, Chelan Hotel, meals in.

Sturgis, Weikle House, meals in.

Communication

Radio

C.N.R. Telegraphs

District Telephone

Saskatchewan Provincial Telephones

III. PROVINCE OF MANITOBA

A. Administrative System

The Manitoba Forest Service administers the Forest Act of 1930 and is concerned solely with matters pertaining to timber, other branches of the Department of Mines and Natural Resources administering to particular resources.

The Forest Service is headed by the Provincial Forester, Colonel H. I. Stevenson, assisted by a senior forest engineer and an officer in charge of timber disposal.

The province is divided into four districts, named after the principal points of the compass. Headquarters of the Eastern and Southern Districts are in Winnipeg; of the Western, in Dauphin and of the Northern, at The Pas. Each District is administered by a District Forester, assisted by fire rangers at important centres. Forest reserves are staffed by forest rangers, in charge of a senior ranger. Each forest ranger is responsible for a definite territory within and beyond his assigned station. Certain areas of Crown lands are cared for by additional personnel located at convenient points.

The principal duties of the field staff include the prevention of cuttings in trespass, the supervision of authorized cuttings and the detection and suppression of forest fires. Inspection of sawmill operations, timber scaling and, on the forest reserves, the maintenance of improvements, such as telephone lines, are also required of the ranger.

B. Districts

1. Northern Forest District

At The Pas, Mr. R. Harvey, District Forester, was visited and he laid out a tentative plan for the contacting of most of his fire rangers who are placed

at strategic points in his district. Chief Ranger T. Ewings was also met at the same time.

Since the Manitoba Forest Service Air Base is at Cormorant Lake (Mile 42 Hudson Bay R. R.), it was necessary to operate from there. This point was reached by gascar. The right of way from The Pas to Cormorant Lake is for the main part low and swampy (Manitoba Lowlands), bearing large quantities of larch and black spruce regeneration. Older stands of Jack pine and hardwoods are encountered on the drier, sandier sites. There is considerable witches' broom on Jack pine in places and occasionally it is to be seen on black spruce and tamarack. The aspen has been very severely defoliated, and the birch as well, by larvae of the forest tent caterpillar. Black poplar, here as elsewhere, appears to be immune.

At Cormorant Lake, Fire Rangers W. Erlandson and P. Myers were met. In the company of the former, a field trip was made which resulted in location of larvae of the European larch sawfly on young tamarack. Chrysomyxa rust was present on spruce regeneration. Leaving Cormorant Lake by seaplane, a flight of approximately 635 miles was made to Norway House, Island Lake, Gods Lake, Cross Lake, back to Norway House and return to Cormorant Lake. This resulted in the contacting of the following fire rangers, respectively: P. Durand, A. Bowman, G. Evans, A. Sinclair.

Beating of spruce at Norway House produced larvae

of Pikonema dimmockii, and from larch, Anoplonyx laricis larvae. Some cone injury by unknown larvae was noted on spruce. Also Chrysomyxa rust was very heavy. In fact, this rust was readily observed from the air due to its color, throughout the area of flight above mentioned. In many places the spores had already been discharged and were seen to cover the surfaces of small lakes and the margins of large ones with a distinctly reddish tinge for miles after mile. However, when one carefully examined infested trees on the ground, they appeared quite strong although reddish or yellowish. Adequate green needles in most cases remained unharmed and the new growth was full and healthy.

Beatings at Cross and Island Lakes produced no larvae; a few larvae of Pikonema dimmockii were recovered from black spruce at Gods Lake.

Regarding the general topography of this large area, seen from the air it presents a land surface apparently thickly wooded on the drier sites, while the different colors of vegetation seem to represent stages in successional vegetational development of the wetter areas. Thus, bright green areas were interpreted as tamarack swamps. Often the surface moisture could be seen reflecting light in streaks and ribbons; dark green areas appear to be black spruce, and more brownish-green masses, Jack pine. Where these latter were themselves broken up

by lighter green masses, these were interpreted as hardwood admixture. In the more open areas the wet hay meadow and swail types of land was especially conspicuous and watercourses of varying size could be readily traced by the green reeds and other vegetation forming bands along their often tortuously winding beds.

In the territory from Lake Winnipeg and up the Nelson River (Playgreen Lake) to Norway House, the Precambrian rocks are dominantly exposed. At the source of the Nelson the widely expanded portion is dotted with myriad small rocky islands, for the most part devoid of vegetation. At Norway House the forest cover was seen to be made up of black spruce, Jack pine and hardwoods, with scattered balsam. From Norway House eastwards to Island Lake the forest cover is dense and rocky masses show up infrequently. However, north from Island Lake to Gods Lake the land has been severely burnt over, which taken in conjunction with the fact that climatic conditions are becoming increasingly severe (due to latitude), means that natural succession will take a considerable time to overlay these bald, rocky surfaces with the thin deposit of organic matter upon which tree growth may be re-established.

From Cormorant Lake it was necessary to take the train to Wabowden (Mile 139, Hudson Bay R.R.) in order to contact Fire Ranger W. Hislop. The country between these two points is generally low and swampy, being still in

the Manitoba Lowlands type. The cover is black spruce and tamarack, with hardwood admixture on the drier parts and a rich ground cover of Sphagnum, Ledum, etc. The aspen bore light and patchy evidence of forest tent caterpillar attack, while damage to birch by Agrilus was widespread. Occasionally, a tamarack would be noted with the characteristic twig and terminal injury promoted by oviposition of the European larch sawfly. This is a safe assumption, insofar as larvae of this pest were discovered at Cormorant Lake as previously mentioned, and subsequently their location at Thicket Portage, even more northerly than Wabowden, will be discussed.

Having contacted W. Hislop, several trips of a reconnaissance nature were taken in his company by gascar north and south of the ranger station. In this area there was frequent damage to birch by Agrilus and occasional young spruce trees bore injury apparently caused by weevil larvae. Chrysomyxa rust was present. Larvae of Pikonema alaskensis were observed to have done considerable damage to ornamental white spruce in the garden of a Wabowden resident. In Hislop's company, a trip by gascar was undertaken to Thicket Portage (Mile 187, Hudson Bay R.R.) to contact Fire Ranger W. Wedge.

At Mile 159 distinct evidence of larch sawfly was noted in the form of a terminal twig of tamarack, presenting the typical hooked shape of such attack and, in addition, the egg slits. This was very recent, but no larvae were found. However, at Thicket Portage, Mile 187, larvae of this pest were recovered from a mature tamarack, as well as larvae of Semiothisa sexmaculata, S. granitata and Marlatt's sawfly. Beating of spruce recovered larvae of Neodiprion abietis. W. Wedge reports Chrysomyxa as far north as Mystery Lake, some 40 miles away and north of the Burntwood River. Mr. Huddy, the trader at Nelson House, reported it very scarce up there and getting more noticeable as he came south. Not far north of Thicket Portage the Manitoba Forest Service regard timber as beyond value of fire control and hence this Ranger Station is the most northerly in the Northern District.

From Thicket Portage we returned to Wabowden by gascar. At the latter point the writer cleared up some difficulties of G. Bremner, Hudson's Bay Company post manager.

Flying from Wabowden to Sherridon, Fire Ranger C. Hanson was contacted at the Cold Lake Ranger Station. In his company, a trip up Kississing (Cold) Lake was undertaken. Balsam were noted in several places to be reddened and dying and investigation showed twig- and

wood-borers. There was occasional evidence of forest tent caterpillar attack on aspen, of medium severity. A group of young larch were found heavily infested with larvae of the European larch sawfly.

From Sherridon the flight was continued to Cranberry Portage to meet G. Ferguson, Fire Ranger there. Beating of spruce produced only larvae of Pikonema dimmockii. The fall cankerworm was present on birch to some extent. The writer proceeded from Cranberry Portage to Flin Flon by train. At Flin Flon he contacted O. B. McNeil of the Saskatchewan Department of Natural Resources and G. Jones, Fire Ranger, Manitoba Forest Service. In the company of the former, a field trip was made to Beaver Lake, Saskatchewan. There, especially on the islands, forest tent caterpillar attack to aspen had been quite severe. Beating of larch resulted in the location of larvae of the European and Marlatt's larch sawflies, and of Semiothisa sexmaculata. Some cone-worms of black spruce were noted while beating recovered larvae of Caripeta divisata, Herculia thymetusalis and Hyphantia cunea.

With G. Jones a canoe trip was begun on Ministikwan (Big Island) Lake, through a creek to the northeast arm of Schist Lake, into the northwest arm of Schist Lake, thence into the northeast arm of Lake Athapapuskow almost to Sourdough Bay. A very severe forest tent caterpillar

outbreak had been in progress along the shores of the first two mentioned lakes and particularly on Big Island in the first mentioned (Ministikwan Lake). However, at the time visited the trees had for the most part releafed, but thinly, and moths were on the wing and ovipositing at that time. There has been a great deal of burning along these lakes, resulting from campfires that have gotten beyond control, but on richer sites white spruce may be found up to 3' D.B.H. The climax on rocky sites is black spruce and Jack pine is characteristically subordinate. Agrilus evidence on birch is frequent. A great deal of Chrysomyxa spores on the water in places, making it look blood red in reflected light, were noted. The following larvae were recovered from beating spruce: Pikonema dimmockii, Pinipestis reniculella and Protoboarmia porcelaria.

From Flin Flon the writer returned to The Pas by gascar with C. Jones and thence proceeded to Hudson Bay Junction, Saskatchewan, by train.

(a) Summary, Northern Forest District

(i) Personnel contacted. The District Forester, Mr. R. Harvey, his chief ranger and eleven of his thirteen fire rangers were contacted. This involved travel by train, airplane and gascar, aggregating some 1,300 miles.

(ii) Insect conditions. The most destructive insect in this district at the present time is the forest tent cater-

pillar, whose ravages seem to be becoming yearly more widespread. Very severe attack occurred from The Pas to Cormorant Lake along the Hudson Bay Railway, a distance of 42 miles. The previous year severe attack had but reached Atikameg Lake, Mile 17. On the The Pas-Flin Flon line damage was noticeable all the way, but severest between Wanless and Atik, and between Cranberry Portage and Channing. The remaining portions were of a moe medium intensity. The European larch sawfly was found at several widely separated points, namely; Cormorant Lake, Thicket Portage and Sherridon. Agrilus damage to birch was very widespread.

(iii) Accommodation and Communication.

Accommodation

The Pas - Opasquai Hotel

Flin Flon - Flin Flon Hotel

Communication

Manitoba Provincial Telephones

C.N.R. Telegraphs

C.N.R. Telephones

APPENDIX A

SPRUCE DETERIORATION IN SASKATCHEWAN

By D. N. Smith

Spruce Deterioration in Saskatchewan

A cause of considerable economic loss, both to operators and the provincial government results from fungous disease of spruce in old and overmature stands of white spruce. This, of course, is not strictly an entomological problem, but has such ramifications as will be shown below.

In the Big River - Delaronde Lake area such loss has been very great. Mr. J. K. Anderson of Big River, a sawmill and planer operator, suffered severely last winter. His cut was 300,000 feet, which, except for slight salvage, proved entirely worthless. According to Mr. Johnson, there is no way of knowing before felling that a tree is worthless. It may appear perfectly sound, may ring sound upon striking the base, but farther up the bole be completely rotten. The rot too seems to be irregularly and unpredictably distributed throughout the trunk.

To encourage logging in these stands, the Department of Natural Resources reduced stumpage from $3.10 per thousand to $1.10. Operators want the timber at fire-kill rates ($0.60 per thousand) and consider it a risk at that figure.

It was impossible to visit these areas since torrential rains had made trails impassable and time did not permit the sacrifice of the several days

necessary to reach them by canoe and on foot. However, samples of lumber resulting from such stands were examined. The heartwood was completely mottled and brittle from hyphal threads, visible in white patches throughout the surface and no doubt impregnating the whole volume.

Another troublesome area was situated on Candle Lake, northeast of Paddockwood and southeast of Prince Albert National Park. Here also the timber was old and overmature. This area comprises a timber berth, 1212B, on the west shore of Candle Lake. The berth had been held in trust for many years for the owner's heir, now of age. The berth could not be sold, as there is so much rot in the stand that no one will risk the $4.50 per thousand that is asked for it.

In the company of H. P. Pond, Forester of the Department of Natural Resources, an examination of this area was made. The trunk of the tree was beaten in 92 instances, resulting in 38% of this number producing an unsound ring. Many of these trees were between 6-8" D.B.H., indicating that not all trees affected are overmature. A large number of these trees were infested with bark-beetles, although the foliage was green. One large tree in an exposed position near the shoreline had but recently been blown down--a conclusion attested to by the condition of its foliage. This tree

was entirely rotten inside, the wood being dry, friable and reddish coloured, and its trunk was heavily infested with bark-beetles resembling Ips. This association of heartrot and bark-beetles is peculiar in that the trees do not show the characteristic chlorosis common to scolytid attack. Attack, however, was of only one season's standing, since excavation was not extensive and the galleries contained immature adults. Some sound trees showed evidence of beetle attack, with subsequent vacation of galleries in evidence. This indicates that trees must first be weakened by other agencies.

The question of site enters into this condition because the stand is situated upon a coarse gravel deposit but a few feet from the surface.

Old age alone would not readily appear the sole cause. Apparently destruction of this stand is due to overmaturity--broadly interpreted as tree age in excess of the site's ability to support the stand density--with subsequent infection from heartrot organisms. The two agencies operating together so reduce the vitality of the timber concerned that bark-beetles find in it a ready-made habitat. Trees in which bark-beetles are tunnelling extensively must surely die. There is a probability, remote of course, that with so much available material for propagation bark-beetles may increase out of all

proportion to the weakened timber and succeed in establishing themselves in the remaining sound trees, with obvious results. Such a situation has occurred in the past in the western forests and is to be gravely considered. Knowledge of the habits of bark-beetles in central Canada is in a very elementary state and their exact tendencies cannot be predicted. However, it is obvious from all aspects that a recommendation to decimate the unsound timber of this stand is tenable.

APPENDIX B

NOTES ON THE FOREST TENT CATERPILLAR IN NORTHERN MANITOBA AND NORTHERN SASKATCHEWAN, TOGETHER WITH A LIST OF PERSONNEL CONTACTED, AND THEIR LOCATIONS & POST OFFICES.

By D.N. Smith

Observation of foliage under conditions of transit shows that feeding by forest tent caterpillars larvae is widespread, but of exceedingly variable intensity, throughout the areas traversed in northern Saskatchewan and northern Manitoba. Quite noticeable is the apparent high immunity of black poplar to feeding by this pest, even when mixed in stands of aspen most severely defoliated. However, willow, alder, hazel and birch do not fare so well and, in some localized areas north of The Pas, Manitoba, the latter has suffered a most as greatly as the aspen.

Attack, as evidenced by defoliation, appears to be sporadic and uneven, but three main centres of infestation seem to obtain. Two of these are old offenders, while the third is reportedly much more recent. These centres are respectively: Nipawin and Hudson Bay Junction, Sask.; and The Pas, Manitoba.

Natural control of pupae by a dipterous parasite, and evidence of other parasitism, was encountered. Greatest incidence of this was observable at Cormorant Lake and Ministikwan Lake, Manitoba, and at the National Forestry Program Camp No. 3, northerly from Hudson Bay Junction, Saskatchewan. However, survey returns from material submitted indicate that such control is not so localized. Natural control of this pest in northwestern Ontario appears to be effectively imposed by a type of infectious wilt disease. Such has not been observed in northern

Manitoba or Saskatchewan. On the other hand, the incidence of parasitism in the Ontario areas is reputedly low, and a mutual exchange of control agents between northern Saskatchewan, northern Manitoba and northwestern Ontario is suggested as an interesting and potentially useful experiment. The northern areas mentioned appear to possess conditions of humidity and temperature comparable in part to those existing in northwestern Ontario and such an infectious disease might greatly supplement control by parasitism on establishment. Introduction of parasites into northwestern Ontario necessitates caution with respect to favorable absorption by the other possible hosts and freedom from undesirable parasite complexes which might conceivably result.

I. DETAILED DATA

Note: Place refers in some instances to the vicinity of the point intended, as e.g.; "Crean Lake", below. To be more specific, Location is given wherever advisable the order being Range, Township, section, meridial direction. Location refers to the last mentioned point in the Place column.

No.	Place	Location	Intensity	Date
(1)	Crean Lake, Prince Albert Nat'l Park, Sask.	1-59-W2	patchy & light	June 17, 1939.
	Prince Albert to Meadow Lake, Sask.	C. P. R.	very light	June 19, 1939.
(2)	Meadow Lake Provincial Forest, Sask.	17-58-W3	patchy & light	June 20, 1939.
	Meadow Lake to Flotten Lake, Sask.	17-63-W3	patchy & light	June 21, 1939.
	Meadow Lake, townsite and vicinity, Sask.	--------	medium to heavy	June 21, 1939.
	Meadow Lake to St. Walburg, Sask.	C. N. R.	patchy & light	June 24-25, 1939.
(3)	Makwa (Loon) Lake, Sask.	22-58-W3	light	June 24, 1939.
(4)	Prince Albert to Holbein, Sask.	2-48-36 W3	light	July 4, 1939.
(5)	Prince Albert to De Laronde Lake, Sask.	--------	light	July 7, 1939.
	Prince Albert to Emma Lake, Sask.	--------	medium	July 9, 1939.
(6)	Emma Lake to Candle Lake to Prince Albert, Sask.	--------	light	July 11-12, 1939.
	Prince Albert to N.F.P.#4, La Corne Forest, Sask.	19-50-9W2	light	July 13, 1939.
	N.F.P.#4 to Saskatchewan River, Sask.	---------	heavy	July 14, 1939.
(7)	N.F.P.#4 to Smeaton, Sask.	---------	light to medium	July 15, 1939.
	N.F.P.#4 to Nipawin, Sask.	---------	medium to heavy	July 18, 1939.
	Nipawin to Grassy Lake, Sask.	15-54-W2	medium	July 20, 1939.
	Nipawin to Carrot River, Sask.	11-50-5W2	patchy & light	July 21, 1939.
(8)	Carrot River to The Pas bridge, Sask.	9-50-W2-	light to medium	July 22, 1939.
(9)	Carrot River to Arborfield, Sask.	---------	patchy, light to medium	July 24, 1939.
	Arborfield to Connell Creek Tower, Sask.	10-48-16W2	medium to heavy	July 24, 1939.

No.	Place	Location	Intensity	Date
(11)	Nipawin to Three Rivers Cabin, Sask.	8-55-W2	medium to heavy	July 25, 1939.
(10)	Three Rivers Cabin to Sipanok Cabin, Sask.	4-53-W2	light to medium	July 30, 1939.
	Sipanok Cabin to The Pas, Manitoba.	--------	patchy & light	July 31, 1939.
	The Pas to Cormorant Lake, Manitoba.	H.B.R.R.	heavy	Aug. 1, 1939.
	Cormorant Lake to Wabowden, Manitoba.	H.B.R.R.	light	Aug. 5, 1939.
(12)	Cold (Kississing) Lake, Manitoba.	--------	medium	Aug. 9, 1939.
	Cranberry Ptge. to Channing, Manitoba.	F.F.R.R.	medium to heavy	Aug. 10, 1939.
	Channing to Ministikwan Lake, Inlet & N.E. arms of Schist Lake, to N. arm of Lake Athapapuskow, Manitoba.		medium to heavy	Aug. 11, 1939.
(15)	Beaver (Amisk) Lake, Sask.	--------	medium to heavy	Aug. 14, 1939.
	Channing to Atik, Man.	F.F.R.R.	medium	Aug. 15, 1939.
	Atik to Wanless, Man.	F.F.R.R.	medium to heavy	Aug. 15, 1939.
	Wanless to The Pas, Manitoba.	F.F.R.R.	medium	Aug. 15, 1939.
	Hudson Bay Junction to N.F.P.#3, Sask.	(13-mile tower (5-36-W2	heavy	Aug. 17, 1939.
	Hudson Bay Junction to Greenbush, Sask.	C. N. R.	light to medium	Aug. 20, 1939.
	Greenbush to Mistatim, Sask.	C. N. R.	medium to heavy	Aug. 21, 1939.
(13)	Mistatim to Chelan, Sask.	10-42-16-W2	light	Aug. 22, 1939.
	Chelan to Somme, Sask.	7-41-W2	medium	Aug. 23, 1939.
	Somme, Sask.	7-41-W2	heavy	Aug. 23, 1939.
	Hudson Bay Junction to Tallpines, Sask.	C. N. R.	very heavy in places	Aug. 24, 1939.
	Tallpines to Endeavour, Sask.	C. N. R.	medium to heavy	Aug. 25, 1939.

The terms "Light", "Medium", and "Heavy" are relative to the observed evidence of defoliation. Thus, "Heavy" refers to a condition where the tree presents an appearance of almost complete denudation,

to one in which almost every leaf is severely eaten and of a ragged nature. The other two terms relate directly and in diminishing intensity to "Heavy."

It may be added that re-leafing takes place shortly after the cessation of larval feeding and within a few weeks the tree bears considerable foliage, however certainly less in total leaf surface than formerly. Trees north of Cranberry Portage, Manitoba, have re-leafed two years successively, according to local report. Presumably this re-leafing is accomplished at the expense of what should have been the next season's leaf-buds.

Personnel - Dept. of Natural Resources, Saskatchewan

MEADOW LAKE DISTRICT

A. G. Macaskill	District Supt.	Meadow Lake
A. W. B. Benson	Forest Supervisor	Meadow Lake
R. Arnold	Field Officer	Spruce Lake
W. Barnett	Field Officer	Glaslyn
R. Higman	Field Officer	Paradise Hill
S. Mitchell	Field Officer	Loon Lake
T. Pugh	Field Officer	Meadow Lake
F. W. Redhead	Field Officer	Isle a la Crosse
E. A. Sharman	Field Officer	Pierceland
F. Timpson	Field Officer	Green Lake

PRINCE ALBERT DISTRICT

E. C. Coursier	District Supt.	Prince Albert
E. J. Marshall	Forest Supervisor	Prince Albert
O. G. Horncastle	Senior Forester	Prince Albert
H. P. Pond	Forester	Prince Albert
T. H. Adams	Field Officer	Holbein
A. O. Aschim	Patrolman	Candle Lake
J. M. Brown	Field Officer	Strong Pine
J. C. Callaghan	Field Officer	Prince Albert
D. Frechette	Field Officer	Leoville
P. C. Hogan	Field Officer	Paddockwood
L. S. Horne	Field Officer	Kinistino
Jos. Johnson	Field Officer	Tweedsmuir (Emma Lake)
S. A. Matheson	Field Officer	Nipawin (Beaver House)
A. W. May	Field Officer	Nipawin
H. S. Nicholson	Field Officer	Macdowall
E. C. Over	Field Officer	Big River (De Laronde Lake)
G. M. Parker	Field Officer	Choiceland (Crassy L.)
D. Patterson	Field Officer	Lac la Ronge
D. R. Pitts	Field Officer	Mildred
C. E. Potter	Field Officer	Big River
F. R. Rafuse	Field Officer	Carrot River

HUDSON BAY JUNCTION DISTRICT

R. T. Cook	District Forester	Hudson Bay Junction
C. R. Christie	Forest Supervisor	Hudson Bay Junction
F. H. Hewitt	Forester	Hudson Bay Junction
C. Soules	Cruiser	Hudson Bay Junction
C. Abra	Field Officer	Chelan

HUDSON BAY JUNCTION DISTRICT (CONT'D)

Dr. Horwill	Field Officer	Crooked River
O. B. McNeil	Field Officer	Flin Flon
L. Moulton	Field Officer	Prairie River
C. Otterbein	Field Officer	Summer: Nipawin (Three Rivers) Winter: The Pas
F. Preece	Field Officer	Hudson Bay Junction
K. O. Sanders	Field Officer	Endeavour
C. Schell	Field Officer	Pelly
T. Shannon	Field Officer	Somme
L. Simmons	Field Officer	Mountain Cabin - The Pas P.O.

Personnel - Manitoba Forest Service

NORTHERN DISTRICT

R. Harvey	District Forester	The Pas
T. Ewings	Chief Ranger	The Pas
A. Bowman	Fire Ranger	Island Lake
P. Durand	Fire Ranger	Norway House
W. Erlandson	Fire Ranger	Cormorant Lake
G. Evans	Fire Ranger	Gods Lake
G. Ferguson	Fire Ranger	Cranberry Portage
C. Hanson	Fire Ranger	Sherridon
W. Hislop	Fire Ranger	Wabowden
(P. Jenson	Pilot	Cormorant Lake (TCA)
(Bud Jones	Pilot	Cormorant Lake (TCA)
C. Jones	Fire Ranger	Channing
P. Myers	Fire Ranger	Cormorant Lake
A. Sinclair	Fire Ranger	Cross Lake
F. Small	Mechanic	Cormorant Lake
W. Wedge	Fire Ranger	Thicket Portage

The fire rangers at Herb Lake and Grand Rapids were not contacted.

Personnel - Prince Albert National Park

H. Knight	Superintendent	Summer: Waskesiu Winter: Prince Albert
B. M. Strong	Asst. Supt.	Summer: Waskesiu Winter: Prince Albert
G. L.Davis	Chief Warden	Summer: Waskesiu Winter: Prince Albert

Personnel - Prince Albert National Park (Cont'd)

WARDENS:

Wm. Anderson	(Cookson)	Silver Grove
H. Gonge	(Summer: Waskesiu) (Winter: Prince Albert)	Bittern Lake
H. E. Harrison	(Summer: Waskesiu) (Winter: Prince Albert)	Kingsmere Lake
G. Holden	(Summer: Waskesiu) (Winter: Prince Albert)	Meridian Cabin
R. Hubel	(Summer: Waskesiu) (Winter: Prince Albert)	Waskesiu Townsite
F. Jervis	(Big River)	Boundary Cabin
E. L. Millard	(Cookson)	Rabbit Cabin
C. Pocock	(Park Valley)	Sturgeon River

Non-Executive Personnel

Locations

SASKATCHEWAN

Home	Post Office	Name
Beaver House	(Nipawin)	B. A. Matheson
Big River	(De Laronde L.)	E. C. Over
Big River	----------	C. E. Potter
Candle Lake	(Paddockwood)	A. O. Aschim
Carrot River	----------	F. R. Rafuse
Chelan	----------	C. Abra
Choiceland	(Grassy Lake)	G. M. Parker
Crooked River	----------	Dr. Horwill
De Laronde Lake	(Big River)	E. C. Over
Emma Lake	(Tweedsmuir)	Jos. Johnson
Endeavour	(Ushta)	K. O. Sanders
Flin Flon	(Beaver Lake)	C. B. McNeil
Glaslyn	----------	W. Barnett
Grassy Lake	(Choiceland)	G. M. Parker
Green Lake	----------	F. Timpson
Holbein	----------	T. H. Adams
Hudson Bay Junction	----------	F. Preece
Isle a la Crosse	----------	F. W. Redhead
Kinistino	----------	L. S. Horne
Lac la Ronge	----------	D. Patterson
Leoville	----------	D. Frechette
Loon Lake	----------	S. Mitchell
Macdowall	----------	H. S. Nicholson
Maloneck Cabin	(Pelly)	C. Schell
Meadow Lake	----------	T. Pugh
Mildred	----------	D. R. Pitts
Mountain Cabin	(The Pas)	L. Simmons (moved?)
Nipawin	(Beaver House)	B. A. Matheson
Nipawin	----------	A. W. May
Paddockwood	(Candle Lake)	A. O. Aschim
Paddockwood	----------	P. C. Hogan
Paradise Hill	----------	R. Higman
Pelly	(Maloneck Cabin)	C. Schell
Pierceland	----------	E. A. Sharman
Prairie River	----------	L. Moulton
Prince Albert	----------	T. Callaghan
Somme	----------	T. Shannon
Spruce Lake	----------	R. Arnold
Strong Pine	----------	J. M. Brown
The Pas	(Mountain Cabin)	L. Simmons (moved?)
The Pas	(Three Rivers Cabin-winter)	C. Otterbein
Three Rivers Cabin	(Nipawin - summer)	C. Otterbein
Tweedsmuir	(Emma Lake)	Jos. Johnson
Ushta	(Endeavour)	K. O. Sanders

MANITOBA

Home	Post Office	Name
Channing	----------	G. Jones
Cormorant Lake	----------	W. Erlendson, P. Meyer
Cranberry Portage	----------	G. Ferguson
Cross Lake	----------	A. Sinclair
Cods Lake	----------	O. Evans
Island Lake	----------	A. Bowman
Norway House	----------	P. Durant
Sherridon	----------	C. Hanson
The Pas	----------	T. Ewings
Thicket Portage	----------	W. Wedge
Wabowden	----------	W. Hislop

PRINCE ALBERT NATIONAL PARK

Bittern Lake	(Summer: Waskesiu) (Winter: Prince Albert)	H. Genge
Boundary Cabin	(Big River)	P. Jervis
Crean Lake	(Summer: Waskesiu) (Winter: Prince Albert)	(P. Russell, resigned)
Kingsmere Lake	(Waskesiu)	H. E. Harrison
Meridian Cabin	(Winter: Prince Albert)	(Chief Warden, C. Davis (C. L. Holden
Rabbit Cabin	----------	E. L. Millard
Silver Grove	(Cookson)	Wm. Anderson
Sturgeon River	----------	C. Pocock
Waskesiu	----------	R. Rubel

II. DISTANCES TRAVELLED

A. Province of Saskatchewan

Winnipeg, Manitoba, to Prince Albert, Sask.	732 miles

1. Prince Albert National Park

Waskesiu to Montreal Lake and return	54 miles
Waskesiu to Crean Lake and return	26 miles
Waskesiu to Sturgeon River and return	150 miles
Waskesiu to First Narrows and return	30 miles
	260

2. Meadow Lake District

Prince Albert to Meadow Lake and return	210 miles
Meadow Lake to Flotten Lake and return	90 miles
Meadow Lake to N.F.P. #3 and return	80 miles
Meadow Lake to Loon Lake	38 miles
Vicinity Loon Lake	30 miles
Loon Lake to St. Walburg	40 miles
St. Walburg to Meadow Lake	78 miles
Meadow Lake to N.F.P. #3 and return	80 miles
	646

3. Prince Albert District

Prince Albert to N.F. P. #4 and return	120 miles
Prince Albert to North Cabin and return	90 miles
Prince Albert to Big River and return	210 miles
Vicinity Big River	45 miles
Prince Albert to Emma Lake	32 miles
Vicinity Emma Lake	80 miles
Emma Lake to Paddockwood	30 miles
Paddockwood to Candle Lake	31 miles
Vicinity Candle Lake	12 miles
Candle Lake to Prince Albert	62 miles
Prince Albert to N.F.P. #4	60 miles
Vicinity N.F.P. #4	10 miles
N.F.P. #4 to Smeaton and return	31 miles
N.F.P. #4 to Beaver House	29 miles
Beaver House to Botany P.O. and return	86 miles
Beaver House to Crassy Lake	22 miles
Vicinity Crassy Lake	6 miles
Crassy Lake to Nipawin	34 miles
Vicinity Nipawin	10 miles
Nipawin to Carrot River	48 miles
Vicinity Carrot River	132 miles
Nipawin to Beaver House	12 miles
Beaver House to Three Rivers Cabin	71 miles
Vicinity Three Rivers Cabin	20 miles
	1283

4. Hudson Bay Junction District

Three Rivers to The Pas, Manitoba	200 miles
Hudson Bay Junction to N.F.P.#5 and return	52 miles
Vicinity N.F.P. #5	6 miles
Hudson Bay Junction to Prairie River	25 miles
Prairie River to Crooked River	25 miles
Vicinity Crooked River	20 miles
Crooked River to Chelan	35 miles
Chelan to Somme	18 miles
Somme to Carragana to Prairie River	33 miles
Prairie River to Hudson Bay Junction	25 miles
Hudson Bay Junction to Ushta Siding	42 miles
Ushta Siding to Pelly and return	124 miles
Pelly to Maloneck Cabin and return	44 miles
Ushta Siding to Sturgis	35 miles
	684

B. Province of Manitoba

1. Northern Forest District

The Pas to Cormorant Lake	42 miles
Cormorant Lake to Norway House	120 miles
Norway House to Island Lake	155 miles
Island Lake to Gods Lake	60 miles
Gods Lake to Cross Lake	140 miles
Cross Lake to Norway House	40 miles
Norway House to Cormorant Lake	120 miles
Cormorant Lake to Wabowden	95 miles
Vicinity Wabowden	30 miles
Wabowden to Thicket Portage and return	96 miles
Wabowden to Cold Lake	100 miles
Vicinity Cold Lake	10 miles
Cold Lake to Cranberry Portage	35 miles
Cranberry Portage to Flin Flon	35 miles
Vicinity Flin Flon and Channing	45 miles
Channing to Beaver Lake and return	38 miles
Channing to The Pas	87 miles
The Pas to Hudson Bay Junction, Sask.	88 miles
	1336

SUMMARY TOTAL

Winnipeg to Prince Albert	732 miles
Prince Albert National Park	260 miles
Meadow Lake District	646 miles
Prince Albert District	1283 miles
Hudson Bay Junction District	684 miles
Northern Forest District	1336 miles
Sturgis to Winnipeg	324 miles
GRAND TOTAL	5265 miles

FOREST INSECT SURVEY

By D. M. Smith

I. INTRODUCTORY STATEMENT

To round out the contact and reconnaissance projects of previous seasons, conducted preparatory to the inception of Survey operation by the Winnipeg Laboratory for central Canada, activities were undertaken into the Thunder Bay Forest District of northwestern Ontario and the Eastern, Western, and Southern Forest Districts of Manitoba.

II. PROVINCE OF ONTARIO

A. Personnel Contacted

1. Ontario Forest Branch

By mutual co-operation between the Winnipeg Laboratory and the Ontario Forest Branch at Port Arthur, Ontario, personnel of the latter organization within the Thunder Bay District were contacted. In the course of these contacts, the aim of the survey was explained, examples were given to illustrate the importance of forest entomology to forest conservation, and field trips were undertaken. These served not only to demonstrate the actual processes of collection of samples and their shipment, but also as opportunities for personal observation of the entomological status of the forested parts of the area.

Before giving detail regarding contacts made

and areas visited, an outline of the organization of personnel and administration in the Thunder Bay District will be given.

The Thunder Bay Forest District is divided for convenience in administration into four fire divisions. The Forest District office is in Port Arthur, under the charge of the District Forester, and a Chief Fire Ranger is located in this office responsible for all fire problems in the Thunder Bay Fire Division. The three remaining fire divisions, each under a Chief Fire Ranger, are Longlac, Nipigon and Pays Plat respectively.

Subdivision of responsibility within the fire division is in the order Deputy Chief Fire Ranger, of which there may be several scattered at strategic points, and Fire Ranger. Specialized personnel are also found, such as pumpmen, truck drivers, boat captains, boat engineers, gascarmen, etc.

All air travel is under the direction of the Provincial Air Service, at the requisition of the District Forester and his Chief Fire Rangers in emergency, and aircraft bases are located at Port Arthur, MacDiarmid, Nakina and Pays Plat.

The Thunder Bay District is claimed to be one of the richest timber areas in eastern Canada at the present time. Some 80,000 square miles of accessible and

merchantable black spruce are to be found in the area from Port Arthur eastward to Heron Bay and northward to the transcontinental railway. 90% of Ontario's natural resource income is said to be centered in this area and one-third of the income of the twin cities of Port Arthur and Ft. William derives therefrom.

Personnel Contacted

District Forester: F. Dawson

a. Thunder Bay Fire Division

Chief Fire Ranger: M. Sauerbrei
Deputy Chief Fire Ranger: J. Chisholm
Deputy Chief Fire Ranger (Sauerbrei Lake): A. Oresky
Deputy Chief Fire Ranger (Garden Lake): G. Hornick
Deputy Chief Fire Ranger (Hurkett): T. Dowell

b. Nipigon Fire Division

Chief Fire Ranger: J. P. Legris
Deputy Chief Fire Ranger: A. Jacobson
Fire Ranger: J. Rabb
Fire Ranger: C. Dubis
Pilot: R. Ross
Boat Captain: J. Nicholson
Boat Engineer: K. Greenshields
Radio Operator: F. MacCormack
Clerk: S. Hilbert
Nipigon River Patrol: A.J.E. Bouchard
E. Bouchard
Deputy Chief Fire Ranger (Jackfish Is.): C. Longila
Fire Ranger (Jackfish Is.): J. Bruchette
Fire Ranger (Jackfish Is.): R. Lemieux
Fire Ranger (Jackfish Is.): O. Mendelin
Fire Ranger (Jackfish Is.): R. Riddell
Fire Ranger (Jackfish Is.): K. Danielson
Boat Captain (Jackfish Is.): E. Chisholm
Boat Engineer (Jackfish Is.): W. Greenshields
Deputy Chief Fire Ranger (Beardmore): J. Latreille

c. Pays Plat Fire Division

Chief Fire Ranger: H. Bishop
Pilot: C. MacIntyre
Air Engineer: J. Kincaid
Boat Captain: W. Chisholm
Boat Engineer: R. Caron
Radio Operators: B. Bell, C. Weddell
Deputy Chief Fire Ranger: J. Turner
Clerk: D. Dasey
Truck Driver: M. Otway
Pumpman: F. Polino
Fire Ranger: N. Cunningham
Deputy Chief Fire Ranger (Peninsula): J. McMartin
Fire Ranger (Peninsula): W. Ballard

d. Longlac Fire Division

Chief Fire Ranger: V. Mawn
Deputy Chief Fire Ranger: J. Jarvis
Senior Ranger: J. Ritchie
Boat Captain: S. Grasser
Towerman: C. Tomlinson
Clerk: W. Wilson
Deputy Chief Fire Ranger (Jellicoe): A. Killick
Fire Ranger (Jellicoe): J. Fleming
Deputy Chief Fire Ranger (Geraldton): E. Ward

e. Other O.F.B. Personnel

Deputy Chief Ranger: S. W. Burk, Hillsport (Kapuskasing District)
Deputy Chief Ranger: G. Burns, White River (Sault Ste. Marie)
Deputy Chief Ranger: G. McCuaig, Heron Bay (Sault Ste. Marie)
Fire Rangers: J. Kenneguisser) Heron Bay
B. Thorsteinson)(Sault Ste. Marie)

2. Private Companies & Individuals

Due to the previously mentioned extent of resources and community value of resources in the Thunder Bay District, it was considered of importance to attempt to enlist the interest, if not the active co-operation, of all those organizations whose investment of capital

depended upon the perpetuation of such resources.

The following is a list of those firms and representatives of firms contacted and their locale:

Abitibi (Thunder Bay) Pulp & Paper Co., Port Arthur.

J. Auden, Woods Manager, Port Arthur.
W. Christie, Assistant Woods Manager, Port Arthur.
W. Stevens, Chief of Control, Port Arthur.
W. Knight, Drive Foreman, Hydro.
G. M. Stewart, Superintendent of Control, Hydro.
F. Hicks, Cruiser, Port Arthur.

Don A. Clarke & Co., Timber Contractors, Port Arthur.

Don A. Clarke, Proprietor.

Cowan & Faber, Foresters, Timber Jobbers & Timberland Agents, Port Arthur.

W. O. Faber

C. W. Cox & Company, Port Arthur.

C. W. Cox, Proprietor (Mayor of Port Arthur).
G. Hines, Camp Foreman } Hogarth
M. Bezugloy, Bush Foreman }

C. Gardner & Co., Port Arthur.

C. Gardner, Proprietor.

General Timber Co., Port Arthur.

A. L. Johnson, Vice-President, Port Arthur.
J. Cowan, Woods Superintendent } Peninsula
L. Sorenson, Forester }

Great Lakes Paper Co., Fort William.

B. Avery, Woods Manager, Fort William.
B. Southam, Assistant Woods Manager, Fort William.
E. Burk, Logging Engineer, Port William.
R. Silversides, Forester.
P. Ward, Cruiser.

Hammermill Paper Co., Port Arthur.

M. Cochrane, Manager, Port Arthur.

Ontario Paper Company, Heron Bay.

J. Davis, Resident Manager, Heron Bay.
R. Botham, Woods Superintendent, Depot.
A. Baird, Forester.
Messrs. Frapier, Priddle, Dundas, Madge & Roper.

Pigeon Timber Co., Port William.

E. Hunt, Manager Woods Operations, Port William.
O. Nordlander, Woods Superintendent, Neys.

Provincial Paper Co., Port Arthur.

A. G. Pounsford, General Manager, Port Arthur.
W. Johnson, Mill Superintendent, Port Arthur.
J. C. MacLeod, Woods Superintendent, Port Arthur.
Andrews, Assistant Woods Superintendent, Port Arthur.
D. White, Purchasing Agent, Port Arthur.
E. Beatty, Assistant Purchasing Agent & Cruiser, Port Arthur.
J. MacLeod, Cruiser, Port Arthur.

Pulpwood Supply Co., Longlac.

W. McNutt, Manager.

O. Styffe & Co., Port Arthur.

O. Styffe, Director.
H. Styffe, Manager.
P. Peterson, Woods Superintendent.

Miscellaneous

R. Beaudro, Ontario Department Game & Fisheries, MacDiarmid.

K. Sjolander, Lake Sulphite Co., Nipigon.

B. General

The following information is included to facilitate further work in the area and to show the background against which the work was performed.

1. Accommodation & Communication

The following remarks are in the nature of

recommendations based on personal preferences:

Port Arthur, Prince Arthur Hotel, meals at Murray's Grill, Rudy's Nips. Other restaurants incomparable.

Port William, meals at White's Cafe.

Nipigon, International Hotel, noisy but modern, meals in Olympia Cafe.

Rossport, Rossport Inn, meals in.

Longlac, Hotel.

MacDiarmid, Alex MacLeod's Boarding House, meals in.

At other points it is necessary to rely upon the accommodation of the ranger station or commercial operation and it is best to take a sleeping bag along for all overnight trips. Arrangements for meals are usually readily made with the forestry or camp clerks.

Communication is possible by C.N.R. and C.P.R. telegraph, and by Ontario Forestry Branch telephone and radio facilities. All points on the railway receive mail daily, and it is best to have correspondence addressed care of O.F.B. at Port Arthur. If one is going to be away from that point for several days, they will forward mail to points indicated.

2. Transportation

All forms of transportation are available within the district, varying with the fire division to some extent. In the Thunder Bay Division, trucks, canoes and aircraft receive the greatest use; in the Nipigon

Division, aircraft and cabin cruiser and to some extent gascar; in the Longlac Division, aircraft, cabin cruiser and gascar are employed; and at Pays Plat all the above facilities are available for land, water and air travel.

3. District Description

The District is divided by its natural features of topography into three main characteristic areas; what might be called the coastal, the inland and the Lake Nipigon. The topographic variation within the areas is accompanied by vegetative characteristics and these will be outlined briefly.

The area encompassed by the shoreline between the Twin Cities and Heron Bay is very rough and rugged, the coastline between broken by four main bays; Thunder, Black, Nipigon and Heron respectively, the former being the largest of all. A great many rivers of varying size empty into them and some of these, such as the Nipigon and Pic, are of considerable size. Inland, the rivers follow valleys of varying widths, in many places these taking the form of terraces the topography of which is flatly rolling. A good example of this is to be found in the vicinity of Dorion and Hurkett, and to a lesser extent about Pays Plat.

Inland from the coastal area, the land is very rolling, except in the region of terraces and river valleys.

The topography is often very rugged and sheer cliffs of basaltic and sedimentary rocks are common. In the low spots are found tamarack and black spruce, with the latter predominant. Tamarack appears most abundant on the extremely low, flat, wet areas and is occasionally to be found free from spruce association. On the drier sites, it is not uncommon to find tamarack, black spruce, birch, aspen and Jack pine all growing in intimate association. A number of representative instances are to be found along the highway between Nipigon and Schreiber. On the hilltops where good soil deposits are found, the cover is white spruce, aspen and balsam; while Jack pine occupies the least favorable sites on rugged outcrops and thin soils, or sandy plains. The most extensive association in this inland portion is, however, that of black spruce with tamarack, balsam and occasionally Jack pine, black spruce being predominant. On the rolling, higher and more rocky areas, a boreal association is to be found, dominated by Jack pine, intermixed with black and white spruce, balsam, birch and aspen.

The Lake Nipigon area differs somewhat in its northern and northeastern portion in that low sandplains are common. These bear predominantly black spruce, Jack pine on the higher areas, tamarack in the swamps. The moss is often deep and the forest is in many respects

virgin, both from attacks of fire and utilization by man.

The main point to be considered in the outline of topography and vegetation given above is the overall, broad-scale homogeneity of the plant association and the intimate relationship of Jack pine, white and black spruce, balsam, tamarack and hardwoods. This point will be enlarged below.

4. Insect Conditions

As noted above, all the commonly occurring coniferous trees of the district are in close association and wherever isolated groups occur by reason of topography, as Jack pine on the high spots and black spruce, particularly, on the lower ones, there exist intermediate species making for a continuity of general type.

The importance of this from the standpoint of Jack pine and spruce budworm attack cannot be sufficiently emphasized and should certainly not be underestimated. The reasons for this statement are twofold. Firstly, the seriousness and extent of the Jack pine budworm epidemic current in the area from Port Arthur west and northwesterly might easily spread east into this enormous area; secondly, the spruce budworm epidemic current in the Algoma District might easily spread westward and northerly into the same area. Since the former race of budworm is a Jack pine, and to some extent a spruce feeder, and the latter is a spruce and balsam feeder, and in view of the

homogeneity of the forest cover noted above, it will be evident that host selection of each race might broaden to include all species of conifers present.

At the present time the district appears to be in a state of freedom from serious insect activity, insofar as numerous beatings made at various points within its confines were completely negative, others revealing only innocuous and insignificant species. At Sauerbrei Lake the aspen showed a certain amount of kill-back and evidenced retardation from forest tent caterpillar attack in 1938. Mr. Gresky reports a 30% mortality amongst overmature spruce in the Black Sturgeon Mountains due to bark beetles. An area of Jack pine several acres in extent in the vicinity of the Provincial Paper Company's Camp No. 6 exhibited considerable mortality. This was judged to be due to the removal of spruce which had been associated in the stand - which grows on a sandy-clay site - with consequent weakening of the trees. Many show evidence of attack by borers which apparently is the ultimate cause of death.

Ips were occasionally noted in cordwood culls at many points.

More serious pests such as the Jack pine budworm and European larch sawfly were located at several widely scattered points.

(a) Jack pine Budworm

The region of greatest activity by this pest is

along the eastern front of the epidemic extending from the lakehead to the Manitoba boundary. On the outskirts of Port Arthur and Fort William, in groups of Jack pine about golf courses, roadsides and other uncultivated areas, it was to be found with but a few minutes' search. As one progressed west between Fort William and Kakabeka Falls, the attack increased in intensity, attaining an average of about medium. Reports of severe attack were received indicating an extension of the previous season's outbreak in the area lying between Mack and Graham, northwest of Kakabeka Falls; and of an absence of budworm attack in the area south of the Trans-Canada Highway, between the Seine River and Lac des Milles Lacs. At Northern Lights Lake there was very light attack reported this season.

East of the lakehead, attack is both rare and local. In fact, only three areas were noted to harbour budworm, although it would be expected to appear in diluted proportions throughout the whole district. Larvae were recovered from young Jack pine along the right of way of the C.N.R between Kinghorne and Keemle (Mile 34) and in this area mature Jack pine showed occasional terminal and leader killing, usually not more extensive than a foot and, on the average, only a few inches. This attack would seem to be a very local one. However, the timber mentioned occurs between two areas of low, black

spruce-tamarack cover and might be the beginning of an east-west Jack pine ridge, in which case its extent is unknown. The attack seemed most likely to have been of 1938 origin, some possibly 1939. Further west of this point, at Jellicoe, more larvae were found, but no evidence of previous malformations or damage to the trees was apparent. During July a sample of parasites (Ephialtes) was shipped to Longlac, Ontario, (Ontario Forest Branch) for release at these points.

At the eastern end of the District a single larva of the budworm was taken from Jack pine at the Philipp's Creek camp of the Ontario Paper Company. Further examinations and beatings of spruce, balsam, Jack pine and tamarack produced no larvae of any description. Nor was any damage evident. At a point where the proposed Trans-Canada Highway meets the Pic River, further larval collections were made.

The above collections are the sum total of observed budworm incidence. Negative beatings were made at Wolf Lake, Wolf River, Garden Lake, Stirling Tower, Pine Portage, Hydro, Lake Helen, Longlac, Paya Plat.

A report received from J. Rab, Ontario Forest Branch, MacDiarmid, described a larval insect whose habits seemed to coincide with those of the Jack pine budworm. This observation was made on the west shore of Grand Bay, Lake Nipigon.

Another report by E. Bouchard, O.F.B. ranger, MacDiarmid, refers to the terminal attack of Jack pine regeneration during 1939 near the Chrome Mine at Collins, Ontario, north of Lake Nipigon.

The bronze birch borer is destructive to open-growing trees wherever found; most noticeable attack was between Pays Plat and Rossport, and at Peninsula.

(b) European Larch Sawfly

Evidence of the presence of this insect was observable at Peninsula and at Heron Bay, Ontario. A slight amount of damage was noted at Philipp's Creek Camp, Ontario Paper Company. At the former point, the tamarack is sparsely interspersed with black spruce on the low swampy portions of the margin of Lake Superior and considerable terminal distortion and killing was noted on those trees seen. This, however, might conceivably be due to host scarcity and pest abundance relations.

At Heron Bay, the tamarack occurs in more extensive amounts, particularly in the area between the Little Black and Pic Rivers, and in this area attack by the sawfly was noted to be heavy, approximately 10% top-killing being observable from the previous season's activity. That it was 1939 activity was attested by Deputy Chief Fire Ranger, C. McCuaig, who had found larvae very numerous there in that season. Beating recovered a few small larvae, some 3/16" in length, and it was apparent that the

season was just commencing for them. Climatic conditions throughout the entire District were from ten days to two weeks behind the previous year * and later than the general average, according to forestry officials. The season was also said to be wetter.

C. Summary

1. Personnel Contacted

The District Forester, four chief fire rangers, fifteen deputy chief fire rangers, and thirty-four associated members of the Ontario Forest Branch in the Thunder Bay Forest District were contacted. In addition, contact was made with executive and field personnel of all the more important and extensive private enterprises concerned with woods operations within the District.

2. Insect Conditions

Based upon field observation and negative results from beatings, it can be stated that no apparent insect damage is present, with the exception of localized attacks upon tamarack at Peninsula and Heron Bay by the European larch sawfly and an attack of previous seasons' occurrence on Jack pine by the budworm at Mile 54 west of Longlac,

*Ice went out on Lake Nipigon on May 16th in 1939 and on May 26th in 1940. On June 20, 1940, west of Port Arthur the temperature dropped to 2° of frost (Seine River), while on June 19th some snow was experienced coming down the Nipigon River.

Ontario, on the C.N.R. Larvae were recovered there, at Jellicoe, and at a point 25 miles west of White River and north of Heron Bay and in the vicinity of the Twin Cities, westwards to Kakabeka Falls.

III. PROVINCE OF MANITOBA

A. Personnel Contacted

1. Manitoba Forest Service

(a) Eastern Forest District

Wilson, Mitchell } Chief Rangers, Lac du Bonnet
C. Malaher, Chief Ranger, Rennie (Whiteshell Forest Reserve)

(b) Southern Forest District

J. Vicars, Chief Ranger, Boissevain (Turtle Mountain Forest Reserve)
W. Wardrop, Chief Ranger, Marchand } (Sandilands Forest Reserve)
J. Kokandovich, Ranger, Woodridge }

(c) Western Forest District

J. C. Somers, District Forester, Dauphin
A. W. Brain, Forest Engineer, Dauphin
E. Koons, Chief Ranger, Swan River
B. Gilmore, Ranger, Bield
C. Dunlop, Ranger, Deepdale
W. Mawdsley, Ranger, Durban
R. Adams, Ranger, Birch River
J. Thompson, Ranger, Mafeking
F. Imrie, Ranger, Barrows
W. Shiels, Retired Ranger, Minitonas
E. Marner, Ranger, Garland
H. Clee, Ranger, Grandview

2. Manitoba Paper Co., Pine Falls, Manitoba.

A. MacKenzie, Woods Manager
R. Rigg, Chief of Control
Clarke, Superintendent of Control
G. Bayley, Cruiser

3. Riding Mountain National Park

O. Heaslip, Superintendent
J. Chalmers, Accountant
L. Best, Forest Supervisor
P. Brodie, Chief Warden
J. Allan, Warden
D. Binkley, Warden
W. Franks, Patrolman

B. Insect Conditions in the Riding Mountain National Park

1. Jack Pine Budworm

(See Memorandum on following pp.)

(MEMORANDUM

RE:) JACK PINE BUDWORM SITUATION
IN THE RIDING MOUNTAIN NATIONAL PARK, MANITOBA.

(August 16,) 1940.

The region of the park with which this memorandum deals includes the pine stands located on the eastern portion, north and south of the Morgate Road.

The significance of insect injury in relation to these stands is apparent in view of a proposed cutting programme and the desire on the part of the Parks and Forest Service authorities to design a cutting programme that might be as beneficial as possible to the park. Definite information in relation to insect injury in these areas was desired by the authorities so that a cutting programme might also serve as an improvement cutting should insect injury be serious.

Mr. D. M. Smith of the Forest Insect Laboratory at Winnipeg was delegated to examine these areas between August 10th and 15th inclusive and this was supplemented by a visit by Mr. Richmond on August 15th.

The following summarizes conditions and findings made:

The Jack pine budworm is present and has been in a moderate to light degree throughout these pine stands during 1940. From personal observations and reports by Mr. G. Tunstell, Forester, there seems no doubt that its

origin would date at about 1936, synchronous with its outbreak in other parts of central Canada. This early attack has apparently been restricted to the mature dominant trees, where crown and terminal injury is now apparent. The current year's attack is for the most part confined to young growth of the 40-50 year age-class. It seems quite evident that the current attack on young growth has moved in from these mature trees.

Three principal areas are involved and are discussed separately below.

The first area, No. 916 on the Forest Service timber type map, north of the Morgate Road, represents an extensive mature stand of pine and the heaviest attack. The greatest injury becomes evident as one progresses deeper into this stand and is severest where the density of the stand is the least. Budworm feeding is for the most part 3 to 4 years old with practically no current defoliation evident. Dead terminals and stagging of trees are quite evident but not extreme, the severest being killed back for about one foot. General defoliation of the entire tree is also quite noticeable, extreme cases being stripped as much as 50%. The average degree of defoliation, however, is much lighter than this, estimated at some 15%. Complete mortality of timber due to budworm is negligible.

The second area, No. 701 Forest Service timber

type map, south of the Norgate Road, is a continuation of this mature stand where cutting operations are projected. It represents a much lighter attack when compared to 916. In age, it is apparently the same as No. 916. Some terminal killing has occurred to an extent of one foot and the general thinning of foliage from budworm feeding is very evident in the more extreme cases. A light degree of feeding occurred during the current season, but on the whole this area has not suffered to any serious degree. The heaviest attack seems centered on the eastern extremity of this stand, south of Mile 15, Norgate Road.

The third area is represented by young growth of a 40-50 year age-class between Mile 11-12 Norgate Road. This stand is situated half way between those two already discussed, Nos. 916 and 701. This is a spruce-pine admixture with scattered mature dominant trees. As in the two areas already discussed, these large mature trees have suffered an attack some 3 or 4 years previously and dead terminals and stagging are apparent. The young growth, however, has undergone considerable defoliation during 1940 and, in this respect, is totally unlike areas 916 and 701. While the present degree of defoliation will not result in any great mortality, the thinned foliage throughout this stand is most apparent and a serious budworm situation might arise. It represents a considerable increase over 1939.

SUMMARY

Based on the above general observations, the present status of this timber and the budworm may be summarized as follows:

The budworm attack in this area is of some 3 or 4 years of age, the mature timber having suffered the early attack while the young growth is now the most affected. It seems apparent that the attack on young growth has originated from the mature trees.

The future of the mature timber in stands 701 and 916 seems to be quite favourable, barring a sudden increase in the budworm population. While certain injury has been done, particularly to the terminals and leaders, these trees have for the most part completed their growth and the dead leaders are of minor consequence. In connection with mortality of mature dominant Jack pine, it should be mentioned that from intensive studies conducted by this laboratory in 1939, it has been quite definitely established that some 85% of the mortality occurs within 2 years following severe attack. In that these trees have been attacked some 4 years ago, mortality from this cause is not expected, barring a sudden and unexpected return of the budworm.

The future of the young growth adjacent to the Norgate Road is a more serious consideration. Barring further heavy defoliation, the result will probably be a

restricted growth in height among those whose leaders have been badly damaged. This will result in their becoming overtopped by their more vigorous neighbors and the production of a stand of uneven heights. Should heavy feeding continue, a fair mortality would be expected by the fall of 1941, accompanied by severe damage to the remainder, which would be apparent for several years following until sufficient new growth had been produced to overcome the damage done.

The future of the budworm cannot be accurately stated at the moment. No data are available with which to derive conclusions. It would be a reasonable assumption, however, to state that a 50:50 chance prevails that this insect will not continue to increase. The need for a careful analysis of the budworm in the park is apparent and, with the slackening of its activities in other areas, further attention can be directed to this territory. Generally speaking, budworm activity in the Riding Mountains is very mild in comparison with its destruction elsewhere.

It should be pointed out that the usual damage to small reproduction caused by larvae dropping from the mature trees is of no consequence in this infestation, for in those areas examined there is a most regrettable absence of any reproduction.

RECOMMENDATIONS

It is not deemed necessary that any changes be made to the cutting programme in order to cope with the budworm problem from the standpoint of salvage.

It is recommended, however, that where cutting is practised open growing mature trees be included. Our data invariably indicate that it is those trees possessed of well lighted crowns that are the preferred feeding grounds of the budworm. Such mature trees whose vitality is normally low possess limited ability to recover once heavily attacked. This applies equally to tall dominant trees with a clean bole and tufted crown projecting above the general forest canopy. Such trees once weakened are unable to recover and serve as breeding grounds for other destructive secondary insects as bark-beetles and wood-borers. Even aged, wellstocked stands of moderate density suffer the least. The removal of such scattered trees is of decided benefit. While trees of this type are frequent in area 701 on which cutting is already planned, their removal would probably follow. The area, however, where the greatest consideration should be given this type of tree is the young stand referred to at Mile 11-12 Norgate Road. Here, scattered and isolated mature dominant trees are to be found overtopping the young vigorous growth and they constitute a definite hazard. Their terminals have already

been killed and they possess little aesthetic value, and in all probability will gradually die. Their removal is, therefore, strongly recommended.

The problem of secondary insects (bark-beetles and wood-borers) should be given most serious consideration. Dying and weakened timber, newly cut logs, green slash, etc. constitute ideal breeding grounds for these insects. Such insects are capable of wholesale destruction of green timber and constitute a menace that should be watched. The infestation of green logs occurs for the most part in early summer and up to mid-June the population is found within the logs and slash. The removal of logs and the burning of slash prior to this time not only eliminates the breeding ground but also destroys the thousands thus trapped in these logs. It is extremely important that:

- (a) All winter cut wood be removed from the park not later than June 15.

(b) All slash accumulation be burned prior to that date.

The burning of slash appears to be of paramount importance, for apart from the entomological aspect it would eliminate a future fire hazard and open a dense grass mat to allow the germination of seed. The total lack of re-

Riding Mountain National Park

--O--

Photo illustrates dense nature of ground cover - being of grasses and shrubs of such a nature as to preclude germination of seeds and subsequent absence of regeneration under undisturbed site conditions.

Compare with Sandilands Forest Reserve.

Sandilands Forest Reserve

Note size and abundance of regeneration under mature trees. Compare with the situation illustrated in Riding Mountain National Park.

Sandilands Forest Reserve

-o-

This photo illustrates seedling sparcity in Sandilands Reserve under conditions of excess grass development, an unusual feature in this area. The regeneration indicated by arrow seems when the ground was scorified by falling tree in top background.

production in these mature stands would seem to be a very vital problem.

Respectfully submitted,

H. A. RICHMOND,
Entomologist in Charge,
Forest Insect Laboratory,
University of Manitoba,
Winnipeg, Manitoba.

August 16, 1940.

2. European Larch Sawfly

The following summarizes the findings with respect to the European larch sawfly situation upon tamarack in the Riding Mountain National Park, Manitoba. These observations were made during the latter part of August, 1940.

It would seem best to consider that after the control of the sawfly epidemics by the parasite Mesoleius tenthredinis, liberated in this area some 2 decades ago, certain groups of individuals in different parts of the park survived. However, not only did they have thenceforth to compete with their introduced natural enemies for existence, but in addition the previous depredations of their own species upon the tamarack had produced a deficient food supply, sufficient only to maintain them at best at an existence threshold. While both these views are hypothetical, it is useful to consider them in view of circumstances of the present.

In general, there has been a marked increase in the number of areas where light defoliation, and terminal distortion resultant from oviposition therein, are to be found. Actively feeding larvae were observed in many instances, and the instars of larvae, as indicated by their size, were widely separated in some places. Such activities are seemingly widespread throughout the tamarack

in the park. The situation does not seem serious as yet in view of the extreme localisation of acute attack. However, they must be regarded as foci for more general attack at some future time.

Heavy attack was noted at several points in the immediate vicinity of Clear Lake. The attack was originally discovered by Mr. C. Tunstall, District Forest Officer, Winnipeg, for the Dominion Forest Service. Through his interest and co-operation, these points were visited, examined, and sampled. The points of heaviest attack may be enumerated:

Wasagaming Townsite

Ta-Wa-Pit Drive, directly east of the McMorran Agencies, and south of Henson & Co., Druggists.

Air Base

Golf Links, vicinity Holes 5 and 6.

Lake Audy Road, Mile 13, south to Clear Lake.

It is to be noted that the above, with the exception of the last area, are small groups, or isolated trees, and grow for the most part on more or less disturbed sites. The sites are quite dry relative to the swamp stands. In the latter, the occurrence of damage is light and infrequent. Trees growing alone or openly seem more susceptible than those growing in groups or in stands. These factors seem to weaken the tree in

some way so that its susceptibility increases in the first instance, making it attractive to sawfly females for oviposition, with resultant build-up of population on these "nutritional islands." A moderately dry site would also presumably favour overwintering of cocoons.

The last area, just south of the Lake Audy Road, is one of more normal aspect with respect to sawfly attack. Thus, it is a true swampy site, the timber is fairly close-growing and more or less dense, and the crown damage and distortion are easily seen in a large percentage of cases. However, the attack has been of greater severity in the past than at present, although relatively severe this season. That it has been subject to sawfly attack for some seasons is evidenced by the characteristic crookedness of trunk in numbers of instances. This larch area extends south to a raised sand-gravel beach upon which spruce, pine and hardwoods are to be found, and thence a drop brings the shore of Clear Lake to view. Along the shore at this point are scattered tamarack of fair size and they have been rather heavily attacked. Insofar as these trees are growing on a sand-gravel beach terrace and are very exposed and heavily attacked, they furnish further support for the general trend of tree susceptibilities, as noted above.

Because terminal distortion and empty cocoons are to be found in varying degree in all tamarack examined,

it is concluded that populations of endemic status have persisted for some seasons and, under the favorable growing conditions of this one, become sufficiently numerous to attract attention to their defoliations.

In order to avoid a future situation of serious aspect arising by surprise, it cannot be too strongly recommended that tamarack, growing in small groups and in large, be faithfully sampled once a month in all sections of the park, using the beating method advocated by the Forest Insect Survey. It should be pointed out, too, that negative recoveries from beatings are what is desired, for obvious reasons, but that negative reports not based on beatings are of more harm than worth, since they create a false sense of security.

The investigation showed that sawfly activity during 1940 exhibited a marked increase in intensity and extent and, in some places, caused considerable defoliation. There is a strong possibility that increase in numbers of the sawfly would be accompanied by a corresponding increase in the agents of natural control. In order to determine whether natural control is operative, and how effective it is, a series of some 1,200 cocoons is under observation in the Winnipeg Laboratory. It is to be anticipated that parasitism of some degree will be found because of the apparent persistence of the setback given to the sawfly by parasite introduction into the park some

years ago. At the time of writing, however, the experiments have not been running for a sufficient time to derive much data, but there are some indications of an encouraging nature.

C. General

1. Accommodation & Communication

(a) Eastern Forest District

Pine Falls - Pine Falls Hotel - Fair, meals in.
Rennie - Rennie Hotel - Excellent, meals in.
West Hawk Lake - Tourist Cabins - no information, good meals in Trans-Canada Restaurant.

Meals and fairly good accommodation may also be obtained in Lac du Bonnet and Whitemouth.

Communication presents no difficulties in settled areas.

(b) Southern Forest District

Turtle Mountain Forest Reserve - nearest point is Boissevain, hotel and restaurants.

Telephone.

(c) Western Forest District

Dauphin - Hotel, Tourist Camp (not recommended), restaurants.
Grandview - good hotel, restaurants.
Bield - no accommodation, best to proceed to Roblin.
Roblin - good hotel, meals in.
Deepdale - no accommodation, if late proceed to Benito.
Durban - accommodation very poor, proceed to Swan River.
Swan River - Hotel, Tourist Camp. Latter very good! Good restaurants.
Birch River - Excellent meals and accommodation, nothing north to The Pas that is desirable; therefore, work from this point for contact of rangers, at Mafeking and Barrows.
Minitonas - hotel and restaurants.
Garland - no accommodation. Excellent hotel and meals at Pine River.
Telephone, telegram.

2. Transportation

All districts are reached by roads of one kind or another, varying from the Trans-Canada Highway to the most primitive of bush trails where it is necessary to ford rivers. In unsettled areas, travel is chiefly by airplane for long distances, on foot for short. There is a certain amount of water travel available in some districts. Maps are on file, in the laboratory, of the Western Forest District; the Sandilands, Whiteshell & Turtle Mountain Forest Reserves, showing trails, etc. All possible co-operation is generously extended by the organizations concerned.

3. District Description

(a) Eastern Forest District

While this District has not yet been adequately visited or organized, the topography and cover are fairly uniform in the southern and eastern parts. Here the District lies on the margin of the Canadian Shield, and is of granitic nature, containing very large numbers of lakes and streams, interspersed with rocky ridges and outcrops and areas of low swampland. The land rises gently but definitely from west to east, from 750 feet at Lake Winnipeg to 1,050 feet at the Ontario-Manitoba Boundary.

The timber is for the most part inaccessible, although on the Winnipeg River, its tributaries and Lake

Winnipeg much black spruce is cut for pulpwood. Along the Greater Winnipeg Water District Railway, large amounts of aspen, tamarack and Jack pine are cut for fuel wood for Winnipeg and the settled areas and Jack pine is extensively cut for ties wherever accessible.

(b) Southern Forest District

(i) Sandilands Forest Reserve. The reserve is the residual glacial material of morainic and outwash origin subsequent upon the activities of glacial Lake Agassiz. The soil is very sandy, particularly on the numerous ridges that abound. The cover is dominantly Jack pine with some restricted areas of black spruce in the low-lying muskegs, together with tamarack and a small amount of cedar. Very limited and inconsequential groups of scrub oak, ash, mountain ash and red pine are to be found. In the northeastern parts of the Reserve, large stocks of aspen are available for cordwood and some use for sawlogs is made of the better material.

(ii) Turtle Mountain Forest Reserve. This reserve lies along the international boundary in southwestern Manitoba, and is the summit of a series of low hills which rise rather sharply from the level prairie to the north. The soil is of a terminal morainic nature resultant from the glaciers but unlike that of the Sandilands is of a till-like nature. The dominant vegetation is aspen, with oak and

other hardwoods in some places, but conifers are very scarce. Growth is very luxuriant. The Reserve encompasses a great many small lakes, ponds and sloughs, but is of greater value for grazing stock than for timber other than fuel- and post-wood.

(c) Western Forest District

This forest district includes the forested areas encompassed by the Duck Mountain and Porcupine Forest Reserves and the crown lands extending eastwards to Lakes Manitoba and Winnipegosis and north to the Saskatchewan River.

The Duck Mountains and Porcupine Mountains, together with the Riding Mountains, Pembina, Brandon and Tiger Hills and Turtle Mountain, to the south, form the so-called Manitoba Escarpment, marking the dividing point between the first and second prairie steppes. However, Riding, Duck and Porcupine Mountains are of importance here because they mark the apex of the mixedwood forest belt triangle, extending northwesterly to the MacKenzie River and Alaska.

The characteristic composition of this forest belt is admixture of white spruce and aspen. On disturbed areas, such as burns, pure and sometimes extensive stands of poplar are to be found (as on Lake Audy Road in Riding Mountains, Singoosh Lake Road in Duck Mountains, and also on Madge Lake Road, etc.) and, in some instances spruce

regeneration is beginning to appear amongst the aspen. It is said that white spruce grows best under these conditions and that these areas contain the most valuable areas of that species in Manitoba. In this belt, balsam is occasionally to be found in pure stands, also due to burns, it is believed. Jack pine has a very insignificant role, occurring on sandy, poor, or burnt-over soils that would not support the other species. The soil generally is a deep, morainic boulder clay, overlain by silt in the lower portions.

East of the escarpment, the land drops gradually to Lakes Manitoba, Dauphin, Swan and Winnipegosis and, consequently, the drainage is west to east. Myriads of small streams and rivers have their origin in the hills, the highest point of which, Baldy Mountain in the Duck, is 2,727 feet above sea level and almost 2,000 feet above Lake Winnipeg. This lower land has been much modified in the past by glacial action, being in fact the bed of Lake Agassiz. Sand and gravel beaches, deep peaty swamps (alkaline in reaction from the close-to-surface limestone bedrock), reassorted sands and materials of that nature are common. Black spruce and tamarack are the chief cover in the swampy areas; Jack pine occupies the sandy, gravelly ridges and plains, while hardwoods such as poplars, Manitoba maple, birch, elm and ash are found in the richer

silt deposits overlying the boulder clays in some areas previously in the river valleys. This area falls into the Manitoba Lowlands belt.

(i) Riding Mountain National Park. The Park is included here since it falls into the topographical categogry. The park flora in the eastern, southeastern and northern parts correspond closely to the typical mixedwood belt. However, much of the western portion is in the aspen grove belt and contains very little softwood material.

(ii) Duck Mountain Forest Reserve. This Reserve is entirely within the mixedwood belt and is the highest part of the escarpment. This is the most important forest area in Manitoba, containing large areas of fine young spruce admixed with poplar and balsam, just reaching a merchantable age. The area is under semi-management and is possibly the best example of the art in Canada.

(iii) Porcupine Mountain Forest Reserve. This Reserve is separated from the Duck Mountains by the Swan River Valley, an area of lower-lying land exceedingly rich in boulder clay overlain by silt deposits and consequently an agricultural area.

This Reserve is very steep on the easterly and northerly slopes leading upward to an extensive plateau. This is somewhat rolling and contains a number of lakes, some of considerable size. There are also large areas of poor drainage. The best timber is now to be found at the

north and south ends of the Reserve, the north end supporting two sawmills, the south end one. Between the Reserve and Lake Winnipegosis is an area of similar nature to that described for the Duck. Occasional sand plains occur and these bear Jack pine of small size.

4. Insect Conditions

(a) Eastern Forest District

No evidence of insect damage was seen at the early date the limited portions of this area were visited. Beatings in the vicinity of Pine Falls resulted in the recovery of only insignificant species. However, two reports are worthy of investigation with respect to the Jack pine budworm. One of these refers to an attack to Jack pine along a low coastal sand plain to the south of the mouth of the Winnipeg River, extending from Stead to Belair in 1937; the other to an extensive area of reddening of Jack pine on ridges, as seen from the air near the Manitoba-Ontario boundary and northerly from that previously recorded at West Hawk Lake.

On May 30th the town of Pine Falls was swarming with queens of what appeared to be carpenter ants. They were on the streets, in houses and on the wing over a considerable area. This flight may in some way be related to slash in the surrounding timber. No other castes were seen.

(b) Southern Forest District

Trees observed on the Turtle Mountain area were apparently in complete health, and since the area is one of hardwoods, damage to any extent would be readily apparent if present.

In the Sandilands Reserve this season the situation with respect to the Jack pine budworm will be found under another section of the Annual Technical Report, dealing with a review of permanent sample plots.

(c) Western Forest District

The conditions with respect to the European larch sawfly and Jack pine budworm situations within the Riding Mountain National Park will be found under that heading (III, B (1) and B (2), P. 26). At no other point was the Jack pine budworm noted in either the Duck Mountain or Porcupine Reserves, although considerable reconnaissance in Jack pine stands was undertaken. The former area of severe attack, at Cowan, Manitoba, appears to have subsided.

The European larch sawfly also proved very uncommon. It was located north of the Bield ranger station in the southwestern corner of the Duck Mountain Reserve (T27-27-24); and northeast of the Grandview ranger station, in the southeastern corner of the same reserve (T23-27-32,33) The last point of contact was just south of the hamlet of Birch River, Manitoba, on Highway No. 10, in a spruce-tamarack swamp-to the north of this point, as far as Barrows,

infrequently a tamarack terminal was noted to bear the characteristic oviposition crook.

The bronze birch borer was noted wherever birch occurred, in the Riding Mountain, Duck Mountain, and Porcupine Mountain areas, and upon crown lands. Stands of any size at all are infrequent and seldom more than a few acres in extent. The sawmill at Barrows Siding utilizes birch to some extent for railroad track shims, but otherwise no great economic loss seems to be caused thereby, chiefly because isolated, open-growing trees are the ones affected.

The forest tent caterpillar was noted to have attacked aspen, birch, hazel, alder and willow in the Porcupine and Duck Mountains. Heaviest attack centered on the east border of the Porcupine Mountains and the northwest border of the Duck Mountains between Durban and Minitonas and extending southerly at least as far as Wellman Lake. The south and southeast borders of the latter Reserve were extremely lightly affected. Black poplar was noted to be immune here, as observation has shown it to be elsewhere.

At Singoosh Lake, in the Duck Mountains, a slight amount of activity upon white spruce was noted, presumed to be caused by one of the Pikonemas.

D. Summary

1. Personnel Contacted

Four members of the personnel of the Manitoba Paper Company, seven of Riding Mountain National Park, and eighteen of the Manitoba Forest Service were contacted on behalf of the Forest Insect Survey.

2. Insect Conditions

Jack pine budworm: Active and aggressive in the Riding Mountain National Park.

European larch sawfly: Apparently it will be increasingly necessary to watch the status of this pest, particularly in the Riding Mountain National Park, as it is becoming common and locally destructive.

Forest tent caterpillar: Active and heavy on both sides of the Swan River Valley.

Bronze birch borer: Found in isolated birch wherever trees occur.

IV. EXTENSION OF PROJECT

The project requires extension to cover the Eastern Forest District of Manitoba and that portion of the Western Forest District lying to the east of the Manitoba escarpment, as far as Lake Winnipegosis.

In Ontario, the Sioux Lookout Forest District remains only preliminarily visited and forms the only area of any size in northwestern Ontario to which the Survey has not been fully extended.

The work would cost approximately $250.00 and possibly much less.

PROVINCE OF ONTARIO

Ontario Forest Branch

Port Arthur District

District Forester: F. Dawson (Forestry Corps)

1. **Thunder Bay Fire Division**

Chief Fire Ranger: M. Sauerbrei
Office Assistant: J. Chisholm (C.N.R.)
Deputy Chief Fire Ranger (Sauerbrei Lake) A. Oresky
" " " " (Murkett) T. Dowell
" " " " (Garden Lake) C. Hornick
Fire Ranger: B. Strangee

Deputy Chief Fire Ranger (Savanne) P. Girard
" " " " (Northern Light Lake) Craig

2. **Nipigon Fire Division**

Chief Fire Ranger: J. P. Legris
Deputy Chief Fire Ranger: A. Jacobson
Fire Ranger: J. Reb
" " : C. Dubis
Pilot: R. Ross
Boat Captain: J. Nicholson
Boat Engineer: K. Greenshields
Radio Operator: F. MacCormack
Clerk: S. Hilbert
Nipigon River Patrol: A.S.E. Bouchard
E. Bouchard
Deputy Chief Fire Ranger (Jackfish Island) C. Longila
Fire Ranger (Jackfish Island) J. Bruchette
R. Lemieux
Fire Ranger (Chief Bay) O. Mendelin
" " (" ") K. Danielson
" " (" ") R. Riddell
Boat Captain: E. Chisholm
Boat Engineer: W. Greenshields
Deputy Chief Fire Ranger: (Beardmore) J. Latreille

3. **Pays Plat Fire Division**

Chief Fire Ranger: H. Bishop
Pilot: C. MacIntyre
Air Engineer: J. Kincaid
Boat Captain: W. Chisholm
Boat Engineer: R. Caron

3. Pays Plat Fire Division (Cont'd)

Radio Operators: B. Bell, C. Weddell
Deputy Chief Fire Ranger: J. Turner
Clerk: D. Dasey
Truck Driver: M. Otway
Pumpman: F. Polino
Fire Ranger: N. Cunningham
Deputy Chief Fire Ranger (Peninsula) J. McMartin
Fire Ranger (Peninsula) W. Ballard

4. Longlac Fire Division

Chief Fire Ranger: V. Mawn
Deputy Chief Fire Ranger: J. Jarvis
Ranger: J. Ritchie
Boat Captain: S. Grasser
Towerman: C. Tomlinson
Clerk: W. Wilson
Deputy Chief Fire Ranger (Jellicoe) A. Killick
Fire Ranger (Jellicoe) J. Fleming
Deputy Chief Fire Ranger (Geraldton) E. Ward

5. Other O.F.B. Personnel (Not in Thunder Bay District)

Deputy Chief Fire Ranger: S.W. Burk, Hillsport (Kapuskasing)
Deputy Chief Fire Ranger: G. Burns, White River (Sault Ste. Marie)
Deputy Chief Fire Ranger: G. McCuaig, Heron Bay (Sault Ste. Marie)
Fire Ranger: J. Kenneguisser) Heron Bay
Fire Ranger: B. Thorsteinson) (Sault Ste. Marie)

Private Corporations

1. Abitibi (Thunder Bay) Pulp & Paper Company, Port Arthur.

J. Auden - Woods Manager)
W. Christie - Assistant Woods Manager) Port Arthur
W. Stevens - Chief of Control
G. M. Stewart - Superintendent of Control Hydro
W. Knight - Drive Foreman "
F. Hicks - Forester Port Arthur

2. Cowan & Faber, Foresters, Jobbers, Timberland Agents.

W. O. Faber

3. Don A. Clarke & Co., Timber Contractors, Port Arthur.

Don A. Clarke, Prop.

4. C. W. Cox & Co., Timber Contractors, Port Arthur.

C. W. Cox, Prop. (Mayor of Port Arthur)
C. Hines, Supervisory Foreman)
M. Bezugloy, Bush Foreman) Helen Lake Camps

5. C. Gardner & Co., Timber Contractors, Port Arthur.

C. Gardner, Prop.

6. General Timber Co., Contractors, Operators, Supply, Port Arthur.

A. L. Johnson, Vice-President, Port Arthur.
J. Gowan, Woods Superintendent) Peninsula
L. Sorenson, Forester)

7. Great Lakes Paper Company, Port William.

B. Avery, Woods Manager, Port William.
B. Southam, Assistant Woods Manager, Port William.
E. Burk, Forest Engineer, Port William.
R. Silversides, Forester, Port William.
P. Ward, Cruiser, Port William.

8. Hammermill Paper Company, Port Arthur.

M. Cochrane, Manager, Port Arthur.

9. Ontario Paper Company, Heron Bay.

J. Davis, Resident Manager, Heron Bay.
R. Botham, Woods Superintendent, Depot.
H. Baird, Forester, Depot.
Messrs. Frapier, Priddle, Dundas, Madge & Hoper.

10. Pigeon Timber Company, Port William.

E. Hunt, General Manager, Port William.
O. Nordlander, Woods Superintendent, Neys.

11. Provincial Paper Company, Port Arthur.

A. O. Pounsford, General Manager, Port Arthur.
W. Johnson, Mill Superintendent, Port Arthur.
J. C. MacLeod, Woods Superintendent, Port Arthur.
Andrews, Assistant Woods Superintendent, Port Arthur.
D. White, Purchasing Agent, Port Arthur.
E. Beatty, Assistant Purchasing Agent and Cruiser
J. MacLeod, Cruiser

12. Pulpwood Supply Company, Longlac.

W. McNutt, Resident Manager, Longlac.

13. O. Styffe & Co., Pulpwood Contractors, Port Arthur.

O. Styffe, Director
H. Styffe, Manager
P. Peterson, Woods Superintendent

14. Lake Sulphite Company, Nipigon.

K. Sjolander

PROVINCE OF MANITOBA

Manitoba Forest Service

1. Eastern Forest District

Wilson)
Mitchell) Chief Rangers, Lac du Bonnet.
C. Malaher, Chief Ranger, Rennie.

2. Southern Forest District

J. Vicars, Chief Ranger, Boissevain
(Turtle Mountain Forest Reserve).
W. Wardrop, Chief Ranger, Marchand.
J. Kokandovich, Ranger, Woodridge
(Manitoba Forest Service).

3. Western Forest District

District Forester: J. C. Somers, Dauphin.
Forest Engineer: A. W. Brain, "
Chief Ranger: E. Koons, Swan River.
Rangers: B. Gilmore, Bield.
C. Dunlop, Deepdale.
W. Mawdsley, Durban.
R. Adams, Birch River.

3. Western Forest District (Cont'd)

Rangers: J. Thompson, Mafeking.
F. Imrie, Barrows.
W. Shiels, Minitonas. (retired)
E. Warner, Garland.
H. Clee, Grandview.

Private Corporations

Manitoba Paper Company, Pine Falls.

A. MacKenzie, Woods Manager
R. Rigg, Chief of Control
Clarke, Superintendent of Control
G. Bayley, Cruiser

Individuals	Tenure*	Organization	Address
Adams, R.	S	Man. For. Service	Birch River, Man.
Andrews	P	Provincial Paper Company	Port Arthur, Ont.
Auden, J.	E	Abitibi Pulp & Paper Co.	Port Arthur, Ont.
Avery, B.	E	Great Lakes Paper Company	Ft. William, Ont.
Baird, H.	P	Ont. Paper Co.	Heron Bay, Ont.
Ballard, W.	S	Ont. For. Branch	Peninsula, Ont. (summer)
Bayley, G.	P	Man. Paper Co.	Pine Falls, Man.
Beatty, E.	P	Provincial Paper Company	Port Arthur, Ont.
Bell, B.	S	Ont. For. Branch	Port Arthur, Ont.
Bezuglay, M.	S	C.W. Cox & Co.	Port Arthur, Ont.
Bishop, H.	P	Ont. For. Branch	Pays Plat, Ont.
Botham, R.	P.	Ont. Paper Co.	Heron Bay, Ont.
Bouchard, E.	S	Ont. For. Branch	MacDiarmid, Ont.
Bouchard, A.J.E.	S	Ont. For. Branch	MacDiarmid, Ont.
Brain, A.W.	P	Man. For. Service	Dauphin, Man.
Bruchette, J.	S	Ont. For. Branch	Jackfish Island, Ont. (summer)
Burk, E.	E	Great Lakes Paper Company	Ft. William, Ont.
Burk, S.W.	S	Ont. For. Branch	Hillsport, Ont.
Burns, G.	S	Ont. For. Branch	White River, Ont.
Caron, R.	S	Ont. For. Branch	Pays Plat, Ont.
Chisholm, J.	on leave	Ont. For. Branch	Port Arthur, Ont.
Chisholm, W.	S	Ont. For. Branch	Pays Plat, Ont.
Chisholm, E.	S	Ont. For. Branch	Jackfish Is., Ont.
Christie, W.	E	Abitibi Pulp & Paper Co.	Port Arthur, Ont.
Clarke	P	Man. Paper Co.	Pine Falls, Man.
Clarke, D.A.	E	Don A. Clarke & Company	Port Arthur, Ont.
Clee, H.	P	Man. For. Service	Minitonas (Grandview), Man.
Cochrane, M.	E	Hammermill Paper Company	Port Arthur, Ont.
Cox, C.W.	E	C.W. Cox & Co.	Port Arthur, Ont.
Craig	S	Ont. For. Branch	Northern Lights Lake, Ont.
Cunningham, N.	S	Ont. For. Branch	Pays Plat, Ont.
Danielson, K.	S	Ont. For. Branch	c/o Jackfish Is., Ontario.

Individuals	Tenure*	Organization	Address
Dasey, D.	S	Ont. For. Branch	Pays Plat, Ont.
Davis, J.	E	Ont. Paper Co.	Heron Bay, Ont.
Dawson, F.	E	Ont. For. Branch	Port Arthur, Ont.
Dowell, T.	S	Ont. For. Branch	Hurkett, Ont.
Dubis, C.	S	Ont. For. Branch	MacDiarmid, Ont.
Dundas	S	Ont. Paper Co.	Heron Bay, Ont.
Dunlop, C.	P	Man. For. Service	Deepdale, Man.
Faber, W.O.	E	Faber & Cowan	Port Arthur, Ont.
Fleming, J.	S	Ont. For. Branch	Jellicoe, Ont.
Folino, F.	S	Ont. For. Branch	Pays Plat, Ont.
Frapier	S	Ont. Paper Co.	Heron Bay, Ont.
Gardner, C.	E	C. Gardner & Co.	Public Utilities Bldg., Port Arthur.
Gilmore, B.	P	Man. For. Service	Bield, Man.
Girard, F.	S	Ont. For. Branch	Savanne, Ont.
Gowan, J.	E	General Timber Co.	Peninsula, Ont. (summer)
Grasser, S.	S	Ont. For. Branch	Longlac, Ont.
Greenshields, K.	S	Ont. For. Branch	MacDiarmid, Ont. (summer)
Greenshields, W.	S	Ont. For. Branch	Jackfish Is., Ont. (summer)
Gresky, A.	S	Ont. For. Branch	Sauerbrei Lake, Ont. (summer)
Hicks, F.	P	Abitibi Pulp & Paper Co.	Port Arthur, Ont.
Hilbert, S.	S	Ont. For. Branch	MacDiarmid, Ont. (summer)
Hines, G.	P.S.	C.W. Cox & Co.	Port Arthur, Ont.
Hornick, G.	S	Ont. For. Branch	Garden Lake, Ont.
Hunt, E.	E	Pigeon Timber Co.	Ft. William, Ont.
Imrie, F.	S	Man. For. Service	Barrows, Man.
Jacobson, A.	S	Ont. For. Branch	MacDiarmid, Ont.
Jarvis, J.	S	Ont. For. Branch	Longlac, Ont.
Johnson, A.L.	E	General Timber Co.	Port Arthur, Ont.
Johnson	E	Provincial Paper Company	Port Arthur, Ont.
Kenneguisser, J.	S	Ont. For. Branch	Heron Bay, Ont.
Killick, A.	S	Ont. For. Branch	Jellicoe, Ont.
Kincaid, J.	P	Provincial Air Service	Pays Plat, Ont. (summer)
Knight, W.	S	Abitibi Pulp & Paper Co.	Port Arthur, Ont.
Kokandovich, J.	P	Man. For. Service	Woodridge, Man.
Koons, E.	P	Man. For. Service	Swan River, Man.

Individuals	Tenure*	Organization	Address
Latreille, J.	S?	Ont. For. Branch	Beardmore, Ont.
Legris, J.	P	Ont. For. Branch	MacDiarmid, Ont.
Lemieux, R.	S	Ont. For. Branch	Jackfish Is., Ont. (summer)
Longila, C.	S	Ont. For. Branch	Jackfish Is., Ont. (summer)
MacCormack, P.	S	Ont. For. Branch	MacDiarmid, Ont.
McCuaig, C.	S	Ont. For. Branch	Heron Bay, Ont.
MacIntyre, C.	P	Provincial Air Service	Pays Plat, Ont. (summer)
MacKenzie, A.	E	Man. Paper Co.	Pine Falls, Man.
MacLeod, J.C.	E	Provincial Paper Company	Port Arthur, Ont.
MacLeod, J.	?	Provincial Paper Company	Port Arthur, Ont.
McMartin, J.	S	Ont. For. Branch	Peninsula, Ont.
McNutt, W.	E	Pulpwood Supply Co.	Longlac, Ont.
Madge	S	Ont. Paper Co.	Heron Bay, Ont. (summer)
Malsher, G.	P	Man. Forest Service	Rennie, Man.
Marner, E.	P	Man. Forest Service	Garland, Man.
Mawdsley, W.	P	Man. Forest Service	Durban, Man.
Mann, J.	P	Ont. For. Branch	Longlac, Ont.
Mendelin, O.	S	Ont. For. Branch	c/o Jackfish Is., Ont. (summer)
Mitchell	P	Man. Forest Service	Lac du Bonnet, Man.
Nicholson, J.	S	Ont. For. Branch	MacDiarmid, Ont.
Nordlander, O.	E	Pigeon Timber Co.	Heys, Ont.
Otway, M.	S	Ont. For. Branch	Pays Plat, Ont.
Peterson, P.	P	O. Styffe & Co.	Port Arthur, Ont.
Pounsford, A.G.	E	Provincial Paper Company	Port Arthur, Ont.
Priddle	S	Ontario Paper Co.	Heron Bay, Ont.
Rab, J.	S	Ont. For. Branch	MacDiarmid, Ont.
Riddle, R.	S	Ont. For. Branch	c/o Jackfish Is., Ontario.
Rigg, R.	P	Man. Paper Co.	Pine Falls, Man.
Ritchie, J.	S	Ont. For. Branch	Longlac, Ont. (summer)
Roper	S	Ont. Paper Co.	Heron Bay, Ont.
Ross, H.	P	Provincial Air Service	MacDiarmid, Ont. (summer)
Sauerbrei, M.	P	Ont. For. Branch	Port Arthur, Ont.
Shiels, W.	Retired	Man. For. Service	Minitonas, Man.
Silversides, R.	P	Great Lakes Paper Company	Ft. William, Ont.
Sjolander, K.	?	Lake Sulphite Co.	Nipigon, Ont.

Individuals	Tenure*	Organization	Address
Somers, J.C.	E	Man. For. Service	Dauphin, Man.
Sorenson, L.	P	General Timber Co.	Peninsula, Ont. (summer)
Southam, B.	E	Great Lakes Paper Company	Ft. William, Ont.
Stevens	P	Abitibi Pulp & Paper Co.	Port Arthur, Ont.
Stewart, C.M.	P	Abitibi Pulp & Paper Co.	Hydro, Ont. (summer)
Stranges, B.	S	Ont. For. Branch	Carden Lake, Ont. (summer)
Styffe, O.	E	O. Styffe & Co.	Port Arthur, Ont.
Styffe, H.	E	O. Styffe & Co.	Port Arthur, Ont.
Thompson, J.	P	Man. For. Service	Mafeking, Man.
Thorsteinson, B.	S	Ont. For. Branch	Heron Bay, Ont. (summer)
Tomlinson, C.	S	Ont. For. Branch	Longlac, Ont. (summer)
Turner, J.	S	Ont. For. Branch	Pays Plat, Ont. (summer)
Vicars, J.	P	Man. For. Service	Boissevain, Man.
Ward, P.	P	Great Lakes Paper Company	Ft. William, Ont.
Ward, E.	S.P.	Ont. For. Branch	Geraldton, Ont.
Wardrop	P	Man. For. Service	Marchand, Man.
Weddell, C.	S	Ont. For. Branch	Pays Plat, Ont. (summer)
White, D.	P	Provincial Paper Company	Port Arthur, Ont.
Wilson, W.	S	Ont. For. Branch	Longlac, Ont. (summer)
Wilson	P	Man. For. Service	Lac du Bonnet, Man.

*The column "Tenure" is included due to the probability of high turnover in employment of these men under present conditions of labor. It is likely that completely fresh personnel may become located in areas this coming season.

S = Seasonal
? = Unknown
P = Permanent
E = Executive

A. Forest Insect Reconnaissance Sioux Lookout Forest District, Ontario.

1. Introductory Statement

Work undertaken in this district extends the reconnaissance and personnel contact project into the second last area within the Winnipeg Laboratory territory. At the present time, the Eastern Forest District of Manitoba remains uncovered.

2. Ontario Forestry Branch

a. Sioux Lookout District and Subdivisions

This forest district extends from the Manitoba boundary on the west, easterly to an imaginary north-south line passing through Tashota. The actual area varies somewhat from season to season, being subject to annual revision.

The district is divided into four fire divisions: Sioux Lookout, Red Lake, Lake St. Joseph, and Armstrong.

b. Organisation of Personnel

Until August, 1941, personnel was in charge of a District Forester whose responsibility was to the Toronto office. This arrangement was changed in such a manner that several district foresters are responsible to a Regional Forester, who is in turn responsible to Toronto. This arrangement places more responsibility on less men and provides greater agreement and flexibility.

Within the territory of the Winnipeg Laboratory, the districts of Sioux Lookout, Fort Frances, and Kenora are lumped into one Region; while that of Thunder Bay constitutes a Region unto itself.

The position of District Forester is retained, for each district, and, as formerly, he is assisted by a Crown Timber Officer and by Chief Fire Rangers for each fire division. The latter are assisted by Deputies in charge of Rangers, including pumpmen, gascar men, etc.

Aerial transport is furnished on requisition by the Provincial Air Service, planes being located at Sioux Lookout, Red Lake, Pickle Lake and Armstrong. It is expected that a plane will be stationed on Lake St. Joseph during 1942.

c. Personnel Contacted

The District Forester, J. B. Matthews (now Regional Forester, Thunder Bay District), was visited and, with K. Acheson, his successor, a plan was made for contacting crews in all Fire Divisions.

Before outlining the routes taken in this connection, a list of contacts will be given:

(i) Sioux Lookout District Office

J. B. Matthews, District Forester
(under transfer)
K. Acheson, Successor
D. Love, Crown Lands
Jackson, Clerk

(ii) Sioux Lookout Fire Division

G. Eady, Chief Fire Ranger
R. Hamilton, Deputy, Watcomb
J. Johnson, Ranger, Watcomb
W. Bell, Gascar operator, Sioux Lookout
R. Duff, Ranger, Sioux Lookout

(iii) Red Lake Fire Division

R. Taylor, Chief Fire Ranger
C. Florence, Deputy
J. Jackson, Clerk
R. Williams, Ranger
H. Husick, Ranger
Harper, Ranger
I. Keesic, Ranger
J. Rorke, Deputy, Lost Bay (Uchi Lake)
R. Coltron, Ranger, Lost Bay (Uchi Lake)
A. Burrow, Ranger, Lost Bay (Uchi Lake)
G. Cartier, Deputy, Swain's Lake
R. Berglund, Ranger, Swain's Lake

(iv) Lake St. Joseph Fire Division

V. Johnson, Deputy, Root Bay
G. Guertin, Deputy, Central Patricia (Pickle Lake)
O. Pentznick, Radio Operator, Root Bay
Freedman, Radio Operator, Central Patricia
J. Tait, Ranger, Root Bay
J. Wilson, Ranger, Root Bay
I. Keesic, Ranger, Root Bay

(v) Armstrong Fire Division

J. Ruxton, Chief Fire Ranger
C. Belmore, Senior Ranger
R. Swanson, Ranger
T. Belmore, Ranger
R. Bannister, Towerman
J. Bilski, Gascar operator
J. Wynd, Clerk
R. McNamara, Deputy, Savant Lake
J. Lawrence, Ranger, Savant Lake
T. Laird, Towerman, Savant Lake
K. Eckholm, Deputy, Sturgeon Lake
W. Lea, Ranger, Sturgeon Lake
W. Davidson, Ranger, Tashota (Robinson Lake)

W. Anderson, Deputy, Waboose Falls, Ogoki River
D. Drake, Ranger, Waboose Falls, Ogoki River
G. Oliver, Ranger, Linklater Lake
W. Payles, Deputy, Caribou Lake
D. McMillan, Ranger, Jacobs (Fee's Spur)

In addition to the above members of the Ontario Forestry Branch, the following members of the Provincial Air Service were met in the course of events.

V. Gillard, in charge, Sioux Lookout District
G. Trussler, Pilot, Sioux Lookout
R. Parsons, Pilot, Red Lake
L. Pullin, Pilot, Central Patricia (Pickle Lake)
D. McDonald, Pilot, Armstrong, (Caribou Lake)
L. Fayles, Mechanic, Sioux Lookout
T. Mason, Mechanic, Sioux Lookout
W. Davidson, Mechanic, Red Lake
P. Farr, Mechanic, Pickle Lake
G. Robinson, Mechanic, Caribou Lake

3. General

a. Accommodation and Communication

In Sioux Lookout, there is a Railway Y.M.C.A. The Ontario Forestry Branch generously extend bunkhouse facilities wherever desired, and along the railway hotels are to be found in the more important points, as Savant Lake. Hotels are also located at Red Lake and Pickle Lake.

Communication is achieved by air mail, forestry radio, and C.N.R. telegraph.

b. Transportation

Aerial transportation is provided by the Provincial Air Service, on requisition by the Ontario Forestry Branch. In this District, one is required to sign a release. It is essential that a definite flying

program be laid down before commencement of work, this program to be defined by the District Forester who will requisition such time as needed. Otherwise, the Department might be billed for such service.

The following is a list of flights made in pursuance of the work: (See Province of Ontario, Surveys Branch, Maps 23A and 24A)

(i) August 14th. From Sioux Lookout, northwest to the south shore of Lac Seul, thence west to the point where the Route River enters Lac Seul, thence south to halfway down Route Lake and west across the south half of Thaddeus Lake to Cedar Lake, thence south to centre of Mafeking Township and east across Gullwing Lake, cutting the highway at the south end of Pickerel Arm, thence north north east up Abram Lake to Sioux Lookout.

(ii) August 15th. (a) From Sioux Lookout northwesterly across the northeast corner of Indian Reserve 28 crossing Lac Seul at the narrow portion, thence angling across the western tip of Wapesi Lake to turn north and proceed to Whitemud River and north north west through the middle of Slate Lake and the middle of Barngey Township to Lost Bay Ranger Station.

(b) Lost Bay west to the south half of Joyce Lake, crossing the north half of Little Trout Lake and the middle of Ranger Lake to the Red Lake Ranger Station (directly south of the mid-point of Mackenzie Island).

(iii) August 16th. (a) Red Lake Ranger Station to townsite, thence east over Ranger, Little Trout and Joyce Lakes, northwest to Swain's Lake (northeast corner of Goodall township).

(b) Swain's Lake southeasterly to Lost Bay.

(c) Lost Bay, east south east to Jeanette Lake, angling towards Root Bay at the western end of Lake St. Joseph.

(iv) August 18th. Root River northeast across Lake St. Joseph to Pembina River, angling east north east over Carpenter Lake, south of Sky Lake and bearing towards Little Ochig Lake, thence north north east between Ochig Lake and the Transmission line of the Hydroelectric system running from Rat Rapids to Pickle Lake.

(v) August 19th. Pickle Lake south to Rat Rapids, angling so that plane passed directly over Osnaburgh House on Lake St. Joseph, thence south south west across Hughes Lake, across the western portion of Pashkokogan Lake and the extreme southwestern half of McCrea Lake, the west halves of Jabez, Neverfreeze, Elwood and Whimbrel Lakes to Stillar Bay, Savant Lake.

(vi) August 20th. (a) From Savant Lake south south west across Harold Lake to the north arm of Sturgeon Lake, landing near St. Anthony Mine.

(b) East from St. Anthony Mine over the east arm of Sturgeon Lake, north thirds of Vanessa and Sesagaganaga Lakes, the south ends of Antler and Aldridge Lakes, thence angling east north east to McKenzie Lake.

(c) McKenzie Lake north to Caribou Lake.

(vii) August 22nd. (a) Caribou Lake south to McKenzie Lake, east south east to Mt. St. John, across Lake Nipigon to Brittania Islands, south east to Ombabika Island, thence north east along Ombabika River to Robinson Lake.

(b) Robinson Lake northwest to Goode Lake, bisecting it in a northwest to southeasterly manner, thence north to the Height of Land and angling towards Tape Lake, north to Waboose Rapids on the Ogoki River.

(c) Waboose Rapids south west to median half of Mojikit Lake, skirting Snake Lake on the north shore, crossing Cliff Lake on its southern third and thence to north end of Linklater Lake.

(d) Linklater Lake south west to Caribou Lake and returning to Ranger Station and Air Base.

c. District Description

The District exhibits a certain amount of topographical and ecological variation in its various sections .

(i) Topography. Within the area of the Sioux Lookout, Savant Lake, and Sturgeon Lake triangle, the land is rough and rolling, with numerous lakes. The surface was strongly glaciated. Apparently, Lake Agassiz had no influence upon it, since glacial deposits are few, the soils being thin with occasional morainic ridges and much exposure of the Precambrian rock.

The Red Lake, Uchi Lake and Pickle Lake areas also possess thin soil-cover and are characterized by poor drainage conditions.

The rectangular area embracing Lake St. Joseph--Ogoki River--, Armstrong and Tashota, encloses a fairly level area characterized by extensive sand and gravel deposits, by low Precambrian outcrops and shallow, swampy depressions.

The area about Armstrong and the northern shores of, especially that to the east of, Lake Nipigon, is somewhat similar but rather more rolling, at the same time being low except for the occurrence here and there of dykes of diabase trap rock which remained uneroded by glaciation and sometimes attain a height of 400 feet above lake level. Glaciation laid down considerable areas of fine clay and sand, occupying large areas of the shoreline and extending up the river valleys. These deposits had their origin in Lakes Warren or Algonquin, the area being laid down under one of their arms.

(ii) Forest Types. The topography and drainage conditions have had considerable effect upon forest associations, but the inter-gradations are innumerable, due to modifications of topography in localized areas.

In the area containing Sioux Lookout, Savant Lake, Sturgeon Lake, Red Lake, Uchi Lake and Pickle Lake, the chief species are Jack pine and black spruce. The low, poorly drained areas predominate in poorly developed black spruce, mixed with Jack pine, on the drier,and tamarack on the wetter sites. Extensive fires in the northwestern parts of the area have aggravated the thin-soil conditions and have favoured the spread of Jack pine. On the deeper soils along lake shores and up the river valleys, white spruce, balsam fir, white birch, aspen and black poplar occur, forming stands of good growth. White birch is general, usually intimately associated with aspen. About Sioux Lookout and north to Lake St. Joseph, the occasional small group of red and sometimes white pine may be found. This is the limit of their ranges. However, cabins on Lake St. Joseph contain red pine logs of 20 inches and over in diameter, so their growth is by no means stunted by the latitude, although of course they may be very old.

White cedar is occasionally seen in most parts of the area.

d. Insect Conditions

(i) Jack pine Budworm. Jack pine is distributed on two chief types of sites--rocky ridges and sandy plains--although found in admixture with other species on the heavier soils.

Where seen, budworm activity was very light, and the species is probably endemic at points such as Red Lake, Sioux Lookout, Pickle Lake and Savant Lake, where individuals were recovered from tree beatings. At Yonde, and between miles 145 and 146 on the C.N.R. south line from Sioux Lookout to Port Arthur, evidence of slight feeding appeared. This latter area apparently suffered from the more general attack of 1939, since top-kill remains, in some cases as much as 2 feet of it. Total damage would be about 1%. In this connection, the ranger at Watcomb, R. Hamilton, reports that he noted from the air in 1939 that small areas of very brown Jack pine lay between Zarn Lake and the railroad. It is probable that the condition mentioned above may extend over a considerable area.

At Watcomb, on the same branch line, 1941 feeding was scattered but intense. Actual defoliation on affected trees (new growth) would amount to about 1/4.

Other evidence of 1939 damage was observed on a ridge running northwesterly-southeasterly to the west of Trout Lake. Here a mortality estimated at 20% remains.

Along the C.N.R. west of Armstrong, the budworm becomes evident about 1/4 mile west of Jacobs and extends west to Harvey. Feeding has been very intense but is scattered over a considerable area. There is ample evidence that in 1939 and 1940 the trees were severely defoliated, as much as 75% in many instances, judging by present thinness of crowns. Particularly intense feeding occurred, apparently in 1940, producing very thin crowns on the trees between Jacobs and Cameole. Curiously, no top-kill whatsoever was in evidence and no mortality was noted. This area may be the northern limit of the infestation centering about Graham to the south. This fits the observation of J. Ruxton, Chief Fire Ranger, Armstrong, who noted from the air in 1940 that considerable redness of Jack pine was to be seen to the southernmost limits of his district, extending northwards to the railway.

Some slight top-kill was in evidence on Jack pine in association with black spruce near Root Bay, Lake St. Joseph.

(ii). European Larch Sawfly. Tamarack is not very widely or extensively distributed so as to be access-

ible to Ranger Stations.

Evidence of oviposition by Pristiphora was noted at Pickle Lake, Savant Lake and Waboose Rapids on the Ogoki River. A few actively feeding larvae were recovered from trees examined in 1939 by H.A. Richmond on the west arm of Caribou Lake, north of Armstrong. The infestation at that time was found quite heavy but at the present time is quite light and no mortality has resulted.

The most extensive and severe centre of sawfly attack begins along the C.N.R. about 3/4 mile east of Ogaki, extending to Jacobs, and in patches reaching as far as Allanwater. Greatest damage has been done in the vicinity of Ogaki and Fee's Spur and about the Ontario Forestry Branch tower at Jacobs. Apparently the attack extends deeply north and south of the railway, and some top-kill is appearing. This damage was first observed in 1939 by J. Ruxton, Chief Fire Ranger. Some 'control' by mice is operative, as "moused" cocoons bore evidence. A few cocoons showed emergence holes, presumably those of chalcids.

(iii) Birch Leaf Skeletoniser. The infestation of birch by this pest was almost total in the areas seen. By aerial observation, birches were seen to be affected as far as the eye could see, in the vicinity of the

following points: Sioux Lookout, Red Lake, Swain's Lake, Lost Bay, Lake St. Joseph, Pickle Lake, Savant Lake, Sturgeon Lake, McKenzie Lake, Caribou Lake, Linklater Lake, Robinson Lake, Ogoki River. Canadian Airways pilots report that it extends to, and is more intense, 250 miles north of Pickle Lake.

As far as personal observation showed (and subsequent Departmental reports gave all eastern Canada to be affected), the infestation thinned out and became very scarce east of Tashota and northwesterly to the Ogoki River, that is, east of a line drawn joining these two points. The infestation was evident as far west as the Manitoba boundary, along the railroad.

In these infestations, the birch stands out reddish- or orange-brown against the clear green aspen with which it is intimately associated. The centre of infestation would be about Lake St. Joseph and its islands, extending north for a great distance, as noted above. The leaves in places were affected to such an extent that it was almost impossible to find a healthy one; even the coppice growth near ground-level was severely attacked.

A certain amount of natural control other than parasitism would appear to have been operative, since, wherever beatings were undertaken, large numbers of spiders were shaken down, as well as Pentatomids

and Coccinellids.

(iv) Bronze Birch Borer. Agrilus work is evident wherever birch was approached on the ground. On both sides of the highway linking Sioux Lookout with the Trans-Canada, the damage is very serious; at least 75% of trees seen were dead and the tops had blown off some seasons previously. Branchless stubs up to 30 feet or more in height abound. There is also much top-kill of living trees, and those with their upper halves dead are common.

At the Red Lake Ranger Station, most of the birch about the buildings are affected, chiefly because the ground has been cleared and, being on a point of land exposed to strong winds, their susceptibility is likely high.

The chief danger to birch from this insect resolves itself around the potential increase of it as a result of the severe setback birch must have received by foliage loss from the birch leaf skeletonizer.

Agrilus was noted also at Watcomb Ranger Station, at Lost Bay, and at Savant Lake, where it was common and injurious, causing top-kill.

(v) Other species. Where tree beating was possible, it was undertaken, and the following is a list of recoveries:

PLACE	BOX NO.	HOST	SPECIES	FAMILY	RECORD NO.
Red Lake	67719	Black Spruce	(Tortricidae sp.)*, Eupithecia sp., Podisus serieventris Uhl.	Geometridae Pentatomidae	310
Red Lake	67720	Balsam	Argyrotaenia occultana Frmn., Protoboarmia porcelaria Gn., Palthis angulalis Hbn., (Tortricidae sp.)*, Ellopia fiscellaria Gn., Cleis picta Rand., Hellamira scalaris Say, Agrilus anxius Gory, Neodiprion abietis Harris, (Chalcidae sp.--ex.N.abietis Harr.).	Tortricidae Geometridae Phalaenidae Geometridae Chrysomelidae Cerambycidae Cerambycidae Tenthredinidae	306
Red Lake	67721	-----	Arachnida sp.	----------	---
Red Lake	67722	Black Spruce	(Geometridae sp.)*, (Tortricidae sp.)*, (Lepidoptera sp.)*, Pikonema alaskensis Roh., Cacoecia fumiferana Clem.	 Tenthredinidae Tortricidae	309
Red Lake	67725	White Birch	Croesus latitarsus Nort., Corythuca sp., Bucculatrix canadensisella Cham., Unknown leaf miners.	Tenthredinidae Tingidae Lyonettiidae	308
Red Lake	67726	Jack pine	(Tortricidae sp.)*, (Coleoptera sp.)*, Lucidota corrusca L., Cleis picta Rand.	 Lampyridae Chrysomelidae	307
Lake St. Joseph	67559	White Birch	Bucculatrix canadensisella Chamb., (Aphidae sp.)*	Lyonettiidae	325

* Classification already designated by enclosure within brackets.

PLACE	BOX NO.	HOST	SPECIES	FAMILY	RECORD NO.
Lake St. Joseph	67562	White Birch	Bucculatrix canadensisella Chamb.,	Lyonettiidae	326
			Tropaea luna Linn.	Saturniidae	
Lake St. Joseph	67616	Larch	Olene plagiata Wlk.,	Liparidae	324
			Semiothisa sexmaculata Pack.,	Geometridae	
			Semiothisa granitata Gn.,	Geometridae	
			(Geometridae sp.)*,		
			Protoboarmia porcelaria Gn.,	Geometridae	
			Anoplonyx laricis Marl.	Geometridae	
Pickle Lake	67565	White Birch	Bucculatrix canadensisella Chamb.,	Lyonettiidae	339
			(Tenthredinidae sp.)*,		
			Acronicta innotata Grt.,	Phalaenidae	
			(Geometridae sp.)*.		
Pickle Lake	67617	White Spruce	Cacoecia fumiferana Clem.,	Tortricidae	338
			Chrysomyxa sp.,	(Fungus)	
			Eupithecia sp.	Geometridae	
Savant Lake	67563	Aspen	Pontania bozemani Cooley,	Tenthredinidae	327
			(Tortricidae sp.)*,		
			Meroptera pravella Grt.	Pyralidae	
Sturgeon Lake	67566	Balsam	Ellopia fiscellaria Gn.,	Geometridae	336
			(Tortricidae sp.)*,		
			(Phalaenidae sp.)*.		
Sturgeon Lake	67618	White Spruce	Ellopia fiscellaria Gn.,	Geometridae	340
			Camponotus pennsylvanicus de G.,	Formicidae	
			Protoboarmia porcelaria indicatoria Wlk.,	Geometridae	
			Physokermes piceae Schr.,	Coccidae	
			(Lepidoptera sp.)*.		
Armstrong	17251	Black Spruce	Pikonema alaskensis Roh.,	Tenthredinidae	334
			Pikonema dimmockii Cress.,	Tenthredinidae	
			Semiothisa granitata Gn.	Geometridae	

* Classification already designated by enclosure within brackets.

PLACE	BOX NO.	HOST	SPECIES	FAMILY	RECORD NO.
Armstrong	67573	Larch	Anoplonyx laricis Marl., Semiothisa sp.	Tenthredinidae Geometridae	347
Caribou Lake	67624	Poplar	Chrysomela tremulae Fab., Pontania sp., (Hemiptera sp.)*, Calligrapha sp., Pemphigus rileyi Steb., Eplstrophe sp., (Ichneumonidae sp.)*.	Chrysomelidae Tenthredinidae Chrysomelidae Aphidae Syrphidae	342
Caribou Lake	67625	Larch	Pristiphora erichsonii Htg., Anoplonyx laricis Marl., Semiothisa sexmaculata Pack., Protoboarmia porcelaria On., (Hemiptera sp.)*, (Lepidoptera sp.)*.	Tenthredinidae Tenthredinidae Geometridae Geometridae	343
Tashota	67571	Larch	Anoplonyx laricis Marl., (Geometridae sp.)*, Semiothisa granitata On.	Tenthredinidae Geometridae	349
Tashota	67622	Black Spruce	Pikonema dimmockii Cress., Ellopia fiscellaria On.	Tenthredinidae Geometridae	350
Waboose Falls	67623	White Spruce	Semiothisa granitata On., Chrysomyxa sp.	Geometridae (Fungus)	352
Winklater Lake	67572	White Spruce	Pikonema alaskensis Roh.	Tenthredinidae	348
Jacobs (Tower)	67574	Larch	Pristiphora erichsonii Htg.	Tenthredinidae	351

* Classification already designated by enclosure within brackets.

In the vicinity of Watcomb Ranger Station, quite a number of aspen were found heavily attacked by round-headed borers, presumably Saperda. The trunks of the trees were black and oily, as though wiped over by a creosoted brush. Masses of frass were hanging about the exposed wounds.

No signs of forest tent caterpillar were noted, but a few historic facts concerning the insect were gathered. According to J. Johnson, Ranger in the Watcomb area, an exceedingly heavy attack occurred in 1936, egg masses being very common. In 1937, many of these were found not to have hatched, the spring being cold and wet. The outbreak accordingly subsided. He quoted an old trapper who had spent 30 years in the Sturgeon Lake area, who, in connection with this pest, said that in the early days it occurred in small local epidemics but never became extensive. However, huge fires swept over the area in 1916 and large areas succeeded as hardwoods, chiefly aspen. This had made an excellent nutritional environment for the forest tent caterpillar.

V. Johnson, Lake St. Joseph, reported that the forest tent caterpillar was present in enormous numbers in 1939, and previously in 1936. In the Savant Lake area, R. McNamara reports that the pest was epidemic between 1937 and 1939.

4. Summary

a. Personnel contacted.

The senior officers and field staff of the Ontario Forestry Branch in the Sioux Lookout Forest Division, comprising 6 executive and 30 staff individuals, were contacted between August 12th and August 25th, involving extensive travel and reconnaissance, chiefly by air, courtesy of the Provincial Air Service on requisition of the Ontario Forestry Branch. This amounted to approximately 795 miles of air travel, or about 10 hours flying time. At commercial rates, this cooperation would have a monetary value of several hundred dollars.

b. Insect Conditions.

No widespread infestations were encountered, with the exception of that of the birch leaf skeletonizer (Bucculatrix canadensisella Chamb.) which occurs on birch stands throughout the district. The area about Lake St. Joseph was found to be particularly heavily attacked.

The Jack pine budworm (Cacoecia fumiferana Clem.) was located at a number of points, being present endemically; in some places feeding was intense upon new growth, as: Watcomb, Savant Lake, and in the vicinity of Harvey.

The European larch sawfly (Pristiphora erichsonii Htg.) was recovered at a few points but only in the area between Ogaki and Allanwater was damage

by it noted. In this area, a good deal of top-kill has resulted.

Northern 1939 Winnipeg: Insect and Disease Species Index