ANNUAL REPORT OF FOREST RESEARCH TECHNICIANS

LARCH SAWFLY POPULATION DYNAMICS STUDIES

1968

by
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FOREST RESEARCH LABORATORY

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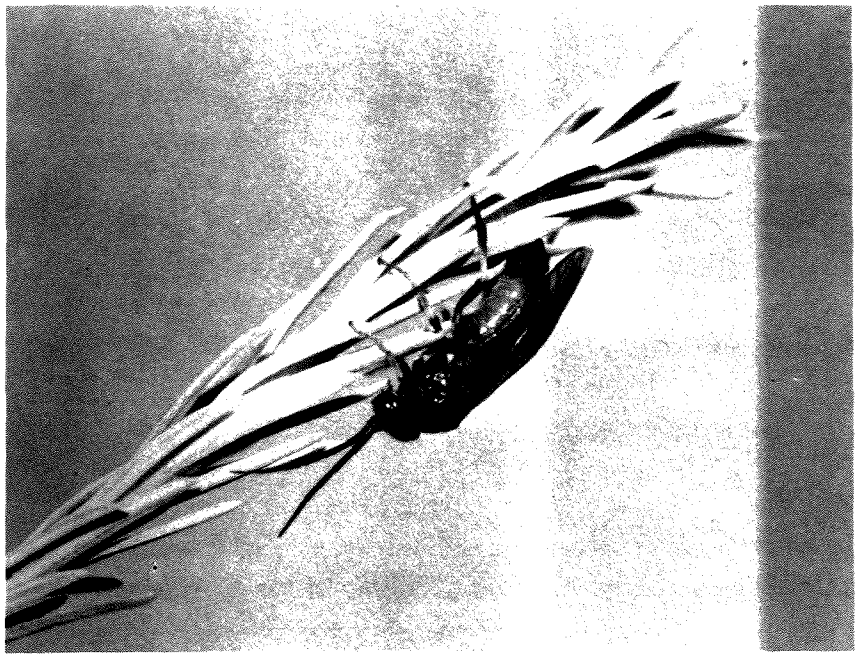

Fig. 1 Larch sawfly female laying eggs in tamarack terminal shoot

Photo by E. Rayner

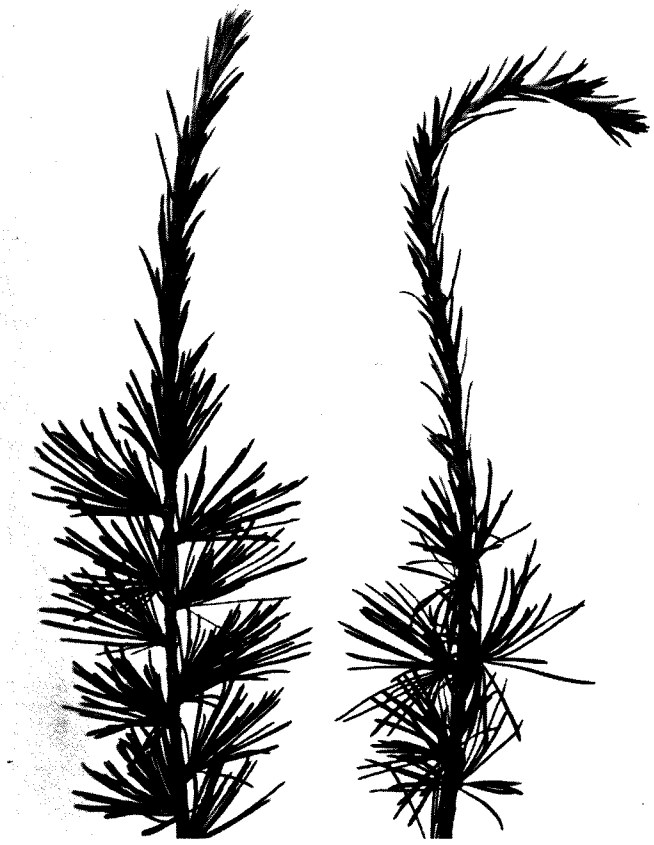

Fig. 2 Normal tamarack shoot (left) and curled shoot (right) resulting from oviposition damage

Photo by E. Rayner

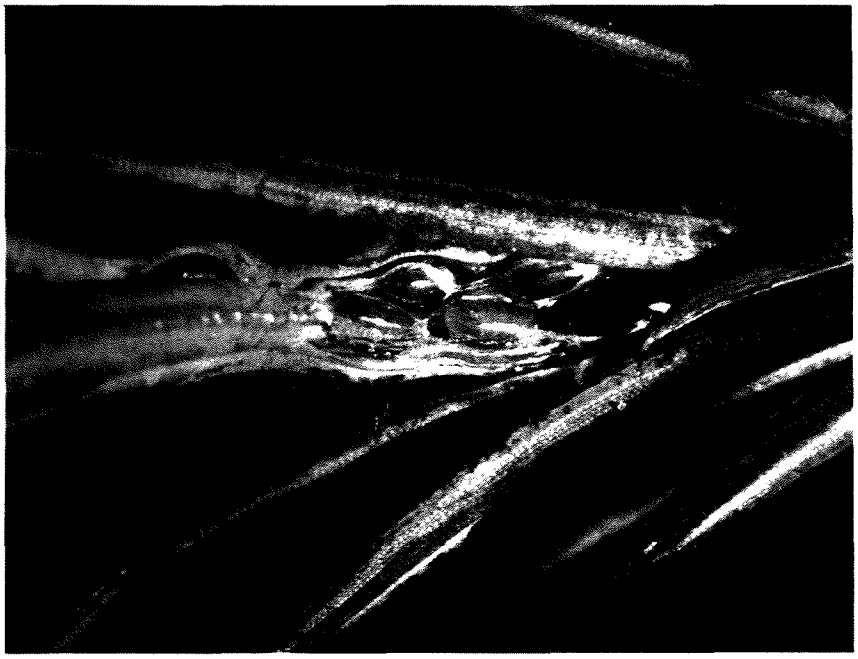

Fig. 3 Swollen eggs in terminal shoot

Photo by E. Rayner

Fig. 4 First and second-instar larvae feeding damage

Photo by C. Burdall

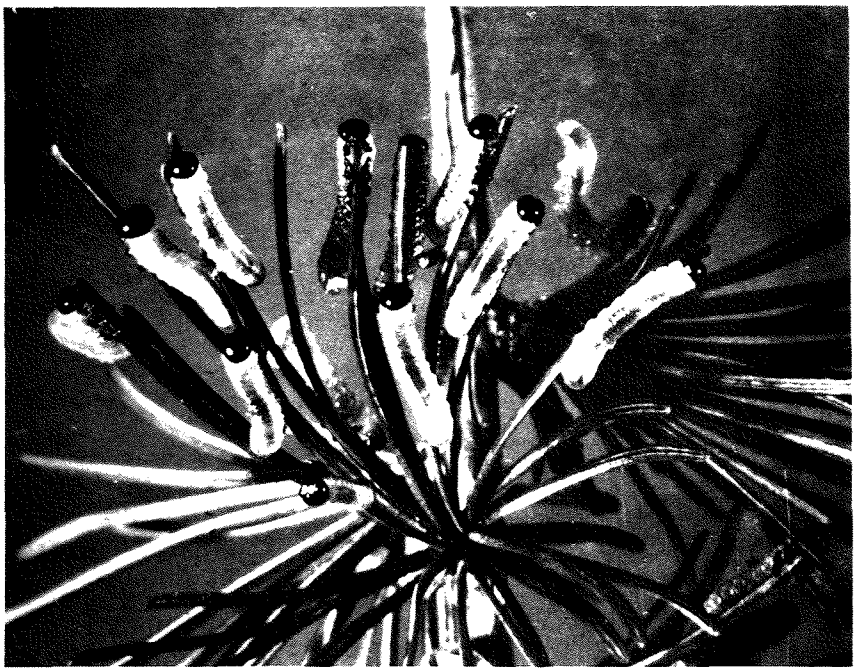

Fig. 5 Fourth-instar larch sawfly feeding on tamarack

Photo by C. Burdall

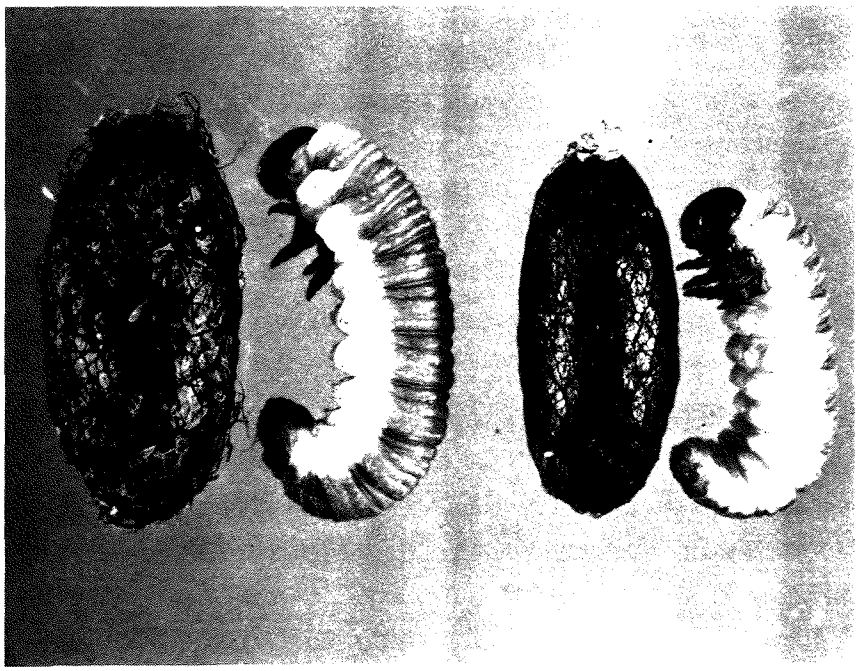

Fig. 6 Normal cocoon and eonymph of female larch sawfly (left) and cocoon and eonymph of female parasitized by Olesicampe benefactor (right)

Photo by E. Rayner

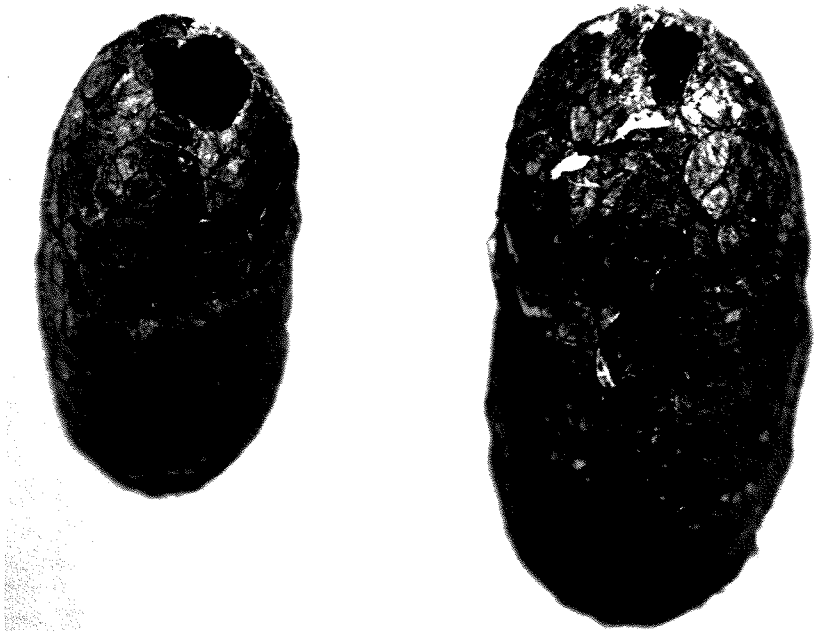

Fig. 7 Larch sawfly cocoons with parasite emergence hole of Olesicampe benefactor (left) and Bessa harveyi (right)

Photo by E. Rayner

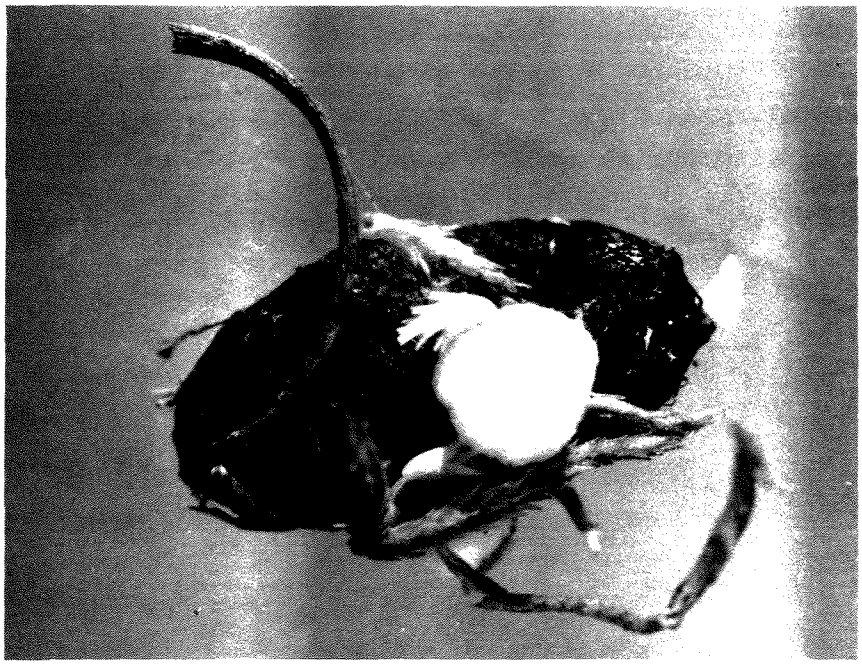

Fig. 8 Larch sawfly cocoons with fructifications of Beauvaria bassiana

Photo by R. Cheale

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INTRODUCTION

This annual report deals with the technical and field aspects of the life table research projects being conducted by the Larch Sawfly Investigation group from the Whiteshell Field Station and the maintenance and operation of this field station property. During 1968, the collection of data for estimating the populations of larch sawfly in all stages, parasites, vertebrate and invertebrate predators was continued at seven study plots. Annual estimates were made of mortality in the egg stage, the larval instars and cocoon stage. Foliage samples were collected in the spring at the Darwin, Seddon's Corner and Pine Falls plots.

Measurements of the relative topographical level of the ground surface at emergence trap locations in four plots were completed in 1968. Records of meteorological events, water table fluctuations, defoliation, host tree mortality and phenology were continued. Recording instruments to measure rainfall, wind gusts, miles of wind, solar radiation, temperature and relative humidity were operated at each plot. In those plots with high sawfly populations, triangular boxes containing moss, each covering an area of two feet square, were examined for cocoons to determine their survival under near natural conditions. Field trials of a magnetic tape recorder were continued at the Rennie plot.

These projects were under the direction of the following research officers in their respective areas of program responsibilities:

W. J. TURNOCK - Project leader; co-ordination of program planning; advanced synthesis and interpretation and report of results of overall project; bioclimatology and impact of Bessa harveyi.

W. G. H. IVES - Primary analyses of data from the life table system.

C. H. BUCKNER - Vertebrate predators, energetics, co-actions and predator responses.

J. A. MULDREW - Biological control studies including the development of impact studies of introduced parasites.

R. J. HERON - Physiology and nutrition, with current emphasis on laboratory studies of the effects of temperature and humidity on development, fecundity and survival.

FIELD STATION OPERATION

In 1968, the Whiteshell Field Station, which serves as field headquarters for the larch sawfly group, operated from May 1 to September 20. Major station improvements included the addition of two trailers, one for the Forest Insect and Disease Survey and the other as accommodations for field station personnel. Power, water and sewer services were completed at the units by late June. In late fall a new pre-cast one thousand gallon septic tank was installed to replace the existing main tank which was crumbling and leaking. The porch additions on cabins 2 and 3 were partitioned at the glassed sections for use as bedrooms. Exterior painting was completed on the kitchen-dining room and cabin 2 and some minor alterations were made to the kitchen counters in cabin 3. No major work is contemplated for 1969 except for a continuation of painting and upkeep to the exteriors and interiors of the buildings.

Assignments to married quarters accommodation including the additional trailers were as follows:

Cottage 1 - D. G. H. Ray

Cottage 2 - C. H. Buckner

Cottage 3 - W. J. Turnock

Trailer 1 - R. M. Smith

Trailer 2 - J. M. Bergeron

Trailer 3 - G. N. Still F.I.D.S.

Trailer 4 - J. A. Drouin

ASSIGNMENT OF PERSONNEL

In 1968, four Forest Research Technicians, five student assistants, two Insect Sampling and Rearing Aides and two hourly rate employees were assigned to larch sawfly investigations. A graduate assistant, J. M. Bergeron was assigned to vertebrate predators under Dr. C. H. Buckner. The other hourly rate employees were the cook and maintenance man. The personnel, hourly rate categories and length of employment follow:

FR-260-8993	May 6-Sept. 13	E. Marchuk	Student Assistant	19 weeks
FR-260-8987	May 6-Sept. 14	C. Christie	Student Assistant	19 weeks
FR-260-8995	May 6-Aug. 23	R. Martens	Student Assistant	16 weeks
FR-260-8998	May 6-Sept. 13	N. Roller	Student Assistant	19 weeks
FR-260-8997	May 6-Sept. 16	C. Prouse	Student Assistant	19 weeks
FR-260-8928	July 1-Aug. 27	P. Ludwig	I.S.R.A.	8 weeks
FR-260-8930	July 1-Sept. 6	W. Giesbrecht	I.S.R.A.	9 weeks

FR-260-8981	May 6-Sept. 16	J. M. Bergeron	Graduate Assistant	20 weeks
FR-260-8916	June 13-Aug. 30	F. Horan	Student Assistant	11 weeks
FR-260-9105	May 6-Sept. 20	Mrs. A. McNarland	Cook	20 weeks
FR-260-9104	May 6-Sept. 20	M. McNarland	Maintenance	20 weeks

One student assistant, F. Horan, was assisting Dr. R. E. Wall with poplar decay studies.

TRANSPORTATION EQUIPMENT

Changes in the vehicle fleet operating from the field station in 1968 included a half-ton G.M.C. Carryall and a half-ton Chevrolet truck with a six foot box which were acquired as replacements for an International-Travelall and Chevrolet half-ton. A Pontiac station wagon was also acquired later in the season for the vertebrate predator group.

POPULATION DYNAMICS STUDIES, LIFE TABLE PLOTS

Larch sawfly populations increased slightly at the Riverton plot. Water levels remained low because there was no flooding from Lake Winnipeg, and this may have contributed to this increase. Slight increases also occurred at Telford and Darwin, while at Rennie, Seddon's Corner, Hodgson and Pine Falls populations continued to decline. In general, the decline in populations may be attributable to cool, wet weather during the 1968 season.

Defoliation at the Hodgson, Seddon's Corner and Rennie plots decreased considerably in 1968 with only fair foliage production at Hodgson. At Darwin defoliation increased to severe and at the remaing three plots conditons were much the same as in 1967. With a return to lower water levels at Riverton, sampling procedures in the plot were reinstated, meteorological equipment remained minimal but 100 emergence cages were installed and serviced.

At the Hodgson plot, a new water level pipe was placed at the northwest corner as the existing pipe was plugged with mud. Water levels remained high throughout most of the season because of abnormal rainfall.

Parasitism at Hodgson by the introduced parasite Olesicampe benefactor Hinz increased from 19 per cent in 1967 to 61 per cent in 1968. At Pine Falls and Riverton parasitism by this parasite remained high at 94 and 97 per cent respectively.

Because of continuing high water levels at Darwin, 27 emergence cages were moved to higher ground within their original randomized positions. Thunderstorms on July 14 and 16 produced a total of 1.93 inches of rain, with winds gusting 13 to 18 miles per hour. As a result, heavy larval drops were recorded in the oil funnel positions during regular servicing on July 18 as was heavy mortality, through drowning, of fifth instar larvae.

At Seddon's Corner on July 16 a heavy thunderstorm produced 1.08 inches of rain, with winds gusting to 30 miles per hour. Plot servicing was carried out shortly after this storm and as at Darwin heavy mortality from larval drowning occurred.

An estimate of this mortality was made by counting the numbers of larvae within a series of transects of pools in the Darwin and Seddon's Corner plots. Each 30 x 3 inch transect, divided into 3 x 6 inch units, was laid along the radius of a pool. The locations of the transects were selected randomly by using the pool closest to a sawfly sampling location. At the Darwin plot, 17 transects were used and 25 at Seddon's Corner. For each sampling unit the water depth and the number of dead larvae was recorded.

Water depth varied from zero to six inches at Darwin and zero to four and one-half inches at Seddon's Corner (Table I). The average number of dead larvae per transect was 27.8 and 6.2 in the two plots. Thus drowning caused considerable larval mortality.

Meteorological instruments, recorders and oil drops were serviced at weekly intervals while emergence traps were changed every second week at each plot. Predator sampling was also carried out at all plots except Riverton. Larval drop moss tins in association with oil drop traps were continued in 1968 at Rennie, Darwin and Seddon's Corner. These moss samples are used to obtain supplementary information on the seasonal parasitism of Bessa harveyi Tsnd. and also on the populations of the green larch looper Semiothisa sexmaculata Pack. These traps were serviced at weekly intervals.

Foliage sampling was carried out at Darwin, Pine Falls and Seddon's Corner in 1968. This information will provide a basis for comparing intensity of sawfly infestations in stands of larch with the variation in volume of foliage available.

Vandals at the Rennie plot on the evening of June 15, systematically tore up 80 per cent of the emergence cages and larval drops, broke or crushed the plastic emergence traps, tampered or jammed some of the meteorological instruments at both the Stevenson screen and tower. Except for small gaps in the weather records and negligible losses in emerged insects, very little data was lost and the plot was returned to full operation several hours later.

With the increase in populations at Rennie, Darwin and Seddon's Corner in 1966 and 1967, forty triangles were introduced at each of these plots to furnish supplementary survival estimates. These triangles were stratified according to topography; divided between the high, mid and low positions.

In 1966, 110 triangles were established as follows: Rennie (40), Seddon's Corner (40), Darwin (30). In 1967, 40 triangles were established at Hodgson and in the same year, 15 triangles were removed from Rennie, 15 from Seddon's Corner and ten from the Darwin plot. The moss was then sorted for cocoons which were subsequently separated into living, dead or parasitized classes and packaged and overwintered for rearing in 1968. The total number of cocoons found at the stratified locations in the fall sorting procedure, including parasitism, overwintering mortality and the total sound cocoons reared in 1968 are shown in Table II.

TABLE I

Sampling Position Number, Average Water Depth and Total Number of Drowned Larvae in 42 Transects at Darwin and Seddon's Corner in 1968

Darwin			Seddon's Corner		
Position number	Average water depth (inches)	Total no. drowned larvae	Position number	Average water depth (inches)	Total no. drowned larvae
1	2.5	21	2	1.0	4
2	3.6	15	4	1.5	9
3	3.0	53	6	1.0	3
4*	2.9	0	10	1.3	4
5	2.5	24	16	1.3	3
6*	0	0	18	2.0	6
7*	2.9	0	21	1.3	7
8	2.0	23	26	2.6	20
9	2.5	32	28	1.0	7
10	2.8	35	32	1.9	3
11	2.0	74	37	1.9	2
12	3.7	14	41	1.5	6
13	1.5	35	44	1.0	5
14	2.6	7	46	2.1	12
15	2.5	39	48	1.6	6
16	4.0	2	54	1.6	6
17	3.5	99	60	1.0	3
Total		473	70	1.3	8
			72	2.8	6
			78	1.0	4
* No tree crown above randomly selected transect			80	1.5	6
			89	2.0	5
			91	1.6	7
			96	2.5	7
			98	3.3	6
			Total		155

TABLE II

Total Cocoons Found in 40 Triangles, Parasitism, Miscellaneous Dead, Fungus, and Total Sound Reared in 1968 (1967 Generation)

Plot position and number of triangles examined	Total cocoons	Fall and Spring Mortality			Total sound cocoons reared
		Bessa	Fungus	Misc.*	
Rennie Hi(4)	311	42	2	20	247
Mid(5)	375	55	-	45	275
Lo(6)	418	67	1	51	299
Seddon's Hi(4)	273	40	-	18	215
Corner Mid(5)	309	45	1	15	248
Lo(6)	320	58	-	28	234
Darwin Hi(4)	264	18	1	13	232
Mid(3)	215	21	-	9	185
Lo(3)	189	4	-	20	165

* Includes predator mortality, mechanical damage, turgid, etc.

In the fall of 1967, fifteen triangles at both the Rennie and Seddon's Corner plots and ten at the Darwin plot were covered with fine mesh screen at completion of larval drop. These triangles were removed in late summer 1968 and the moss sorted for emerged cocoons to obtain supplementary survival estimates. A description of triangle position, number removed, total cocoons, adult emergences, parasitism, predation, miscellaneous mortality and holdover follows in Table III. The holdover cocoons were further dissected and separated into eonymphs and pronymphs and the eonymphs examined for parasitism by Bessa harveyi Tsnd. Although scars indicating parasitism by B. harveyi were found, no living parasite maggots occurred in the eonymphs or pronymphs.

In the fall of 1968, a total of 33 triangles were removed from four plots: Rennie, Seddon's Corner, Hodgson and Darwin. After sorting the moss for cocoons the results indicated a marked decline in populations. A description of triangles sorted, total cocoons, parasitism, predation and miscellaneous mortality follows in Table IV. With the marked reduction in populations, triangles will be discontinued in 1969. At Darwin, the main cause for the absence of cocoons in the triangles was severe flooding throughout the plot.

In 1968, all egg shoots were again reared in the constant temperature room with excellent success. The addition of an automatic de-humidifier maintained humidity at an ideal rearing range with no loss of material due to moulds or water droplets. The constant temperature room was also used with success as a holding area for larch sawfly and Bessa harveyi adults.

Mass rearings of approximately 20,000 fourth and fifth instar larvae were carried out at the field station to obtain experimental cocoon material for laboratory rearings.

Topography measurements of both even and odd emergence cage positions were completed at the remaining three plots (Pine Falls, Hodgson, Seddon's Corner) in 1968.

The analog recorders functioned well at all plots. Testing procedures on a D-mac logger unit was continued at the Rennie plot but were independent of the events recorded simultaneously on the analog recorders to prevent any loss of data in case of malfunction.

PROCESSING OF DATA

The transfer of oil, paired oil and colony collection data to data sheets was completed in early fall. Transfer of cocoon (1967 generation) rearing records and all meteorological data, (wind, wind gusts, rain, sunshine, temperature, and relative humidity) to data sheets was completed during the winter. Some revisions were made to data code cards 1 to 8 to meet the changing values of the life tables. The transfer of larval drop funnel, cocoon collections (card 08) to data cards for the years 1955 to 1962 at the existing plots was well under way. Changes in clearing methods and techniques for colonies of second instar larch sawfly parasitized by Olesicampe benefactor Hinz. implemented during 1968 greatly reduced the back log of colonies to be processed. This data transfer was also nearly completed.

TABLE III

Total Cocoons found in 40 Triangles, Adult Emergence, Parasitism, Predation, Miscellaneous Mortality and Holdovers in August, 1968 (1967 Generation)

Plot position and number of triangles examined	Total cocoons	Adult emergence	Parasitism*	Predation	Miscellaneous dead**	Holdover
Rennie Hi(4)	270	60	127	15	42	26
Mid(5)	402	65	147	25	127	38
Lo(6)	415	51	94	8	168	67
Seddon's Hi(4)	217	36	47	3	114	17
Corner Mid(5)	210	14	53	11	89	43
Lo(6)	329	24	37	21	186	51
Darwin Hi(4)	283	118	65	20	24	56
Mid(3)	265	56	52	3	82	72
Lo(3)	112	5	8	2	49	48

* Includes parasitism by Bessa harveyi and Mesoleius tenthredinis

** Includes dead by fungus, mechanical damage, etc.

TABLE IV

Total Cocoons Found in 33 Triangles Including Parasitism and Miscellaneous Dead in August, 1968 (1968 Generation)

Plot, position and number of triangles examined	Total cocoons	Fall mortality			Total sound remaining
		Bessa	Predation	Miscellaneous	
Rennie Hi(2)	48	5	2	2	39
Mid(2)	76	10	2	2	62
Lo(2)	61	9	1	1	50
Seddon's Hi(2)	58	12	2	8	36
Corner Mid(1)	19	2	-	2	15
Lo(3)	53	26	3	5	19
*Hodgson Hi(6)	41	16	5	1	19
Mid(5)	22	10	3	-	9
Lo(4)	36	9	1	5	21
Darwin Hi(3)	0	-	-	-	0
Mid(2)	0	-	-	-	0
Lo(1)	0	-	-	-	0

* Includes both normal and parasitized by Olesicampe

EFFECTS OF DEFOLIATION ON THE HOST STANDS

In 1968, foliage production was sparse at the Hodgson and, to a lesser extent, Seddon's Corner plots. Few cones were produced in any of the tamarack stands, a drastic reduction from the heavy cone crop of 1967.

Records of defoliation, tree diameter and tree mortality were made in the seven plots (Table V). Although tree deaths were few, growth appears slow in those plots with a history of heavy sawfly defoliation. The records of defoliation, diameter, height and tree mortality for the Picnic plot were reviewed and anomalies in past summaries corrected (Table VI). Since 1955, 35 per cent of the trees have died and many suffered a height reduction from top kill. Diameter growth has been very slow, increasing, for the plot average, only 0.5 inches in 13 years. In fact, individual tree growth has been even less, since the increase in the plot average for 1968 is partially attributable to the death of many of the smaller trees.

LARCH SAWFLY POPULATION AND SURVIVAL ESTIMATES

Data from larch sawfly egg, larval and cocoon collections were coded and recorded on data sheets for transfer to I.B.M. cards. The survival estimates for each larval instar collection period and confidence intervals for the seven plots in operation during 1968 are shown in Tables VII to XIII.

Populations per acre are estimated annually for eggs, cocoons and confidence intervals for each stage are calculated (Table XIV).

MORTALITY FACTORS

Water Levels

The larch sawfly is susceptible to mortality from flooding in the larval and cocoon stages. Water level measurements in each plot are taken weekly during the summer and intermittently thereafter (Table XV, XVI) to provide data from which the effects of fluctuating water levels on the sawfly survival are determined.

The Hodgson plot had high standing surface water early in the 1968 season and for the remainder of the season extremely high water conditions prevailed. The number three pipe in the northwest corner of the Hodgson plot was replaced in the latter part of May as it appeared to be plugged with mud at a reading of 47.5 inches. No water level readings were taken from this pipe from July 12, 1967 until its replacement on May 21, 1968.

In 1968, the low water levels at the Riverton plot enabled all emergence trap positions to be used. At Darwin, the emergence cages at 27 positions were placed on higher ground in early June due to the high water levels in the plot. On July 16-18 heavy rain and high winds caused premature larval drop and high mortality through drowning of fourth and fifth instar larvae at Seddon's Corner and Darwin. Heavy rains in August raised water levels in all seven plots and as a result water level pipes froze early in the winter season.

TABLE V

Tamarack Mortality and Defoliation in
Seven Population Dynamics Plots

Plot	No. living trees remaining in plot 1968	Trees dying in 1968	% trees dying in 1968	Average DBH of dead trees	Living trees* DBH (Inches) Mean	DBH (Inches) Range	Height (Feet) Mean	Height (Feet) Range	Defoliation % Mean	Defoliation % Range
Rennie	267	2	1.0	5.2"	5.0	2.9-7.2	46	32-58	42	14-95%
Telford	236	3	1.3	1.0"	1.2	.5-4.0	8	2-24	4	0-50%
Seddon's Corner	491	4	0.8	2.3"	3.8	1.4-7.4	36	18-48	21	3-67%
Pine Falls	551	5	0.9	0.9"	1.8	.2-9.3	18	5-52	1	0-5%
Riverton	268	0	-	-	3.6	1.2-8.8	27	7-43	2	0-17%
Darwin	178	1	0.6	2.4"	7.1	2.2-11.5	41	17-60	61	14-95%
Hodgson	338	1	0.3	0.5"	2.2	.5-4.0	20	8-30	15	0-91%

* Calculations based on total number of trees in plot

TABLE VI

Corrected Summary of Tree Growth
and Mortality, Picnic Plot 1955 to 1968

	Living Trees					Annual Mortality		
Year	No.	Mean Diameter (inches)	Mean Height (feet)	Defoliation (%) Mean	Range	No.	% of 1955	Mean Diameter (inches)
1955	411	4.5[1]	45[1]	Severe	-	-	-	-
1956	402	-	45(20)	Severe	-	9	2.2	3.8
1957	383	-	45(20)	Severe	-	19	4.6	3.5
1958	364	-	-	Moderate	-	19	4.6	3.8
1959	321	-	-	37	5-75	43	10.5	3.9
1960	298	4.6[1]	40(30)	32	1-73	23	5.6	4.0
1961	290	-	36(30)	13	1-47	8	1.9	4.7
1962	285	4.6[1]	48(40)	3	0-9	5	1.2	4.6
1963	284	4.9	43	17	3-36	1	0.2	4.0
1964	279	4.9	46	17	3-36	5	1.2	4.1
1965	278	4.8	45	9	2-25	1	0.2	3.4
1966	272	4.9[1]	46	49	9-100	6	1.5	3.9
1967	269	5.0	46	64	7-100	3	0.7	5.5
1968	267	5.0[1]	46	42	14-95	2	0.5	5.2

[1] All living trees measured

TABLE VII

Survival Estimates by Larval Instar and Collection Period
with 95% Confidence Interval for Rennie Plot 1968

Collection Date	Eggs		I		II		III		IV		V	
	N	%	N	%	N	%	N	%	N	%	N	%
11/VI/68	5	88.7	-	-	-	-	-	-	-	-	-	-
18/VI/68	29	91.8	1	68.9	-	-	-	-	-	-	-	-
25/VI/68	41	89.9	1	71.4	-	-	-	-	-	-	-	-
2/VII/68	39	84.8	11	63.2	5	48.1	-	-	2	57.9	1	36.5
9/VII/68	38	75.7	6	73.7	13	79.3	10	62.4	2	45.5	2	75.0
16/VII/68	32	69.1	15	70.6	22	56.0	7	55.1	14	44.3	19	41.8
23/VII/68	10	77.5	4	58.1	8	45.1	8	46.4	12	55.0	8	46.6
30/VII/68	3	57.4	13	71.7	11	62.9	5	52.3	6	40.4	20	35.5
6/VIII/68	-	-	4	46.8	7	68.2	9	58.7	10	61.7	8	39.4
Total	197	81.9	55	67.4	66	61.7	39	55.7	46	48.7	58	38.8
ldl		± 2.8		± 7.1		± 7.4		± 9.0		± 15.4		± 6.3

N = Number of colonies or clusters examined
% = Per cent survival of eggs or larvae
ldl = ½ 95% Confidence interval width

TABLE VIII

Survival Estimates by Larval Instar and Collection Period
with 95% Confidence Interval for Telford Plot 1968

Collection Date	Eggs		I		II		III		IV		V	
	N	%	N	%	N	%	N	%	N	%	N	%
12/VI/68	-	-	-	-	-	-	-	-	-	-	-	-
19/VI/68	30	84.2	-	-	-	-	-	-	-	-	-	-
26/VI/68	36	77.5	2	93.3	-	-	-	-	-	-	-	-
3/VII/68	34	75.9	37	78.5	10	83.8	-	-	-	-	-	-
10/VII/68	41	76.3	13	73.2	26	74.7	-	-	3	66.7	-	-
17/VII/68	30	73.2	15	89.0	21	78.5	4	65.6	11	67.7	5	66.7
24/VII/68	15	80.1	16	72.5	11	72.1	9	66.4	9	64.7	11	46.3
31/VII/68	2	86.3	4	95.7	13	78.0	13	58.1	13	58.6	14	40.4
7/VIII/68	-	-	-	-	1	100.0	9	65.7	12	57.0	15	47.8
Total	188	77.5	87	79.3	82	77.0	35	59.6	48	60.6	45	46.5
ldl		± 2.9		± 5.0		± 3.7		± 6.9		± 6.8		± 9.0

N = Number of colonies or clusters examined
% = Per cent survival of eggs or larvae
ldl = $\frac{1}{2}$ 95% Confidence interval width

TABLE IX

Survival Estimates by Larval Instar and Collection Period
with 95% Confidence Interval for Seddon's Corner Plot 1968

Collection Date	Eggs		I		II		III		IV		V	
	N	%	N	%	N	%	N	%	N	%	N	%
11/VI/68	18	79.3	-	-	-	-	-	-	-	-	-	-
18/VI/68	33	84.3	11	74.4	-	-	-	-	-	-	-	-
25/VI/68	50	81.1	13	93.3	9	89.8	4	87.2	-	-	-	-
2/VII/68	50	85.0	29	93.8	9	86.3	4	75.8	6	93.9	-	-
9/VII/68	34	79.8	14	72.2	9	54.8	2	14.3	2	40.4	2	50.0
16/VII/68	16	61.4	13	60.8	19	73.2	11	53.5	14	45.7	1	90.9
23/VII/68	3	83.8	5	50.3	13	57.2	10	41.9	11	40.6	1	44.4
30/VII/68	-	-	-	-	14	57.0	10	55.0	7	41.6	6	43.8
6/VIII/68	-	-	5	62.2	4	52.1	13	49.8	6	33.6	6	32.5
Total	204	80.8	90	76.3	77	64.1	54	51.9	46	44.1	16	43.0
ldl		± 2.7		± 6.9		± 6.3		± 7.2		± 8.1		± 13.4

N = Number of colonies or clusters examined
% = Per cent survival of eggs or larvae
ldl = ½ 95% Confidence interval width

TABLE X

Survival Estimates by Larval Instar and Collection Period
with 95% Confidence Interval for Pine Falls Plot 1968

Collection Date	Eggs		I		II		III		IV		V	
	N	%	N	%	N	%	N	%	N	%	N	%
13/VI/68	-	-	-	-	-	-	-	-	-	-	-	-
20/VI/68	15	86.9	-	-	-	-	-	-	-	-	-	-
27/VI/68	36	86.3	6	69.1	-	-	-	-	-	-	-	-
4/VII/68	43	81.0	8	74.6	5	22.7	-	-	-	-	-	-
11/VII/68	47	74.9	24	65.3	9	64.3	6	58.4	8	33.0	-	-
18/VII/68	38	73.6	9	75.8	18	67.8	18	62.2	13	69.0	10	45.7
25/VII/68	17	73.8	4	73.7	19	61.0	8	61.8	10	64.0	15	60.6
1/VIII/68	4	81.7	2	74.1	8	40.3	13	55.0	7	38.8	15	44.2
8/VIII/68	-	-	2	83.8	9	82.8	8	66.7	17	55.3	15	58.0
15/VIII/68	-	-	1	66.7	3	87.2	5	58.5	6	50.5	8	65.4
22/VIII/68	-	-	2	57.1	2	32.5	8	75.0	7	61.9	8	52.9
Total	200	78.0	58	69.4	73	61.7	66	61.2	68	55.1	71	52.8
ldl		± 3.1		± 6.4		± 8.9		± 4.9		± 6.8		± 6.0

N = Number of colonies or clusters examined
% = Per cent survival of eggs or larvae
ldl = $\frac{1}{2}$ 95% Confidence interval width

TABLE XI

Survival Estimates by Larval Instar and Collection Period
with 95% Confidence Interval for Riverton Plot 1968

Collection Date	Eggs		I		II		III		IV		V	
	N	%	N	%	N	%	N	%	N	%	N	%
12/VI/68	-	-	-	-	-	-	-	-	-	-	-	-
19/VI/68	-	-	-	-	-	-	-	-	-	-	-	-
26/VI/68	12	98.6	-	-	-	-	-	-	-	-	-	-
3/VII/68	19	86.2	4	47.6	3	61.7	-	-	-	-	-	-
10/VII/68	14	81.6	6	53.1	2	53.8	-	-	1	29.4	1	23.5
17/VII/68	8	80.5	26	75.9	8	71.0	2	58.9	1	80.0	2	23.5
24/VII/68	2	95.7	6	80.8	6	57.3	8	78.5	25	48.6	12	40.7
31/VII/68	1	69.4	3	73.5	11	70.2	10	52.9	4	50.7	3	61.4
7/VIII/68	-	-	1	84.0	2	90.9	10	68.0	5	33.3	4	42.6
Total	56	85.9	46	71.9	32	66.7	30	64.6	36	47.7	22	41.8
ldl		± 4.5		± 6.7		± 9.8		± 9.3		± 10.9		± 12.1

N = Number of colonies or clusters examined
% = Per cent survival of eggs or larvae
ldl = ½ 95% Confidence interval width

TABLE XII

Survival Estimates by Larval Instar and Collection Period
with 95% Confidence Interval for Darwin Plot 1968

Collection Date	Eggs		I		II		III		IV		V	
	N	%	N	%	N	%	N	%	N	%	N	%
13/VI/68	34	85.5	-	-	-	-	-	-	-	-	-	-
20/VI/68	41	82.8	3	78.9	8	90.5	-	-	-	-	-	-
27/VI/68	57	85.7	13	76.7	5	64.0	8	48.0	3	31.3	-	-
4/VII/68	47	82.2	22	78.0	11	50.4	6	90.5	2	48.4	3	30.6
11/VII/68	9	77.1	8	52.9	16	59.3	15	59.9	8	54.8	2	66.7
18/VII/68	6	81.8	9	74.3	6	60.0	12	50.5	16	37.0	13	38.9
25/VII/68	1	90.0	2	72.7	2	77.3	5	53.7	6	62.9	11	53.7
1/VIII/68	-	-	-	-	3	92.6	3	89.8	1	52.5	1	20.0
Total	195	83.7	57	73.8	51	62.6	49	59.9	36	45.0	30	43.5
ldl		± 2.3		± 6.4		± 8.2		± 8.3		± 7.4		± 7.6

N = Number of colonies or clusters examined
% = Per cent survival of eggs or larvae
ldl = ½ 95% Confidence interval width

TABLE XIII

Survival Estimates by Larval Instar and Collection Period
with 95% Confidence Interval for Hodgson Plot 1968

Collection Date	Eggs		I		II		III		IV		V	
	N	%	N	%	N	%	N	%	N	%	N	%
12/VI/68	15	91.3	-	-	-	-	-	-	-	-	-	-
19/VI/68	30	90.4	3	85.4	-	-	-	-	-	-	-	-
26/VI/68	37	85.7	5	96.6	1	100.0	-	-	-	-	-	-
3/VII/68	43	86.7	18	63.1	8	69.7	1	66.7	-	-	-	-
10/VII/68	31	70.4	25	75.4	13	63.9	2	33.3	1	83.3	1	45.2
17/VII/68	39	81.6	9	63.7	24	52.2	16	62.4	9	39.1	2	56.0
24/VII/68	15	87.8	11	66.1	4	63.2	16	57.3	20	54.4	6	54.4
31/VII/68	1	63.6	12	88.4	12	67.2	17	66.8	7	76.0	13	39.0
7/VIII/68	-	-	5	81.8	10	92.3	9	72.5	14	56.9	7	61.7
14/VIII/68	-	-	-	-	2	50.0	-	-	4	42.6	2	68.4
Total	211	84.1	88	73.6	74	64.4	61	63.0	55	54.9	31	48.2
ldl		± 2.6		± 5.8		± 6.1		± 6.8		± 7.2		± 13.7

N = Number of colonies or clusters examined
% = Per cent survival of eggs or larvae
ldl = ½ 95% Confidence interval width

TABLE XIV

Adult, Egg, Larval and Cocoon Populations per Acre and Their One-half 95% Confidence Intervals ldl in 1968

	Rennie		Telford		Seddon's Corner		Pine Falls		Riverton		Darwin		Hodgson	
	No.	ldl	No.	ldl	No.	ldl	No.	ldl	No.	ldl	No.	ldl	No.	ldl
Adults	23,740	9,079	165	220	19,384	7,991	4,574	2,360	436	640	18,949	10,318	5,663	4,336
Eggs	1,381,001	556,943	99,837	60,391	1,577,638	407,326	538,135	194,886	215,238	125,687	2,682,078	645,499	272,068	182,629
Instar I	968,082	-	77,074	-	1,176,918	-	380,461	-	162,289	-	1,928,414	-	201,058	-
Instar II	920,646	-	76,766	-	1,121,603	-	368,286	-	156,284	-	1,835,850	-	192,211	-
Instar III	861,725	-	73,695	-	1,002,713	-	352,818	-	148,314	-	1,714,684	-	180,678	-
Instar IV	804,851	-	65,441	-	917,482	-	340,822	-	137,487	-	1,575,795	-	171,102	-
Instar V	751,731	-	61,515	-	865,186	-	327,530	-	125,938	-	1,462,338	-	162,547	-
Cocoons	554,083	108,554	4,550	1,895	328,442	48,138	121,968	26,968	32,017	10,528	436,253	139,657	28,532	8,783

TABLE XV

Water Levels in Six Larch Sawfly Population Dynamics Plots 1968

Rennie			Telford			Seddon's Corner			Pine Falls			Riverton			Darwin			Hodgson		
Jan.	15	51.2	Jan.	16	F.	Jan.	16	38.4	Jan.	16	52.4	Jan.	17	F.	Feb.	14	F.	Jan.	17	56.4
Feb.	14	F.	May	16	11.2	Feb.	14	38.0	Feb.	14	54.0	Feb.	15	F.	March	13	F.	Feb.	15	56.5
March	13	F.	May	21	11.0	March	13	38.8	March	14	54.0	March	14	F.	April	18	17.0	March	14	56.8
April	18	F.	May	29	11.0	April	18	24.6	April	18	44.6	April	16	F.	May	17	9.4	April	16	F.
May	15	21.3	June	5	11.3	May	15	14.8	May	22	23.5	May	22	18.0	May	23	9.9	May	21	16.9
May	23	22.7	June	12	10.4	May	21	14.8	May	30	23.8	May	29	18.3	May	30	11.1	May	29	16.0
May	28	22.7	June	19	11.2	May	28	15.1	June	6	24.8	June	5	18.9	June	6	10.8	June	5	18.6
June	4	22.4	June	26	11.6	June	4	15.3	June	13	24.1	June	12	18.9	June	13	9.8	June	12	21.4
June	11	21.2	July	3	10.4	June	11	13.6	June	20	27.1	June	19	19.8	June	20	11.8	June	19	29.9
June	18	24.2	July	10	10.9	June	18	14.5	June	27	29.6	June	26	21.4	June	27	13.0	June	26	35.9
June	25	26.2	July	17	10.8	June	25	15.5	July	4	26.4	July	3	18.6	July	4	9.6	July	3	16.0
July	2	23.1	July	24	10.9	July	2	14.0	July	11	28.8	July	10	19.9	July	11	11.8	July	10	23.0
July	9	25.8	July	31	10.9	July	9	14.0	July	18	31.8	July	17	21.3	July	18	10.0	July	17	33.5
July	16	25.2	Aug.	7	11.3	July	16	13.5	July	25	33.9	July	24	21.4	July	25	9.9	July	24	38.1
July	23	24.9	Aug.	14	12.1	July	23	13.5	Aug.	1	35.6	July	31	21.9	Aug.	1	10.3	July	31	41.8
July	30	26.0	Aug.	21	11.0	July	30	13.4	Aug.	8	38.8	Aug.	7	22.9	Aug.	8	11.8	Aug.	7	44.6
Aug.	6	27.3	Aug.	28	10.4	Aug.	6	14.1	Aug.	15	40.1	Aug.	14	22.1	Aug.	15	12.3	Aug.	14	42.8
Aug.	13	30.3	Sept.	4	10.4	Aug.	13	15.0	Aug.	22	28.1	Aug.	21	19.5	Aug.	22	11.3	Aug.	21	22.8
Aug.	20	28.1	Sept.	11	10.5	Aug.	20	13.6	Aug.	29	24.8	Aug.	28	19.8	Aug.	29	11.1	Aug.	28	31.1
Aug.	27	27.5	Sept.	17	10.1	Aug.	27	13.3	Sept.	5	25.3	Sept.	4	19.8	Sept.	5	10.8	Sept.	4	17.5
Sept.	3	27.8	Oct.	2	10.2	Sept.	3	13.6	Sept.	10	26.8	Sept.	10	20.8	Sept.	11	11.3	Sept.	10	24.0
Sept.	10	30.7	Oct.	18	10.2	Sept.	10	13.6	Sept.	26	25.6	Sept.	26	20.4	Sept.	17	10.1	Sept.	26	31.5
Sept.	17	26.7	Oct.	31	10.3	Sept.	24	13.1	Oct.	9	26.8	Oct.	10	20.1	Oct.	2	10.8	Oct.	10	30.3
Oct.	2	26.0	Nov.	19	F.	Oct.	9	13.5	Oct.	25	25.3	Oct.	23	20.1	Oct.	18	10.0	Oct.	23	27.6
Oct.	18	25.1	Dec.	19	F.	Oct.	25	13.3	Nov.	18	26.4	Oct.	29	19.4	Oct.	31	9.6	Nov.	18	29.5
Oct.	31	25.5				Nov.	19	F.	Dec.	18	30.3	Nov.	18	20.1	Nov.	19	F.	Dec.	18	39.0
Nov.	19	26.3				Dec.	19	F.				Dec.	18	F.	Dec.	19	F.			
Dec.	20	F.																		

TABLE XVI

Mean Water Levels Calculated from Corrected Water Levels
in Relation to Lowest Depression at Seven Plots 1968

Rennie		Telford		Seddon's Corner		Pine Falls		Riverton		Darwin		Hodgson	
Jan. 15	-23.8	Jan. 16	F..	Jan. 16	-18.4	Jan. 16	-23.6	Jan. 17	F.	Feb. 14	F.	Jan. 17	-31.9
Feb. 14	F.	May 16	+7.2	Feb. 14	-18.0	Feb. 14	-25.3	Feb. 15	F.	March 13	F.	Feb. 15	-32.0
March 13	F.	May 21	+7.4	March 13	-18.8	March 14	-25.3	March 14	F.	April 18	+ 2.8	March 14	-32.3
April 18	F.	May 29	+7.4	April 18	- 4.6	April 18	-15.9	April 16	F.	May 17	+10.4	April 16	F.
May 15	+ 6.0	June 5	+7.1	May 15	+ 5.3	May 22	+ 5.3	May 22	+5.3	May 23	+ 9.9	May 21	+ 7.6
May 23	+ 4.7	June 12	+7.8	May 21	+ 5.3	May 30	+ 5.0	May 29	+5.0	May 30	+ 8.6	May 29	+ 8.5
May 28	+ 4.7	June 19	+7.2	May 28	+ 4.9	June 6	+ 4.0	June 5	+4.4	June 6	+ 9.0	June 5	+ 5.9
June 4	+ 4.9	June 26	+6.8	June 4	+ 4.8	June 13	+ 4.6	June 12	+4.4	June 13	+ 9.8	June 12	+ 3.1
June 11	+ 6.2	July 3	+8.0	June 11	+ 6.4	June 20	+ 1.6	June 19	+3.5	June 20	+ 8.0	June 19	- 5.4
June 18	+ 3.2	July 10	+7.5	June 18	+ 5.5	June 27	- 0.9	June 26	+1.9	June 27	+ 6.8	June 26	-11.4
June 25	+ 1.2	July 17	+7.6	June 25	+ 4.5	July 4	+ 2.4	July 3	+4.6	July 4	+10.1	July 3	+ 8.5
July 2	+ 4.3	July 24	+7.5	July 2	+ 6.0	July 11	0.0	July 10	+3.4	July 11	+ 8.0	July 10	+ 1.5
July 9	+ 1.6	July 31	+7.5	July 9	+ 6.0	July 18	- 3.0	July 17	+2.0	July 18	+ 9.8	July 17	- 9.0
July 16	+ 2.2	Aug. 7	+7.1	July 16	+ 6.5	July 25	- 5.1	July 24	+1.9	July 25	+ 9.9	July 24	-13.6
July 23	+ 2.4	Aug. 14	+6.3	July 23	+ 6.5	Aug. 1	- 6.9	July 31	+1.4	Aug. 1	+ 9.5	July 31	-17.3
July 30	+ 1.3	Aug. 21	+7.4	July 30	+ 6.6	Aug. 8	-10.0	Aug. 7	+0.4	Aug. 8	+ 8.0	Aug. 7	-20.1
Aug. 6	0.0	Aug. 28	+8.0	Aug. 6	+ 5.9	Aug. 15	-11.4	Aug. 14	+1.1	Aug. 15	+ 7.5	Aug. 14	-18.3
Aug. 13	- 2.9	Sept. 4	+8.0	Aug. 13	+ 5.0	Aug. 22	+ 0.6	Aug. 21	+3.8	Aug. 22	+ 8.5	Aug. 21	+ 1.8
Aug. 20	- 0.8	Sept. 11	+7.9	Aug. 20	+ 6.4	Aug. 29	+ 4.0	Aug. 28	+3.5	Aug. 29	+ 8.6	Aug. 28	- 6.6
Aug. 27	- 0.2	Sept. 17	+8.3	Aug. 27	+ 6.8	Sept. 5	+ 3.5	Sept. 4	+3.5	Sept. 5	+ 9.0	Sept. 4	+ 7.0
Sept. 3	- 0.5	Oct. 2	+8.2	Sept. 3	+ 6.4	Sept. 10	+ 2.0	Sept. 10	+2.5	Sept. 11	+ 8.5	Sept. 10	+ 0.5
Sept. 10	- 3.3	Oct. 18	+8.2	Sept. 10	+ 6.4	Sept. 26	+ 3.1	Sept. 26	+2.9	Sept. 17	+ 9.6	Sept. 26	- 7.0
Sept. 17	+ 0.7	Oct. 31	+8.1	Sept. 24	+ 6.9	Oct. 9	+ 2.0	Oct. 10	+3.1	Oct. 2	+ 9.0	Oct. 10	- 5.8
Oct. 2	+ 1.3	Nov. 19	F.	Oct. 9	+ 6.5	Oct. 25	+ 3.5	Oct. 23	+3.1	Oct. 18	+ 9.8	Oct. 23	- 3.1
Oct. 18	+ 2.3	Dec. 19	F.	Oct. 25	+ 6.8	Nov. 18	+ 2.4	Oct. 29	+3.9	Oct. 31	+10.1	Nov. 18	- 5.0
Oct. 31	+ 1.8			Nov. 19	F.	Dec. 18	- 1.5	Nov. 18	+3.1	Nov. 19	F.	Dec. 18	-14.5
Nov. 19	+ 1.0			Dec. 19	F.			Dec. 18	F.	Dec. 19	F.		
Dec. 20	F.												

METEOROLOGICAL RECORDS

The month of May was cool with a mean temperature of 48.0 degrees, and above average precipitation of 3.90 inches, which was twice the normal for this month. June was cool with an average temperature of 59.6 degrees, which was slightly below normal. The total rainfall of 3.26 inches was normal for the month. July had below normal temperatures, the average daily temperature being 63.7 degrees. The maximum and minimum temperatures for July were 90 degrees and 38 degrees respectively. Rainfall for the month was well above normal, with a total of 5.66 inches falling, compared to the normal of 2.71 inches. A thunderstorm of July 16, dropped 1.55 inches of rain in 30 minutes. Winds gusted up to a maximum of 38 m. p. h. on that date. August was cool and wet. The average temperature for the month was 59.9 degrees and the total rainfall of 5.63 inches was twice the normal amount for August. September had a normal average temperature of 57 degrees and normal precipitation of 2.31 inches. Sunshine for the month was slightly less than usual. October had an average temperature of 42 degrees. The first frost came on October 4, which made the total frost-free period of 145 days, or 14 days longer than normal. Total precipitation for October was 1.59 inches.

VERTEBRATE PREDATORS

Small Mammal Populations

Small mammal populations on the larch sawfly life table plots showed no remarkable changes in 1968 as compared to those in 1967. Populations of voles decreased slightly in 1968 while insectivore populations increased slightly. In general, populations of both rodents and insectivores on these plots were low.

Numbers of the predator Mustela erminea showed a general decline in 1968 over the high numbers of 1967. However, there were still an average of 1.8 weasels per plot in 1968 as compared to 2.1 in 1967. Six M. erminea were recorded on the Darwin plot in 1968 where five had been caught in 1967.

A list of the small mammals encountered on these plots is presented in Table XVII and the populations of these are summarized in Table XVIII.

Cocoon Predation by Small Mammals

The estimated mortality inflicted by small mammals on the cocoon stage of the larch sawfly, as assessed through identification of the characteristic markings left by rodents or insectivores on planted cocoons of the 1967-68 generation, is presented in Table XIX.

These results show a general decrease in predation by small mammals on the 1967-68 generation of larch sawfly cocoons compared to that of the 1966-67 generation. This general decrease in predation corresponds to a general decline in small mammal populations from 1966 to 1967.

TABLE XVII

List of Small Mammals Frequenting the Larch Sawfly Study Sites in Manitoba

Species	Abbreviations
Sorex cinereus cinereus Kerr (the common cinereous shrew)	S. cinereus
Sorex arcticus laricorum Jackson (the southern saddle-backed shrew)	S. arcticus
Microsorex hoyi hoyi (Baird) (the American pigmy shrew)	M. hoyi
*Sorex palustris palustris Richardson (the American water shrew)	S. palustris
Blarina brevicauda manitobensis Anderson (the Manitoba short-tailed shrew)	B. brevicauda
*Peromyscus maniculatus bairdii (Hoy and Kennicott) (Baird's white-footed mouse)	P. maniculatus
*Zapus hudsonius hudsonius (Zimmerman) (the Hudson Bay jumping mouse)	Z. hudsonius
Synaptomys cooperi cooperi Baird (Cooper's lemming vole)	S. cooperi
Clethrionomys gapperi loringi (Bailey) (the plains red-backed vole)	C. gapperi
Microtus pennsylvanicus drummondii (Audubon and Bachman) (Drummond's meadow vole)	M. pennsylvanicus
Tamiasciurus hudsonicus hudsonicus (Erxleben) (the Hudson Bay red squirrel)	T. hudsonicus
Glaucomys sabrinus sabrinus (Shaw) (the Hudson Bay flying squirrel)	G. sabrinus
Eutamias minimus borealis (Allen) (the northern interior chipmunk)	E. minimus
Mustela erminea richardsonii Bonaparte (Richardson's ermine)	M. erminea
*Mustela rixosa rixosa (Bangs) (the least weasel)	M. rixosa

* Not observed on the study plots in 1968

TABLE XVIII

Small Mammal Populations per Acre in 1968

	Rennie	Telford	Seddon's Corner	Pine Falls	Darwin	Hodgson
S. cinereus	1.36	.96	1.16	.56	1.28	0
S. arcticus	.08	.08	0	0	.08	0
M. hoyi	0	0	.36	0	.17	0
B. brevicauda	.54	.09	.86	.99	.27	0
Total Insectivores	1.98	1.13	2.38	1.55	1.80	0
S. cooperi	0	0	.08	0	0	0
C. gapperi	3.19	1.06	0	2.98	.21	.43
M. pennsylvanicus	.12	2.00	.10	0	2.00	0
Total Rodents	3.31	3.06	.18	2.98	2.21	.43
E. minimus				1*		
T. hudsonicus	4*		3*	1*		
G. sabrinus	1*			1*		
M. erminea	1*		1*	3*	6*	

* = Total number caught rather than population per acre

TABLE XIX

Per Cent of Larch Sawfly Cocoons of the 1967-68 Generation Destroyed by Small Mammals

	Rennie (1)	Telford (2)	Seddon's Corner (3)	Pine Falls (4)	Darwin (6)	Hodgson (7)
Insectivores	34.9	70.8	41.6	52.2	35.5	6.4
Rodents	20.4	14.2	17.6	27.4	43.6	37.1
Total	55.3	85.0	59.2	79.6	79.1	43.5

Bird Populations

The annual bird census showed a considerable increase in both total populations of birds and numbers of species recorded. In 1968 populations at Darwin, Pine Falls and Seddon's Corner increased by 40%, 77% and 188% respectively, the Rennie populations increased by 8% while populations on the Telford and Hodgson plots declined 14% and 15% respectively.

A comparison of total populations per acre and number species for each plot for the last five years is shown in Table XX.

Energy Flow

As part of a continuing effort to assess the energy flow through the larch-larch sawfly-predator-parasite system, 75 samples of tamarack foliage were analysed in 1968 by bomb-calorimetery to determine the energy content of the larch sawfly's food source. These first samples were from foliage sampled in the Hodgson plot in 1967. Samples of both spring and fall foliage were analysed to determine seasonal changes in energy content. Results of the analyses indicated an average calorific value for larch needles of 4.663 calories per gram. There was no significant calorific difference between spring and fall foliage. Further analysis will be made in 1969 of foliage from the other life table plots, and the complete data on this phase of the energy flow analysis should be available in early 1970.

Investigations by C. H. Buckner in 1965 have provided data on the calorific value of larch sawfly fifth-instar larvae, eonymphs and adults; and plans in 1969 include the calorific analysis of the early-instar larvae.

TABLE XX

Total Populations per Acre and Number of Species (in Parenthesis) of Birds at the Larch Sawfly Study Sites from 1964 to 1968

Year	Rennie	Telford	Seddon's Corner	Pine Falls	Riverton	Darwin	Hodgson
1964	11.43(29)	5.93(15)	3.25(12)	9.74(34)	9.00(31)	8.73(29)	-
1965	-	-	4.09(14)	-	-	8.15(22)	-
1966	9.01(16)	3.64(13)	5.19(16)	5.81(22)	5.74(26)	7.08(20)	-
1967	13.32(26)	11.37(20)	4.04(12)	5.79(19)	-	12.96(22)	11.81(27)
1968	14.44(31)	9.96(26)	11.64(22)	10.30(28)	-	18.19(36)	10.28(26)