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ABSTRACT

The distribution and frequency of collections of 55 insect species that attack larch, Larix laricina, in Newfoundland are listed. A second list provides the names of parasites reared from larch insects. Five major pests, their life cycle, damage and infestation history are described. Canadian Forestry Service, Forest Insect and Disease Survey records of collections between 1951 and 1979 were consulted.

RÉSUMÉ

On a fait une liste de la distibution et de la fréquence des collection de 55 espèces d'insectes qui attaquent le mélèze, Larix laricina, à Terre-Neuve. La deuxième liste fournit les noms de parasites qui vivent sur les insectes du mélèze. On décrit cinq insectes majeurs, leur cycle de vie, les dommages qu'ils causent et l'histoire de cette infestation. On a consulté les dossiers des collections faites entre 1951 et 1979, par le Service Canadien des Forêts dans leurs études sur les insectes et maladies de forêts.

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INTRODUCTION

Eastern larch or tamarack (Larix laricina (Du Roi) K. Koch) is a boreal species that grows throughout Canada (Hosie 1969). However, appreciable merchantable volumes of eastern larch occur only in Manitoba and British Columbia (Anon. 1970). The species was virtually eradicated from large parts of eastern North America in the late 1800's by severe infestations of the larch sawfly (Carroll 1964). Since then larch has been making a gradual recovery. In Newfoundland, larch is common as a minor component of many softwood stands, or occasionally it may form pure stands on bog sites where other species are unable to survive. Only a few pure larch stands occur in the Province and these occupy small, irregular areas.

Research on hybrid larch, in both Europe and North America, has been in progress for many years and some very successful interspecific hybrids have been developed. Planting experiments that involve native, exotic and hybrid species are also in progress in Newfoundland. There is considerable optimism that the hybrid and exotic species may outperform the native larch and perhaps other softwood species as well (Hall 1977). Both the pulp and paper industry (Kubes and Swan 1974) and the Province are interested in using larch as a commercial pulping species.

Management and utilization of larch requires consideration of the damage to trees and stands caused by insect attack. This report provides a comprehensive listing of the insect pests collected on and known to be associated with larch in Newfoundland. The distribution and frequency of collections are indicated for each insect listed. A listing is also provided of the parasites reared from larch pests. Five pest species considered to be of potential economic importance are described in detail.

INSECTS COLLECTED ON LARCH

The insects from all forest trees and shrubs are examined each year by Forest Insect and Disease Survey field staff. Insects from larch have been collected in all ten Survey Districts on the island of Newfoundland (Fig. 1). A total of 55 species have been collected between 1951 and 1980. Some of these insects were identified by regional staff, but most by specialists of the Entomological Research Institute, Canadian Department of Agriculture, Ottawa. Appendix I is a taxonomic listing of the species collected and their distribution and frequency by Survey District.

Parasites often effectively control population levels of forest insect pests. The parasite complex of two pests, the larch casebearer and the larch sawfly, have been investigated in detail in Newfoundland (Raske and Schooley 1979, Warren and Pardy 1968). Foreign parasites were introduced to strengthen the effects of natural parasites on both these pests. Parasites have also been recorded from 24 other

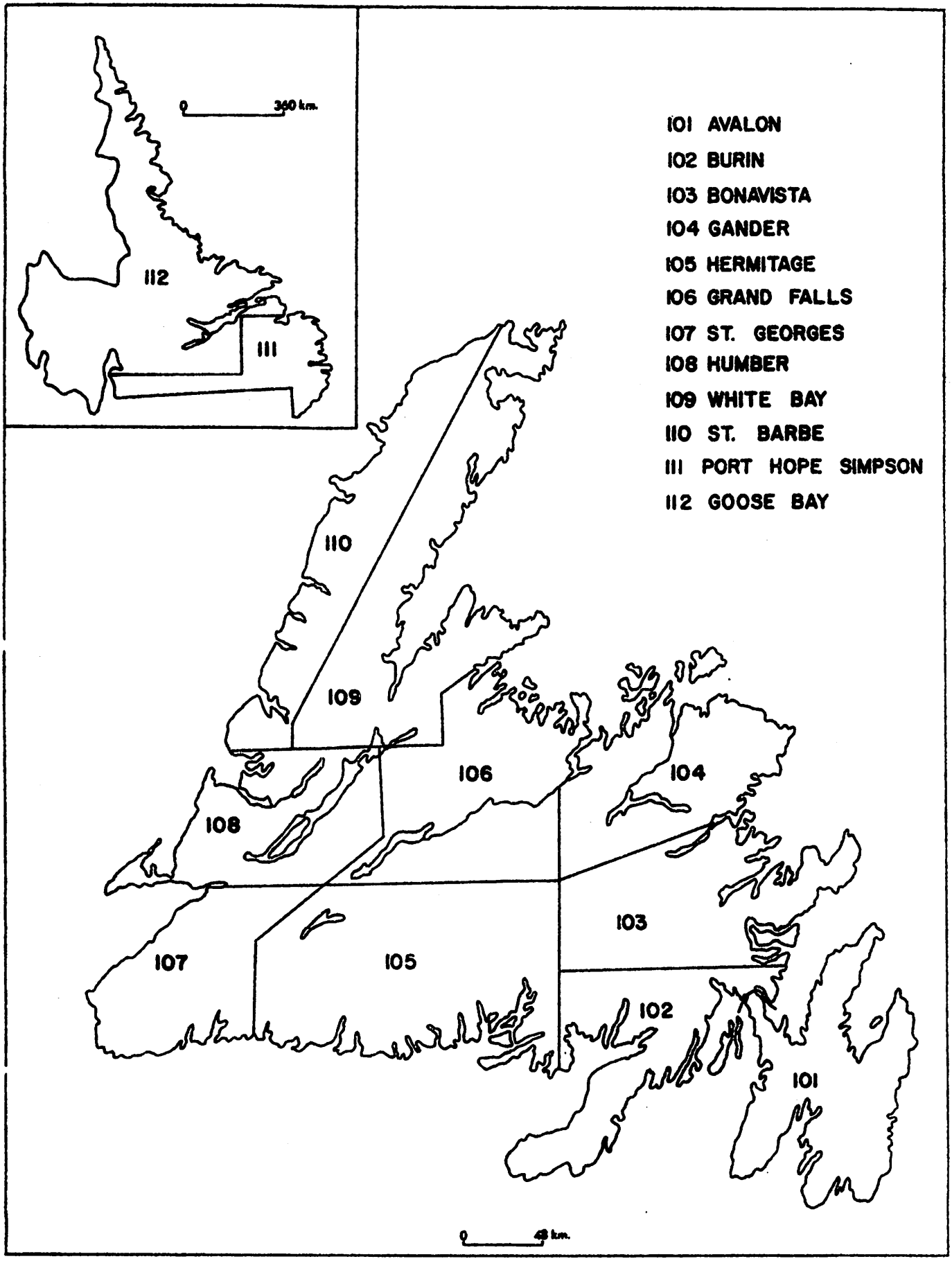

Fig. 1. Forest Insect and Disease Survey Districts.

insects that attack larch. A list of all parasites and their insect hosts is provided in Appendix II. Introduced parasites are specially indicated.

MAJOR PESTS OF LARCH IN NEWFOUNDLAND

Five insect pests which attack larch may cause serious growth losses and mortality. These, in order of importance are the larch sawfly (Pristiphora erichsonii), the eastern larch beetle (Dendroctonus simplex), the spruce budworm (Choristoneura fumiferana), the larch casebearer (Coleophora laricella), and the larch needleworm, (Zeiraphera improbana). A brief description of each of these including their life history, parasites, infestation history, and damage follows.

Larch Sawfly

The larch sawfly is a major defoliator of all species of larch in Europe where it is a native pest and in North America where it is thought to have been accidentally introduced in the late 1800's (Turnock 1972, Wong 1974). This insect destroyed virtually all mature larch in Newfoundland in the early 1900's (Carroll 1964). Since then several infestations have occurred but the insect has not caused any significant tree mortality. According to Clark et al. (1974) the first outbreak on replacement stands was recorded on the Avalon Peninsula in 1925. Other outbreaks occurred on the Avalon Peninsula between 1935 and 1947 and at various other locations in eastern Newfoundland between 1952 and 1960. In central Newfoundland outbreaks occurred between 1942 and 1948, and between 1952 and 1970. In western Newfoundland, outbreaks were first

recorded in 1942. They continued until 1958 and reoccurred at various locations between 1955 and 1973. A large new outbreak in western Newfoundland started in 1978 and is continuing.

Sawfly adults emerge from cocoons in the soil from late June to mid-July (Clark et al. 1974). Adults are 6-9 mm long, and black with a broad, yellow band on their abdomen. Females deposit 20-200 eggs in rows under the bark of current shoot tips. The shoots are injured during egg laying and as a result curl downwards. Hatching occurs in about a week and the young larvae feed along the edges of the needles; later stages of the larvae consume entire needles. Mature larvae are about 2 cm long. Their heads and thoracic legs are black and their bodies are greyish-green above and paler green underneath. When feeding is complete, larvae drop to the ground, where they pupate and overwinter in dark brown cocoons.

A total of 10 parasite species have been reared from the larch sawfly in Newfoundland (Appendix II). These include Mesoleius tenthredinis Morley, an introduced species, and two indigenous species, Bessa harveyi (Tns.) and Eclytus ornatus Holmg. However, parasites do not significantly reduce the extent or intensity of sawfly outbreaks (Warren and Pardy 1968). In 1958 the masked shrew (Sorex cinereus cinereus Kerr) was introduced to Newfoundland from New Brunswick to improve the control of a number of forest insects which pupate in the soil or forest litter (Clark et al. 1973). The shrew established readily and by 1972 occurred in virtually all forested areas of the Island. Too little time has passed to permit a precise determination of the impact of this predator

on forest insect pests; however, it may now be reducing larch sawfly numbers significantly (Bider and Sarrazin 1972).

Eastern Larch Beetle

The eastern larch bark beetle usually attacks larch trees that have been weakened by any one of several physical disturbances or injury such as flooding, snow breakage, windthrow or recent cutting. Consequently, it is not generally regarded as being of major economic importance. However, trees that have been repeatedly defoliated by insects such as the larch sawfly and the spruce budworm are also susceptible to beetle attack. Beetle infestations developing after defoliation have recently occurred at various locations in New Brunswick and Prince Edward Island in eastern and central Nova Scotia (Magasi 1979) and throughout Newfoundland (personal communication).

Adult eastern larch beetles are dark brown and about 4 mm long. Susceptible trees may be attacked at any time from mid-June to early September. Circular entrance holes are mined into the bark and verticle galleries, 20 to 25 cm long are formed next to the wood surface. Groups of three to six eggs are deposited in grooves cut into the sides of the galleries. Adult beetles may re-emerge to construct a second or third gallery during the season. Eggs hatch in about ten days and larvae construct individual mines in the bark tissue adjacent to the original galleries. Later stages of the larvae expand the mine into irregularly shaped feeding areas and pupation and hibernation occurs there. The principal overwintering stage is the young adults; these are

the beetles that are observed attacking trees in the spring. Some large larvae may also overwinter. These emerge as adults during the summer.

No parasites of the eastern larch beetle have been collected in Newfoundland.

Spruce Budworm

The spruce budworm is a native forest insect that periodically causes extensive defoliation and mortality to balsam fir (Abies balsamea (L.) Mill.) and to other conifer species including larch. The first major outbreak of this pest in Newfoundland began in 1971 and is still persisting in 1980.

Adult moths have a wingspan of about 20 mm and are dull grey with their forewings marked with streaks and spots of brown. They are active from mid-July to mid-August and deposit small, oval, pale green eggs in clusters of 10-20 on the needles of the host tree. The pale yellow to light brown larvae that hatch from the eggs do not feed but search for protected sites where they construct silken cells called "hibernaculae". The larvae overwinter in these structures. Young larvae become active again in early June and mine the most recently formed buds and needles. Within a few days the larvae emerge from these mines to feed on the new foliage. Mature larvae are about 25 mm long and are reddish-brown to dark brown with whitish-yellow tufts of short hair along their bodies. They complete their feeding in July or early August and pupate within webbed loose cells of foliage on the trees (Crummey and Otvos 1980).

Larch is not the primary host of the spruce budworm but it will oviposit, overwinter and readily feed on this tree species. Larch distributed as a minor component of balsam fir and spruce stands also becomes infested when budworm larvae hanging on silken threads are wind blown from adjacent trees. This occurs most frequently when larvae move in search of new feeding sites. Larch occurring in black spruce (Picea mariana (Mill.) B.S.P.) stands is often more severely defoliated than the spruce. Larch occurring in white spruce or balsam fir stands is usually defoliated to the same degree as its companion trees. The pruning of new shoots and killing of needle clusters on larch trees is also a common form of spruce budworm damage.

In Newfoundland eight species of parasites commonly occur on spruce budworm collected from balsam fir and spruce. Only three of these parasites, one of which was introduced to Newfoundland, have been reared from budworm collected from larch (Appendix II).

Larch Casebearer

The larch casebearer defoliates native and exotic larches of eastern and western North America and was accidentally introduced from Europe. It was first recorded in the United States in 1886, in Canada in 1905 and the earliest record in Newfoundland was 1941. It now occurs in all larch stands on the Island (Raske and Schooley 1979). Severe defoliation by this insect retards tree growth and if continued for more than two years tree mortality may occur.

Adult moths are small, and have narrow silvery to grey-brown wings fringed with long hairs. Moths emerge about the end of June and yellowish eggs are laid singly on the foliage (Raske and Schooley 1979). On hatching, larvae bore directly into the leaves and feed within the needles until late summer. At this time part of a mined needle is used by each larva to construct a cigar-shaped case over their bodies. The larvae migrate from the foliage before the leaves fall and overwinter within their cases fastened to the twigs or branches. In the spring larvae move to the new foliage, attach their cases to the surface of needles and mine out the interior tissues. Full grown larvae are about 6 mm long, with black heads, thoracic and anal shields. They pupate within their larval case in mid-June.

About 20 species of native insects parasitize the larch case-bearer in eastern North America; 13 have been collected in Newfoundland (Appendix II). However, none of these have ever been recorded as abundant enough to regulate populations. In an attempt to improve the native parasite complex, five parasite species were introduced from England into eastern Canada and the eastern United States between 1931 and 1939. Two of the species, Agathis pumila (Ratz.) and Chrysocharis (= Epilampsis) laricinellae (Ratz.), became established in Ontario, and this prompted the introduction of these two species at various locations in Newfoundland between 1944 and 1947. Both species became established but A. pumila has become the most dominant, parasitizing up to 80% of the host larvae (Raske & Schooley 1979).

Larch Needleworm

The larch needleworm is native throughout southern Canada and northern United States. This pest has never caused major damage in Newfoundland but severe and extensive infestations occurred in British Columbia in 1965 and Ontario in 1970 (Lindquist 1973).

Adult moths are small, grey to light brown, with dark diagonal markings on their forewings. They are active in August and lay irregularly shaped, flattened, silver eggs singly or in clusters of up to 20, on the scales of the current year's cones. The eggs overwinter, then hatch in May. The young larvae are yellow with dark brown heads and prothoracid shields and feed within clusters of new needles. Later stages of the larvae web needles together to form compact feeding tubes. Mature larvae are black and about 15 mm long. Feeding is usually completed by late July and the larvae drop to the ground, construct silken cocoons and pupate.

Only one species of parasite has been reared from the needleworm in Newfoundland (Appendix II). A total of five additional parasite species are reported by Lindquist (1973).

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APPENDIX I

Distribution of Insects Collected on Larch by Survey Districts in Newfoundland

The following is a taxonomic listing of all species collected from larch, their distribution by Survey District in Newfoundland and the number of collections made between 1951 and 1980.

Insect	Survey District	Number of collections
COLEOPTERA		
Cerambycidae — Roundheaded wood borers		
Anoplodera canadensis (Oliv.) Redshouldered pine borer	Grand Falls	1
Anoplodera tibialis Lec.	Grand Falls	1
	Hermitage	
Monochamus scutellatus (Say) Whitespotted sawyer	Bonavista	1
	Grand Falls	1
	Humber	1
	St. Barbe	1
Rhagium inquisiter (Linn.)	Bonavista	1
Coccinellidae — Lady beetles		
Anatis mali (Say) Eyespotted lady beetle	Avalon	1
	Bonavista	3
	Grand Falls	1
	Humber	1
Curculionidae — Snout beetles or weevils		
Hylobius pinicola (Couper) Couper's collar weevil	Grand Falls	1
	Humber	1
	St. Georges	1

APPENDIX I. (Cont'd.)

Insect	Survey District	Number of collections
Scolytidae – Bark beetles		
Dendroctonus simplex LeC. Eastern larch beetle	Avalon	3
	Bonavista	1
	Gander	12
	Grand Falls	30
	St. Georges	4
	Humber	6
	White Bay	5
Orthotomicus caelatus (Eich.)	Bonavista	1
Polygraphus rufipennis (Kby.) Four-eyed spruce bark beetle	Bonavista	1
Trypodendron lineatum (Oliv.) Striped ambrosia beetle	Bonavista	1
HOMOPTERA		
Aphididae – Aphids or plant lice		
Cinara laricifex (Fitch) Black larch aphid	Avalon	2
	Bonavista	2
	Grand Falls	2
	Humber	2
	St. Georges	2
Adelgidae		
Adelges strobilobius (Kalt.) Woolly larch aphid	Bonavista	1
	St. Georges	1
HYMENOPTERA		
Tenthredinidae – Sawflies		
Anoplonyx luteipes (Cress.) Marlatt's larch sawfly	Avalon	36
	Bonavista	197
	Burin	18
	Gander	30

APPENDIX I. (Cont'd.)

Insect	Survey District	Number of collections
	Goose Bay	1
	Grand Falls	226
	Hermitage	4
	Humber	127
	St. Barbe	25
	St. Georges	125
	White Bay	41
Pristiphora erichsonii (Htg.) Larch sawfly	Avalon	43
	Bonavista	336
	Burin	17
	Gander	100
	Goose Bay	18
	Grand Falls	584
	Hermitage	1
	Humber	215
	St. Barbe	39
	St. Georges	260
	White Bay	136
LEPIDOPTERA		
Coleophoridae — Casebearer moths		
Coleophora laricella (Hbn.) Larch casebearer	Avalon	96
	Bonavista	231
	Burin	7
	Gander	34
	Grand Falls	71
	Hermitage	6
	Humber	77
	St. Barbe	16
	St. Georges	112
	White Bay	26
Geometridae — Geometrid moths		
Biston cognataria (Guen.) Pepper-and-salt moth	Gander	1
Campaea perlata (Guen.) Light emerald looper	Gander	1
	Grand Falls	1
	St. Georges	1

APPENDIX I. (Cont'd.)

Insect	Survey District	Number of collections
Caripeta divisata Wlk. Gray spruce looper	Avalon	1
	Bonavista	2
	Grand Falls	5
	Humber	2
	White Bay	1
Dysstroma truncata Hufn.	Bonavista	1
Ectropis crepuscularia (Schiff.) Flat-faced looper	Bonavista	1
	Humber	1
	St. Barbe	1
	St. Georges	1
Eupithecia filmata Pears Early brown looper	White Bay	1
Eupithecia fletcherata Tayl.	St. Georges	1
Eupithecia gibsonata Tayl.	Humber	1
Eupithecia luteata Pack. Fir needle inchworm	Grand Falls	3
Hydriomena divisaria (Wlk.) Transverse-banded looper	Bonavista	1
Lambdina fiscellaria fiscellaria (Gn.) Eastern hemlock looper	Avalon	5
	Bonavista	20
	Burin	2
	Gander	3
	Grand Falls	19
	Humber	3
	St. Barbe	3
	St. Georges	22
	White Bay	12
Nepytia canosaria (Wlk.) False hemlock looper	Avalon	1
	Grand Falls	1
Nyctobia limitaria (Wlk.) Green balsam looper	Avalon	1
	Bonavista	8
	Grand Falls	4
	Humber	3
	St. Barbe	2
	St. Georges	1
	White Bay	4

APPENDIX I. (Cont'd.)

Insect	Survey District	Number of collections
Epirrita autumnata benshawi (Swett) November moth	White Bay	1
Hypagyrtis piniata (Pack) Pine looper	Avalon	1
	Bonavista	2
	White Bay	1
Prochoerodes transversata (Drury) Large maple spanworm	Bonavista	1
Semiothisa granitata (Gn.) Green spruce looper	Bonavista	5
	Gander	1
	Grand Falls	1
	St. Barbe	1
	White Bay	1
Semiothisa oweni (Swett) Owen green looper	Bonavista	2
	Gander	1
Semiothisa sexmaculata (Pack) Green larch looper	Avalon	2
	Bonavista	7
	Gander	4
	Grand Falls	10
	Humber	2
	St. Barbe	3
	St. Georges	6
	White Bay	4
Lymantriidae — Tussock moths		
Orgyia leucostigma (J.E. Smith) Whitemarked tussock moth	Bonavista	1
	White Bay	1
Orgyia antiqua (L.) Rusty tussock moth	Avalon	4
	Bonavista	21
	Burin	3
	Gander	2
	Grand Falls	12
	Hermitage	1
	Humber	4
	St. Barbe	2
	St. Georges	16
	White Bay	6

APPENDIX I. (Cont'd.)

Insect	Survey District	Number of collections
Dasychira plagiata (Wlk.) Pine tussock moth	Grand Falls	1
	St. Barbe	1
Olethreutidae — Olethreutid moths		
Zeiraphera improbana (Wlk.) Larch needleworm	Avalon	21
	Bonavista	63
	Burin	3
	Gander	8
	Grand Falls	18
	Humber	7
	St. Barbe	3
	St. Georges	9
	White Bay	7
Noctuidae — Owlet moths and underwings		
Anomogyna elimata (Gn.) Chameleon caterpillar	Avalon	1
	Humber	1
	St. Barbe	1
Anomogyna perquiritata (Morr.) Gray spruce cutworm	Grand Falls	1
Feralia jocosa (Guen.) Red-marked caterpillar	Avalon	1
	Bonavista	2
	Burin	1
	Gander	2
	Humber	1
	St. Georges	1
Lithophane thaxteri Grt. Owlet moth	Bonavista	1
Orthosia hibisci (Guen.) Green fruitworm	Grand Falls	1
Panthea acronyctoides Wlk. Tufted spruce caterpillar	Bonavista	4
	Grand Falls	1
	White Bay	3

APPENDIX I. (Cont'd.)

Insect	Survey District	Number of collections
Polia frustrata Mcd.	White Bay	2
Polia pulverulenta (Smith)	Bonavista	1
Syngrapha alias (Ottol.) Spruce climbing cutworm	St. Georges	1
Syngrapha selecta (Wlk.) Verdigris autograph	Bonavista	2
Psychidae — Bagworm moths		
Solenobia walshella Clem. Larch bagworm	Avalon	3
	Bonavista	7
	Gander	1
	Grand Falls	3
	St. Barbe	1
	St. Georges	1
	White Bay	3
Pyralidae — Pyralid moths		
Dioryctria reniculelloides M. & M. Spruce coneworm	Bonavista	1
	Grand Falls	1
	Hermitage	1
Tortricidae — Leafroller moths		
Acleris variana (Fern.) Blackheaded budworm	Avalon	1
	Bonavista	3
	St. Barbe	1
Argyrotaenia velutinana (Wlk.) Redbanded leafroller	Bonavista	2
Choristoneura fumiferana (Clem.) Spruce budworm	Avalon	4
	Bonavista	7
	Gander	5
	Grand Falls	15
	Hermitage	2
	Humber	20
	St. Barbe	2
	St. Georges	7
	White Bay	7

APPENDIX I. (Concl'd.)

Insect	Survey District	Number of collections
Clepsis persicana Fitch White-triangle leafroller	St. Georges	1
Yponomeutidae – Ermine moths		
Argyresthia laricella Kft. Larch twig borer	St. Georges	1

APPENDIX II

The Parasites of Insects that Attack Larch.

The following is a list of parasites reared from insects that attack larch. Parasites introduced to Newfoundland are identified with an asterisk.

Insect Host	Parasite
Anomogyna elimata (Gn.)	*Gravenhorstia* sp.
Anoplonyx canadensis Hgtn.	*Bessa harveyi* (Tns.) *Erromenus* sp. *Mesoleius* sp.
Argyrotaenia velutinana (Wlk.)	*Eclytus* sp. *Glypta* sp.
Campaea perlata (Guen.)	*Dusona seamansi* (Vier.)
Caripeta divisata Wlk.	*Apanteles paleacritae* Riley *Blondelia eufitchiae* (Tns.) *Platylabus clarus* (Cress.) *Rogas* sp.
Choristoneura fumiferana (Clem.)	*Apechthis ontario* (Cress.) *Glypta fumiferana* (Vier.) *Phaeogenes hariolus* (Cress.)
Coleophora laricella (Hbn.)	*Agathis pumila* (Ratz.) *Bracon gelechiae* Ashm. *Campoplex* sp. *Campoplex mellipes* (Prov.) *Chrysocharis laricinellae* (Ratz.) *Dicladocerus* sp. *Gelis* sp. *Gelis apantelis* (Cush.) *Gelis tenellus* (Say) *Habrocytus phycidus* Ashm. *Habrocytus semotus* (Wlk.) *Mesopolopus* sp. *Scambus decorus* Wly. *Scambus hispae* (Harr.) *Spilochalcis albifrons* (Walsh)
Dioryctria reniculelloides M. & M.	*Actia interrupta* Curr. *Agria housei* Shew. *Apechthis ontario* (Cress.) *Diadegma* sp. *Diadegma conodor* (Vier.) *Ichneumon dioryctriae* Heinr. *Nemorilla pyste* (Wlk.)

APPENDIX II. (Cont'd.)

Insect Host	Parasite
Ectropis crepuscularia (Schiff.)	*Meteorus hyphantriae* Wly.
Epirrita autumnata henshawii (Swett)	*Euplectrus mellipes* Prov. *Phryxe pecosensis* (Tns.)
Eupithecia filmata Pears.	*Apanteles compressus* Mues. *Apanteles nemoriae* Ashm. *Casinaria eupitheciae* Vier.
Eupithecia fletcherata Tayl.	*Meteorus nr. versicolor* (Wesm.)
Eupithecia luteata Pack.	*Apanteles compressus* Mues. *Casinaria eupitheciae* Vier. *Meteorus* sp. *Phobocampe* sp.
Feralia jocosa (Guen.)	*Euplectrus mellipes* Prov.
Hydriomena divisaria (Wlk.)	*Diadegma* sp. *Lypha maculipennis* Ald.
Nyctobia limitaria (Wlk.)	*Apanteles* sp. *Aphanistes* sp. *Casinaria geometrae geometrae* Wly. *Gravenhorstia* sp. *Ictericophyto spinosa* (Coq.) *Ictericophyto tibialis* (Curr.) *Madremyia saundersii* (Will.) *Phobocampe* sp. *Phryxe pecosensis* (Tns.) *Zele* sp.
Parorgyia plagiata (Wlk.)	*Apanteles fiskei* Vier.
Polia frustrata Mcd.	*Banchus inermis* Prov.
Pristiphora erichsonii (Htg.)	*Bessa* sp. **Bessa harveyi* (Tns.) *Eclytus* sp. *Eclytus* n. sp. *Eclytus ornatus* Holm. *Euceros* sp. *Gelis* sp. *Mesoleius* sp. **Mesoleius tenthredinis* Morl. *Olesicampe* sp.

APPENDIX 11. (Concl'd.)

Insect Host	Parasite
Semiothisa granitata (Gn.)	*Apanteles* sp. *Apanteles paleacritae* Riley *Casinaria forcipata* Wly. *Casinaria geometrae geometrae* Wly. *Casinaria semiothisae* Wly. *Dusona vicina* (Prov.) *Euceros frigidus* Cress. *Euceros thoracicus* Cress. *Meteorus reticulatus* Mues. *Phobocampe* sp. *Rogas* sp.
Semiothisa sexmaculata (Pack)	*Apanteles* sp. *Apanteles compressus* Mues. *Casinaria semiothisae* Wly. *Dusona vicina* (Prov.) *Rogas* sp.
Solenobia walshella Clem.	*Campoplex* sp.
Syngrapha alias (Ottol.)	*Rogas* sp. *Stenichneumon militarius leucopus* Heinr.
Zeiraphera improbana (Wlk.)	*Eclytus* sp.