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BIOLOGICAL AGENTS RELEASED IN NEWFOUNDLAND FOR THE CONTROL OF FOREST INSECT PESTS

by R.C. Clark, Imre S. Otvos, and K.E. Pardy



NEWFOUNDLAND FOREST RESEARCH CENTRE
ST. JOHN'S, NEWFOUNDLAND
INFORMATION REPORT N-X-96

JUNE 1973

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INTRODUCTION

Biological control in forest management is the use of biotic agents for the planned regulation of insect pest populations. The method when successful, provides continuous, self-maintaining reduction of pest numbers so that damage is less frequent or severe. Although biological control may be expensive initially and take a long time to show results, in the long term it can provide an economic and effective method of reducing insect damage. If properly selected, biotic agents have the added advantage of causing little or no deleterious effects on the environment. These attributes are of particular significance in controlling forest insects where reducing the cost of protecting a slow growing crop is of major importance and where the frequent application of insecticides could have undesirable effects on the environment.

Prior to 1949, biological control programs against forest insect pests in Newfoundland were conducted by the Newfoundland Forest Protection Association with the help of Government of Canada facilities. Later the planning and initiating of biological control action became a responsibility of the Canadian Forestry Service, but introduction of biotic agents are made only with approval of the Province. These programs in Canada are undertaken co-operatively by the Canada Department of

Agriculture, the Canadian Forestry Service, and the Commonwealth Institute of Biological Control. The latter institute has its headquarters in Trinidad and maintains stations throughout the world including Europe, India, Pakistan, Australia and Japan. It conducts the basic research on candidate species in their country of origin and collects and ships selected candidates to a quarantine centre in Canada for later distribution to requesting establishments. Background research on the feasibility of introducing a vertebrate predator is normally conducted by the Canadian Forestry Service. The Canadian Forestry Service, Institute of Insect Pathology at Sault Ste. Marie, Ontario, has the primary responsibility for researching and arranging for the introduction and distribution of disease organisms.

This report documents the known information on the introduction, release, establishment and effectiveness of those biological agents (parasites, predators and pathogens) introduced into Newfoundland to improve the control complexes of forest pests.

BIOLOGICAL CONTROL PROGRAMS CONDUCTED IN NEWFOUNDLAND

In Newfoundland, biological control programs have been conducted against the following 10 forest insect species: the eastern hemlock looper, spruce budworm, blackheaded budworm, balsam woolly aphid, European spruce sawfly, larch sawfly, larch casebearer, satin moth, birch casebearer, and the birch leafminer. A summary of these programs is shown in Table 1.

Table 1.- Summary of biological control programs against forest insects
in Newfoundland.

Pest species	Biological control agent(s)	Number of species	
		Released	Established
Eastern Hemlock Looper	Parasites	1	1
	Pathogen (virus)	1	0
Spruce Budworm	Parasites	8	2
Blackheaded Budworm	Parasites	2	2
Balsam Woolly Aphid	Invertebrate Predators	16	5
	Pathogen (fungal)	1	0
European Spruce Sawfly	Parasites	4	1
	Vertebrate Predators (shrew)	1	1
	Pathogen (virus)	1	1
Larch Sawfly	Parasites	2	1
	Vertebrate Predators (shrew)	1	1
Larch Casebearer	Parasites	2	2
Satin Moth	Parasites	2	1
Birch Casebearer	Parasites	2	Unknown at this time
Birch Leafminer	Parasites	2	Unknown at this time

A summary of the introductions, including the intended host, biological agent, country of origin, time and place of release and number of specimens released at each point is given in Appendix I. Survey districts referred to in Appendix I are shown in Fig. 1. The total number of parasites and predators released against each host is given in Appendix II. Some of the introduced parasites have transferred to pest species other than the intended host. Known occurrences of this behaviour are shown in Appendix III. The details of the biological control action and an evaluation of its success is discussed below for each of the 10 insect pests.

Eastern Hemlock Looper, *Lambdina fiscellaria fiscellaria* (Guen.) -

The hemlock looper is a native forest insect that defoliates a variety of coniferous host tree species. In Canada, it occurs from Alberta to Newfoundland (15), and in the United States, from the Lake States to the eastern seaboard (17).

In Newfoundland the principal host is balsam fir, *Abies balsamea* (L.) Mill., and outbreaks have been recorded in fir forests on the Island since 1912. These outbreaks usually begin as small scattered infestations which often coalesce to cover large irregular areas. They usually last from 5 to 7 years but infestations in individual stands usually collapse in 2 years. Damage is most prevalent in mature and overmature stands and tree mortality has averaged more than 200,000 cords of merchantable wood per annum during the three outbreaks which occurred in the past 30 years.

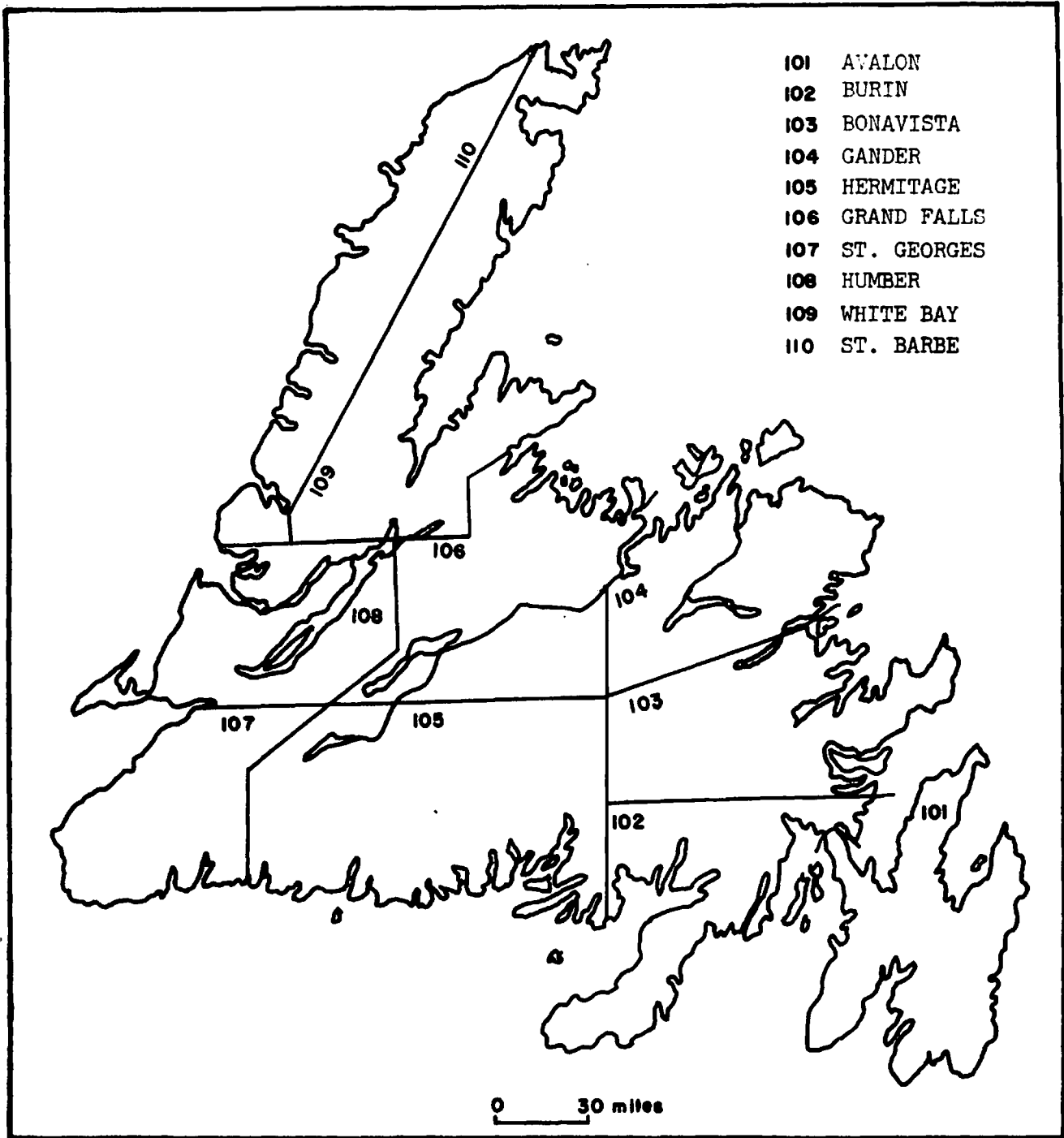


Fig. 1. Forest Insect and Disease Survey Districts

Between 1949 and 1951, several colonies of a tachina fly, *Winthemia occidentis* Rnh., were introduced from British Columbia, and released in western and central areas of the Island (Appendix I). This species is known to be an effective parasite of the closely related western hemlock looper, *L.f. lugubrosa* (Hulst.), and the oak looper, *L.f. somniaria* (Hulst.). Although several larvae, tentatively identified as *W. occidentis*, were collected in the release area in 1951 (3), no recoveries of this species were positively identified until 1969 when large numbers were reared from looper larvae collected across the Island (14). *Winthemia occidentis* is one of four tachina species attacking the hemlock looper in Newfoundland. The other three are *Blondelia eufitchiae* (Tns.) and *Phryxe pecosensis* (Tns.), two native species, and *Madremyia saundersii* (Will.) a species introduced against the spruce budworm. No hymenopterous parasites have been introduced against the hemlock looper. However two species, *Apechthis ontario* (Cress.) and *Itoplectis conquisitor* (Say), introduced against the spruce budworm and the blackheaded budworm, have now become common parasites of the looper. Parasitism by the four tachina species averaged 13% in 1969, 17% in 1970, and 22% in 1971. During the same period, parasitism by eight hymenopterous species was less than 5% and was caused chiefly by *A. ontario* and *I. conquisitor*. Records obtained in the early 1950's show that parasitism by Hymenoptera was about 30% and by Diptera less than 5%. This apparent reversal of parasitism in the past 20 years indicates that *W. occidentis*, once established, became a dominant parasite at the expense of the other native and exotic species.

In 1948, an attempt was made to introduce a polyhedrosis virus against the hemlock looper. The virus was extracted from diseased looper larvae by pathologists of the Insect Pathology Research Institute, Sault Ste. Marie. It was applied as a liquid suspension on looper infested trees at Gander Lake and Bay d'Espoir in Newfoundland. No diseased larvae were found in 1949, but in 1950 an unidentified "wilt" disease caused considerable looper mortality in widely scattered areas. The distance between these locations and the nearest point of virus dissemination makes it unlikely that the introduced virus was responsible for the epizootic (3). This assumption was further supported by investigations conducted during 1969 and 1970 when attempts were again made to control the looper by applying a virus extract. The disease did kill a low proportion of the larvae on treated trees but failed to spread to looper larvae on adjacent trees or to have any apparent effect on the looper population in the next year. Meanwhile a disease, having symptoms similar to those described earlier for the "wilt disease", terminated the looper outbreak in many areas of the Island. This disease has now been identified by Dr. D.M. MacLeod of the Insect Pathology Research Institute as being caused by two fungi, *Entomophthora sphaerosperma* Fres. and *Entomophthora* nov. sp., the latter being the more prevalent of the two. It now appears that these native fungi are a primary cause of the collapse of hemlock looper outbreaks on the Island. Experiments are being conducted on the manipulation of the epizootic caused by these fungi to control this important forest pest.

Spruce Budworm, *Choristoneura fumiferana* (Clem.) - The spruce budworm is a native insect that periodically causes defoliation and mortality to a wide variety of coniferous tree species in North America. It is a major pest of balsam fir, white spruce, *Picea glauca* (Moench.) Voss and red spruce, *P. rubens* Sarg. in Ontario, Quebec and New Brunswick. In Newfoundland, small scattered outbreaks have occurred frequently in the past but they have never caused any extensive defoliation or tree mortality, presumably because climatic conditions on the Island are unfavourable for sustaining outbreaks. Nevertheless, the importance of the pest in eastern North America, prompted the introduction of parasites to improve the effectiveness of the native parasite complex on the Island.

Between 1947 and 1951 eight species of parasitic insects were introduced from Europe (Appendix I). Of the eight species only two, *Apechthis ontario* (Cress.) and *Maadremyia saundersii* (Will.), have been recovered from the budworm and these, in conjunction with the native parasites, do not appear to have appreciably improved the effectiveness of the parasite complex (7). An outbreak of the spruce budworm commenced in 1971 and continued to increase in extent and intensity in 1972 when moderate to severe defoliation occurred over an estimated 1,600,000 acres of fir and spruce forest (9).

Blackheaded Budworm, *Acleris variana* (Fern.) - The blackheaded budworm is native to North America, and in Newfoundland it attacks balsam fir, white spruce and black spruce, *Picea mariana* (Mill.) B.S.P.

Two major outbreaks have occurred on the Island since 1946. They each lasted about 6 years and caused defoliation over extensive areas of spruce-fir forests, particularly in eastern and central Newfoundland. Although tree mortality has not been excessive stands have been degraded by mortality and top killing, especially where trees have also been weakened by other insects such as the balsam-fir sawfly, *Neodiprion abietis* complex.

Two parasitic species, *Itoplectis conquisitor* (Say) and *Meteorus trachynotus* Vier., were released against this budworm in east-central Newfoundland in 1950. The former species has not been recovered from the blackheaded budworm, probably because it is a pupal parasite (11) and the pupal stage of this budworm has not been collected for parasite studies, however, it was recovered from hemlock looper pupae in 1970 and 1971. *M. trachynotus* was recovered from the blackheaded budworm following release, however, Survey records show that *M. trachynotus* is probably a native species because it was recovered from both the blackheaded budworm and the spruce budworm, prior to its introduction in 1950. In any case, it is assumed these two parasites add additional control to the complex of more than 30 species that are largely responsible for terminating outbreaks of the blackheaded budworm in Newfoundland (7).

Balsam Woolly Aphid, *Adelges piceae* (Ratz.) - The balsam woolly aphid is a serious pest of true firs, *Abies* spp., in eastern and western Canada, and in many of the northeastern and northwestern states of the

U.S.A. In Newfoundland, balsam fir is the only native host. Studies have indicated that the aphid was introduced to the west coast of Newfoundland about 1940, and to the east coast of the Island about 10 to 15 years earlier. In 1949 small outbreaks were recorded for the first time in the Codroy Valley in western, and on the Avalon Peninsula in eastern, Newfoundland. Additional outbreaks were recorded on the Burin Peninsula in 1954 (4), and at Norris Arm in central Newfoundland in 1961. By 1972 all of the outbreaks had expanded and they now cover an estimated 4 million acres throughout the Island.

No insect parasites have been recorded for the balsam woolly aphid but it, and related aphid species, are attacked by insect predators and a pathogen. Therefore, attempts at biological control involved the introduction of a number of insect predators and one parasitic fungus.

A total of 16 species of insect predators have been introduced (Appendix I). Of these, only five, *Leucopis* spp., *Cremifania nigrocellulata* Cz., *Aphidoletes thompsoni* Möhn., *Aphidecta oblitterata* L. and *Laricobius erichsonii* Rosen., have become established. Studies have shown that these species become established only when aphid numbers are high, in excess of 15 per node. Unfortunately, balsam fir can be severely damaged at population levels of four aphids per node (8). All indications are that the introduced predators, together with the five known native species, have had little or no influence in reducing damage caused by the aphid. In 1969, an attempt was made to introduce a parasitic fungus, *Fusarium larvarum* Forbel, to control the aphid. The introduction was a failure and the fungus was never recovered.

Larch Sawfly, *Pristiphora erichsonii* (Htg.) - The larch sawfly is a major defoliator of all species of larch. It is thought to have been accidentally introduced into North America and virtually destroyed all of the mature tamarack, *Larix laricina* Du Roi K. Koch, in Newfoundland (5) and elsewhere on the continent near the turn of the century (16). Since then, outbreaks have occurred periodically but tree mortality has been negligible. Larch does not occur in sufficient quantity to be of commercial importance in Newfoundland. However, its rapid growth rate, relative resistance to decay and many potential uses, would make it desirable as a reforestation species if the sawfly could be controlled. Several species of parasites have been reared from the larch sawfly including *Mesoleius tenthredinis* Morley, introduced in 1942 (Appendix I), and the indigenous species *Bessa harveyi* (Tns.) and *Eclytus ornatus* Holmg. However studies have shown that parasites have not greatly reduced the intensity or extent of sawfly outbreaks (18).

In 1958, 22 specimens of the masked shrew, *Sorex cinereus cinereus* Kerr, an insectivorous mammal, were introduced to improve the control complex of a number of forest insect pests, especially those that spend much of their life cycle on the ground (Appendix I). The animal established readily and after 5 years occupied an area within a radius of 30 miles of the release point (19). Dispersal continued and by 1972 the shrew had been recovered in virtually all of the forested area of

the Island. It is too early in the history of the introduction of this predator to determine precisely what impact it will have on insect pests but studies indicate that it is already reducing larch sawfly numbers significantly (2) and minimizing the effect of outbreaks (16).

European Spruce Sawfly, *Diprion hercyniae* (Htg.) - The European spruce sawfly, an introduced pest, was considered a major threat to the spruce forests of eastern Canada in the 1930's (1). In 1940, infestations were recorded in the Humber Valley of western Newfoundland, and had spread to the Baie Verte and Northern peninsulas by 1948, and into central and eastern areas of the Island by 1959. The history of extensive tree mortality in Quebec and the rapid spread of the sawfly on the Island, prompted Newfoundland Forestry officials to initiate a biological control program against this pest in 1943.

Between 1943 and 1949, four European species of parasitic insects were introduced and released into infested stands in western Newfoundland (Appendix I). The species included three Hymenoptera: *Dahlbominus fuscipennis* (Zett.), *Exenterus amictorius* (Panz.), and *E. confusus* Kerr, and a Diptera, *Palexorista bohémica* Mesn. The *Exenterus* spp., and *P. bohémica* have been shown by Neilson and Morris (13) to be important as regulators of sawfly populations in the Maritimes. In Newfoundland, none of the hymenopterous species and only one specimen of the Diptera, *P. bohémica* have been recovered. Improved rearing techniques are currently being used in an attempt to determine the influence of parasites on the population levels of this sawfly.

The virus, *Borrelinavirus hercyniae*, was introduced from the Maritime Forest Research Centre, Fredericton, N.B. in 1943 and 1944 because it had been identified as a key factor in the reduction of sawfly numbers in that Province. It was applied as a liquid suspension to sawfly infested white spruce trees in the Humber Valley in western Newfoundland. It established readily, but appeared to spread slowly, therefore, it was applied again in 1948 to infested trees on the Baie Verte Peninsula. At the same time it was also introduced into sawfly infestations on the Northern Peninsula, by releasing virus infected larvae collected in the Humber Valley. Although the sawfly infestations collapsed by 1950, sawfly numbers increased again in both central and western areas of the Island by the late 1950's. However, the high populations lasted only 1 or 2 years as compared to the 5 to 8 year period recorded in the 1940's. The virus is considered to be the principal factor in shortening the duration of these outbreaks but the introduced masked shrew is also credited with improving the biological control complex of this sawfly (10).

Larch Casebearer, *Coleophora laricella* (Hbn.) - The larch casebearer is an introduced insect that attacks native and European larch in eastern North America. It was first recorded in 1886 at Northhampton,

Mass. in the United States. The first Canadian record was at Ottawa in 1905 and it is assumed to have resulted from a separate introduction. The earliest record in Newfoundland was in 1941 (12).

Persistent outbreaks, in eastern Canada in the early 1900's, resulted in the importation of five species of parasitic insects from England between 1931 and 1939. Successful establishment of two species, *Agathis pumila* (Ratz.) and *Kratochviliana* (*Chrysocharis* = *Epilampsis*) *laricinellae* (Ratz.), in Ontario resulted in recolonization of both species in other provinces. Between 1944 and 1947 colonies of *A. pumila* and *K. laricinellae* were introduced from Ontario and released at numerous points throughout Newfoundland (Appendix I). Both species became established but *A. pumila* is only rarely recovered whereas *K. laricinellae* is regularly recovered and appears to be the dominant species.

Satin Moth, *Stilpnotia salicis* (L.) - The satin moth is native to Europe and western Asia where it occurs commonly on various species of poplar and willow. It was first recorded in North America in 1920 on Carolina poplar, *Populus canadensis* var *eugenei* (Simon Louis) Schelle, near Boston, Mass. During the next few years it spread into New Hampshire and Maine, and by 1930 it had reached southern Nova Scotia and southwestern New Brunswick. These early infestations were confined primarily to exotic poplar species planted for shade and ornamental purposes. However, in more recent years attacks have become common on native poplars in woodland areas.

In Newfoundland the satin moth was first recorded in 1934 and since that time it has become a major pest of poplars throughout the Island (6).

In 1936, 1940 and 1942 two species of insect parasites, *Apanteles solitarius* (Ratz.) and *Meteorus versicolor* (Wesm.) were introduced and released in Newfoundland (Appendix I). Only *A. solitarius* became established and is now considered to be the major factor in reducing the extent of damage and the duration of satin moth outbreaks on the Island. Prior to the introduction of *A. solitarius*, outbreaks of the pest persisted from 1 to 6 years, branch and twig mortality was common, and some ornamental trees were killed. Since the successful establishment of the parasite, outbreaks have lasted only 1 or 2 years and damage has been negligible.

Birch Casebearer, *Coleophora fuscedinella* (Zell.) - The birch casebearer, a defoliator of birch, was probably accidentally introduced into Newfoundland on hardwood nursery stock. It was discovered in 1953, on Manitoba maple, *Acer negundo* L. at Doyles in the Codroy Valley. Since then it has spread rapidly and caused extensive defoliation of white birch, *Betula papyrifera* Marsh., stands in western and central areas of the Island. The importance of controlling this pest has increased with the recent interest in the utilization of birch as a commercial forest tree. In 1967 studies were initiated to determine the biology of the casebearer and to examine methods for its control. These studies indicated that

biological control would offer the only practical approach to reducing damage caused by this pest in forest stands. The existing insect parasite complex was weak, with only 12 species being reported as compared to 25 in Maine, 17 in New Brunswick and 27 in Europe.

In 1971, specimens of *Campoplex* spp., (*C. borealis* Zett and *C. nov. sp.*) were introduced from Europe and released on caged white birch infested with casebearer larvae at Cormack, in western Newfoundland (Appendix I). In the following year, about 500 *Campoplex* adults emerged in the cages and these were released about 10 days after emergence. In 1972, an additional 57 adults of *Campoplex* spp. were released in casebearer-infested birch stands near Badger, in central Newfoundland. Results appear promising but successful establishment cannot be confirmed until adults are recovered from wild populations.

Birch Leafminer, *Fenusa pusilla* (Lep.) - The birch leafminer, another European species attacking birch foliage has been reported from Ontario, Quebec and the Maritime Provinces in Canada, and from the eastern United States. It was first recorded in Newfoundland in 1954 and has since spread through much of the Island. It is abundant on small roadside trees and ornamentals and is not presently considered an important pest of forest stands. However, it appears to have the potential to become a serious problem of young birch especially when damage is added to that caused by other defoliators. For this reason, several small shipments

of two parasite species *Priopoda nigricollis* (Thomson) and *Grypocentrus albipes* (Ruthe) were introduced from Europe in 1972 and released in cages on infested birch trees near Pasadena in western Newfoundland.

Establishment of the parasites cannot presently be determined, however, mating, host searching and oviposition were observed for *P. nigricollis* and healthy active adults of both species were found in the cages up to 12 days after release.

SUMMARY AND CONCLUSIONS

Since the 1940's, 25 species of parasites, 16 invertebrate predators, 1 vertebrate predator, and 3 pathogens have been introduced into Newfoundland in an attempt to control 10 species of forest insects.

In 1971 and 1972 a total of four species of parasites, namely *Campoplex borealis*, *C. n. sp.*, *Priopoda nigricollis* and *Grypocentrus albipes*, were introduced against the birch casebearer, and the birch leafminer. Although the results appear promising it is too early to evaluate the establishment or effectiveness of these parasites. Among the other 21 species of parasites introduced, only 10 are known to have become established. These include: *Agathis pumila*, *Apanteles solitarius*, *Apechthis ontario*, *Itoplectis conquisitor*, *Kratochiviliana laricinellae*, *Madremyia saundersii*, *Mesoleius tenthredinis*, *Meteorus trachynotus*, *Palexorista bohémica*, *Winthemia occidentis*. Of these, *A. solitarius*, introduced against the satin moth between 1936 and 1942, is considered

the most successful. Since its establishment and dispersal, the duration of satin moth outbreaks has decreased and damage has been negligible. Although results have not been as spectacular *M. occidentis*, *M. saundersii*, *M. tenthredinis*, *A. ontario* and *I. conquisitor* are all recovered consistently either from their intended hosts or alternate pest species, and doubtless contribute to the eventual collapse of outbreaks of the black-headed budworm, spruce budworm and the hemlock looper. The remaining four parasites are rarely collected and therefore are assumed to be of little importance in controlling forest pests. However, this assumption may not be valid as no intensive studies have been conducted to examine the status of these parasites.

Seventeen species of predators (16 invertebrate and 1 vertebrate) have been introduced. Of these only 5 invertebrate and the vertebrate, the masked shrew, have become established and only the shrew is considered successful. It is a valuable predator of the larch sawfly and probably other sawfly species. The other five predators which became established were released against the balsam woolly aphid. Despite successful establishment and dispersal they, in conjunction with the native predators, have failed to significantly reduce aphid populations below levels at which economic damage occurs.

Of the three disease organisms introduced only one, the polyhedrosis virus on the European spruce sawfly, became established. This disease is considered to be a primary factor in controlling outbreaks of this sawfly.

There are many reasons why the introduction of biotic agents does not always guarantee successful control of pest insects. Included among those are: the inability of a candidate species to adapt to a new environment or to a new host species; excessive competition from native species; unsuitable weather conditions at the time of liberation and poor synchronization with the susceptible stage of a new host. In addition there is the risk of an intended control agent becoming a pest in a new environment. Therefore, it is obvious that introductions should not be undertaken without first obtaining a thorough knowledge of the biological feasibility of the program.

Although the success to failure ratio of such programs is not likely to be high, outstanding success has been achieved in Newfoundland in controlling the satin moth, European spruce sawfly and the larch sawfly. Furthermore, 45 different species of biological control agents have been introduced without causing any deleterious effects on the environment. Such a record in forest pest control is most encouraging. However, this method of control should not be looked upon as the ultimate end to all pest problems. There are some pest species in Newfoundland such as the balsam woolly aphid, that will most likely be controlled only by silvicultural methods and others, like the hemlock looper, that may require the periodic application of insecticides, and the salvage and pre-salvage cutting of susceptible stands, to effectively minimize losses. Regardless of these problems the record to date indicates the need for a continuing

search for new agents to suppress forest pests in Newfoundland and the introduction of candidates should be encouraged whenever background research indicates a reasonable chance of success.

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Appendix I - Introduced Parasites, Predators and Pathogens, by Host

Agent	Origin	Number Released	Date	Release Area	Lat. ° '	Long. ° '	Survey Dist.	Ref.
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Eastern Hemlock Looper - *Lambdina fiscellaria fiscellaria* (Gn.)

Parasites

<i>Winthemia occidentis</i>	B.C.	70	28-8-49	Grand Lk. Rd.	48.40	58.09	108	12
"	"	75	28-8-49	Harpoon R.R.	48.35	56.38	106	"
"	"	979	24-7-50	Spruce Bk.	48.46	58.11	108	"
"	"	2,451	24-7-31-7-50	Little Georges	48.49	58.06	108	"
"	"	2,794	25-7-50	Red Indian Lk.	48.37	57.09	106	"
"	"	298	23-7-51	Spruce Bk.	48.46	58.11	108	"
"	"	294	24-7-51	French Bk.	48.08	58.55	108	"
"	"	297	28-7-51	Red Indian Lk.	48.37	57.09	106	"
"	"	497	1-8-51	Western Blue Pd.	50.21	57.13	110	"

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Pathogens

Nuclear polyhedr. virus	Ont.	-	27-7-48	Gander Lk.	48.53	54.54	104	1948*
"	"	-	6-8-48	Bay d'Espoir	47.56	56.45	105	"

Spruce Budworm - *Choristoneura fumiferana* (Clem.)

Parasites

<i>Apechthis ontario</i>	Unknown	2,070	23-7-47	Bowring Park	47.34	52.44	101	1947*
"	"	300	1948	St. John's	47.34	52.44	101	1951*
<i>Ceromasia auricaudata</i>	B.C.	500	12-7-46	Waterford Br.	47.52	52.44	101	12
"	"	450	12-7-47	Bowring Park	47.34	52.44	101	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. ° '	Long. ° '	Survey Dist.	Ref.
<i>Itoplectis obesus</i>	Unknown	300	12-7-47	Bowring Park	47.34	52.44	101	1947*
<i>Madremyia saundersii</i>	"	475	12-7-47	"	47.34	52.44	101	"
"	"	500	1948	"	47.34	52.44	101	1951*
"	"	500	24-7-48	Memorial Sq. Bell Island	47.39	52.57	101	1948*
<i>Omotoma fumiferanae</i>	"	1,500	9-7-49	Bowring Park	47.34	52.44	101	1951*
"	"	-	1949	Thorburn Rd.	47.34	52.45	101	"
<i>Phorocera incrassata</i>	B.C.	200	12-7-47	Bowring Park	47.34	52.44	101	12
<i>Phytodietus fumiferanae</i>	"	132	10-7-48	Grand Lk. Bk.	48.41	58.07	108	"
"	"	75	11-7-48	Gambo Pond	48.46	54.14	103	"
<i>Pseudosarcophaga affinis</i>	"	426	12-7-47	Bowring Park	47.34	52.44	101	"
"	"	420	10-7-48	Sandy River	48.45	56.00	106	1948*
"	"	547	7-7-11-7-48	Gambo Pond	48.46	54.14	103	12
"	"	452	19-7-48	Grand Lk. Bk.	48.41	58.07	108	"
"	"	300	9-7-49	Thorburn Rd.	47.34	52.45	101	"
"	"	470	8-7-50	Main Bk.	49.50	56.55	109	"
"	"	475	8-7-50	Big Falls Trail	49.22	57.10	109	"
"	"	999	8-7-50	Rattling Bk. Depot	48.58	55.18	106	"
"	"	559	20-8-50	Neyles Bridge	49.04	55.02	104	"
"	"	535	21-8-50	Marks Hill	48.25	53.38	103	"
"	"	600	27-6-51	Mt. Scio Rd.	47.34	52.44	101	"
"	"	574	27-6-51	Masons Pond	48.44	54.24	103	"
"	"	589	29-6-51	Neyles Bridge	49.04	55.02	104	"
"	"	600	30-6-51	Southern Bay	48.24	53.40	103	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. ° '	Long. ° '	Survey Dist.	Ref.
<u>Blackheaded Budworm - Acleris variana (Fern.)</u>								
<i>Itoplectis conquisitor</i>	Unknown	28	20-8-50	Neyles Bridge	49.04	55.02	104	1950*
" "	"	28	21-8-50	Between Sweet Bay and Charleston	48.25	53.38	103	"
<i>Meteorus trachynotus</i>	"	21	20-8-50	Neyles Bridge	49.04	55.02	104	"
" "	"	21	21-8-50	Between Sweet Bay and Charleston	48.25	53.38	103	"
<u>Balsam Woolly Aphid - Adelges piceae (Ratz.)</u>								
<u>Predators</u>								
<i>Adalia luteopicta</i>	India	31	7-7-60	Steady Bk.	48.58	57.48	108	8
" "	"	63	3-9-60	"	48.58	57.48	108	"
" "	"	65	9-9-60	"	48.58	57.48	108	"
<i>Adalia ronina</i>	Japan	67	14-7-61	Deer Lk.	49.11	57.27	108	"
<i>Adalia tetraspilota</i>	India	19	8-8-60	Corner Bk.	48.57	57.56	108	"
" "	"	14	10-8-60	"	48.57	57.56	108	"
<i>Aphidecta obliterated</i>	Europe	16	6-7-57	John's Beach	49.04	58.10	108	12
" "	"	22	1-8-58	Frenchman's Cv.	49.03	58.10	108	"
" "	Czech.	186	24-6-59	Pasadena	49.02	57.36	108	8
" "	"	549	16-7-59	St. Georges	48.26	58.30	107	"
" "	"	934	19-5-60	Pasadena	49.02	57.36	108	"
" "	"	153	29-6-62	Steady Bk.	48.58	57.48	108	"
" "	"	352	5-7-62	"	48.58	57.48	108	"
" "	"	343	25-7-62	Pynns Bk.	49.05	57.32	108	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. ° '	Long. ° '	Survey Dist.	Ref.
<i>Aphidecta obliterated</i>	Germany	989	14-5-63	Deer Lk.	49.11	57.27	108	8
"	"	1,515	5-5-64	Steady Bk.	48.58	57.48	108	"
"	Czech.	255	27-4-65	Little Rapids	48.59	57.43	108	"
"	Germany	297	27-4-65	"	48.59	57.43	108	"
"	Czech.	509	2-5-66	Deer Lk.	49.11	57.27	108	"
"	Austria	950	8-9-66	"	49.11	57.27	108	"
"	"	430	20-9-66	"	49.11	57.27	108	"
"	"	4,288	16-5-67	Snug Hbr.	49.10	57.28	108	"
"	(Germany Austria)	1,096	1968	Deer Lk.	49.11	57.27	108	"
"	Europe	891	1969	Nr. Stephenville Crossing	48.29	58.26	108	"
<i>Aphidoletes thompsoni</i>	Czech.	55	14-8-58	Wild Cove	49.58	58.57	108	12
"	"	65	16-8-58	Black Duck	48.34	58.12	108	"
"	"	141	21-5-59	Corner Bk.	48.57	57.56	108	8
"	"	887	9-6-59	"	48.57	57.56	108	"
"	"	309	12-6-59	Frenchman's Cv.	49.03	58.10	108	"
"	"	1,045	16-6-59	"	49.03	58.10	108	"
"	"	742	18-6-59	Deer Lk.	49.11	57.27	108	"
"	Germany	3,091	21-7-59	Frenchman's Cv.	49.03	58.10	108	"
"	"	2,571	22-7-59	"	49.03	58.10	108	"
"	"	4,888	24-7-59	"	49.03	58.10	108	"
"	"	8,580	28-7-59	"	49.03	58.10	108	"
"	"	6,538	29-7-59	Corner Bk.	48.57	57.56	108	"
"	"	284	11-8-59	"	48.57	57.56	108	"
"	"	270	25-7-62	Steady Bk.	48.58	57.48	108	"
"	"	1,482	20-8-63	Pynns Bk.	49.05	57.32	108	"
"	"	1,635	21-8-63	"	49.05	57.32	108	"
"	"	1,950	24-8-63	"	49.05	57.32	108	"
"	"	134	29-8-63	"	49.05	57.32	108	"
"	"	70	1-6-65	"	49.05	57.32	108	"
"	"	899	7-6-65	"	49.05	57.32	108	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. o ' "	Long. o ' "	Survey Dist.	Ref.
<i>Aphidoletes thompsoni</i>	Germany	280	8-6-65	Pynns Bk.	49.05	57.32	108	8
"	"	316	20-7-65	"	49.05	57.32	108	"
"	"	230	22-7-65	"	49.05	57.32	108	"
"	"	7,582	26-5-66	"	49.05	57.32	108	"
"	"	6,000	30-5-66	"	49.05	57.32	108	"
"	"	3,100	30-5-66	Snug Hbr.	49.10	57.28	108	"
"	"	1,967	1-6-66	"	49.11	57.27	108	"
"	"	900	24-6-66	Deer Lk.	49.11	57.27	108	"
"	"	7,320	27-6-66	"	49.11	57.27	108	"
"	"	4,700	28-6-66	"	49.11	57.27	108	"
"	"	3,550	29-6-66	"	49.11	57.27	108	"
"	"	7,315	1968	Nr. St. John's	47.34	52.44	101	"
<i>Ballia eucharis</i>	India	32	9-6-60	Corner Bk.	48.57	57.56	108	"
<i>Cremifania nigrocellulata</i>	Germany	198	11-8-59	"	48.57	57.56	108	"
"	"	17	24-5-61	Frenchman's Cv.	49.03	58.10	108	"
<i>Exochomus lituratus</i>	Pakistan	110	26-8-60	"	49.03	58.10	108	"
<i>Exochomus uropygialis</i>	India	49	7-7-60	Steady Bk.	48.58	57.48	108	"
"	"	35	3-8-60	"	48.58	57.48	108	"
"	"	52	17-8-60	Frenchman's Cv.	49.03	58.10	108	"
"	Pakistan	1,250	25-8-60	"	49.03	58.10	108	"
"	India	90	29-8-60	Steady Bk.	48.58	57.48	108	"
"	Pakistan	1,589	3-9-60	Frenchman's Cv.	49.03	58.10	108	"
<i>Harmonia breiti</i>	Pakistan	88	26-8-60	"	49.03	58.10	108	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. O ' '	Long. O ' '	Survey Dist.	Ref.
Laricobius erichsonii	Europe	843	10-6-52	Robinsons	48.15	58.46	107	12
"	"	2,502	1-6-54	Flat Bay Bk.	48.24	58.35	107	"
"	"	445	17-5-55	Pulpwood Siding	48.27	58.26	107	"
"	"	447	17-5-55	"	48.27	58.26	107	"
"	"	448	17-5-55	Little Barachois Bk.	48.27	58.26	107	"
"	"	451	17-5-55	"	48.27	58.26	107	"
"	"	500	17-5-55	"	48.27	58.26	107	"
"	"	250	17-5-55	St. Georges	48.26	58.30	107	"
"	"	496	1-6-55	Jeffrey's	48.12	58.50	107	"
"	"	495	1-6-55	"	48.12	58.50	107	"
"	"	494	1-6-55	"	48.12	58.50	107	"
"	"	496	7-6-55	Nardinis	48.27	58.26	107	"
"	"	492	7-6-55	"	48.27	58.26	107	"
"	"	290	7-6-55	"	48.27	58.26	107	"
"	"	120	20-6-55	Harrys River	48.31	58.28	108	"
"	Czech.	994	23-5-58	Wild Cove Pt.	48.58	57.54	108	"
"	Germany	2,270	23-5-58	John's Beach	49.03	58.10	108	"
"	Czech.	1,310	24-5-58	Riverside, Corner Bk.	48.57	57.53	108	"
"	Germany	958	24-5-58	Wild Cove	48.58	57.53	108	"
"	"	1,255	28-5-58	Flat Bay Bk.Valley	48.24	58.25	107	"
"	"	1,130	30-5-58	Steady Bk.Siding	48.58	57.48	108	"
"	"	375	30-5-58	"	48.58	57.48	108	"
"	Czech.	1,043	27-5-59	Steady Bk.	48.58	57.48	108	8
"	Germany	2,159	27-5-59	"	48.58	57.48	108	"
"	"	5,300	18-5-60	Pynns Bk.	49.05	57.32	108	"
"	"	1,078	25-5-60	"	49.05	57.32	108	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. °	Long. °	Survey Dist.	Ref.
<i>Laricobius erichsonii</i>	Germany	1,850	26-5-60	Corner Bk.	48.57	57.56	108	8
"	"	1,118	24-5-61	Frenchman's Cv.	49.03	58.10	108	"
"	"	5,071	18-5-62	Deer Lk.	49.11	57.27	108	"
"	"	1,996	26-5-62	Pynns Bk.	49.05	57.32	108	"
"	"	873	31-5-62	Deer Lk.	49.11	57.27	108	"
"	"	704	8-5-63	Lewisporte	49.14	55.03	104	"
"	"	1,165	28-5-63	Tulks Bk.	48.33	57.13	106	"
"	"	941	11-5-64	Cormack	49.18	57.23	109	"
"	"	878	19-5-64	Reidsville	49.13	57.23	108	"
"	"	152	27-5-65	Cormack	49.18	57.23	109	"
<i>Leucopis n.sp nr.melanopus</i>	Germany	160	3-9-59	McIvers	49.04	58.07	108	"
"	"	495	3-9-68	Black Duck	48.34	58.21	108	"
"	"	545	1968	Birchy Lk.	49.22	56.40	109	"
<i>Leucopis obscura</i>	Europe	2	7-6-55	St. Georges	48.26	58.30	107	12
"	"	19	26-7-55	"	48.26	58.30	107	"
"	"	55	12-6-56	Frenchman's Cv.	48.08	58.10	108	"
"	"	189	15-6-56	Cooks Bk.	48.59	58.04	108	"
"	N.B.	98	5-8-56	Bay of Islands	49.01	58.06	108	"
"	Austria	24	27-5-65	Deer Lk.	49.11	57.27	108	8
"	"	55	1-6-65	"	49.11	57.27	108	"
<i>Pullus impexus</i>	Europe	1,306	1-7-52	Robinsons	48.15	58.46	107	12
"	"	784	12-6-53	Flat Bay Bk.	48.24	58.35	107	"
"	"	750	17-6-53	"	48.24	58.35	107	"
"	"	2,570	9-7-54	Nardinis	48.28	58.25	107	"
"	"	2,000	16-7-54	Wild Cove Pt.	49.02	58.28	108	"
"	"	297	11-7-55	Nardinis	48.28	58.25	107	"
"	"	298	11-7-55	"	48.28	58.25	107	"
"	"	295	11-7-55	"	48.28	58.25	107	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. o ' "	Long. o ' "	Survey Dist.	Ref.
<i>Pullus impexus</i>	Europe	464	6-7-57	John's Beach	49.04	58.10	108	12
" "	"	513	1-8-58	Frenchman's Cv.	48.08	58.10	108	"
" "	Germany	6,000	11-6-59	South Bk.	49.01	57.37	108	8
" "	"	3,500	12-6-59	Frenchman's Cv.	48.08	58.10	108	"
" "	"	420	18-6-60	Wild Cove Pt.	49.02	58.28	108	"
" "	"	726	23-6-60	Corner Bk.	48.57	57.56	108	"
" "	"	131	26-6-61	Steady Bk.	48.58	57.49	108	"
" "	"	18,036	7-6-66	Snug Hbr.	49.10	57.28	108	"
<i>Scymnus pumilio</i>	Australia	4,042	1-6-60	Corner Bk.	48.57	57.56	108	"
" "	"	1,973	8-6-60	"	48.57	57.56	108	"
" "	"	2,683	15-6-60	"	48.57	57.56	108	"
" "	"	989	23-6-60	"	48.57	57.56	108	"

Pathogens

<i>Fusarium larvarum</i>		1969	Black Duck	48.34	58.21	108	28-1969*
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Parasites

European Spruce Sawfly - *Diprion hercyniae* (Htg.)

<i>Dahlbominus fuliginosus</i>	Europe	200,000	20-8	25-8-42	Humber Dist.	- -	- -	108	12
" "	"	200,000		21-6-43	"	- -	- -	108	"
" "	"	200,000		22-6-43	Grand Falls Dist.	- -	- -	106	"
" "	"	610,000	7-7	5-9-44	Humber Dist.	- -	- -	108	"
" "	"	630,000	24-7	5-9-44	Grand Falls Dist.	- -	- -	106	"
" "	"	200,000	2-8	9-8-44	Ferryland Dist.	- -	- -	101	"
" "	"	100,000		5-9-44	St. Georges Dist.	- -	- -	107	"
" "	"	1,000,000		1945	(Brig Bay, Hawkes Bay, (Port Saunders, (St. Margaret's Bay, (Daniels Hbr.	- -	- -	110	1945*

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. o ' "	Long. o ' "	Survey Dist.	Ref.
<i>Dahlbominus fuliginosus</i>	Europe	650,000	1945	White Bay Shore, Grand, Sandy, Birchy Lks.	- -	- -	109	1945*
"	"	1,000,000	1946	Corner Bk.	48.57	57.56	108	1951*
"	"	1,500,000	1-7 2-7-46	Humber Dist.	- -	- -	108	1946*
"	"	3,200,000	25-6 27-6-47	"	- -	- -	108	12
"	"	100,300	26-6-47	Baie Verte	49.56	56.11	109	"
"	"	400,000	26-6-47	Hampden, Humber Rd.	- -	- -	109	"
"	"	100,000	26-6-47	Flat Bay Bk.	48.24	58.32	107	"
"	"	100,000	27-6-47	Codroy Pd.	48.05	58.52	107	"
"	"	100,000	27-6-47	Spruce Bk.	48.46	58.11	108	"
"	"	400,000	14-8-48	Grand Falls Dist.	- -	- -	106	"
"	"	200,000	14-8-48	Humber Dist.	- -	- -	108	"
<i>Exenterus abruptorius</i> (prob. <i>amictorius</i>)	"	350	28-7-46	Lady Slipper Rd.	48.52	57.51	108	1946*
<i>Exenterus amictorius</i>	Europe	386	31-7-43	Harpoon R.R.	48.45	56.36	106	12
"	"	148	31-7-43	Little Hbr.	49.09	57.28	108	"
"	"	150	31-7-43	Little Rapids Farm	48.59	57.43	108	"
"	"	150	31-7-43	Lower Humber River	- -	- -	108	"
"	"	245	12-8-43	Bonne Bay Rd.	49.17	57.30	110	"
"	"	244	12-8-43	Sandy Lk.	49.23	56.58	109	"
"	"	348	7-8-44	Lower Humber River	- -	- -	108	"
"	"	225	21-8-44	South Bk.	49.01	57.36	108	"
"	"	352	21-8 4-9-44	Little Rapids Farm	48.59	57.43	108	"
"	"	344	28-7-46	Lady Slipper Rd.	48.52	57.51	108	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. ° ' "	Long. ° ' "	Survey Dist.	Ref.
<i>Exenterus amictorius</i>	Europe	571	14-8-46	Hawkes Bay	50.37	57.07	110	12
"	"	665	19-8-46	South Branch	45.54	59.02	107	"
"	"	238	2-9-46	Pynns Bk.	49.05	57.32	108	"
"	"	87	10-9-46	Chouse Bk.	49.37	56.46	109	"
"	"	233	23-8-47	Adies Pond	49.25	57.18	109	"
"	"	80	4-9-47	West Pond	49.24	56.13	106	"
"	"	218	23-7-49	West Bk. Bridge	49.22	56.15	106	1949*
<i>Exenterus confusus</i>	Europe	250	12-8-43	Sandy Lk.	49.23	56.58	109	12
"	"	79	7-8-44	Little Rapids Farm	48.59	57.43	108	"
<i>Paalexorista bohémica</i>	Europe	499	12-8 9-9-43	Harpoon R.R.	48.45	56.36	106	"
"	"	235	9-9-43	Bonne Bay Rd.	49.17	57.30	110	"
"	"	239	9-9-43	Deer Lk.	49.11	57.27	108	"
"	"	230	9-9-43	Humber Canal	49.12	57.17	108	"
"	"	240	9-9-43	Little Rapids Farm	48.59	57.43	108	"
"	"	241	9-9-43	Steady Bk.	48.58	57.49	108	"
"	"	48	7-8-44	Humber Dist.			108	"
"	"	153	21-8 4-9-44	Little Rapids Farm	48.59	57.43	108	"
"	"	157	4-9-44	South Bk.	49.01	57.37	108	"
"	"	144	5-9-44	Windsor Lk.	47.36	52.49	101	"
"	"	2,487	6-7 24-8-45	Ten Mile Lk.	51.04	56.45	110	"
"	"	2,862	7-7 23-8-45	Hawkes Bay	50.37	57.07	110	"
"	"	492	11-7-45	Little Rapids Farm	48.59	57.43	108	"
"	"	490	11-7-45	Midland Rd.	49.02	57.33	108	"
"	"	920	11-7-45	Pynns Bk.	49.05	57.32	108	"
"	"	460	12-7-45	Birchy Lk.	49.19	56.44	109	"
"	"	430	12-7-45	Sandy Lk.	49.23	56.48	109	"
"	"	450	16-7-45	Bonne Bay Rd.	49.17	57.30	110	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. O'	Long. O'	Survey Dist.	Ref.
<i>Palexorista bohemica</i>	Europe	444	16-7-45	Corner Bk.	48.57	57.56	108	12
"	"	470	16-7-45	Rocky Bk.	49.13	57.26	108	"
"	"	428	16-7-45	Soper's Crossing	48.57	58.03	108	"
"	"	2,985	7-8-45	Harpoon R.R.	48.45	56.36	106	"
"	"	488	23-8-45	Portland Creek	50.11	57.36	110	"
"	"	718	24-8 27-8-45	River of Ponds	50.33	57.24	110	"
"	"	494	1946	Indian Bk.	- -	- -	106	1951*
"	"	493	28-7-46	Pinchgut Rd.	48.55	57.51	108	12
"	"	843	28-7-46	Lady Slipper Rd.	48.52	57.51	108	"
"	"	1,475	29-7-46	Corner Bk.) Deer Lk. Rd.)	- -	- -	108	"
"	"	495	5-8-46	Connors Bk.	48.48	57.27	108	"
"	"	494	5-8-46	Glovers Island	48.54	57.33	108	"
"	"	496	5-8-46	Little Grand Lk. Rd.	48.40	58.05	108	"
"	"	1,491	14-8-46	Hawkes Bay	50.37	57.07	110	"
"	"	431	19-8-46	Ball Pond	- -	- -	108	"
"	"	365	19-8-46	Cooks Bk.	48.55	58.04	108	"
"	"	466	19-8-46	Fisher's Bk.Rd.	49.00	57.32	108	"
"	"	480	19-8-46	Georges Lk.	48.48	58.06	108	"
"	"	487	19-8-46	Shoulder Lk.	- -	- -		
"	"	483	19-8-46	Twin Steady	- -	- -	108	"
"	"	989	24-8 26-8-46	Birchy Lk.	49.19	56.44	109	"
"	"	476	26-8-46	Hampden Rd.	49.26	56.58	109	"
"	"	1,436	26-8-46	Sandy Lk.	49.23	56.58	109	"
"	"	966	29-8 2-9-46	Bonne Bay Rd.	49.17	57.30	110	"
"	"	450	2-9-46	Goose Arm Rd.	49.12	57.40	108	"
"	"	470	2-9-46	Lomond Rd.	49.26	57.40	110	"
"	"	500	10-9-46	Alder Pond	49.27	57.10	109	"
"	"	486	10-9-46	Chouse Bk. Rd.	49.32	56.53	109	"
"	"	1,945	25-7-47	Stag Hill Rd.	48.48	57.55	108	"
"	"	467	25-7-47	Underground Bk.	- -	- -	108	"
"	"	493	2-8-47	Georges Lk.	48.48	58.06	108	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. o ' "	Long. o ' "	Survey Dist.	Ref.
<i>Palexorista bohemica</i>	Europe	986	2-8-47	Grand Lk.	48.40	58.05	108	12
"	"	1,495	2-8-47	Harpoon R.R.	48.45	56.36	106	"
"	"	1,925	9-8-47	Goose Arm Rd.	49.12	57.40	108	"
"	"	2,491	16-8-47	Portage Rd.	- -	- -	108	"
"	"	1,958	23-8-47	Adies Pond	49.25	57.18	109	"
"	"	1,963	4-9-47	West Pond	49.24	56.13	106	"
"	"	2,000	4-9-47	Hawkes Bay	50.37	57.07	110	1947*
"	"	1,000	5-9-47	Southwest Arm	49.22	55.23	104	12
"	"	500	5-9-47	Middle Arm	49.47	56.09	109	"
"	"	500	5-9-47	West Arm	49.21	55.26	104	"
"	"	738	2-9-48	Pynns Bk.	49.05	57.32	108	"
"	"	2,914	13-8-48	Fishers Bk.Rd.	49.00	57.32	108	"
"	"	497	23-7-49	Burnt Berry Bk.	49.29	56.06	106	"
"	"	442	23-7-49	Halls Bay Rd.	49.16	56.08	106	"
"	"	475	1-8-49	Chouse Bk. Rd.	49.32	56.53	109	"
"	"	466	1-8-49	Hampden Rd.	49.26	56.58	109	"
"	"	400	1-8-49	Whites Rd.	48.33	58.24	108	"
"	"	435	1-8-49	Crabbs River	48.11	58.47	107	"
"	"	480	1-8-49	Spruce Bk.	48.45	58.10	108	"

Pathogens

<i>Borrelinavirus hercyniae</i>	N.B.	-	1943-44	South Bk.	49.01	57.36	108	1945*
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Larch Sawfly - *Pristiphora erichsonii* (Htg.)

Parasites

<i>Mesoleius tenthredinis</i>	Man., Que.	410	10-7-40	Terra Nova	48.29	54.13	103	12
"	"	21	11-7-40	Gambo	48.46	54.14	104	"
"	"	19	22-7-43	Corner Bk.	48.57	57.56	108	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. ° '	Long. ° '	Survey Dist.	Ref.
<i>Mesoleius tenthredinis</i>	Man., Que.	162	31-7-43	Millertown	48.57	56.19	106	12
"	"	2,135	17-7 17-8-44	Humber Dist.	- -	- -	108	"
"	"	522	24-7-44	Sandy Lk.	49.23	56.58	106	"
"	"	1,729	24-7 17-8-44	Millertown	48.57	56.19	106	"
"	"	217	1-8-44	Whitbourne	47.25	53.33	101	"
"	"	750	18-8-44	Avalon Dist.	- -	- -	101	"
"	"	90	24-8-45	Ten Mile Lk.	51.04	56.53	110	"
"	"	1,450	20-8-47	Cochrane Pond Rd.	47.33	52.44	101	"

Predators

<i>Sorex cinereus cinereus</i>	N.B.	10 males 12 females	Sept., -58	4 mi. East St. Georges	48.25	58.25	107	1959*
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Larch Casebearer - *Coleophora laricella* (Hbn.)

Parasites

<i>Agathis pumila</i>	England	880	3-7-44	Badger-Botwood Rd.	49.05	55.26	106	12
"	"	222	24-7-44	Sandy Lk.	49.23	56.58	109	"
"	"	34	31-7-44	Harpoon R.R.	48.45	56.36	106	"
"	"	624	16-7-45	Redcliff	48.34	53.29	103	"
"	"	606	16-7-45	Main Dam	49.12	57.20	108	"
"	"	1,248	16-7-45	Exploits Dam	48.46	56.37	106	1945*
"	"	682	19-7-45	Witless Bay Line	47.16	52.51	101	12
"	"	1,854	7-8 15-8-46	Harpoon R.R.	48.45	56.36	106	"
"	"	2,683	14-8-46	Hawkes Bay	50.37	57.07	110	"
"	"	965	10-9-46	Sandy Stream	49.19	57.10	106	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Cont'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. o ' "	Long. o ' "	Survey Dist.	Ref.
<i>Agathis pumila</i>	England	922	13-9-46	North Bk.	48.40	58.12	107	12
"	"	901	14-9-46	Awachenjeech Bk.	48.41	58.12	108	"
"	"	1,245	1-8-47	Cochrane Pond Rd.	47.33	52.44	101	"
"	"	1,555	7-8-47	Peters Pond	49.05	55.27	106	"
"	"	1,537	9-8 16-8-47	Main Dam	49.12	57.20	108	"
"	"	552	4-9-47	East River	49.26	57.45	110	"
"	"	3,068	6-9-47	Southern Arm	49.27	57.54	110	"
<i>Kratochviliana laricinellae</i>	"	4,800	3-7-44	Badger-Botwood Rd.	49.05	55.26	106	"
"	"	810	17-7-44	Corner Bk.	48.57	57.56	108	"
"	"	908	24-7-44	Sandy Lk.	49.23	56.58	109	"
"	"	844	12-7-45	Millertown	48.49	56.32	106	"
"	"	211	13-7-45	Eel Bk.	49.07	55.13	104	"
"	"	422	13-7-45	Jumpers Bk.	49.02	55.25	104	"
"	"	211	13-7-45	Neyles Bk.	49.04	55.02	104	"
"	"	844	13-7-45	Terra Nova	48.27	54.21	103	"
"	"	5,868	16-7-45	Humber Dist	- -	- -		
"	"	925	20-7-45	Shoal Hbr.	48.12	54.03	103	"
"	"	2,505	29-7-46	Main Dam Rd.	49.12	57.20	108	"
"	"	9,462	30-7 1-8-46	Harpoon R.R.	48.45	56.36	106	"
"	"	6,622	1-8-46	Placentia	47.14	53.58	101	"
"	"	3,575	2-8 3-8-46	Badger-Botwood Rd.	49.05	55.26	106	"
"	"	1,609	3-8-46	Mile 240, Gander Dist.	49.03	55.00	104	"
"	"	1,817	5-8-46	Little Grand Lk. Bk.	48.37	57.56	108	"
"	"	7,315	5-8 9-9-46	Howley	49.11	57.08	108	"
"	"	3,668	10-8-46	Millertown Jct.	49.01	56.20	106	"
"	"	1,567	10-8-46	Peters River	49.07	55.24	106	"
"	"	4,808	14-8-46	Hawkes Bay	50.37	57.07	110	"
"	"	1,340	10-9-46	Sandy Stream	49.19	57.10	110	"

Appendix I - Introduced Parasites, Predators and Pathogens, by Host (Concl'd.)

Agent	Origin	Number Released	Date	Release Area	Lat. ° '	Long. ° '	Survey Dist.	Ref.
<i>Kratochviliana laricinellae</i>	England	2,000	24-5-47	Whitbourne	47.26	53.34	101	12
"	"	3,522	30-5 26-7-47	Holyrood	47.24	53.08	101	"
"	"	1,764	24-7-47	Witless Bay Line	47.16	52.51	101	"
"	"	513	2-8-47	Grand Lk.	48.40	58.05	108	"
"	"	582	2-8-47	Millertown Jct.	49.01	56.20	106	"
"	"	826	16-8-47	Main Dam	49.12	57.20	108	"
"	"	2,829	23-8-47	Deer Lk.	49.11	57.27	108	"
"	"	485	6-9-47	Southern Arm	49.27	57.54	110	"

Satin Moth - *Stilpnotia salicis* (L.)

Parasites

<i>Apanteles solitarius</i>	U.S.A.	173	22-6-36	Topsail Rd.	47.34	52.44	101	12
"	"	260	25-6-36	Carpasian Rd.	47.34	52.44	101	"
"	"	30	29-6-36	Littledale	47.32	52.44	101	"
"	B.C.	35	17-6-40	Carbonear	47.44	53.15	101	"
"	"	45	29-6-40	Brigus	47.32	53.13	101	"
"	"	507	6-6 3-7-42	Sandy Pt.	48.27	58.30	107	"
<i>Meteorus versicolor</i>	"	23	6-6-42	St. Georges Dist.	- -	- -	107	"

Parasites

Birch Casebearer - *Coleophora fuscedinella* (Zell.)

<i>Campoplex</i> spp.	Germany	394	Aug., 71	15 mi. N.E. Deer Lk.	49.22	57.20	109	1971*
"	"	57	Aug., 72	7.7 mi. S.W. Badger	48.54	56.12	106	"

Parasites

Birch Leafminer - *Fenusa pusilla* (Lep.)

<i>Grypocentrus albipes</i>	Germany	13	Aug., 72	Pasadena	49.01	57.36	108	1972*
<i>Priopoda nigricollis</i>	"	213	Aug., 72	"	49.01	57.36	108	"

*Annual reports, Newfoundland Forest Protection Association, 1945-1972.

Appendix II - Introduced Parasites, Predators and Pathogens by Species

Agent	Intended Host	Total No. Released	Established*
<u>Parasites</u>			
<i>Agathis pumila</i> (Ratz.)	Larch casebearer	19,578	X
= (<i>Bassus pumilus</i> (Ratz.))			
<i>Apanteles solitarius</i> (Ratz.)	Satin moth	1,050	X
<i>Apechthis ontario</i> (Cress.)	Spruce budworm	2,370	X
<i>Campoplex</i> spp.	Birch casebearer	451	U
<i>Ceromasia auricaudata</i> Tns.	Spruce budworm	950	0
<i>Dahlbominus fuliginosus</i> Nees	European spruce sawfly	10,890,300	0
= (<i>D. fuscipennis</i> (Zett.))			
= (<i>Microplectron fuscipennis</i> (Zett.))			
<i>Exenterus amictorius</i> (Panz.)	" " "	4,684	0
<i>E. confusus</i> Kerr.	" " "	329	0
= (<i>E. clarypennis</i> Thomson)			
<i>Grypocentrus albipes</i> (Ruthe)	Birch leafminer	13	U
<i>Itoplectis conquisitor</i> (Say.)	Blackheaded budworm	56	X
<i>I. obesus</i> Cush.	Spruce budworm	300	0
<i>Kratochviliana laricinellae</i> (Ratz.)	Larch casebearer	72,652	X
= (<i>Chrysocharis laricinellae</i> (Ratz.))			
= (<i>Epilampsis laricinellae</i> (Ratz.))			
<i>Madremyia saundersii</i> (Will.)	Spruce budworm	1,475	X
<i>Mesoleius tenthredinis</i> Morley	Larch sawfly	7,505	X
<i>Meteorus trachynotus</i> Vier.	Blackheaded budworm	42	X
<i>M. versicolor</i> (Wesm.)	Satin moth	23	0
<i>Omotoma fumiferanae</i> (Tll.)	Spruce budworm	1,500	0
<i>Palexorista bohémica</i> Mesn.	European spruce sawfly	55,646	X
= (<i>Drino bohémica</i> Mesn.)			
= (<i>Sturmia</i> sp.)			

Appendix II - Introduced Parasites, Predators and Pathogens by Species (Cont'd.)

Agent	Intended Host	Total No. Released	Established*
<i>Phorocera incrassata</i> Smith	Spruce budworm	200	0
<i>Phytodietus fumiferanae</i> Roh.	" "	207	0
<i>Priopoda nigricollis</i> (Thomson)	Birch leafminer	213	U
<i>Pseudosarcophaga affinis</i> (Fall.)	Spruce budworm	7,546	0
= (<i>Agria affinis</i> (Fall.))			
<i>Winthemia occidentis</i> Rnh.	Hemlock looper	7,755	X
= (<i>Omotoma occidentis</i> Rnh.)			
<u>Predators</u>			
<u>Invertebrate</u>			
<i>Adalia luteopicta</i> Muls.	Balsam woolly aphid	159	0
<i>A. ronina</i> (Lewis)	" " "	67	0
<i>A. tetraspilota</i> (Hope)	" " "	33	0
<i>Aphidecta oblitterata</i> (L.)	" " "	13,775	X
<i>Aphidoletes thompsoni</i> Møehn.	" " "	78,896	X
<i>Ballia eucharis</i> Muls.	" " "	32	0
<i>Cremifania nigrocellulata</i> Cz.	" " "	215	X
<i>Exochomus lituratus</i> Gorham	" " "	110	0
<i>E. uropygialis</i> Muls.	" " "	3,065	0
<i>Harmonia breiti</i> Mader	" " "	88	0
<i>Laricobius erichsonii</i> Rosenh.	" " "	41,389	X
<i>Leucopis complex</i> (Possibly 3 species)	" " "	1,642	X
<i>Pullus impexus</i> (Muls.)	" " "	38,090	0
<i>Scymnus pumilio</i> (Weise)	" " "	9,687	0
<u>Vertebrate</u>			
<i>Sorex cinereus cinereus</i> Kerr.	Larch sawfly	10 males 12 females	X

Appendix II - Introduced Parasites, Predators and Pathogens by Species (Concl'd.)

Agent	Intended Host	Total No. Released	Established*
<u>Pathogens</u>			
<u>Viruses</u>			
<i>Borrelinavirus hercyniae virus</i>	European spruce sawfly	-	X
<i>Polyhedrosis</i>	Hemlock looper	-	U
<u>Fungi</u>			
<i>Fusarium larvarum</i> Forbel	Balsam woolly aphid	-	0

* X - Yes
 0 - No
 U - Uncertain

Appendix III. Introduced Parasites which have become established on Hosts other than the Target Species.

Parasites	Intended Hosts	Established on Intended Hosts	Adopted Hosts
<i>Apechthis ontario</i>	<i>Choristoneura fumiferana</i>	Yes	<i>Acleris variana</i> <i>Lambdina fiscellaria</i> <i>Nematus limbatus</i>
<i>Madremyia saundersii</i>	" "	Yes	<i>Lambdina fiscellaria</i> <i>Nyctobia limitaria</i>
<i>Itoplectis conquisitor</i>	<i>Acleris variana</i>	Unknown	<i>Lambdina fiscellaria</i>
<i>Meteorus trachynotus</i>	" "	Yes	<i>Choristoneura fumiferana</i>
<i>Palexorista bohémica</i>	<i>Diprion hercyniae</i>	Yes	<i>Pikonema alaskensis</i>
<i>Kratochviliana laricinellae</i>	<i>Coleophora laricella</i>	Yes	<i>Coleophora fuscedinella</i>