

DISTRIBUTION AND
ECONOMIC IMPORTANCE
OF SOME IMPORTANT SAWFLIES
ATTACKING CONIFERS IN
EASTERN NORTH AMERICA

Thesis for the Degree of M. S.
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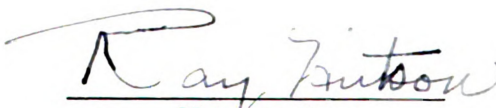
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DISTRIBUTION AND ECONOMIC IMPORTANCE
OF SOME IMPORTANT SAWFLIES ATTACKING CONIFERS
IN EASTERN NORTH AMERICA

By

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INTRODUCTION

During the last decade, Sawflies of both native and European origin have become increasingly important throughout eastern North America.

A review of literature has shown that subsequent to the beginning of the twentieth century at least ten sawflies have become thoroughly established, and have been responsible for considerable damage to both forest and ornamental coniferous plantings throughout northeastern United States and Canada. Six of these sawflies were introduced from Europe; undoubtedly prior to the federal quarantine regulations in 1912.

Only recently have any extensive measures been instituted for the control of these defoliators. Both the governments of the United States and Canada have appropriated large sums of money toward the biological and chemical control of these insects. Numerous publications are available on the life histories and taxonomic features of sawflies, but there has been very little presented on the complete distribution and resulting effects of sawfly epidemics.

The lack of complete North American distribution records by counties, and the increasing importance of these sawflies in our coniferous forests and plantings has prompted the writer to present the complete distribution, by counties, of some of the more important sawflies attacking conifers in eastern North America, and to indicate, where possible, the economic importance attached to the insects discussed in this paper.

METHODS AND PROCEDURE

The sawflies reviewed in this paper as important coniferous defoliators in eastern North America were selected on the basis of host preference, magnitude of distribution, and the amount of available literature.

Individual letters were written to workers in the field of entomology throughout eastern United States and Canada requesting information on county distribution, host preference, percentage of infestation, and control measures instituted. Besides replies from personal correspondence, all literature available on the subject of sawflies was reviewed, and established distribution and other pertinent information was recorded.

Individual maps of eastern North America were then drawn, establishing the distribution of the sawflies discussed in this paper. See appendix F. All counties with established distribution records were indicated by solid marking, whereas cross hatching was used to present those states having sawflies present, but lacking county records. In this paper, eastern North America includes the following territory: in the United States, all states east of the Mississippi River plus Minnesota, Iowa, Missouri, Arkansas and Louisiana; in Canada, all provinces east of Manitoba.

In addition to establishing distribution, the review of literature and personal correspondence made possible the listing of coniferous hosts and the parasites of sawflies dealt with in this thesis. See appendices C and E.

DISCUSSION OF SAWFLY SPECIES

The distribution maps included as appendix F give a vivid picture of the distribution of each sawfly discussed, but they do not provide the reader with authorities for records and the economic importance attached to each species as is included in the discussion. A general description of the life cycles is also included in the following discussion.

That there may be no misunderstanding as to the species of sawflies being discussed, a synoptic list has been prepared and included as appendix A.

INTRODUCED PINE SAWFLY

Diprion simile (Hartig)

The introduced pine sawfly, a native of Europe, was first discovered on this continent near New Haven, Connecticut in 1914. (6) (8) It is now recorded in most of the states along the Atlantic coast from Maine to Virginia, the majority of the infestations occurring in the New England states. This sawfly has also established itself in the Lake States, being particularly destructive to eastern white pine in Minnesota during the year 1942. (21) The following states have been recorded as having this sawfly present: Connecticut, Indiana, Massachusetts, Maine, Michigan, Minnesota, New Jersey, New York, Pennsylvania, and Virginia (P)* (7) (8) (29). See appendix B.

The introduced pine sawfly has been of very little importance in Quebec since its discovery in Montreal.(8) Reports from Ontario show little activity, a medium infestation in Toronto being all that is recorded. There are no reports of this sawfly being active in the Maritime provinces or in Newfoundland.

Eastern white pine is the preferred host of this sawfly, although most all of the five-needled pines are recorded as being attacked, (6) (7) (8) (29). Those forest conifers recorded as hosts of the introduced pine sawfly are listed as appendix C. Injury is usually confined to trees up to 14 years of age, with severe infestations occurring on nursery stock, (42).

*(P) Hereinafter refers to personal correspondence.

In Canada parasites have played an important role in the control of this sawfly. At least five species of parasites have been reared from Diprion simile (Hartig), Microplectron fuscipennis Zett. being the most widely distributed. A further listing of the parasites of this sawfly may be found in appendix E.

In the United States, chemical control has played an important role in keeping the population of the introduced pine sawfly in an endemic state. Arsenate of lead has been the standard insecticide in the past, but with the introduction of the war-time DDT, it was rendered obsolete. DDT is less expensive, and has proven more satisfactory as a poison.

Winter is passed in the prepupal stage among the litter on the ground beneath the infested tree. The adults emerge during April and on through May, there being two broods a year. The eggs are usually deposited in the needle base of the previous years growth. The larvae of the first brood feed on the old growth and the second brood larvae feed on both the old and current seasons growth during August and September. (6) (42).

PLANTATION PINE SAWFLY

Gilpinia frutetorum (Hartig)

The plantation pine sawfly, native to Europe, first became established in North America at Niagara Falls, Ontario, during 1934.(21) At the present Schaffner reports this species occurring quite commonly throughout the New England states and southern Ontario, with a few cases cited in the Lake States.(P) Daviault reports it being unknown in Quebec, but definitely extending throughout the Niagara Falls area to Fort Erie, Ontario.(P) States recorded as having this sawfly at present are: Connecticut, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, and Rhode Island. (P) (26) (42) see appendix B.

The preferred hosts of the plantation pine sawfly are Scotch and Norway red pine, and occasionally it is found on the white pines. (10) (42) see appendix C. This species of sawfly has only recently been noticed in the eastern states, an outbreak in Connecticut causing complete defoliation and death to several acres of pine, as reported by Plumb. (P) In Minnesota Hodson has reported its occurrence, but only in one area and with no conspicuous defoliation. (26)

There are no records of measures instituted in the chemical control of the plantation pine sawfly, but ecological studies have been made and rodents and parasites have proven a major factor in the biological control. (44) Microplectron fuscipennis Zett., has been the major parasite in the biological control of this sawfly.

Winter is passed as a prepupa in the form of a paper-like cocoon spun in the litter on the ground, or occasionally among the needles of the infested tree. The adults are present during early and late summer, there usually being two broods a year. The eggs are deposited in the needles of the host tree, one egg per needle. The larvae are present from June until August, the second brood hatching from late July until early fall. (21) (42)

EUROPEAN SPRUCE SAWFLY

Gilpinia hercyniae (Hartig)

The European spruce sawfly, originally established in Europe, was first introduced into this country during the year 1930, resulting in approximately 100 acres of spruce becoming infested in the Gaspé peninsula, Quebec, Canada. (17) (19) (37)

By 1937, 9800 square miles of spruce were infested, many trees killed and the insect widely spread throughout Canada. (3) The invasion of spruce came to a stand-still during 1940, with the appearance of a virus malady, which decimated the larval population. (15) At present this sawfly is well established in an endemic state throughout the United States where spruce is found growing, particularly in the Lake States. In 1941 Hodson reported this sawfly to be the most important insect attacking spruce in Minnesota, this report being the first record of the European spruce sawfly in the Lake States. (25) The Canadian distribution of this sawfly extends over most of Nova Scotia and Prince Edward Island, all of New Brunswick, north to central Newfoundland, a large portion of northeast Quebec, and two isolated areas in Ontario.

States recorded as having Gilpinia hercyniae (Hartig) within them are: Connecticut, Maine, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. (P) (17) (25) see appendix B.

The European spruce sawfly's host preference is spruce and balsam fir. Black, red, white, and Norway spruce have been

recorded as being as infested by this sawfly. (12) (17) (25) (42)
see appendix C.

The importance of this sawfly may be fully realized after reviewing records stating the total amount of timber destroyed in the Gaspé peninsula during the years 1930 to 1941. In the neighborhood of 325,579,000 cubic feet of wood was destroyed - an average of 33,000,000 cubic feet a year. (15) Other studies have shown that as a result of defoliation there is a marked decline in the rate of growth of the infested trees. (33)

The outbreaks that have occurred in the United States and Canada can readily be explained by the absence of natural parasites which keep the sawfly population in an endemic state. In view of this fact, there is at present much work being done in the liberation of parasites throughout Canada where the European spruce sawfly shows evidence of being in an epidemic form. During a period of five years the Bellville laboratory liberated approximately 240 million species of the parasite Microplectron fuscipennis Zett. (2) The release of this parasite and a virus disease attacking the larvae resulted in a progressive decline in the sawfly population. For a listing of other species of insects parasitizing this sawfly, the reader is referred to appendix E.

Balch in his suggestions for biological control of this insect has recommended clearcutting of all species of conifers in heavily infested areas. This type of cutting should be done during the egg stage in the life cycle of the sawfly, the theory being that the egg population will be destroyed, removing the threat of severe

infestation. Clearcutting the balsam would eliminate the possibility of loss from windblow if spruce alone were taken out. Each spruce tree over six inches in diameter is able to support from 3000 to 5000 larvae, and by clearcutting in heavily infested areas this potential population would be eliminated. (19)

The European spruce sawfly overwinters in the prepupal stage, the larvae pupating during May and the first of June. There are from one to three broods a year. The adults deposit their eggs in slits cut in the needles sometime during May. The first brood of larvae hatches soon after egg deposition and feeds on the old growth; the second brood feeds on the current season's growth. (3) (33) (37) (42).

BALSAM FIR SAWFLY

Neodiprion abietis (Harris)

The earliest record of the balsam fir sawfly in eastern North America was established in 1909 at Goffstown, New Hampshire. (P) This sawfly has been thought to be responsible for infestations in Connecticut as early as 1858, but specimens were not collected.

The present distribution of this sawfly extends throughout the New England states as well as the Lake States and all of Canada where balsam grows naturally. In Canada a belt of infested balsam is bordered on the east by Lake Superior, and on the north by Lake Huron Channel, reoccurring from Ottawa down the river to Hawksbury. (32) It is very common in the province of Quebec, it being intercepted in Alberta during 1946. (19) (32) Scattered infestations have been reported in James Bay and in Newfoundland. (12) (15)

Connecticut, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New York, Rhode Island, Vermont and Wisconsin are states recorded as having the balsam fir sawfly present. (P) (24) (38) (42) see appendix B.

Balsam fir and black spruce are the preferred hosts of the balsam fir sawfly. (24) Other recorded hosts are included as appendix C. There have been records of this sawfly feeding on pine both by Bird and Ruggles, but Atwood has not yet been able to find any evidence of this, and all attempts to rear the sawfly from eggs on pines have failed. (1)

In the New England States, Schaffner attaches little economic importance to this sawfly due to the limited plantings of balsam fir; but in the Lake States Hodson reports the balsam fir sawfly to have been the most important and destructive insect on spruce during 1939. (24) (42)

Both chemical and biological measures have played an important role in the control of this sawfly. DDT has been used in a number of cases in the United States, and in Canada the liberation of parasites has decreased the sawfly population to some degree. At least twenty-four parasites have been reared from Neodiprion abietis (Harris), the genus Exenterus being most prevalent. (12) For a complete list of insects parasitizing the balsam fir sawfly, the reader is referred to appendix E.

The eggs of the balsam fir sawfly are deposited in the needles of the host tree during the months of August through September, the insect overwintering in this stage. The larvae feed during the months of August through October. The paper-like cocoons are spun by the larvae and are attached to the needles or they may be buried in the litter at the base of the tree. Pupation occurs in the fall, the adults emerging and immediately laying their eggs. There is but one brood a year. (12) (42)

JACK PINE SAWFLY

Neodiprion banksianae(Rohwer)

The jack pine sawfly a native to North America, is generally distributed throughout the Great Lakes region and New England, extending northward through the jack pine range from New Brunswick to eastern Manitoba, Canada. (1) This species of sawfly has been reported by Daviault as very rare in the province of Quebec. (P)

States having records of infestation are Massachusetts, Michigan, Minnesota, Ohio, and Wisconsin. (P) (29) (42) see appendix B.

The preferred host of the jack pine sawfly is jack pine as evidenced by its common name, although occasionally it may feed on shortleaf, pitch, and Norway red pine. (P) (29) see appendix C. This insect is a serious defoliator of jack pine throughout the Lake States where it has been responsible for considerable injury during the recent years. Hodson has reported complete defoliation of jack pine and considerable damage to red pine in Minnesota. (29) In other parts of the jack pine range it is not of great economic importance except for localized attacks on ornamentals.

The jack pine sawfly like the balsam fir sawfly spends the winter in the egg stage. Three to five eggs are placed in slits cut into the needles by the adult sawfly during August and September. The larvae appear in the spring and may be found feeding on the old growth during June and July. There is one generation annually, pupation occurring during August and September. The cocoons are spun in the duff beneath the host tree. (42)

RED-HEADED PINE SAWFLY

Neodiprion lecontei (Fitch)

The red-headed pine sawfly appears to be the most widely spread of all our native sawflies and has been recorded in most every state east of the Mississippi River. It is most prevalent in the Lake States, extending eastward to the New England States, and then south throughout the length of the Appalachians to Florida. In Canada this sawfly's range of distribution extends from Sault Ste. Marie east to New Brunswick, and as far north as Lake Kipawa, Quebec. (1) There are scattered infestations along the St. Lawrence River Valley from Port Hope, Ontario to Rimouski, Quebec. (10)

The preferred hosts of the red-headed pine sawfly vary with the regions in which the sawfly is established. In the Lake States jack pine and red pine are preferred, whereas in the south and the east preference is shown for shortleaf and loblolly pine. (P) (27) There are many other conifers on which this sawfly has been recorded, but feeding occurs only on these if the preferred hosts are not available. A more complete listing of host trees of the red-headed pine sawfly is entered in appendix C.

J. A. Beal of Duke University has made a study of the mortality of reproduction defoliated by the red-headed pine sawfly. (4) Using loblolly and shortleaf pine as host trees, Beal observed that open growth pines appeared to withstand defoliation better than pines competing with hardwoods. Observations made by the writer during the summer of 1949, indicated the possibility of host selection rather

than hardwood competition. The red-headed pine sawfly appeared to select jack and red pine partially or fully shaded by hardwoods for egg deposition rather than trees growing in the open. A forthcoming paper by D. M. Benjamin on the ecology of this sawfly will discuss host selection in more detail.* If this condition of host selection or hardwood competition applies to conifers throughout eastern North America, it is a matter of great importance to plantation owners, and the forest services, state and federal. It is possible that those plantings having an overstory will be infested to a greater degree than those growing in pure stands.

The red-headed pine sawfly has been of great importance in Minnesota, Hodson reporting complete defoliation to jack pine plantations in certain areas during 1944 and 1945. (28) In Maryland it is the only sawfly of importance and in New York and Vermont airplane spraying of several hundred acres of red pine has been instituted. (P)

Spraying for the control of this sawfly has been done with DDT, it proving to be the most satisfactory and economical insecticide at the present. In Canada and in certain sections of Michigan parasites have been released as a possible means of controlling this sawfly. In the Lake States a species of Exenterus and a dipterous parasite have commonly been found parasitizing the larvae of the red-headed pine sawfly. A listing of some parasites of this insect is in appendix E.

*D. M. Benjamin, Entomologist, Forest Insect Laboratory, Bureau of Entomology and Plant Quarantine, U.S.D.A. Milwaukee, Wisconsin.

The red-headed pine sawfly passes the winter in the prepupal stage in the litter beneath the infested tree, or occasionally attached to the needles at the base of the tree. The number of generations a year vary. In the south there are three broods, whereas in the northern limits of its range there is but one. The eggs are deposited in slits cut in the needle during June. The larvae immediately after hatching begin to feed on the current season's growth, and continue during the summer months on into fall. The silken cocoons are spun in most cases during late summer. (P) (1) (42)

WHITE PINE SAWFLY

Neodiprion pinetum (Norton)

The white pine sawfly, a native of America, occurs throughout the white pine belt of the United States as far south as Mississippi and west as far as Iowa and Minnesota. The Canadian distribution of this sawfly ranges from the United States border to Lake Baskatong and the Gaspé peninsula, and from Lake Superior to Newfoundland. It has been known to be present in the province of Quebec during the last decade, but of very little importance. (P) States recorded as having this sawfly present are: Connecticut, Georgia, Illinois, Indiana, Massachusetts, Maine, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island and Vermont. (P) (28) (42) see appendix B.

The preferred host of the white pine sawfly is eastern white pine, although this sawfly has been recorded on Scotch pine, pitch pine, shortleaf pine, and Mugho pine. (1) (42) Available records show that outbreaks are infrequent and extremely local, confined to single or small groups of trees as exemplified by feeding on twelve large white pine in Monticello, Indiana. (40)

Winter is passed in the prepupal stage, the adults emerging early in spring. The eggs are deposited in slits cut in the needles by the adults during July and September. The larvae are gregarious feeders usually being active during the months of July through September. The larvae of the white pine sawfly are somewhat similar to the larvae of the red-headed pine sawfly and there is often confusion when differentiating between the two. (1) (42)

RED PINE SAWFLY

Neodiprion sertifer (Geoffroy)

The red pine sawfly, originally from Europe, entered the United States at Sommerset, New Jersey, during May, 1925. (41) (42) At the present this sawfly has established itself in Michigan, Ohio, and the eastern states, where defoliation occurs in forest and watershed plantations. (42) The first Canadian record was at Windsor, Canada, in 1939. It has not spread any appreciable distance from its place of establishment. States in which this sawfly have been reported as present are: Connecticut, Michigan, New Jersey, New York, and Ohio. (P) (41) (42) (43) see appendix B.

The preferred hosts of the red pine sawfly are red pine, Scotch pine, and jack pine. (32) Other important forest conifers recorded as being infested are: ponderosa pine, eastern white pine, and short-leaf pine. (P) (41) (42) see appendix C. The mature foliage of the infested tree is fed upon resulting in serious defoliation when heavily infested. Over 100 acres of red, Scotch, and western yellow pine, planted on private estates in Sommerset, New Jersey were heavily infested in 1939. In the same year the owners of five estates in the East cooperated in helicopter spraying, and a total of 110 acres of pine were sprayed with excellent results. (42)

There have been a few species of parasites reared from the red pine sawfly, but their occurrence has not been recorded as decreasing the sawfly population to any appreciable extent. A listing of the insects parasitizing this sawfly has been compiled in appendix E.

The red pine sawfly passes the winter in the egg stage, the eggs being deposited in slits cut into the needles by the adult. There are usually 3-5 eggs per needle. The larvae are active from May to August, there being but one generation a year. Pupation occurs in late August, the adults emerging during September and October. (41)

(42)

YELLOW-HEADED SPRUCE SAWFLY

Pikonema alaskensis (Rohwer)

The yellow-headed spruce sawfly, a native to North America, occurs throughout the spruce range in Canada and northern United States. In Canada this sawfly is found from British Columbia to New Brunswick and extends north as far as Newfoundland. The yellow-headed spruce sawfly was first recorded in the United States at Forest Hills, Massachusetts, during the year 1916, and since then has been reported in Connecticut, Maine, Michigan, Minnesota, New Hampshire, New York, Rhode Island, Vermont, and Wisconsin. (35) see appendix B.

The preferred host of this sawfly is spruce, being recorded on white, black, red, Engelman, Sitka, Norway, and Colorado blue spruce. (15) (42) see appendix C. The first outbreak of this species in Maine occurred on red spruce in 1947. At that time over 1400 acres of red spruce natural reproduction were sprayed by airplane, lead arsenate being the insecticide. The rate of application was four pounds to one hundred gallons of water plus sixteen ounces of linseed oil. (35) In the Lake States, Hodson reports serious defoliation in a number of plantations in Minnesota, the heaviest in 1942 and gradually decreasing to date. New growth is preferred, and at present this sawfly is a menace to all young open growth plantations and reproduction. (26) A sample of 100 trees of four foot Norway spruce, and white spruce, taken in 1937 showed 40 dead, 41 defoliated seventy-five percent or more, and 19 defoliated less than twenty-five percent. (35)

The yellow-headed spruce sawfly is subject to a large amount of parasitism, Brown reporting at least 16 parasites attacking this sawfly with pupal parasitism amounting to 6-11 percent. (12) For further reference to the parasites of this insect see appendix E.

There is but one generation a year, the winter being passed in the prepupal stage. The adults emerge early in the spring, and lay their eggs in the needles of the host tree. The larvae soon after hatching feed on the new growth, completely defoliating the tree. The larvae are most abundant on young trees in plantations and in open growth natural stands. (35) (42)

LARCH SAWFLY

Pristiphora erichsonii (Hartig)

The larch sawfly is described from Europe, although there exists some difference of opinion among entomologists as to its exact origin. (20) The first record of this sawfly in eastern North America occurred in Quebec during 1853, and later in 1881 it was noticed in Massachusetts. (20) (34) The present range of this sawfly is throughout the Lake States, New England States, and all of Canada where larch grows naturally. It has also been recorded in the Maritime provinces and Newfoundland. The following states have records establishing the larch sawfly within them: Connecticut, Georgia, Massachusetts, Maine, Michigan, Minnesota, New Hampshire, New York, Pennsylvania, and Wisconsin. (28) (37) (39) (42) see appendix B.

The preferred hosts of the larch sawfly are eastern larch and European larch. Both plantations and natural reproduction are attacked with serious outbreaks occurring occasionally which result in heavy mortality. Trees infested with this insect have their terminal twigs killed or permanently distorted by egg ovoposition from the adult sawfly. Hopkins has estimated that the larch sawfly has killed fifty to one hundred percent of the mature larch in the northeastern United States and southern Canada during extensive outbreaks since 1880. (5) It is only recently that larch in the Lake States has returned to a climax condition. However, a current build-up of this sawfly in Minnesota is a serious threat unless control measures are undertaken.

Parasites released in central Quebec, southern Manitoba, and northern Michigan during 1929, have checked infestations greatly. In New Brunswick 80 percent parasitism by Mesoleius tenthredinis Mor. has greatly reduced the occurrence of this sawfly. (45) A further listing of parasites is included as appendix E.

Chemical control measures have been instituted to combat this insect. Lead arsenate has been used on small areas, and DDT spread by airplane has proven satisfactory over larger areas.

Winter is passed in the prepupal stage in a cocoon spun in the litter beneath the infested tree. The adults emerge during May and June, and begin to lay their eggs in two alternate rows in the terminal growth. The larvae are gregarious, usually becoming full grown the middle of July or August, some maturing as late as September. There is usually one generation a year. (20) (42)

SUMMARY AND CONCLUSIONS

Ten species of sawflies have been shown as important feeders on conifers in eastern North America. Five species, Diprion simile (Hartig) Gilpinia frutetorum (Hartig), Gilpinia hercyniae (Hartig), Neodiprion sertifer (Geoffroy), and Pristiphora erichsonii (Hartig) are of European origin; whereas Neodiprion abietis (Harris), Neodiprion banksianae Rohwer, Neodiprion lecontei (Fitch), Neodiprion pinetum (Norton), and Pikonema alaskensis (Rohwer) are native to North America.

The discussion of species, appendaged maps, lists of parasites, and coniferous hosts, give an up-to-date count of the distribution and economic importance of the sawflies treated in this paper.

Of the ten insects discussed it is evident that the sawfly having the most extensive distribution is the red-headed pine sawfly, Neodiprion lecontei (Fitch). With its repeated attacks on jack and red pine in the Lake States and shortleaf and loblolly pine in the eastern and southern states, this insect appears to be the most serious sawfly defoliator in the United States.

Serious defoliation of larch has occurred throughout Canada and the northern part of the United States as a result of extensive feeding by the larch sawfly, Pristiphora erichsonii (Hartig). This sawfly has accounted for a serious loss of larch during the last decade, but a sudden decrease in numbers, probably as a result of parasitism, has prevented the complete loss of our native larch.

Two species of sawflies attacking spruce, Gilpinia hercyniae (Hartig) the European spruce sawfly, and Pikonema alaskensis (Rohwer),

the yellow-headed spruce sawfly, have been responsible for the loss of black, white, and red spruce throughout Canada and the northern part of the United States. The European spruce sawfly has been particularly destructive in the Gaspe peninsula, eastern Quebec, New Brunswick, and northeastern United States; whereas the yellow-headed spruce sawfly is prevalent in great numbers throughout the Lake States, western Quebec, and Manitoba.

The balsam fir sawfly, Neodiprion abietis (Harris), is established in the Lake States, parts of Ontario, and most of Quebec and New Brunswick where balsam fir and spruce grow native.

The jack pine sawfly, Neodiprion banksianae Rohwer, a destructive defoliator of jack pine in the Lake States, has now extended its range into Canada throughout the jack pine belt.

Neodiprion pinetum (Norton), the white pine sawfly, and Diprion simile (Hartig), the introduced pine sawfly, are important as white pine feeders throughout the northern United States; and Gilpinia frutetorum (Hartig), the plantation pine sawfly, and Neodiprion sertifer (Geoffroy), the red pine sawfly are important pests attacking red pine in the Lake States and New England States.

Control measures, both biological and chemical, have been instituted by the governments of the United States and Canada for the purpose of preventing severe epidemics by these sawflies. A list included in this paper establishes the parasites known to be active in the control of the sawflies discussed. Chemical control has consisted of airplane spraying over extensive areas, and hand spraying

for isolated infestations. DDT is the recognized and approved insecticide at present, it being most satisfactory and economical.

The life cycles of the ten species of sawflies presented are approximately the same, except for the fact that the jack pine, red pine, and balsam fir sawflies overwinter in the egg stage; whereas the others discussed winter in the prepupal stage. The number of generations a year vary, the balsam fir sawfly, jack pine sawfly, red pine sawfly, yellow-headed spruce sawfly, and the larch sawfly having one. The introduced pine sawfly, plantation pine sawfly, European spruce sawfly, red-headed pine sawfly, and the white pine sawfly have one or more generations a year depending upon that part of North America in which they are established.

The distribution records presented in this study, as well as information concerning the economic value and range of the preferred coniferous hosts, provide a useful index to the degree of significance attached to some of the important sawflies attacking conifers in eastern North America.

The expanding distribution of the sawflies discussed, as evidenced by new locality records every year, indicates an increasing threat to coniferous plantings and mature trees throughout the United States and Canada. The limit to which the threat of sawfly ingression is able to extend is dependent upon the native range of the preferred hosts, possible parasitism, and climatic conditions. It appears that these sawflies will eventually spread to the very limit of the hosts' natural growing range regardless of biological or chemical control that may be applied. The limits of the sawfly range

are so extensive now that many isolated pockets of sawfly infestations are overlooked, and it seems that not until a severe infestation occurs, are any control measures instituted.

Parasitism does keep a check on the sawfly population, but the parasites rate of build-up, over a period of years, is slow, and severe infestations occur before the sawfly population is reduced.

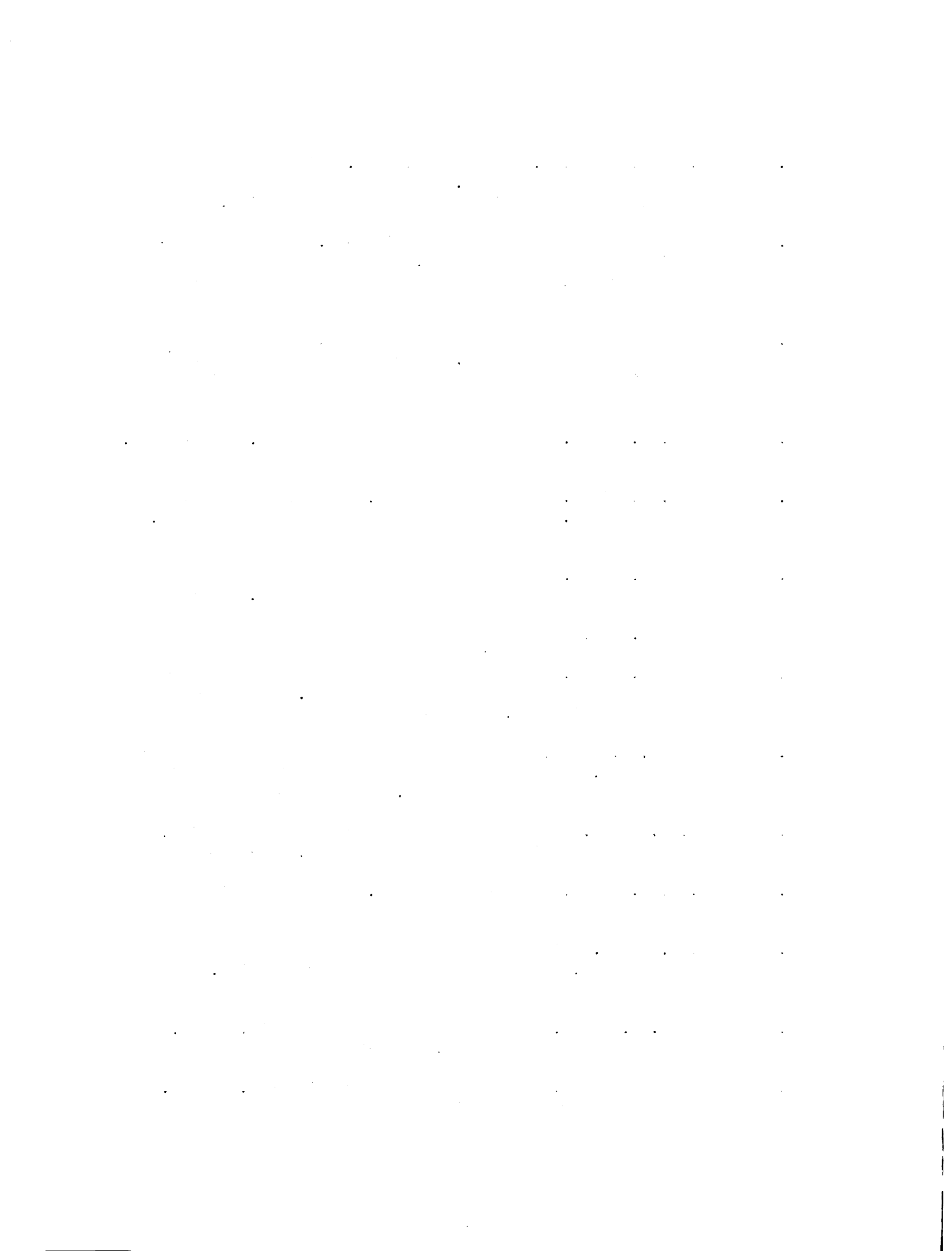
Apparently thorough surveys should be performed, and the location of all endemic population levels recorded. These areas should be constantly observed and when a build-up in population occurs, control measures should be initiated.

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- (P) Personal correspondence

APPENDIX A

SYNONYMY

Introduced pine sawfly, Diprion simile (Hartig)

Dolerus similis Norton
Lophyrus erimita Andre
Lophyrus similis Hartig
Hylotoma similis Kirby
Tenthredo similis Ratzeburg
Diprion simile (Hartig)

Plantation pine sawfly, Gilpinia frutetorum (Hartig)

Tenthredo frutetorum Fabricius
Hylotoma frutetorum (Fabricius)
Pteronix frutetorum Herrich-Schaeffer
Lophyrus frutetorum Hartig
Diprion frutetorum (Hartig)
Gilpinia frutetorum (Hartig)

European spruce sawfly, Gilpinia hercyniae (Hartig)

Gilpinia polytoma (Hartig)
Diprion polytomum (Hartig)
Gilpinia hercyniae (Hartig)

Balsam fir sawfly, Neodiprion abietis (Harris)

Lophyrus abietis Harris
Neodiprion abietis (Harris)

Jack pine sawfly, Neodiprion banksianae Rohwer

Neodiprion n. sp.
Neodiprion banksianae Rohwer
Neodiprion (Neodiprion) ontarioensis Middleton
Neodiprion banksiana (sic) Rohwer
Neodiprion namulus Schedl.

Red-headed pine sawfly, Neodiprion lecontei (Fitch)

Lophyrus Lecontei Fitch
Neodiprion (Neodiprion) lecontei (Fitch)
Neodiprion lecontei (Fitch)

White pine sawfly, Neodiprion pinetum (Norton)

Lophyrus le Contii (sic) Kirkpatrick (Nec Fitch)
Lophyrus pinetum Norton
Lophyrus abboti Riley (nec Leach)
Lophyrus pinetorum Dalle Torre
Neodiprion pinetum (Norton)

Red pine sawfly, Neodiprion sertifer (Rohwer)

Neodiprion sertifer (Rohwer)

Yellow-headed spruce sawfly, Pikonema alaskensis (Rohwer)

Nematus ocreatus (Harrington)
Pachynematus piceae (Harrington)
Pachynematus ocreatus (Harrington)
Pachynematus alaskensis Rohwer
Pikonema alaskensis (Rohwer)

Larch sawfly, Pristiphora erichsonii (Hartig)

Nematus Erichsonii (Hartig)
Nematus Leachii Dahl
Tenthredo (Nematus) Erichsonii Ratzberg
Lygaeonematus erichsonii (Hartig)
Pristiphora erichsonii (Hartig)

The preceding synonymy has been compiled from: (1) (14)

APPENDIX B

DISTRIBUTION OF SAWFLY SPECIES
BY STATES PROVINCES AND COUNTIES

Diprion simile (Hartig)

Connecticut

1. Fairfield
2. Hartford
3. New Haven
4. New London

Indiana (no county records)

Maine

1. Hancock

Massachusetts

1. Essex

Michigan

1. Allegan
2. Berrien
3. Hillsdale
4. Ingham
5. Isabella
6. Kalamazoo
7. Midland
8. Monroe
9. Oceana

Minnesota

1. Aitkin
2. Anoka
3. Goodhue
4. Hennepin
5. Isanti
6. Ramsey
7. Sherburne
8. Washington

New Jersey

1. Bergen
2. Essex
3. Morris
4. Somerset
5. Union

New York

1. Monroe
2. Nassau
3. Queens
4. Westchester

Pennsylvania

1. Dauphin
2. Philadelphia

Virginia (no county records)

Ontario

1. Halton
2. York

Quebec

1. Chambly

Gilpinia frutetorum (Hartig)

Connecticut

1. Fairfield

Massachusetts (no county records)

Minnesota

1. Ramsey

New Hampshire (no county records)

New Jersey (no county records)

New York (no county records)

Pennsylvania (no county records)

Rhode Island (no county records)

Ontario

1. Carleton
2. Elgin
3. Essex
4. Lincoln
5. Norfolk
6. Prescott
7. Simcoe
8. Welland

Quebec

1. Abitibi
2. Gaspé

Gilpinia hercyniae (Hartig)

Connecticut

1. Fairfield

Maine

1. Aroostook
2. Hancock
3. Piscataquis
4. Somerset
5. Washington

Massachusetts (no county records)

Minnesota

1. St. Louis

New Hampshire

1. Carroll
2. Cheshire
3. Coos
4. Grafton
5. Hillsboro
6. Merrimack
7. Sullivan

New Jersey (no county records)

New York

1. Chenango
2. Clinton
3. Columbia
4. Delaware
5. Dutchess
6. Essex
7. Franklin
8. Greene
9. Hamilton
10. Oneida
11. Otsego
12. Schoharie
13. Rensselaer
14. St. Lawrence
15. Ulster
16. Washington

Rhode Island (no county records)

Vermont

1. Addison
2. Bennington
3. Washington
4. Windham

Ontario

1. Bruce
2. Carleton
3. Dufferin
4. Dundas
5. Durham
6. Grenville
7. Grey
8. Haliburton
9. Hastings
10. Huron
11. Lanark
12. Lennox & Addington
13. Nipissing
14. Norfolk
15. Northumberland
16. Ontario
17. Parry Sound
18. Peel
19. Peterborough
20. Prescott
21. Prince Edward
22. Simcoe
23. Victoria
24. Welland
25. Wellington

Quebec

1. Abitibi
2. Argenteuil
3. Beauce
4. Berthier
5. Bonaventure
6. Champlain
7. Charlevoix
8. Chicoutime
9. Compton
10. Dorchester
11. Frontenac
12. Gaspé

Gilpinia hercyniae (Hartig) cont.

Quebec cont.

13. Hull
14. Joliette
15. Kamouraska
16. Labelle
17. Lake St. John
18. Levis
19. L'Islet
20. Lotbiniere
21. Maskinonge
22. Matane
23. Megantic
24. Montcalm
25. Montmagny
26. Montmorency
27. Papineau
28. Pontiac
29. Portneuf
30. Quebec
31. Rimouski
32. St. Maurice
33. Saguenay
34. Terrebonne
35. Timiscaming
36. Wolfe
37. Wright

New Brunswick

1. Carleton
2. Charlotte
3. Albert
4. Kent
5. Kings
6. Gloucester
7. Madawaska
8. Northumberland
9. Pestigouche
10. Queens
11. St. John
12. Sunbury
13. Westmorland
14. York
15. Victoria

Nova Scotia

1. Annapolis
2. Astigonish

Nova Scotia cont.

3. Colchester
4. Cumberland
5. Digby
6. Guysborough
7. Halifax
8. Mants
9. Juneburg
10. Kings
11. Pictou
12. Yarmouth

Prince Edward Island

1. Kings
2. Prince
3. Queens

Cape Breton Island

1. Cape Breton
2. Inverness
3. Victoria

Neodiprion abietis (Harris)

Connecticut (no county records)

Maine

1. Cumberland
2. Sagadahoc
3. York

Massachusetts (no county records)

Michigan

1. Benzie
2. Gogebic
3. Grand Traverse
4. Manistee

Minnesota

1. Beltrami
2. Carlton
3. Clearwater
4. Cook
5. Hubbard
6. Itasca
7. Koochiching
8. Lake
9. Lake of the Woods
10. Roseau
11. St. Louis

New Hampshire

1. Belknap
2. Hillsboro
3. Merrimac

New York

1. Warren
2. Washington

Rhode Island (no county records)

Vermont (no county records)

Wisconsin

1. Ashland
2. Price
3. Sawyer

Ontario

1. Algoma
2. Carleton
3. Dundas
4. Lanark
5. Prescott
6. Renfrew
7. Victoria

Quebec

1. Abitibi
2. Berthier
3. Bonaventure
4. Champlain
5. Charlevoix
6. Chicoutime
7. Compton
8. Frontenac
9. Gaspe
10. Joliette
11. Kamouraska
12. Lake St. John
13. Maskinonge
14. Matane
15. Montcalm
16. Montmagny
17. Pontiac
18. Quebec
19. St. Maurice
20. Saguenay
21. Timiscaming
22. Wright

New Brunswick

1. Charlotte
2. St. John

Nova Scotia (no county records)

Neodiprion banksianae Rohwer

Massachusetts (no county records)

Michigan

1. Wayne

Minnesota

1. Aitkin
2. Becker
3. Cass
4. Crow Wing
5. Clearwater
6. Hubbard
7. Itasca

Ohio (no county records)

Wisconsin

1. Ashland
2. Price
3. Sawyer

Ontario

1. Carleton
2. Grenville
3. Russell
4. Simcoe
5. Sudbury

Neodiprion lecontei (Fitch)

Alabama

1. Barbour
2. Colbert
3. Houston
4. Lauderdale
5. Lee
6. Lowndes
7. Randolph

Arkansas

1. Pope
2. Washington

Connecticut

1. Fairfield
2. Hartford
3. Litchfield
4. Middlesex
5. New Haven
6. New London
7. Tolland
8. Windham

Delaware

1. New Castle

Florida

1. Alachua
2. Duval
3. Franklin
4. Lake
5. Liberty
6. Manatee
7. Marion
8. Orange
9. Okaloosa
10. Polk
11. Putnam

Georgia

1. Berrien
2. Clarke
3. Colquitt
4. Fannin
5. Fulton

Georgia cont.

6. Miller
7. Paulding
8. Peach
9. Rabun
10. Richmond

Illinois

1. Alexander
2. Gallatin
3. Hardin
4. Johnson
5. Massac
6. Pope
7. Saline
8. Williamson

Louisiana

1. Beauregard
2. Bienville
3. Grant
4. Morehouse
5. Rapides
6. Union
7. Washington

Maine

1. Cumberland
2. Hancock
3. Sagadahoc
4. York

Maryland

1. Anne Arundel
2. Baltimore
3. Dorchester
4. Frederick
5. Prince Georges
6. St. Marys

Massachusetts

1. Barstable
2. Berkshire
3. Bristol
4. Essex

Neodiprion lecontei (Fitch) cont.

Massachusetts cont.

5. Franklin
6. Hampshire
7. Middlesex
8. Norfolk
9. Plymouth
10. Worcester

Michigan

1. Alcona
2. Alger
3. Alpena
4. Antrim
5. Charlevoix
6. Chippewa
7. Delta
8. Emmet
9. Gogebic
10. Grand Traverse
11. Iosco
12. Kalamazoo
13. Kalkaska
14. Lake
15. Livingston
16. Manistee
17. Mason
18. Mecosta
19. Menominee
20. Ogemaw
21. Oscoda
22. Ottawa
23. Saginaw
24. Schoolcraft
25. Wayne
26. Wexford

Minnesota

1. Aitkin
2. Anoka
3. Isanti
4. Carlton
5. Cass
6. Clearwater
7. Cook
8. Crow-wing
9. Hubbard
10. Itasca
11. Lake

Minnesota cont.

12. Pine
13. Ramsey
14. Sherburne
15. St. Louis

Mississippi

1. Calhoun
2. Choctaw
3. Copiah
4. Covington
5. Forrest
6. Hancock
7. Harrison
8. Hinds
9. Holmes
10. Jackson
11. Jasper
12. Jefferson
13. Jones
14. Lincoln
15. Lauderdale
16. Marshall
17. Panola
18. Pearl River
19. Pike
20. Pontotoc
21. Rankin
22. Stone
23. Tishomingo
24. Yazoo

Missouri

1. Barry
2. McDonald

New Hampshire

1. Belknap
2. Carroll
3. Cheshire
4. Coos
5. Grafton
6. Hillsboro
7. Merrimack
8. Rockingham
9. Strafford
10. Sullivan

Neodiprion lecontei (Fitch) cont.

New Jersey

1. Bergen
2. Burlington
3. Mercer
4. Morris
5. Union

New York

1. Delaware
2. Dutchess
3. Essex
4. Franklin
5. Fulton
6. Hamilton
7. Jefferson
8. Madison
9. Oneida
10. Oswego
11. Rockland
12. St. Lawrence
13. Suffolk
14. Tompkins

North Carolina

1. Beaufort
2. Edgecombe
3. Moore
4. Pender
5. Perquimans
6. Richmond

Ohio

1. Fulton
2. Hocking
3. Huron
4. Richland
5. Ross
6. Sandusky
7. Scioto
8. Vinton
9. Washington

Pennsylvania

1. Berks
2. Bradford
3. Chester

Pennsylvania cont.

4. Clearfield
5. Dauphin
6. Montgomery
7. Philadelphia
8. Potter
9. Tioga

Rhode Island

1. Newfort
2. Washington

South Carolina

1. Colleton
2. Horry

Tennessee

1. Benton
2. Decatur
3. Hardin
4. Henry
5. Houston
6. Humphreys
7. Perry
8. Stewart
9. Wayne

Vermont

1. Bennington
2. Windham
3. Windsor

Virginia

1. Fairfax
2. James City
3. King and Queen
4. King William
5. Mathews
6. New Kent
7. Norfolk
8. Princess Anne
9. Richmond

Neodiprion lecontei (Fitch) cont.

Wisconsin

1. Ashland
2. Bayfield
3. Door
4. Florence
5. Forest
6. Iron
7. Langlade
8. Lincoln
9. Oneida
10. Price
11. Rusk
12. Sawyer
13. Shawano
14. Taylor
15. Vilas
16. Washburn
17. Waushara
18. Wood

Quebec

1. Argenteuil
2. Champlain
3. Labelle
4. Maskinonge
5. Montcalm
6. Papineau
7. St. Maurice
8. Saguenay
9. Terrebonne
10. Timiscaming

Ontario

1. Algoma
2. Carleton
3. Dundas
4. Glengarry
5. Grey
6. Hastings
7. Lambton
8. Lanark
9. Leeds
10. Muskoka
11. Nipissing
12. Parry Sound
13. Prescott
14. Prince Edward
15. Russell
16. Simcoe
17. Sudbury

Neodiprion pinetum (Norton)

Connecticut

1. Fairfield
2. New Haven
3. New London

Georgia (no county records)

Illinois (no county records)

Indiana

1. White

Iowa (no county records)

Maine

1. Hancock
2. Kennebec

Massachusetts

1. Hampshire

Michigan

1. Ingham
2. Kent
3. Lenawee
4. Wayne

Minnesota

1. Fillmore
2. Hennepin

Mississippi

1. Jackson
2. Oktibbeha

New Hampshire

1. Belknap
2. Carroll
3. Cheshire
4. Coos
5. Grafton
6. Hillsboro
7. Merrimack

New Jersey

1. Morris

New York

1. Albany
2. Essex
3. Franklin
4. Herkimer
5. Livingston
6. Saratoga
7. Warren
8. Westchester

Ohio

1. Knox

Pennsylvania

1. Berks

Rhode Island (no county records)

Vermont (no county records)

Ontario

1. Algoma
2. Elgin
3. Grey
4. Muskoka

Quebec

1. Gaspé
2. Quebec
3. Rimouski

Neodiprion sertifer (Geoffroy)

Connecticut (no county records)

Michigan

1. Crawford

New Jersey

1. Bergen
2. Essex
3. Hunterdon
4. Mercer
5. Morris
6. Passiac
7. Somerset
8. Union
9. Warren

New York

1. Kings
2. New York

Ohio

1. Allen
2. Lucas
3. Sandusky

Ontario

1. Essex
2. Kent
3. Lambton
4. Middlesex
5. Welland

Pikonema alaskensis (Rohwer)

Connecticut (no county records)

Maine (no county records)

Massachusetts (no county records)

Michigan (no county records)

Minnesota

1. Beltrami
2. Carlton
3. Clearwater
4. Cook
5. Itasca
6. Koochiching
7. Lake
8. Lake of the Woods
9. Roseau
10. St. Louis

New Hampshire (no county records)

New York (No county records)

Rhode Island (no county records)

Vermont (no county records)

Wisconsin

1. Oneida

Ontario

1. Algoma
2. Bruce
3. Pary Sound
4. Patricia
5. Thunder Bay

Quebec

1. Chambly
2. Gaspé
3. Jacques-Cartier
4. Lotbinière
5. Pontiac
6. Saguenay
7. Yamasca

New Brunswick

1. St. John
2. York

Pristiphora erichsonii (Hartig)

Connecticut

1. New Haven

Georgia

1. Rabun

Maine

1. Sagadahoc
2. Somerset
3. Washington

Massachusetts

1. Essex
2. Middlesex

Michigan

1. Alger
2. Antrim
3. Benzie

Minnesota

1. Beltrami
2. Carlton
3. Cass
4. Clearwater
5. Cook
6. Grant
7. Hennepin
8. Hubbard
9. Itasca
10. Koochiching
11. Lake
12. Lake of the Woods
13. Marshal
14. Roseau
15. St. Louis
16. Wright

New Hampshire

1. Carroll
2. Cheshire

New Hampshire cont.

3. Coos
4. Rockingham
5. Strafford
6. Sullivan

New York

1. Essex
2. Oneida
3. Otsego
4. St. Lawrence
5. Tompkins
6. Warren
7. Yates

Pennsylvania

1. Lackawanna
2. Mc Kean
3. Tioga

Wisconsin

1. Ashland
2. Oneida
3. Price
4. Sawyer

Ontario

1. Algoma
2. Kenora
3. Muskoka
4. Pary Sound
5. Nipissing
6. Patricia
7. Simcoe
8. Pontiac
9. Rainy River
10. Simcoe
11. Thunderbay

Pristiphora erichsonii (Hartig) cont.

Quebec

1. Abitibi
2. Lake St. John
3. Pontiac
4. Saguenay
5. Timiscaming

Nova Scotia

1. Cumberland
2. Ghalchester
3. Halifax

Labrador (no county records)

The preceeding state, province, and county records were compiled from personal correspondence as indicated in Methods and Procedure, and from literature. (1)(10)(12)(17)(24)(25)(26)(27)(28)(29)(42)(43)(44)(45) etc.

APPENDIX C

LIST OF SAWFLIES AND THEIR RESPECTIVE CONIFEROUS HOSTS

Diprion simile (Hartig)

Austrian Pine
Eastern White Pine
Jack pine
Limber pine
Mugho pine
Pitch pine
Ponderosa pine
Norway Red pine
Scotch pine

Pinus nigra Arnott
Pinus strobus Linnaeus
Pinus banksiana Lambert
Pinus flexilis James
Pinus montana
Pinus rigida Miller
Pinus ponderosa Douglas
Pinus resinosa Aiton
Pinus sylvestris Linnaeus

Gilpinia frutetorum (Hartig)

Jack pine
Norway red pine
Scotch pine
Black spruce
White spruce
Balsam fir

Pinus banksiana Lambert
Pinus resinosa Aiton
Pinus sylvestris Linnaeus
Picea mariana (Mill.) B.S.P.
Picea glauca (Moench.) Voss.
Abies balsamea (L.) Miller

Gilpinia hercyniae (Hartig)

Black spruce
Norway spruce
Red spruce
White spruce
Balsam fir

Picea mariana (Mill.) B.S.P.
Picea abies (Linnaeus)
Picea rubens Sarg.
Picea glauca (Muench.) Voss.
Abies balsamea (L.) Miller

Neodiprion abietis (Harris)

Balsam fir
Black spruce
Engelman spruce
Red spruce
Sitka spruce
Jack pine
Eastern white pine
Pitch pine

Abies balsamea (L.) Miller
Picea mariana (Mill.) B.S.P.
Picea engelmanni (Parry) Engelmann
Picea rubens Sargent
Picea sitchensis (Bong) Carrière
Pinus banksiana Lambert
Pinus strobus Linnaeus
Pinus rigida Miller

Neodiprion banksianaw Rohwer

Jack pine
Pitch pine
Shortleaf pine
Norway red pine

Pinus banksiana Lambert
Pinus rigida Miller
Pinus echinata Miller
Pinus resinosa Aiton

Neodiprion lecontei (Fitch)

Austrian pine
Jack pine
Loblolly pine
Lodgepole pine
Longleaf pine
Mugho pine
Norway red pine
Pitch pine
Ponderosa pine
Scotch pine
Scrub pine
Shortleaf pine
Slash pine
Tamarack

Pinus nigra Arnold
Pinus banksiana Lambert
Pinus taeda Linnaeus
Pinus contorta Douglas
Pinus palustris Miller
Pinus montana
Pinus resinosa Aiton
Pinus rigida Miller
Pinus ponderosa Douglas
Pinus sylvestris Linnaeus
Pinus virginiana Miller
Pinus echinata Miller
Pinus caribaea Mor.
Larix laricina (DuRoi) K. Koch

Neodiprion pinetum (Nort.)

Eastern white pine
Mugho pine
Pitch pine
Scotch pine
Shortleaf pine

Pinus strobus Linnaeus
Pinus montana
Pinus rigida Miller
Pinus sylvestris Linnaeus
Pinus echinata Miller

Neodiprion sertifer (Geoffroy)

Austrian pine
Eastern white pine
Jack pine
Mugho pine
Norway red pine
Ponderosa pine
Scotch pine
Shortleaf pine

Pinus nigra Arnott
Pinus strobus Linnaeus
Pinus banksiana Lambert
Pinus montana
Pinus resinosa Aiton
Pinus ponderosa Douglas
Pinus sylvestris Linnaeus
Pinus echinata Miller

Pikonema alaskensis (Rohwer)

Black spruce
Engelman spruce
Norway spruce
Red spruce
Sitka spruce
White spruce

Picea mariana (Mill.) B.S.P.
Picea engelmanni (Parry) Engelmann
Picea abies (Linnaeus)
Picea rubens Sargent
Picea sitchensis (Bong) Carriere
Picea glauca (Muench) Voss.

Pristiphora erichsonii (Hartig)

Eastern larch
European larch

Larix laricina (DuRoi) K. Koch
Larix decidua Miller

The preceeding information was compiled from literature and personal correspondence as indicated in Methods and Procedure.

APPENDIX D
ECONOMIC VALUE OF IMPORTANT CONIFERS
ATTACKED BY SAWFLIES

Eastern white pine----- Pinus strobus Linneaus

Eastern white pine is noted for its rapid growth after the first two seasons, and the high quality of wood. Because of the demand for its wood, the ease in handling nursery stock, and the high percent of survival when properly planted, this species has been established by the millions throughout the northeastern United States, in fact it has been the principle species used in reforestation for many years.

Uses..... Boxes and crates, patterns, millwork, toys, woodenware, novelties, signs, caskets, building construction, and matches.

Jack pine ----- Pinus banksiana Lambert

Jack pine is essentially a Canadian species reaching best development north and west of Lake Superior. In the Lake States it is one of the most important second growth species, and used to reforest lands in which the humus layer has been destroyed by fire, leaving only bare sand. It serves as a valuable pioneer tree on such areas but eventually will be replaced by red or white pine.

Uses..... Primarily a pulp-wood species, but may be used for lumber. Is increasing in its use for poles after a preservative treatment. Also used for fuel, ties, boxes and crates, and wall board.

Loblolly pine ----- Pinus taeda Linneaus

Loblolly pine, probably the most tolerant species of southern pine, has spread to a remarkable degree in cut-over lands in the south and is especially aggressive in forming pure stands on old fields.

Uses..... An important timber species. The lumber is used chiefly for building materials, including millwork. Also used for boxes and crates. A leading wood in the production of pulp and slack cooperage. Railroad ties, piling, mine timbers, excelsior, and veneer.

Norway red pine ----- Pinus resinosa Aiton

Red pine is grown in large numbers for reforestation purposes, and also has its place in ornamental plantings. It is a fast growing tree of many uses, and of a greater demand than any other species grown in state forest nurseries.

Uses..... Pulpwood, railroad ties, poles, posts, building construction, boxes, crates, and planing mill products.

Shortleaf pine ----- Pinus echinata Miller

Shortleaf pine is a moderately rapid growing tree of the southern pine group, having the ability to sprout after the main stem has been destroyed by fire. It is capable of enduring suppression and showing greatly accelerated growth.

Uses..... Same as loblolly pine.

Black spruce ----- Picea mariana (Mill.) B.S.P.

Black spruce is a very tolerant tree, recovering after long periods of suppression. This tree is especially interesting in marking the northern limit of tree growth.

Uses..... Principle use is pulpwood. Also used in box making, crates, cooperage, paddles, oars, canoes, woodenware, and light construction work. Important as a christmas tree.

Red spruce ----- Picea rubens Sargent

Red spruce is one of the most important of the northeast conifers. The young trees are very tolerant, more so than their associated species, but they grow slowly under forest cover and even in the open do not make rapid growth.

Uses..... Principle use is pulpwood. Also used in the construction of boxes, crates, furniture, millwork, ladder rails. Important as christmas trees.

White spruce ----- Picea glauca (Moench) Voss.

This tree is the most important and the most widely distributed conifer in Canada, but in the United States it is found only in limited areas. White spruce is being used extensively for reforestation both in the United States and Canada because of its fast growth and valuable wood. It is excellent for windbreaks and shelter belts.

Uses..... Pulpwood. Cooperage, boxes, crates, refrigerator, general building purposes, planing mill products, kitchen cabinets, musical instruments, car construction, ship and boat building, furniture and woodwork, ladder rails, paddles and oars.

Balsam fir ----- Abies balsamea (L.) Miller

Balsam fir is a moderately fast growing tree in youth, and aggressive in restocking cutover land even under old stands of spruce and fir. Reproduction is plentiful, and in a great demand for its use as christmas trees.

Uses..... Christmas trees. Packing cases, boxes, crates, sheathing, and in pulp.

Eastern larch ----- Larix laricina (DuRoi) K. Koch

Tamarack, eastern larch, is well noted for its rapid growth on favorable sites, and not damaged by fire due to its wet surroundings.

Uses..... Used in making railroad ties, poles, posts, telephone poles, ship building, heavy construction timbers.

The preceeding information has been compiled from (13)(23)
(31) (36)

APPENDIX E

LIST OF SAWFLIES

AND THEIR RESPECTIVE PARASITES

Diprion simile (Hartig)

1. Cerambycobius sp.
2. Exenterus abruptorius Thb.
3. Exenterus claripennis Thom.
4. Exenterus marginatorius Fabricius
5. Exorista petiolata Cog.
6. Hemiteles utilis Norton
7. Microplectron fuscipennis Zett.
8. Monodontomers dentipes (Beh.)
9. Pachyneuron (Dibrachys) nigrocyanus Norton

Gilpinia frutetorum (Hartig)

1. Microplectron fuscipennis Zett.

Gilpinia hercyniae (Hartig)

1. Aenoplex sp.
2. Aptesis indistincta (Provancher)
3. Bessa selecta Mg.
4. Exenterus abruptorius Thb.
5. Exenterus claripennis Thom.
6. Exenterus marginatorius Fabricius
7. Exenterus tricolor Rom.
8. Exenterus vellicatus Cush.
9. Itoplectis montana
10. Lamachus contortions Dav.
11. Microplectron fuscipennis Zett.
12. Phorocera (near) hamata
13. Spathimeigenia aurifrons Curran
14. Spathimeigenia spinigera Tns.
15. Sturmia sp.
16. Stylocryptus subclavatus (Say)

Neodiprion abietis (Harris)

1. Aleiodes parasiticus Norton
2. Amblymerus verditer (Norton)
3. Bessa selecta Mg.
4. Campoplex genuinis Norton

Neodiprion abietis (Harris) cont.

5. Cheilopachus nigro-cyaneus
6. Cryptus Lophyri
7. Delomerista diprionis Cush.
8. Exenterus abruptorius Thom.
9. Exenterus affinis Rohwer
10. Exenterus canadensis Provancher
11. Exenterus claripennis Thom.
12. Exenterus marginatorius Fabricius
13. Gelis sp.
14. Hemiteles tenellos Say
15. Hemiteles utilis
16. Ichneumon fungor Norton
17. Ichneumon rubicundus Cress.
18. Lamachus contortionis Dav.
19. Lamachus lophyri Ashm.
20. Lamachus ruficoxa Cush.
21. Mesochorus sp.
22. Musca carnoria
23. Phorocera (near hamata)
24. Pimpla inquisitor Say
25. Pteromalus verditer
26. Spathimeigenia aurifrons Curran
27. Spathimeigenia spinigera Tns.
28. Trineptis diprionis Cush.

Neodiprion banksianae Rohwer (no records)

Neodiprion lecontei (Fitch)

1. Admontia hylotomae
2. Exenterus abruptorius Thb.
3. Exenterus claripennis Thom.
4. Exenterus marginatorius Fabricius
5. Masicera sp. (near exilis)
6. Phorocera claripennis Macq.
7. Spathimeigenia spinigera Tns.

Neodiprion pinetum (Norton) (no records)

Neodiprion sertifer (Geoffroy)

1. Delomerista diprionis Cush.
2. Exenterus abruptorius Thb.
3. Exenterus claripennis Thom.
4. Exenterus marginatorius Thb.

Pikonema alaskensis (Rohwer)

1. Bessa selecta Mg.
2. Brachymeria compsiluræ (Cwfd.)
3. Erromenus bedardi Provancher
4. Euceros sp.
5. Holocremmus sp.
6. Hypopteromalus tabacum Fitch
7. Mellitobia chalybii Ashm.
8. Mesochorus spp.
9. Mesoleius sp.
10. Monoblastus ? varifrons Cress
11. Orthostigma sp.
12. Phorocera (near hamata)
13. Scopiorus quebecensis Provancher
14. Smicroplectrus velox Wly.
15. Sturmia sp.

Pristiphora erichsonii (Hartig)

1. Aenoplex sp.
2. Apoteticus (Podisus) modestus
3. Aptesis nigrocinctor
4. Bessa harveyi Mg.
5. Mesoleius tenthredinis Morley
6. Callopiethis (Pteromalus) nematicida Pack
7. Coelichneumon fuscipes Grov.
8. Cryptus minator Grov.
9. Dibrachys n. sp.
10. Diglochis sp.
11. Eclytus ornatus Holm.
12. Exorista sp.
13. Frontina (Masicera) tenthredinidorum Tns.
14. Giolichneumon annulator Fabricius
15. Isaria fasinosa (Decks) Fr. (Fungus)
16. Mesoleius tenthredinis Morley
17. Microcryptus labralis Grov.
18. Microgaster sp.
19. Phygadeuon sp.
20. Pezoporus indistinctus (Provancher)
21. Perilampus sp.
22. Spilocryptus incubitor Stron.
23. Trichogramma minutum Riley

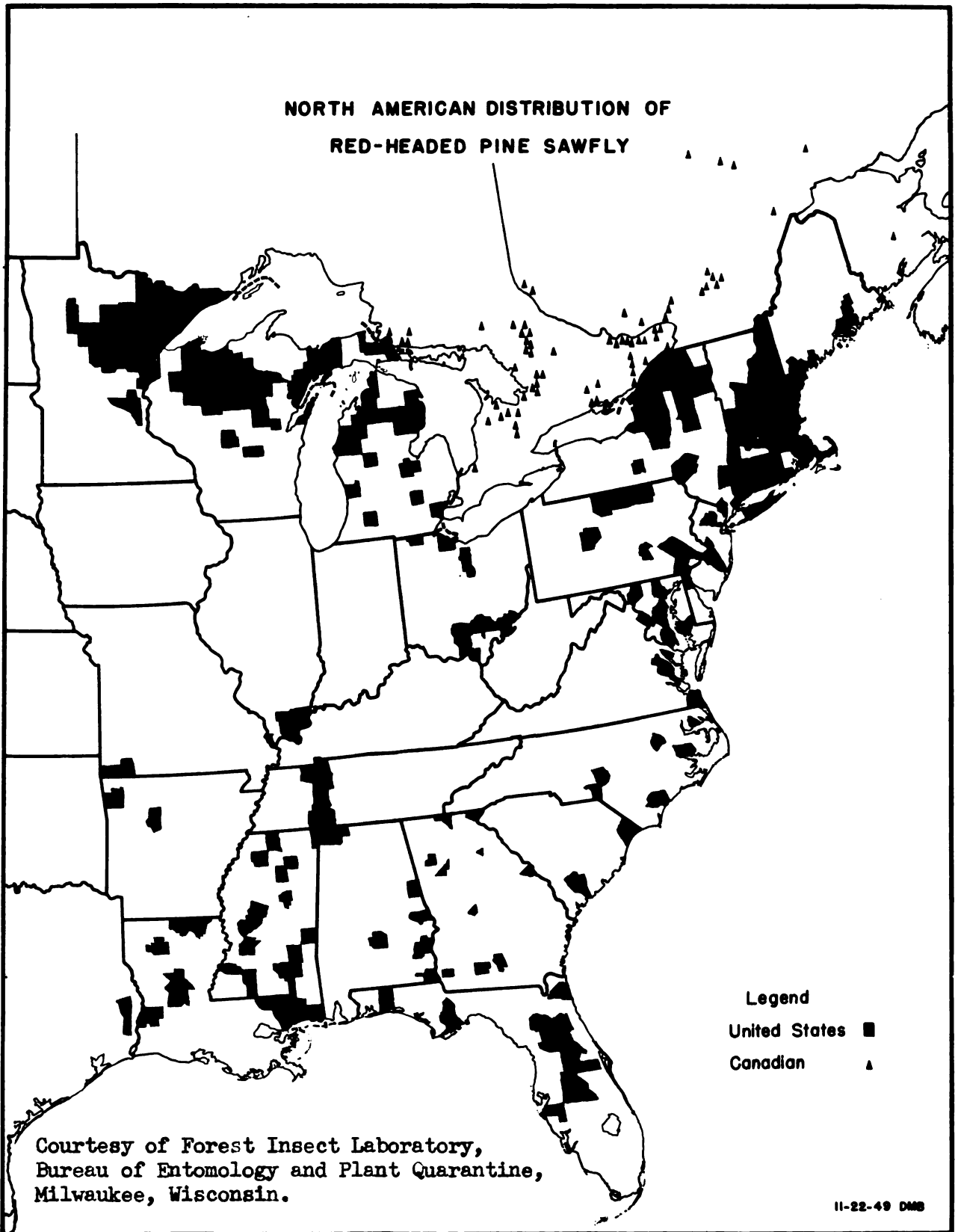
Compiled from: (2)(5)(6)(10)(16)(18)(22)(35)(46)(47)

APPENDIX F
DISTRIBUTION MAPS

The following maps present the known eastern North American distribution of the sawflies discussed in this paper.

Solid marking is used to indicate county records of distribution and cross-hatching indicates states having the sawfly present but with no records of their establishment within counties. Labrador and Manitoba are not included in the maps, but distribution in these sections of North America are included in the discussion of sawfly species.

**NORTH AMERICAN DISTRIBUTION OF
RED-HEADED PINE SAWFLY**



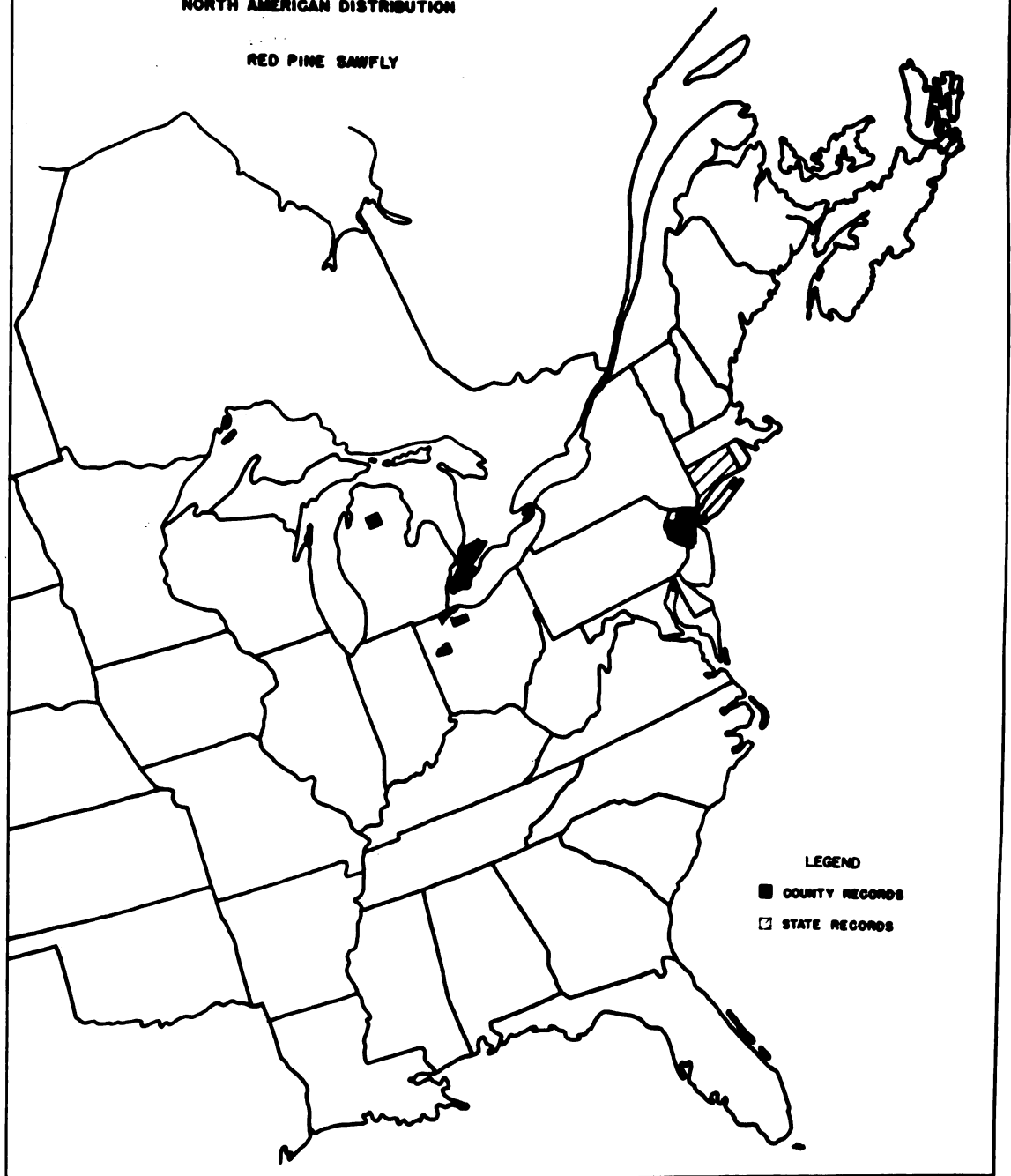
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RED PINE SAWFLY



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