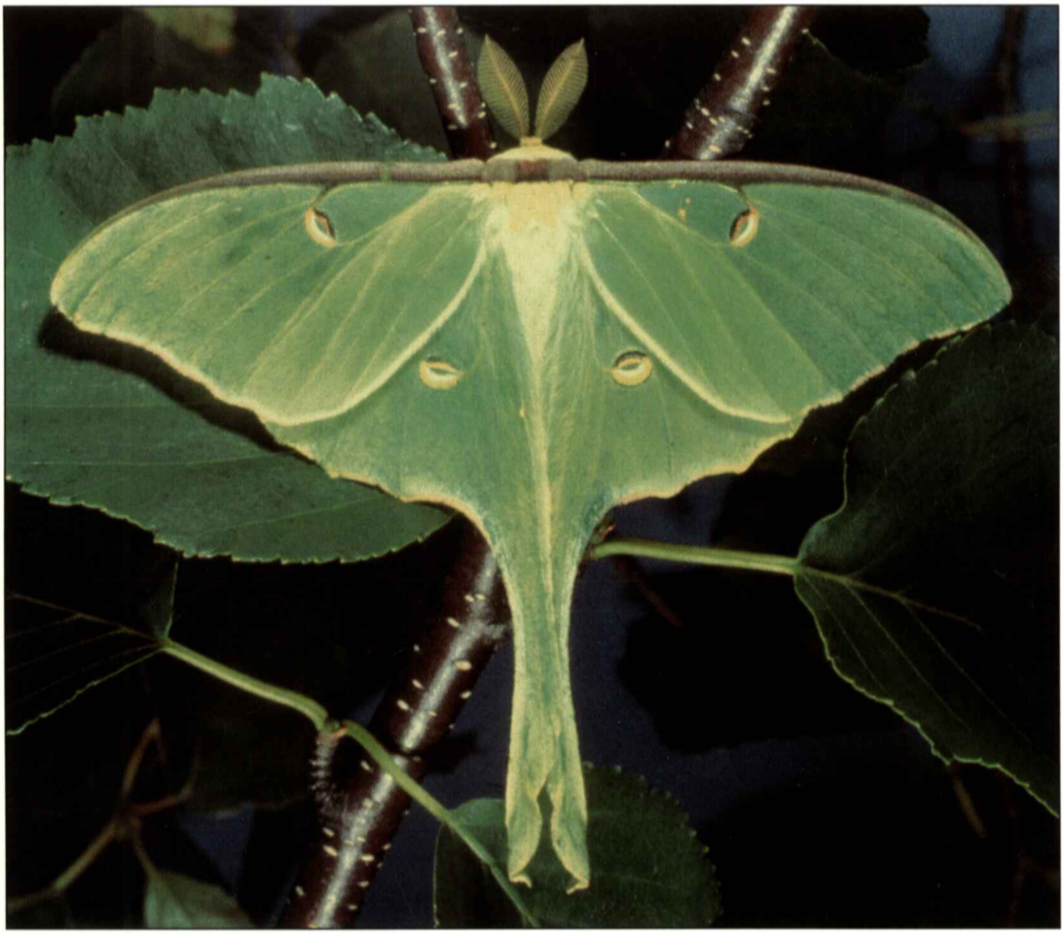
Revised 1997

# Insects of Eastern Hardwood Trees

A.H. Rose and O.H. Lindquist



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Canada

Cover photo: Luna moth

# INSECTS OF EASTERN HARDWOOD TREES

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*Insects of Eastern Pines*
*Insectes des pins de l'est du Canada*

*Insects of Eastern Spruces, Fir and Hemlock*
*Insectes des épinettes, du sapin et de la pruche de l'est du Canada*

*Insects of Eastern Larch, Cedar and Juniper*
*Insectes du mélèze, du thuya et du genévrier de l'est du Canada*

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# Abstract

This handbook is designed to enable people who are interested in trees to identify the insects and mites causing damage to them. About 450 species of insects and mites that have caused noteworthy damage to hardwood trees in Canada east of the Rocky Mountains are included. Identification is based initially on the kind of tree damaged, and the insects are grouped under 20 tree genera. Within each host tree section, flow-chart keys, understandable to the layman, are provided to lead the reader to individual species or groups of similar organisms, with full-color illustrations to confirm the identity of the insect or mite. The accompanying biological sketch for each insect or mite usually includes information on the necessity for control, based largely on Forest Insect and Disease Survey records. Where control is necessary, methods are suggested. Common names of insects are generally used but scientific names are also given in the text.

# Résumé

Ce manuel veut aider les gens qui portent intérêt aux arbres à identifier les insectes et les acariens qui les endommagent. Il traite d'environ 450 espèces d'insectes et d'acariens qui ont causé des dégâts sensibles aux feuillus canadiens à l'est des Rocheuses. L'identification est d'abord basée sur l'espèce d'arbre endommagée, et les insectes sont regroupés en fonction de 20 genres d'arbres. Chaque chapitre sur l'arbre hôte comprend des diagrammes clés simples qui facilitent l'identification des espèces ou de groupes d'espèces voisines, de même que des illustrations en couleur qui permettent de confirmer l'identité de l'insecte ou de l'acarien. À ceci s'ajoute l'histoire naturelle résumée de chaque insecte ou acarien, comportant habituellement des renseignements sur la nécessité des mesures de lutte en grande partie basés sur les dossiers du Relevé des insectes et des maladies des arbres. Lorsque la lutte est nécessaire, des méthodes sont suggérées. En général, les auteurs identifient les insectes par leurs noms communs, mais le nom scientifique latin est aussi donné dans le texte.

# Foreword to the 1982 Edition

This is the last in a series of four handbooks describing insects that damage eastern Canadian trees. The first three books covered the eastern conifer pines, spruces, fir, hemlock, larch, cedar, and juniper and have been widely used by forest managers, pest extension specialists, educators, and the general public. This handbook describes 450 species of insects and mites that are capable of causing damage to eastern hardwood trees. As with the earlier volumes, much of the information has been obtained from records collected by the Forest Insect and Disease Survey Unit of the Great Lakes Forest Research Centre, Canadian Forestry Service, over a 30-year period. Valuable contributions have also been made by specialists at other Canadian Forestry Service Research Centres, and taxonomists at the Biosystematics Research Institute, Agriculture Canada, Ottawa.

The authors of the handbooks, A. H. Rose and O. H. Lindquist, Research Scientist and Senior Technician respectively, have each been employed by the Government of Canada for approximately 30 years, and this final volume represents the culmination of their excellent achievements. They have made a major contribution to Canadian forest entomology through their research studies and by the preparation of this series of insect handbooks.

J. H. Cayford
Director
Great Lakes Forest Research Centre

# Foreword to the 1997 Edition

The biological information in this handbook is, for the most part, the result of over 50 years of data gathering and studies by the Canadian Forest Service, Sault Ste. Marie. While not all insects and mites found on hardwood trees have been included, those that are have caused noticeable damage at one time or another.

This handbook, along with the three others in the *Insects of...* series, was written by two outstanding entomologists, the late Art Rose, Research Scientist, and O.H. Lindquist, Senior Technician.

Recognition must be given to the dedicated field staff who have collected the insects, gathered the biological information and provided many photographic materials. Special acknowledgments should also be given to taxonomists at the Biological Resources Division, Centre for Land and Biological Resources Research (formerly the Biosystematics Research Institute), Agriculture and Agri-Food Canada, and to research scientists at other Canadian Forest Service research centres for their contributions.

Revisions of the handbooks in the *Insects of...* series occur from time to time to keep abreast of the current information concerning scientific name changes and new distribution records. New pests that have become troublesome or recently discovered since the last printing have been added. This handbook is useful to any individual who is confronted with an insect problem or who is curious about insects feeding on eastern hardwood trees. About 500 species of insects and mites are included along with easy-to-use keys, biological information and advice on control.

Kathryn Nystrom
Insect Identification Officer
Canadian Forest Service, Sault Ste. Marie

# Contents

# Introduction

This handbook brings together information on insects and mites that have caused noticeable damage to hardwood trees in central and eastern Canada and adjacent areas of the United States. By "hardwood" we mean broad-leaved or deciduous, as opposed to needle-bearing or coniferous trees.

This is the final handbook in a series prepared for foresters and others who are interested in identifying insects and mites causing injury to trees, and who may wish to take appropriate remedial action.

In preparing these handbooks we were fortunate to have access to the vast amount of information gathered by the national Forest Insect and Disease Survey organization of the Canadian Forest Service over some 40 years of operation. In particular, we made extensive use of Ontario data. However, supplementary information has been drawn from reports and publications by other Canadian and American entomologists. Entomological specialists at the Centre for Land and Biological Resources of Agriculture and Agri-Food Canada in Ottawa provided invaluable assistance in taxonomic matters.

As this handbook deals with many species of insects and mites it was necessary to separate them into manageable groups in order to facilitate identification. The initial separation is based on the species of tree attacked and these are dealt with in order of prevalence and/or economic importance. It is necessary for the reader to identify the tree first; this can usually be done on the basis of leaf shape. The leaf silhouettes at the beginning of each section will provide assistance, but the Canadian Forest Service publication *Trees in Canada* should be consulted for a more positive identification. Insects that have caused noticeable injury to a tree of a particular genus are separated by means of simple flow-chart keys. Where feasible the common names of insects, generally those describing the feeding stage of its damage, are used. However, where little-known or complex groups are discussed, scientific names are used to avoid confusion. From the flow charts the reader is referred to a biological sketch in the text, where an illustration of the insect or its injury on the same or facing page is indicated by . Where the illustration is on another page it is shown by followed by the page number. Where illustrations grouped at the beginning of a section are considered as a pictorial key, the page number of the main text entry is given in the caption. Some insects feed on trees of a number of genera, in which case reference is made to them in different sections of the book. However, the main information on each insect will be found under the tree genus on which it is most commonly found. For some species it was not possible to provide information on seasonal occurrence of the various stages over large areas; in such cases Ontario data are given.

For information about any insect on hardwood trees not described here, a sample of the insect, and of its damage if possible, should be sent to the Forest Insect and Disease Survey at the Forestry Centre serving your area (see map on page 11).

## Injury

Injury to trees can be caused by such varied factors as climate, insects, mites, diseases, birds, and mammals. Man often causes injury by mechanical means or by adversely altering a tree's environment either above or below ground. However, this handbook deals almost exclusively with problems created by insects or mites.

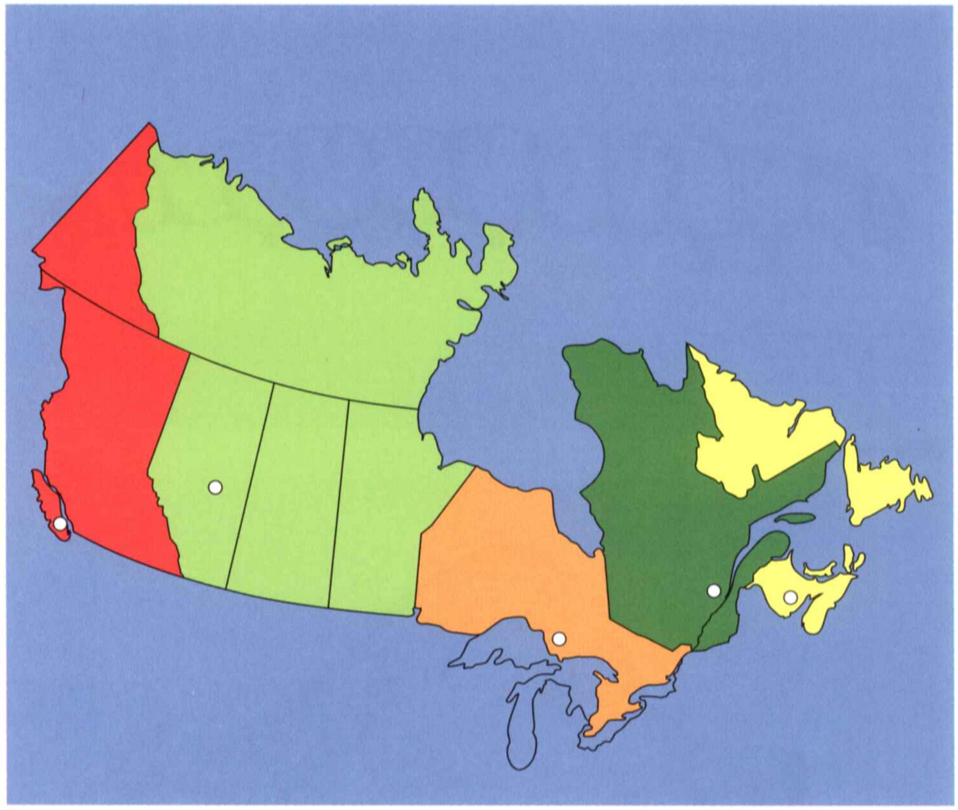
All parts of a tree are subject to attack by some species of insect. The degree of injury, however, depends on the number of insects, type of feeding, time of year, and how vital the part attacked is to the survival of the tree.

## Control

Because the particular pesticides allowed are constantly changing, no specific control measures are given in this handbook. The use of biological insecticides that are more host specific, and therefore presumably less deleterious to the environment, is encouraged wherever they would be effective. Wherever possible, means of control other than pesticides are suggested. We also indicate whether in fact any control measures are warranted or necessary; in the past some threatening pest populations have collapsed without man's intervention and without apparent long-term damage to trees. However, should chemical control measures become necessary, we indicate the stages of the pest's life cycle that are most susceptible to control. Also, to facilitate selection of chemical insecticides, we give the required type of pesticide (contact, systemic, or fumigant). Information on currently registered pesticides may be obtained from various government agencies and is also given on the pesticide container. The advice of a specialist should be obtained if large-scale chemical control is necessary.

## Further reading

Historical information on important or noteworthy forest insects in Canada may be found in publications issued by the Canadian Forest Service of Natural Resources Canada. These include the Annual Reports of the Forest Insect and Disease Survey, and the four-volume report *Forest Lepidoptera of Canada. Eastern Forest Insects,* by W. L. Baker, 1972, Miscellaneous Publication 1175 of the Forest Service of the United States Department of Agriculture is a comprehensive treatment of the subject and contains an extensive list of references to papers in entomology journals. We also recommend a more recent publication, *Insects that Feed on Trees and Shrubs,* by W. T. Johnson and H. H. Lyon, 1976, Cornell University Press. A specialist in forest entomology should be consulted for more detailed information.



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Atlantic Forestry Centre
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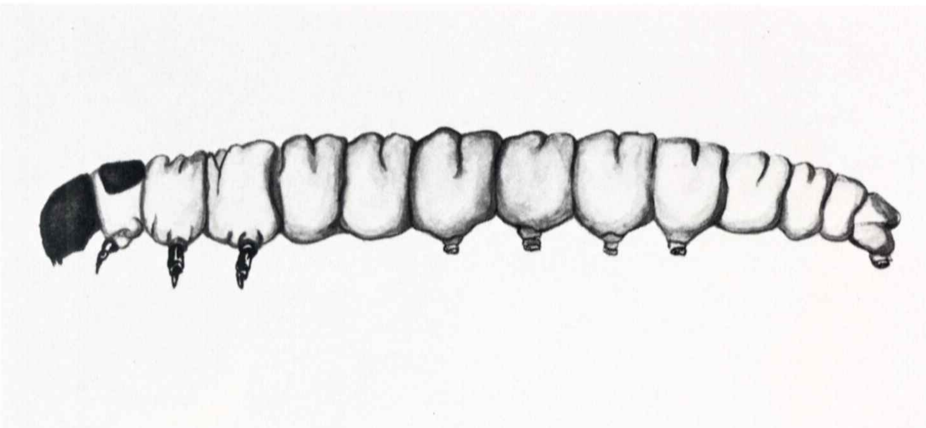
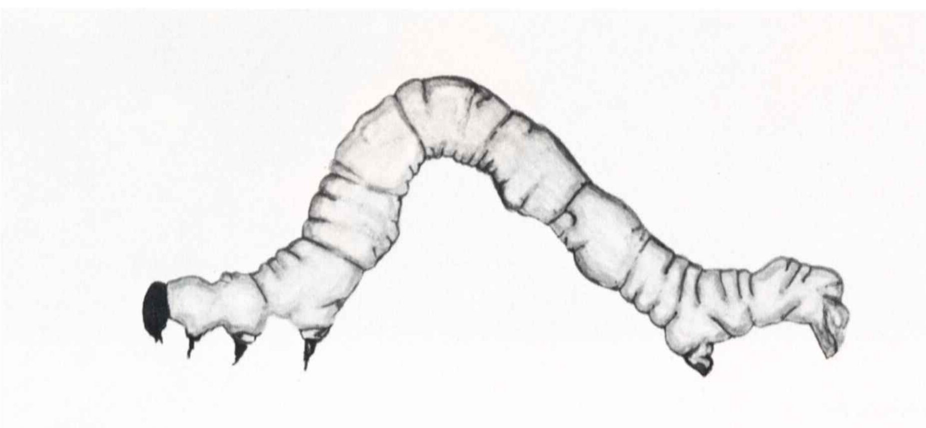
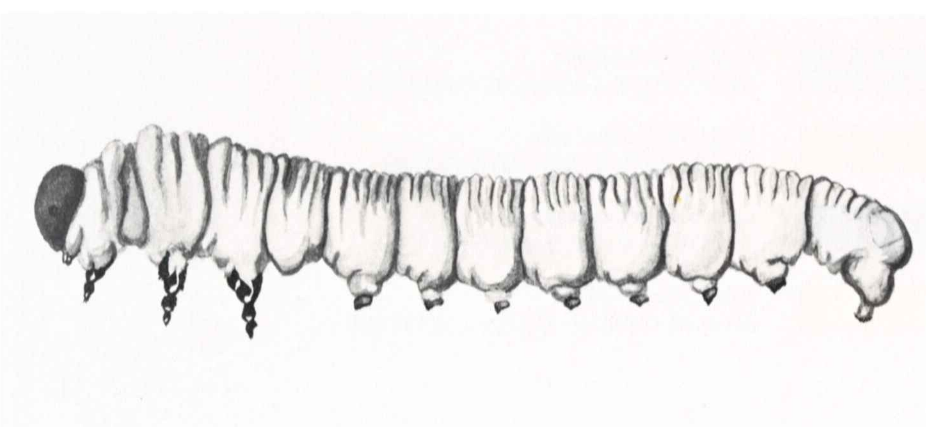
# Types of insects and mites



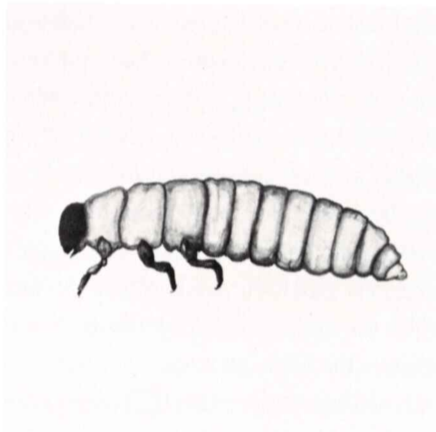
Will be a moth



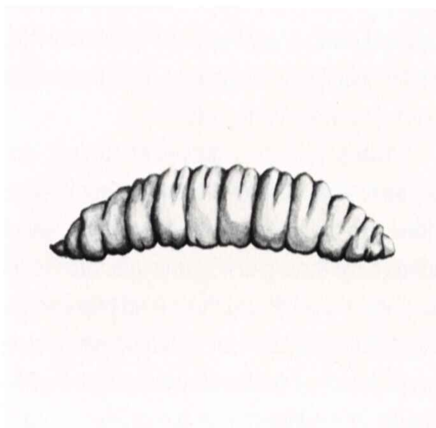
Will be a looper moth

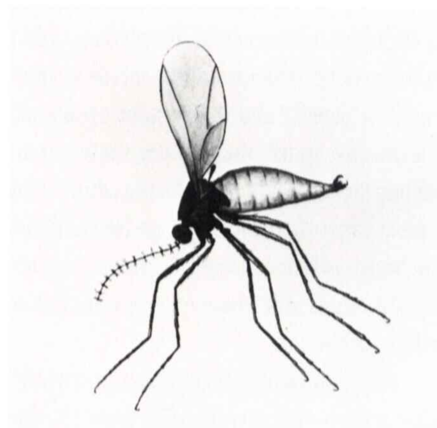


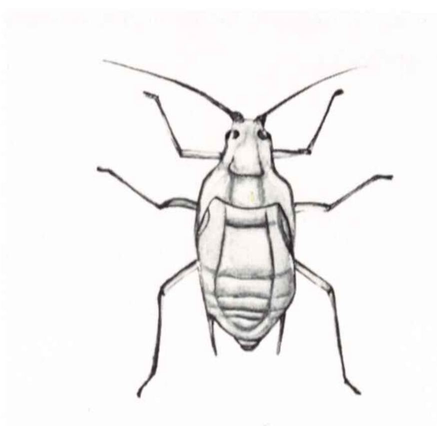
Will be a sawfly

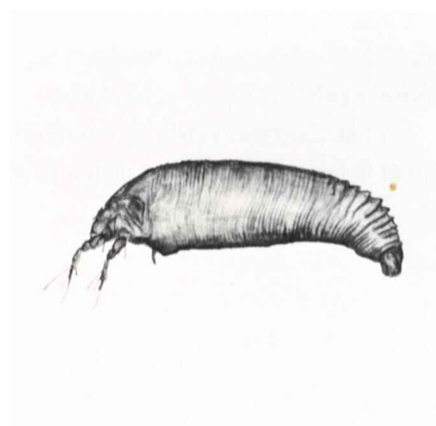

Will be a beetle


Sawfly adult


Will be a two-winged fly (head doesn't show)


Midge adult


Aphid nymph


Eriophyid mite

Most of our destructive forest insects develop through four stages—egg, larva, pupa, and adult—each distinctly different from the other. Eggs are laid openly on any surface or in host plant tissue; they may be single, in groups, in shingle-like clusters, round, oval, or disk-like but all of them are tiny and seldom noticed. The larva, sometimes referred to as "caterpillar", "worm", "grub", or "maggot", is the principal feeding stage. It sheds its skin at intervals as it grows. Larvae, particularly those of moths, vary greatly in color, shape, and size and may be with or without hair. However, most of our forest insects can be grouped according to the general structure of the larvae as illustrated on pages 12 and 13. The pupa or chrysalis is an inactive transformation stage between the feeding larva and the reproducing adult. There is great variety in the form pupae take and they can be exposed or concealed in diverse cocoon-like structures and frequently they are buried in litter or the soil.

Some forest insects develop through only three stages—egg, nymph (page 13), and adult. The nymph sheds its skin at intervals as it grows, but, unlike the larva, it frequently resembles the adult and does not require a pupal stage in which to change to an adult insect.

The adults of many injurious insects discussed in this handbook are seldom noticed because they are often present long before or after damage occurs. Moths are frequently seen but adult sawflies (page 13) are seldom recognized because they are generally much smaller and less conspicuous in coloration. Sawflies derive their name from the microscopic sawlike structure at the tip of the female's abdomen, used to cut slits in plant tissue into which the eggs are deposited. Like their near relatives the bees and wasps, they have two pairs of wings. Midge adults (page 13) are true flies with one pair of wings. They are tiny insects that are seldom seen in the adult stage. Other adults such as winged and wingless moths, beetles, plant bugs, and thrips are illustrated in various sections of the text.

Mites, minute relatives of spiders, are not technically insects because the adults have either two or four pairs of legs, whereas insect adults have three pairs. Young mites generally resemble the adult and there is no pupal stage. Two families of mites are common plant feeders; members of one family cause a wide variety of galls. The gallforming or felt-producing eriophyid mites (page 13) occur commonly on hardwood trees but can be seen only under magnification.

# Galls

Galls are aberrant structures formed by abnormal plant growth and are caused by many forms of life, including viruses, bacteria, fungi, nematodes, mites, and insects. However, most galls are caused by mites and insects. No part of a tree is free from attack by gall formers and all abnormal structures and shapes on any part of the tree should be suspect.

The actual mechanism of gall formation is not clearly understood, but it is believed that galls are caused by the introduction of an extremely active plant growth-regulating chemical that acts on a developing part of the plant and causes it to assume a different character. Moreover, the growth regulator is so highly specific that it results in a gall with a form so localized and characteristic that the gall is frequently used to identify the causal agent. Because tree growth is most active in the spring, most galls are initiated then, in the buds, new leaves, or shoots. However, during the summer further galls develop in new leaves and in the continuing growth under and in the bark of twigs, branches, and roots. As the galls develop to their final shape they supply sustenance and shelter to the developmental stages of the causative organism.

Most galls are not sufficiently abundant to cause tree mortality and generally only the aesthetic appearance of the tree is affected. Usually the number of galls fluctuates at relatively low levels from year to year, with occasional high numbers followed by an abrupt collapse. In some instances parasites and predators appear to be important control agents.

The majority of gall formers are in one family of mites and three families of insects. The mites are in the eriophyid family. These microscopic wormlike creatures, with two pairs of legs instead of the customary four pairs found in other mites, cause a great variety of galls on twigs, shoots, leaves, and buds. They seldom cause appreciable damage in forests and are of concern primarily on ornamental trees for aesthetic reasons. However, with monoculture becoming more common they may increase in importance. Their life histories have not been studied thoroughly. Most species pass the winter as adults in any suitable niche in the tree. The adults move to expanding buds in the spring and their feeding initiates such abnormal development as massive proliferation of buds, tightly rolled leaves, and blister galls, pouch-like galls, and felt-like, brilliantly colored patches called erinea, on either leaf surface. Inside these structures, as the season progresses, eggs and both small white and larger yellow mites, generally representing immature and mature individuals, are usually found. A number of generations may be passed in the gall before the mature mites leave to find suitable hibernation sites. As these mites do not have chewing mouth parts, all their galls retain, throughout their development, an opening to the outside.

Most gall-forming insect species belong to one of three families—midges, aphids and their close relatives, and cynipids—but there are a few gall formers in most orders of insects.

All hardwood trees have galls caused by midges. Many species overwinter as mature larvae in tiny silken cocoons in the gall, on the ground or in the soil, and change to pupae and subsequently to adults in the spring. The tiny adults, seldom observed, lay their eggs on developing tissue. During the development of the gall there may be a single larva or a number of white to yellow or red maggot-like larvae present in the gall. The larvae are active and usually have a darker breast-bone structure near the anterior end. Later in the season, after the larvae have left, the galls discolor. In some instances there are a number of generations during the summer and new galls will be formed where plant development is occurring.

The gall-forming aphids and their relatives attack fewer hardwood trees than the previous group. Poplars, hickories, and hackberry trees seem to be the main hosts. Life cycles in this insect group are often complex. There may be an alternation of food plants with some generations on one tree and other generations on a different tree, with characteristic galls on one or both, or alternation between some herbaceous plant and a tree species. Winged forms develop before the move from one host to the other.

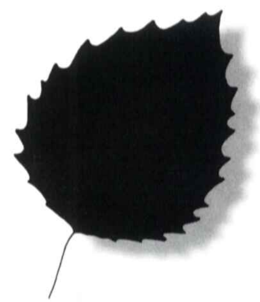
The cynipid galls are for the most part restricted to the various parts of oak trees and over 700 species of the small wasp-like insects are known. Because there are so many species the variety of galls appears to be endless. The life history of many of these gall formers is unknown, but some have alternate generations, with an asexual generation producing a gall on one part of the tree and a sexual generation producing galls on a different part of the tree later in the year. The adults of each of these generations may be strikingly different in appearance, and in the past they were sometimes described as separate species. Often a single larval cell may occupy an insignificant portion of the gall. On the other hand, some galls have many larval cells, which are often shed as the gall matures. When inhabited, each cell contains a tiny curved larva with an indistinct head, or a pupa. The adult usually cuts its way out of the gall.

For additional information on cynipid galls the publication *Cynipid Galls of the Eastern United States* by L. H. Weld, 1959, available from the Entomological Society of Washington, c/o The U. S. National Museum, Washington, D. C., should be consulted.

A number of galls caused by mites and insects are illustrated and discussed in the following sections.

# POPLAR

*Trembling aspen*

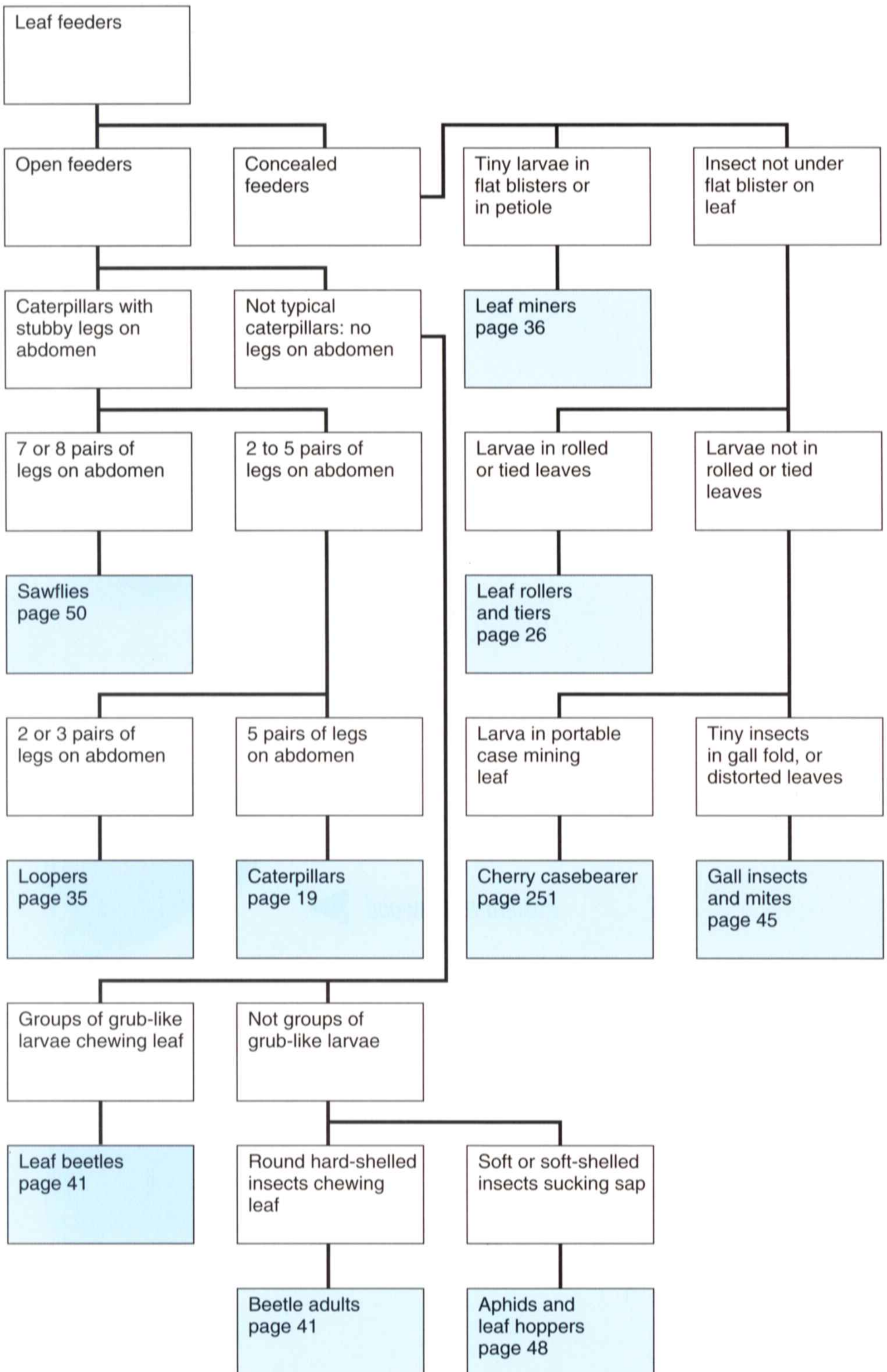


*Large tooth aspen*

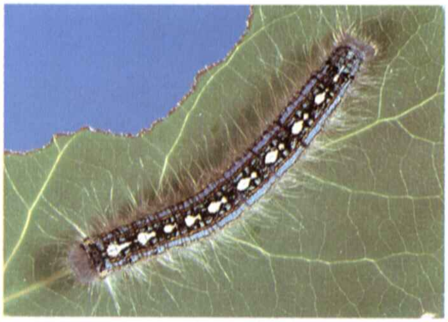
*Eastern cottonwood*

*Balsam poplar*

# Poplar: leaf feeders



# Caterpillars

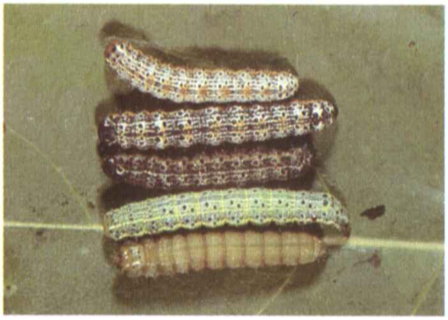

Forest tent caterpillar, p. 21


White underwing caterpillar, p. 24


Satin moth larva, p. 23


Speckled green fruitworms, p. 24


Poplar dagger moth larvae, p. 24


Variable caterpillars, p. 24


Cottonwood dagger moth larva, p. 24

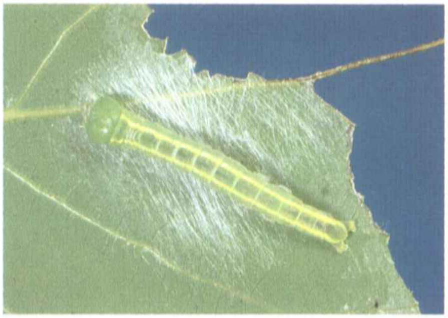

Redhumped caterpillars, p. 24

False hornworm, p. 24

Viceroy larva, p. 25

Rustylined leaftier, p. 24

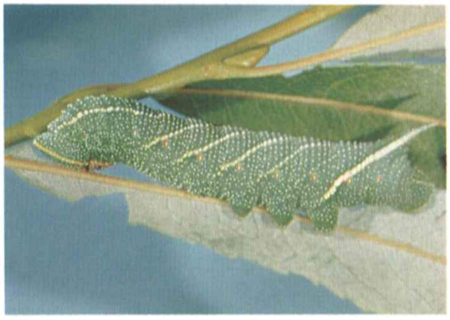
Lappet moth larva, p. 25



Pale green notodontid larva, p. 24

Big poplar sphinx larva, p. 25

*Cerura* species larva, p. 24



Twin-spot sphinx larva, p. 25

Other caterpillars found on poplar:
Rusty tussock moth, page 71
Tiger swallowtail, page 71
Alder dagger moth, page 72
Gypsy moth, page 141
Mourningcloak butterfly, page 175
Rusty whitesided caterpillar, page 198

We illustrate and describe the larvae of 16 species of caterpillars that feed openly on the various poplars. In addition, we list another six species sometimes found on poplar and give information on them under the host trees on which they are more commonly found.

Of the large number of caterpillars that feed openly on aspen, only the forest tent caterpillar (page 19), *Malacosoma disstria* Hübner, causes widespread and severe defoliation. Periodic infestations have been reported since 1835 and there have been infestations somewhere in Canada every year since the Forest Insect Survey was established in Canada in 1936. This forest insect is apparently the most widely distributed species in North America; it is found on broad-leaved trees wherever they grow. It prefers trembling aspen in the northern part of its range, oak in the southern part of its Canadian range, and gum in the southern United States. Sugar maple is often severely defoliated although red maple in the same area is untouched. This tent caterpillar, unlike other eastern members of the genus, does not make a tent in which to shelter.

Winter is spent as a tiny larva inside the egg in a cluster of eggs laid around the twig. As

Defoliated aspen

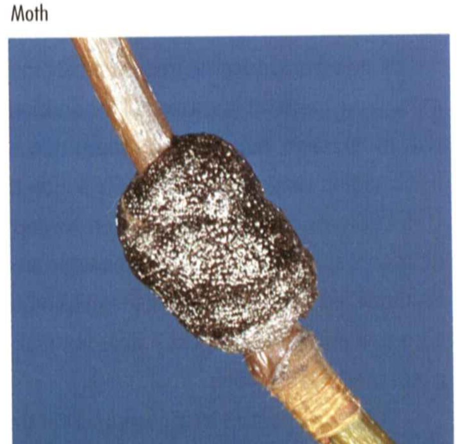
Migrating larvae

leaves appear on the tree in spring the larvae leave the egg cluster and move to the developing leaves, leaving a trail of fine silk. The larvae remain together for a number of larval stages and when they change from one larval stage to the next they leave clusters of shed skins on the trunk and larger branches. Because the larvae feed together they usually eat the leaves on one branch before moving to another, and damage becomes evident sooner than is the case with solitary feeders. When a tree is denuded ( page 21) or when larvae are almost full grown, they wander in groups ( page 21) and defoliate other trees and shrubs. The typical white keyhole marks along the back of the blue-black larvae provide a ready means of identifying them. When feeding is complete, between mid- and late June in Ontario, the larvae spin silken cocoons, usually in leaf clusters , and change to the pupal stage, which lasts about 2 weeks. After mating, the brown moths lay  bands of eggs , covered with gray-black foam, on the tree twigs. By early to mid-August the tiny larvae are present in the eggs, completing the life cycle.

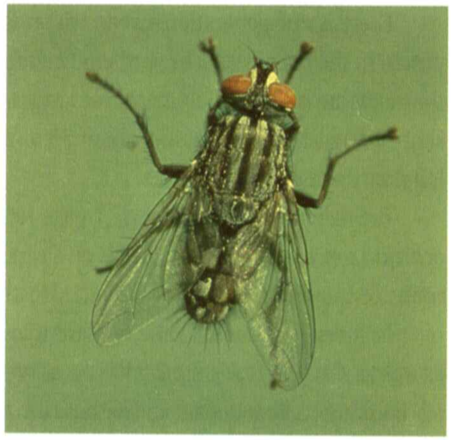
Immense stands of susceptible forests may be denuded by early summer during severe outbreaks but trees that lose their leaves this early will produce another crop of leaves 4 to 6 weeks later. However, years in which larvae seem to be everywhere are soon followed by a longer period during which larvae are seldom seen. The reasons for a phenomenal increase in larval numbers are more obscure than the reasons for rapid decline. For example, unfavorable weather in the spring, when the larvae

Cocoon

Moth



Egg band



*Arachnidomyia (=Sarcophaga) aldrichi*

emerge, often terminates local epidemics. Disease organisms are important in some instances, as are parasites, especially the large flesh fly, *Arachnidomyia (=Sarcophaga) aldrichi* (Parker), which sometimes becomes almost as much of a nuisance as the caterpillar. Furthermore, a scarcity of suitable food is an important factor when epidemics are at their peak.

Recently the application of a bacterial insecticide when the larvae are small has proven effective in protecting the leaves on trees in small areas. On the other hand, because the caterpillars are primarily a nuisance, the use of chemical control measures for large areas is questionable. The homeowner can prevent leaf loss on individual trees by removing the egg bands in the fall or before the larvae emerge in spring, or by using an insecticide soon after the larvae have started to feed in early spring. The use of any control measures, however, is likely to be ineffective against hordes of migrating larvae.

The satin moth (page 19), *Leucoma (=Stilpnotia) salicis* (Linnaeus), an insect introduced from Europe, is currently present from Newfoundland to the Ottawa area, in southern British Columbia, and in the northeastern United States. The larvae feed on all species of poplar and willow, but prefer ornamental varieties of poplar. In the past the satin moth was usually considered to be a pest of ornamental trees. Recently, however, aspen stands have suffered severe defoliation.

There is one generation a year; winter is spent as a third-stage larva under a web of silk and bark particles. The larvae emerge in mid-May and begin feeding, consuming whole leaves except the major veins. A full-grown larva is about 35 mm long with large white spots along the back. Cocoons are spun in the leaves in early July and the moths emerge about 10 days later. The eggs, covered with a white shiny material, are laid in groups, usually on the trunk or branches but sometimes on buildings. Hatching occurs in about 2 weeks and the young larvae move to the leaves, which they skeletonize during two larval feeding stages before seeking hibernation sites.

Although localized infestations are reported each year, their duration has been decreasing recently. It is believed that a combination of parasites and disease organisms is largely responsible.

There are many species of *Acronicta* on various hosts and a few species feed on poplar in southern Canada. The two most common on poplar are the poplar dagger moth (page 19), *A. leporina* (Linnaeus), and the cottonwood dagger moth (page 19), *A. lepusculina* Guenée.

Because both species are solitary feeders and rarely present in significant numbers they are seldom seen. These attractive larvae may be found throughout the summer. When full grown they are about 35 mm long.

The white underwing caterpillar (page 19), *Catocala relicta* Walker, feeds on aspen from Ontario to the Pacific but is most common in the Prairie provinces. The large gray-green larva, which resembles a twig, is present from June to the end of August. The adults in the genus *Catocala* have contrasting bands of color on the hind wings, and are known as "underwing moths."

The speckled green fruitworm (page 19), *Orthosia hibisci* (Guenée), feeds on a wide range of trees from the Atlantic to the Pacific but is not found in large numbers on forest trees. Winter is spent as a pupa in the soil and the moths are in flight in late April and May. Larvae are present from late May to mid-July in Ontario. They attain a length of about 40 mm and occur in two color phases.

The variable caterpillar (page 19), *Pyrrhia exprimens* (Walker), one of the climbing cutworms that feeds at night, is a general feeder. Its main tree hosts from Newfoundland to Alberta appear to be balsam poplar and trembling aspen, where it feeds on developing shoots. Although it is not a common forest insect, high numbers do occasionally occur, and in one instance it destroyed large numbers of white spruce seedlings planted in a recently burned area.

There is one generation a year; winter is passed in the pupal stage. In northern Ontario the moths are in flight in July and larvae are present in August. Mature larvae, about 35 mm long, vary considerably in color.

The redhumped caterpillar (page 19), *Schizura concinna* (J. E. Smith), feeds on a wide range of trees across most of Canada. Hosts include forest, ornamental, and orchard trees as well as shrubs. This caterpillar has occasionally become locally abundant and because it is a gregarious feeder the damage is quite noticeable. There is one generation each year; winter is spent as a larva inside a papery cocoon in the soil litter. Pupation takes place in the spring and larvae are present from mid-July to mid-September. The full-grown larva is about 25 mm long.

A number of solitary feeders belonging to the Notodontid family of moths occur across Canada, mainly on aspen, and usually in late summer. All appear to overwinter in the pupal stage. The false hornworm (page 20), *Pheosia rimosa* Packard, is an open feeder. It has a black horn at the posterior end and is about 40 mm long when full grown. The rustylined leaftier (page 20), *Clostera (=Ichthyura) albosigma* Fitch, is the most common member of the genus. The full-grown larva is about 30 mm long. The pale green notodontid (page 20), *Gluphisia septentrionalis* Walker, is the most common member of the genus feeding on aspen in Ontario. The full-grown larvae are about 25 mm long. In addition, a number of species of *Cerura* (page 20) feed on aspen and willow. These striking forktailed larvae grow to about 40 mm long.

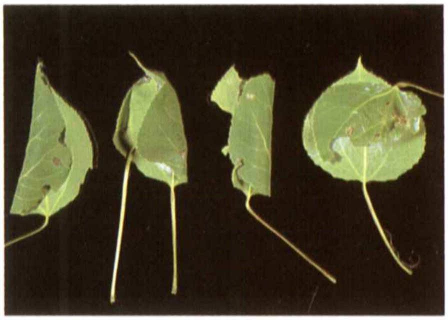
Two species of the genus *Basilarchia (=Limenitis)* (viceroy larva page 20) feed on poplar and willow from Quebec to Alberta. The larvae of the two species are similar and are about 37 mm long when full grown. They are solitary feeders and only small numbers are usually found. The butterfly adults of these larvae are favorites of collectors. *B. archippus* (Cramer) is the viceroy and *B. arthemis arthemis* (Drury) is the white admiral.

Larvae of the lappet moth (page 20), *Phyllodesma (=Epicnaptera) americana* (Harris), are also solitary feeders on a wide range of trees and shrubs, but aspen and willow are the most common hosts. There is a single generation in Canada; winter is spent as a pupa. Larvae feed throughout the summer and when full grown are up to 62 mm long.

Two species of sphinx or hawk moth larvae are occasionally found feeding openly on aspen. The big poplar sphinx (page 20), *Pachysphinx modesta* (Harris), whose mature larva is about 75 mm long, changes to a pupa in late summer. The pupa overwinters and is succeeded in the spring by a large attractive hawk moth. Other large striking larvae with a horn-shaped spine at the posterior end are in the genus *Smerinthus.* The larva of the twin-spot sphinx (page 20), S. *jamaicensis* (Drury), is commonly found on aspen; it is about 65 mm long when full grown.

Big poplar sphinx moth

# Leaf rollers and tiers


Leaf rolls

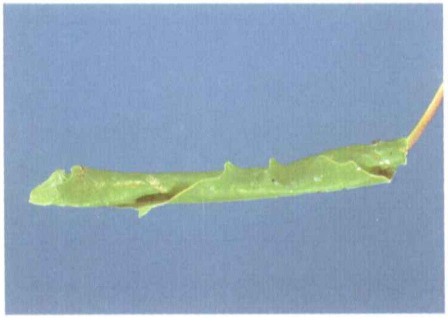

Large aspen tortrix larva, p. 29


Tied leaves

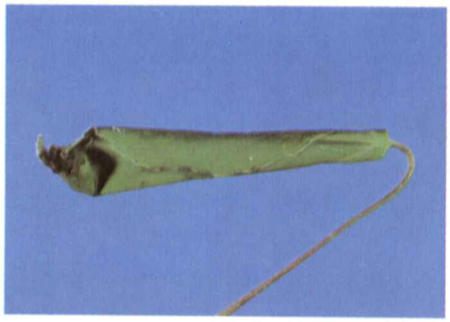

Aspen twoleaf tier, p. 30


Leaf roll


Aspen leafroller, p. 30

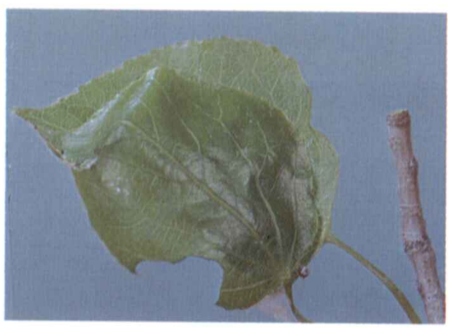

Leaf roll


Darkheaded aspen leafroller, p. 31



Leaf roll

Spotted aspen leafroller, p. 31



Tied leaves

Green aspen leaftier, p. 32

Webbed leaves

Lesser aspen webworm, p. 32

Webbed leaves

Aspen webworm, p. 33

Paleheaded aspen leafroller, p. 31

Goat sallow larva, p. 32

Yellowheaded aspen leaftier, p. 31

Blackcheeked aspen caterpillar, p. 32

Green aspen leafroller, p. 32

Lined black aspen caterpillar, p. 32

Dusky leafroller, p. 32

*Acleris fuscana* larva, p. 32


Poplar leaftiers, p. 33


Fruittree leafroller, p. 33


Obliquebanded leafroller, p. 33

**Larva between leaves tied one flat on top of the other .................................................. Flat leaftier, page 153**

There are many insects that make rolls with one or more leaves, or that tie leaves together with silk. Some of them have been present in large numbers for several consecutive years over large areas and it is not unusual to find a mixture of species in heavily defoliated stands. Most of these rollers and tiers, however, have not caused extensive defoliation.

With the exception of the forest tent caterpillar, no insect is more widespread or consumes more aspen leaves than the large aspen tortrix (page 26), *Choristoneura conflictana* (Walker). Infestations have occurred from the Atlantic to Alaska and south into California wherever trembling aspen occurs. During epidemics, foliage of other trees such as balsam poplar, white birch, and willow may also be eaten. These outbreaks seem to have little effect on the trees. Many parasites and some predators and disease


Large aspen tortrix pupa and moth


Large aspen tortrix eggs

organisms have been associated with declining populations of this pest.

There is a single generation a year; winter is spent as tiny second-stage larvae under a silken cover at the base of the tree. In early May the larvae crawl up the tree and begin mining the buds before they open, causing holes in the rolled leaves. Larvae feed in the expanding leaves, rolling, folding, and tying them together for feeding sites (page 26). The dark green to black larvae attain a length of about 20 mm when full grown. Pupation in tied leaves in a silken cocoon begins about mid-June and the moths (page 29) emerge in about 2 weeks. They are in flight in Ontario from late June to early August. Following mating, eggs are laid in flat clusters (page 29) on the upper leaf surface. They hatch in about 10 days and the tiny larvae skeletonize the leaf surface between two leaves tied together. In mid- to late August the larvae descend the tree to find niches in which to overwinter, completing the cycle.

The second most damaging leaf tier on aspen is probably the aspen twoleaf tier (page 26), *Enargia decolor* (Walker), which has been found throughout much of the range of aspen and cottonwood in Canada and the United States. It appears to be most abundant in Ontario and the Prairie provinces. Little was known about this species until epidemics occurred in northwestern Ontario in the late 1950s and early 1970s. High populations, present at the same time as high populations of other aspen defoliators, lasted only a few years. The reason for the collapse remains obscure, even though a large variety of parasites were present.

Aspen twoleaf tier moth

The aspen twoleaf tier overwinters in the egg stage in a wide variety of locations, but seems to prefer the soil. As the leaves are unfurling in the spring the larvae emerge and, fastening two leaves together with silk, begin feeding. The larvae tie other leaves (page 26) together as they develop, until late July when the pale gray-green larvae are about 30 mm long. Pupation occurs in the soil. The brown moths emerge about 3 weeks later and are in flight during August.

A closely related species, *E. infumata* (Grote) (page 80), usually found on birch in Ontario, has occasionally been found in large numbers on aspen in Alberta.

The aspen leafroller (page 26), *Pseudexentera oregonana* (Walsingham), which feeds almost exclusively on trembling aspen, is another defoliator that has been abundant, both by itself and with other major defoliators. Until recently it was confused with *Epinotia criddleana* (Kearfott), another common aspen defoliator. As a result, most of the information about its distribution has been acquired recently. Large numbers have been reported from Newfoundland to the interior of British Columbia.

Winter is spent as a pupa in the litter beneath the trees and the moths emerge early in the spring, often while there is still snow on the ground. The flat oval eggs are laid singly on twigs and branches. The young larvae tunnel into the expanding buds and subsequently tie the expanding leaves together to form a shelter. Later they are found in tightly rolled leaves ( page 26). When full grown, about 15 mm long, the larvae drop to the ground and spin loose cocoons in the litter. Pupation occurs later in the summer.

The following group of species, essentially aspen feeders, have been abundant at times over the same large areas as the leaf rollers and tiers just described. The darkheaded aspen leafroller ( page 26), *Anacampsis innocuella* (Zeller), feeds mainly on the aspens, probably throughout their ranges in Canada and the United States. The larvae are present from mid-May to mid-July in leaves rolled lengthwise ( page 26). When full grown they cut off the leaf petiole and pupate in the leaf roll on the ground. The moths are in flight in July. A closely related introduced species, *A. populella* (Clerck), has been abundant on silver poplar in Newfoundland.

The paleheaded aspen leafroller ( page 28), *Anacampsis (=Compsolechia) niveopulvella* (Chambers), occurs from New Brunswick to British Columbia, mainly on aspen, and the larvae are present from mid-May to mid-July. The species has been frequently confused with the previously mentioned *A. innocuella.* Whether these two species should be in different genera is questionable.

Three species of the genus *Epinotia* are found on aspen. The yellowheaded aspen leaftier ( page 28), *E. nisella* (Clerck), and the similar *E. criddleana* (Kearfott) occur almost exclusively on aspen. The former has a transcontinental range, whereas the latter seems to be most abundant on the Prairies. Both species apparently overwinter in the egg stage on the twigs, and the larvae emerge as the flower buds are opening. Initially they are bud miners and catkin feeders; later they tie two leaves together in which to feed. Larvae are present until early July and when full grown are about 12 mm long. The third species, the birch-aspen leafroller, *E. solandriana* (Linnaeus), as its English common name implies, feeds on both tree species but because it appears to be more prevalent on white birch in Ontario, it is treated in that section (page 79).

The spotted aspen leafroller ( page 27), *Pseudosciaphila (=Sciaphila) duplex* (Walsingham), has caused widespread defoliation on its own but recently has been more often found mixed with other aspen defoliators. It has a transcontinental distribution in Canada and the United States, feeding principally on the aspens. Winter is spent as tiny larvae in various niches on the tree or in the adjacent ground litter. Larvae emerge as the leaves are unfolding, initially skeletonizing a portion of a curled leaf. Later they roll ( page 27) and tie leaves together to form a nest in which they feed. They grow to a length of about 15 mm before changing to pupae. The moths are present in late June; they lay their flat egg masses on the tree trunk. By early August the eggs have hatched and the young larvae skeletonize the leaves, usually those incorporated in nests of the previous generation. Later they seek sites in which to winter.

The following seven species are not as common as the preceding species and damage by them is seldom observed. Information on their life histories is therefore fragmentary. A number of species of the genus *Apotomis (=Aphania)* feed on poplar but they are relatively rare. The green aspen leafroller (page 28), *A. dextrana* (McDunnough), is found from the Atlantic to British Columbia. In Ontario the larvae are present from mid-May to the end of June.

The dusky leafroller (page 28), *Orthotaenia undulana* (Denis & Schiffermüller) [=*Badebecia urticana* (Hübner)], occurs mainly on poplars but also on willow and, in Canada, is most prevalent on the Prairies. It presumably overwinters as a larva, as larvae are present in early spring followed by moths in June and tiny larvae again in late summer.

The goat sallow (page 28), *Homoglaea hircina* Morrison, is also most prevalent on the Prairies. It passes the winter as a moth and becomes active before all the snow has left the ground in the spring. Larvae are present in tied leaves from early May to early July. The black-cheeked aspen caterpillar (page 28), *Ipimorpha pleonectusa* Grote, has a transcontinental range but in Canada is most prevalent in the Prairie provinces. The larvae eat leaves of all species of poplar but aspen is the main host. In Ontario the larvae are present from mid-May to early July.

The lined black aspen caterpillar (page 28), *Egira (=Xylomyges) dolosa* (Grote), feeds mainly on trembling aspen, from Nova Scotia to British Columbia, and it too is most prevalent in the Prairie provinces. It overwinters in the pupal stage and the moths are in flight in May. Larvae are present in Ontario during June and July.

The green aspen leaftier (page 27), *Pandemis canadana* Kearfott, is present from Nova Scotia to British Columbia but is most prevalent from Ontario to Alberta. It feeds on trembling aspen, willow, and birch but occurs most frequently on the first species. It presumably overwinters in the egg stage as the larvae are present from early May to the end of July, and the moths a little later.

Three of the many members of the genus *Acleris*, one of which is *A. fuscana* (Barnes & Busck) (page 28), feed on trembling aspen foliage; their range is transcontinental but they have not been numerous. They are all leaf tiers, feeding in summer rather than in spring, and changing to pupae in August. The moths are present in August and September; presumably winter is spent in the egg stage.

There are also a number of species that utilize niches such as leaf folds, rolls, and nests created by other species feeding earlier in the season. Their prevalence appears to depend on the number of available niches. The lesser aspen webworm (page 27), *Meroptera pravella* (Grote), has a transcontinental range in Canada but is most common on the Prairies.

In Ontario, the winter is passed as a pupa in the soil; the moths emerge in June. Eggs are present in late June and the larvae are found in webbed leaves (□ page 27) during July and August.

The aspen webworm (□ page 27), *Tetralopha aplastella* (Hulst), occurs across the continent but is most prevalent in the central regions. In Ontario, winter is passed as a larva in the soil and pupae will be found there from late May to late June. Moths are present in late June and the larvae feed in webbed leaves (□ page 27) from July until the leaves fall.

The poplar leaftier (□ page 29), *Nycteola cinereana* Neumoegen & Dyar, has a transcontinental range but is most abundant in central Canada. Balsam poplar is the most common host. This species probably passes the winter in the egg stage, as the moths are present in August. Larvae are found from late May to August in Ontario.

Two species that are very general feeders are found on aspen in appreciable numbers but are better known on other woody plants such as orchard trees, where their damage is economically important. These are the obliquebanded leafroller (□ page 29), *Christoneura rosaceana* (Harris) and the fruittree leafroller (□ page 29) *Archips argyrospila* (Walker). They have, however, on occasion caused considerable defoliation of aspen. The separation of the species in the destructive larval stages is most difficult, whereas the moths appearing later are readily identified. Both have a transcontinental range in Canada and the United States and are found on a number of tree species. Although these two pests have a single generation each year in most of Canada, one of them, the obliquebanded leafroller, has more than one generation in much of the United States.

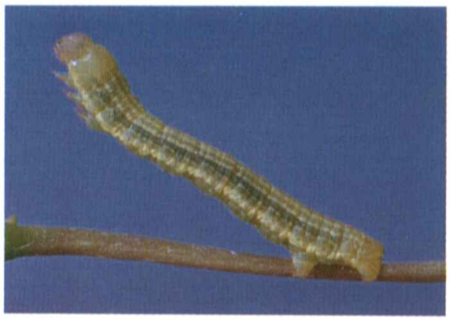
Fruittree leafroller egg cluster

Obliquebanded leafroller egg cluster

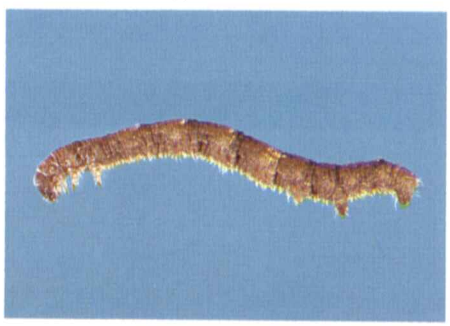
The fruittree leafroller passes the winter in the egg stage in clusters on the twig □. The larvae emerge about mid-May and feed in leaf rolls until early July. When full grown they are about 20 mm long. The pupal stage is present from late June to mid-July and the moths are in flight through much of July.

The life cycle of the obliquebanded leafroller varies considerably over its range, so no attempt will be made to give a generalized life cycle. The moths of both species are in flight about the same time but the obliquebanded leafroller lays its egg clusters on the leaf (page 33) rather than on twigs.

# Loopers

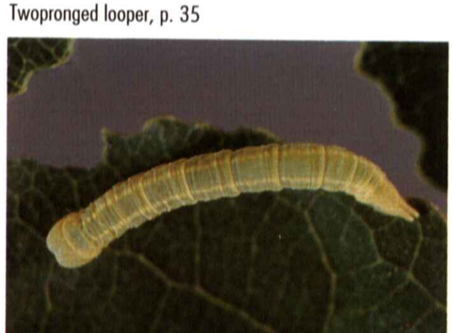


False Bruce spanworm, p. 35



Fringed looper, p. 35

Twopronged looper, p. 35



Twolined aspen looper, p. 36

Other loopers found on poplar:
Maple spanworm, page 69
Hemlock looper, page 69
Bruce spanworm, page 109
Pepper-and-salt moth, page 199

About 12 species of loopers are known to feed on poplar; nine of them are relatively common. We discuss five of them in this section, four with illustrations. A further four are more prevalent on other host trees and are discussed in the relevant sections.

The false Bruce spanworm, *Itame loricaria julia* (Hulst), is found from New Brunswick to British Columbia and is often common on poplar or willow in the Prairies, usually when other defoliators are present in outbreak numbers. It is not often seen as it is a solitary feeder. There are two larval color phases, with brown or green background body color. The larvae are present from May to July and when full grown are about 23 mm long.

The fringed looper, *Campaea perlata* (Guenée), has a transcontinental distribution but the highest numbers have been recorded on the Prairies. Although it is a common feeder in low numbers on many trees, both broad-leaved and coniferous, it has been recorded most frequently on aspen. Larvae are present from May to September and are about 30 mm long when full grown.

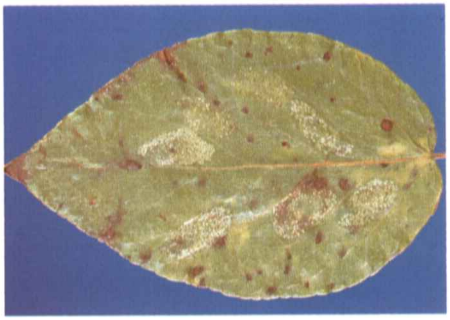
The twopronged looper ( page 35), *Sicya macularia* (Harris), is present in low numbers on a variety of trees from Newfoundland to Alberta. The larvae feed from June to August and grow to about 30 mm long.

# Leaf miners

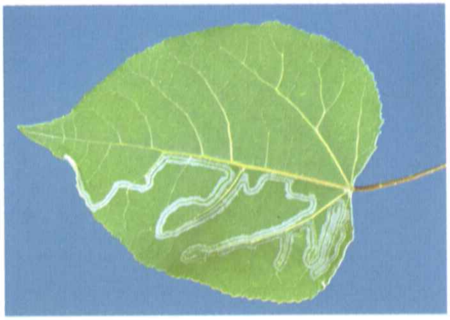
The twolined aspen looper (page 35), *Lobophora nivigerata* Walker, is distributed mainly from Ontario to Alberta and occurs primarily on aspen. No infestations are known. The larvae are present from May to September and when full grown are about 20 mm long.

Another looper occasionally found is *Protitame virginalis* (Hulst). It feeds primarily on trembling aspen in late July and early August in Ontario and the Prairie provinces. This small looper has a green body with a red-brown stripe on the upper surface and a green head with russet markings. When full grown it is about 15 mm long.

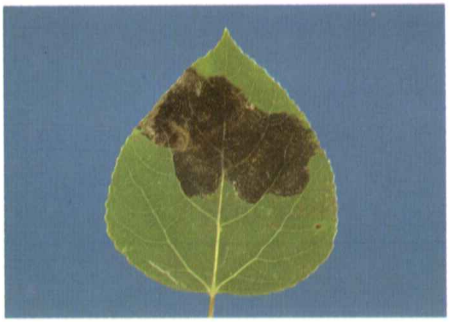
Aspen leafblotch miner, p. 38



Balsam poplar leafblotch miner, p. 38

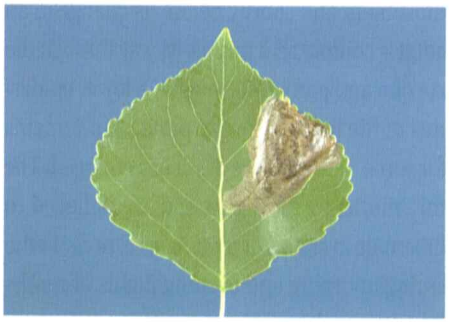


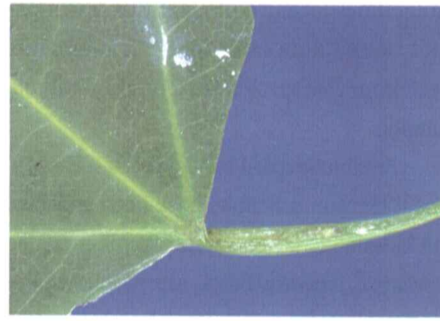
Poplar serpentine leafminer, p. 38



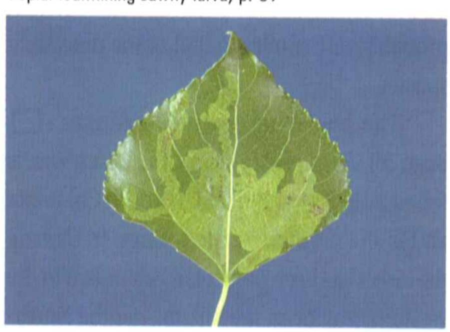
Poplar blackmine beetle, p. 39

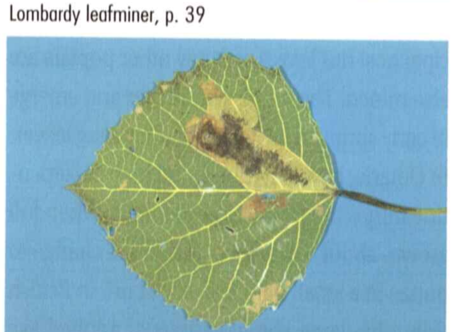
* For a similar mine, made by a beetle larva, see *Brachys aerosus* group, page 158.


Poplar leafmining sawfly*, p. 39


Aspen petiole miner, p. 37


Poplar leafmining sawfly larva, p. 39


Lombardy leafminer, p. 39


Cottonwood leafminer, p. 40

Many different species of insects mine the leaves of poplar. Control measures are seldom warranted, but when they are, a systemic insecticide should be effective against these concealed feeders. We separate the insects into two groups:

Tiny slender larvae tunneling primarily in the leaf petiole ....... ....................................... Petiole miners

Larvae in blisters or winding tunnels in the leaf blade .......... ........................................ Leaf miners

## Petiole miners

The aspen petiole miner, *Ectoedemia argyropeza downesi* Wilkinson and Scoble, is found on trembling aspen and largetooth aspen in Quebec and Ontario. This insect overwinters as a larva in a round flat cocoon on the ground. It changes to a pupa and subsequently to a tiny moth, with a wing spread of about 6 mm, in late May. The eggs are laid on the petioles. One or two whitish slender larvae tunnel in the petiole, causing it to become swollen during the summer. In the autumn they enter the base of the leaf blade. They remain in the mine until after leaf fall and in late autumn emerge to spin cocoons in the ground litter or soil. Though sometimes locally abundant this insect has not caused noticeable injury or premature leaf drop. This species can reproduce without mating.

Adult moths of a related species, *E. canutus* Wilkinson & Scoble, have been collected on balsam poplar in Ontario. Another related species, *E. populella* Busck, causes conspicuous round galls to form on the petiole. It is discussed with other gall-forming insects on page 46.

### Leaf miners

A number of species of leaf miner in the genus *Phyllonorycter (=Lithocolletis)* occur on poplar in North America. Epidemics causing browning of foliage have occurred throughout Ontario, Manitoba, and Saskatchewan. In Ontario, the most common species is the aspen leafblotch miner (page 36), *P. ontario* (Freeman), which mines the leaves of trembling aspen and, to a lesser extent, largetooth aspen. It shows a preference for young trees under 10 cm in diameter at breast height.

This species has one generation each year and overwinters in the adult stage. The eggs are laid singly, one to eight on the underside of each leaf, from about mid-May to mid-June. They hatch in approximately 15 days. The larvae feed in pale round, later oval, blisters on the underside of the leaf until late July or early August. When they are full grown, about 6 mm long, they change to pupae, varying in color from pale to dark brown, in a silken cocoon in the central portion of the mine. The completed mine has a central longitudinal crease or ridge. The pupa is capable of considerable movement and shortly before its change to an adult is completed it pushes its way through the cocoon and partially through the lower epidermis of the leaf, where the pupal skin remains for some time after the moth has emerged. The tiny moths fly in August and are believed to hibernate in stands of pine, spruce, or fir. In the spring, morning and evening flights of moths have been observed moving from stands of conifers to nearby aspen trees. Past epidemics of the aspen leafblotch miner in Ontario were terminated naturally by larval competition and parasites.

A closely related species, the balsam poplar leafblotch miner (page 36), *P. nipigon* (Freeman), produces pale oval mines on the underside of leaves of balsam poplar. It occasionally occurs in large numbers in Ontario, north and west of Lake Superior. Its life cycle is probably very similar to that of the preceding species.

The poplar serpentine leafminer (page 36), *Phyllocnistis populiella* Chambers, is found from Newfoundland to British Columbia and in the northern United States. In Canada the insect has been particularly abundant in the western provinces, the Yukon, and the Northwest Territories. Trembling aspen is the principal host but leaves of many other poplars are also mined. The moths overwinter and emerge in early spring to lay their eggs on young leaves. In Ontario, larvae may be found in their serpentine mines from May to September. When full grown, about 5 mm long, the larvae change to pupae in a small tight leaf-edge curl. In British Columbia large congregations of adults have been reported through the summer to late August. The hibernation site of these tiny moths is not known but is believed to be in the ground litter.

Mortality of aspen stands has been associated with severe recurrent leaf miner infestations in the northwestern United States. For control information contact the appropriate forest research center listed on page 11 or consult your nearest forestry representative.

Three species of poplar blackmine beetles (page 36) in the genus *Zeugophora* are found commonly in eastern and central North America. *Z. scutellaris* Suffrian has occasionally caused severe injury to cottonwood and cottonwood hybrids in southern areas of the Prairie provinces. *Z. abnormis* (LeConte) is often abundant on balsam poplar in Ontario and west of Alberta. The third species, *Z. varians* Crotch, is found commonly on trembling aspen in Ontario.

The life cycle of these species, though not well known, is apparently similar. The larvae overwinter in cells in the soil. The tiny adult beetles, 4 mm or less in length, are present from late May to early July. They feed on the underside of leaves, usually in small circular areas, and do not quite penetrate to the upper surface. The eggs are laid in small cavities on the underside of the leaf. The flat legless larvae feed in black blotch mines on the upper surface from late June to late October and are 5 to 6 mm long when full grown.

Blackmine beetles appear to be of little concern in natural forests but may pose a threat to monocultures of cottonwood and certain poplar hybrids.

The poplar leafmining sawfly (page 37), *Messa populifoliella* (Townsend), is found from New Brunswick to Saskatchewan and from the northeastern United States to New Mexico. The larvae mine the leaves of many kinds of poplar but serious "scorching" of foliage is reported primarily on Carolina poplar in New Brunswick and on trembling aspen and poplar hybrids in southern Saskatchewan.

The larvae overwinter in cells in the soil, changing to pupae in early May. The adults, tiny four-winged "flies", emerge later in May and lay their eggs singly in slits on the margin of the developing leaf. The larvae, pale with brown or black legs and markings (page 37), feed in blotch mines on the upper surface of the leaves from late May to early July. When they are full grown, about 9 mm long, they drop to the ground and enter the topsoil where they form their hibernation cells. Large-scale epidemics of the leafmining sawfly are unknown.

The Lombardy leafminer (page 37), *Paraphytomyza populicola* (Walker), a European species, was found for the first time in Canada on Lombardy poplars in Quebec City in 1956. In subsequent years it has been found in many areas of southern Quebec and southern Ontario. The larvae mine the leaves of many species of poplar, but prefer Lombardy and other ornamental or planted poplars. The insect apparently overwinters as a pupa on the ground and the tiny two-winged flies are active in June and July. The larvae produce small greenish blotch mines on the upper surface of the leaf from July to early October. The larvae are about 2.5 mm long when full grown, legless, pale, and pointed at one end. Reports suggest that they leave the mine and change to tiny brown oval pupae on the leaf surtace; however, it seems logical that many drop directly to the ground. Control measures are seldom warranted for these late-season feeders.

The cottonwood leafminer (page 37), *Paraleucoptera albella* (Chambers), is a common pest of cottonwood in the United States. In Ontario, the insect has been collected from many species of poplar, but only infrequently. The larvae are gregarious in blotch mines on the upper surface of the leaf and may occur from spring until late fall. The mine is gray-green near current feeding sites, turning dark brown with age. The larvae are pale cream to yellowish and about 5 mm long when full grown. When feeding is completed they leave the mine and spin conspicuous white silk hammock-like mats at leaf margins, under which they change to pupae. The adults are tiny moths. There are probably two generations a year in southern Ontario.

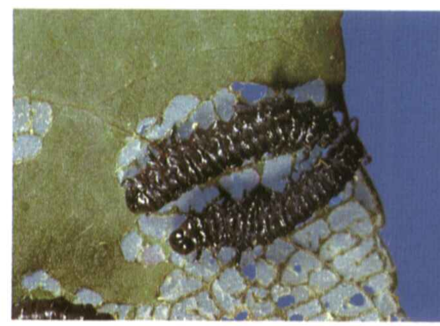
# Leaf beetles

* Photos courtesy of Northern Forestry Centre.

American aspen beetle, p. 42

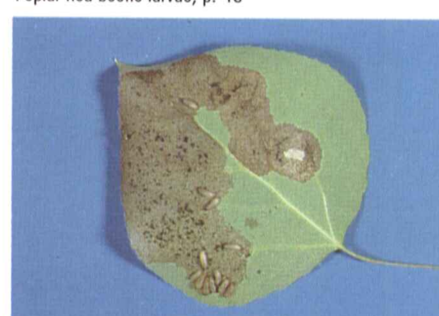
Poplar flea beetle, p. 43

American aspen beetle larvae, p. 42



Poplar flea beetle larvae, p. 43

Aspen leaf beetle*, p. 42



Aspen skeletonizer larvae and eggs, p. 43

Aspen leaf beetle larvae*, p. 43

Poplar-willow leaf weevil, p. 43

Pale green weevil, p. 43

Aspen flea beetle, p. 43

June beetle, p. 44

Chafer beetle, p. 44

There are probably more species of leaf beetles feeding on poplar than on any other kind of tree in North America. A number of them feed on foliage in both the larval and adult stage whereas others feed on poplar only as adults and spend the larval stage feeding on some other plant, often on the roots. There are also species that feed mainly on willow, but where populations are large they spill over on to adjacent poplar. In Canada four genera of beetles feed both as adults and as larvae on the leaves of trembling aspen, largetooth aspen, balsam poplar, and cottonwood, mainly on the Prairies and in Ontario.

The American aspen beetle (page 41), *Gonioctena americana* (Schaeffer), is probably the most prevalent species. It is found in small numbers every year and periodically becomes abundant for a few years, especially on young pole-size aspen or on the lower branches of larger trees.

Adults overwinter in the soil and emerge shortly after the first aspen leaves reach full size. After feeding for a short while the adults lay small clusters of fully formed embryos on the lower leaf surface. The larvae feed for about a month, initially skeletonizing the lower surface and later eating the whole leaf except the veins. On completion of feeding, when the larvae (page 41) are about 10 mm long, they drop to the ground and change to pupae. The adults emerge in about 2 weeks, and after a brief feeding period, return to the soil to pass the winter.

The aspen leaf beetle (page 41), *Chrysomela crotchi* Brown, is the most common member of the genus *Chrysomela* and, in Canada, is found mainly on the Prairies. It feeds mostly on poplars but willows are also attacked. There is one generation a year; the winter is passed as an adult in the ground. However, adults may live and lay clusters of eggs over 2 years. Egg laying, following mating, usually begins in early June and continues into July. The larvae (page 41) are present from July to September. Initially, feeding gregariously, they skeletonize the lower surface of the leaf. Finally they leave only the leaf veins and in heavily infested trees the foliage appears scorched. The pupal stage, mostly on the leaves, lasts about 6 days and the emerging adults feed for a while, consuming all but the major veins, and then enter the ground to hibernate. The seven other members of the genus *Chrysomela* that feed on poplar and willow are also occasionally abundant.

Two kinds of poplar flea beetles in the genus *Altica*, *A. populi* Brown and *A. bimarginata* Say, have been reported from Ontario to British Columbia, but they are most prevalent on the Prairies. Their common name is derived from the ability of the adults to spring rapidly out of the way when disturbed. Adults and larvae (page 41) may be found from May to August, mostly on balsam poplar. The illustrations are of *A. populi*, the common species in Ontario.

The aspen skeletonizer (page 41), *Phratora purpurea purpurea* Brown, has a transcontinental distribution and occurs commonly on aspen. The adult beetles pass the winter in the soil and emerge in May. Eggs are laid on the leaf undersurface and the ensuing larvae feed gregariously from late June into August, skeletonizing the leaves. When they are full grown, about 6 mm long, the larvae drop to the ground where they change to pupae and subsequently to adults. The adults feed for a short while before returning to the soil to hibernate.

The following beetle species feed on poplar only in the adult stage; little is known of the rest of their life history. The poplar-willow leaf weevil (page 41), *Lepyrus nordenskioeldi canadensis* Casey, is relatively large, about 14 mm long. It is sometimes found in high numbers on aspen, from June to August, from the Maritimes to the Prairies and in the adjacent parts of the United States. Another weevil, the pale green weevil, *Polydrusus impressifrons* (Gyllenhal), is a widely distributed introduced species. It feeds on many broad-leaved hosts but in Ontario is most common on aspen, where the slender adults, less than 7 mm long, are found from late May to mid-July. The adult feeds on developing tissue such as leaves, buds, and shoots and their feeding along the leaf margins is conspicuous evidence of their presence.

The tiny aspen flea beetle, *Crepidodera (=Chalcoides) nana* Say, is common on aspen in northern Ontario. Its feeding produces tiny shot holes in the new leaves from early May to early July.

Three genera of scarab or chafer beetle adults periodically defoliate trees, particularly along the forest fringe. The larvae feed on the roots of plants and occasionally cause severe injury to seedlings. The large, robust beetles in the genus *Phyllophaga* range in length from 12 to 24 mm. They are the familiar June beetles (page 42) and their larvae are the gardener's white grubs. Similar but smaller beetles in the genus *Serica,* referred to as chafer beetles here (page 42), are 5 to 11 mm long. The third group includes chafer beetles in the genus *Dichelonyx* (page 90).

The June beetles are in flight in May and June, feeding sporadically on the leaves of trees at night. After mating, the females enter the soil and lay their eggs over several weeks in small balls of soil. The eggs hatch in 2 to 3 weeks and the tiny C-shaped larvae feed initially on organic matter, then on roots. Feeding continues for 2 or 3 years at various depths depending on soil moisture and temperature. The life cycle of the chafer beetle is essentially similar. Because there are a number of different species and there may be different broods of any one species, soil samples may include larvae of different sizes, pupae, and adults.

Because the occurrence of this group of foliage feeders is sporadic and usually of brief duration, the possibility of being able to forecast or prevent damage is remote. Furthermore, trees can usually withstand such injury with little effect.

# Galls – insects and mites

*Aceria* species near *dispar*, p. 46

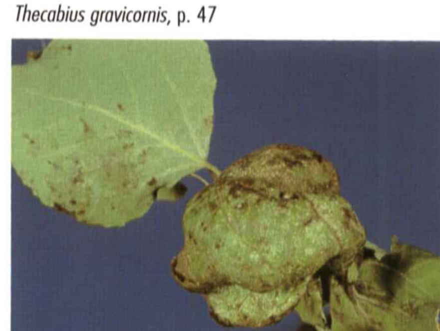
Poplar vagabond aphid, p. 47

*Aceria* species near *dispar*, p. 46

Poplar leaf petiolegall aphid, p. 47

*Thecabius gravicornis*, p. 47

*Phyllocoptes didelphis*, p. 46



*Pachypappa tremulae*, p. 47

*Harmandia* species, p. 47

Poplar petiole gall, p. 48

*Harmandia* species, p. 47

Leaf curl midge, p. 47

*Phyllocolpa* species, p. 47

The leaves of poplars are deformed by a number of gall makers and some of the more common galls are illustrated here. Although general information on gall makers will be found on page 15, specific information follows. Galls on poplar range from a curled or folded leaf edge through partially deformed leaves to structures that bear no resemblance to a leaf. In fact a single species of mite, *Aceria* species near *dispar* (Nalepa), is capable of producing leaf edge rolls, leaf edge frills (page 45), wholly rolled separate leaves, or distorted terminal leaf clusters (page 45), depending on the time of attack by these mites and the stage of development of aspen leaves. Another mite, *Phyllocoptes didelphis* Keifer (page 45), produces blisters on the upper leaf surface filled with a felt-like growth on the lower surface in which the worm-like mites may be found. These microscopic mites have two pairs of legs rather than the customary four pairs. It is believed that they spend the winter as adults in any suitable niche on the tree and then emerge when the buds are opening to feed on the developing tissue. *Aceria* sp. near *dispar* has recently caused widespread damage to trembling aspen in northeastern Ontario, whereas *P. didelphis* has not been abundant. Other eriophyid mites cause pale green felt-like growths on trembling aspen and they are no doubt present on other poplars.

Members of at least four genera of aphids cause galls ranging from individual frilled leaves to bulbous growths involving more than one leaf. They generally appear to be more numerous and diverse on the Prairies than elsewhere in Canada. A most spectacular gall maker found on many poplar species is the poplar vagabond aphid (page 45), *Mordwilkoja vagabunda* (Walsh). A number of the leaves that would normally be on the shoot form part of the gall. The galls remain on the tree after the leaves fall, providing mute evidence of the attack. The eggs overwinter in or near old galls and hatch soon after shoot development starts. The winged forms leave the gall in early July and fly to an unknown secondary host, possibly to develop on its roots. They return to the galls in September.

The genus *Pemphigus* contains as many as 10 species that cause galls on various poplars, both native and introduced. These galls are usually formed at the base of the leaf blade and on the petiole. They have occasionally caused noticeable damage to poplar from Quebec to Alberta but in some instances are more important as pests of their secondary hosts such as lettuce and beets. The secondary host of some species is unknown. A typical spiral gall made by the poplar leaf petiolegall aphid, *P. populicaulis* Fitch, on balsam poplar is illustrated on page 45.

The genus *Thecabius* has at least two species that cause galls, primarily on cottonwood and balsam poplar. The gall of *T. gravicornis* (Patch) (page 45) on balsam poplar is a folded leaf with flocculent aphids inside the fold in early July.

The aphid *Pachypappa tremulae* (Linnaeus) (page 45) causes galls on trembling aspen throughout much of its range. These aphids, usually attended by ants, are present in the galls in June and July.

Midges also cause a number of galls on various poplars, but their biologies are poorly known. In fact some of the midges in the galls may be guests or even predators. Because damage is generally of little consequence the exact identity of midges has often not been determined. Two common galls in the genus *Harmandia* are illustrated on page 46. Damage by the leafcurl midge, *Prodiplosis morrisi* Gagné, to hybrid poplar plantings has been intense in some instances. These midges lay their eggs in young expanding leaves and the feeding of the larvae and their sticky exudate prevents the leaves from unfolding. Eventually the damaged leaves turn black and drop. Because leaf growth and shoot elongation in poplar cultivation may continue over a long period, two or three generations of midges can develop in a single season.

Members of the sawfly genus *Phyllocolpa* can be found on a number of poplar species. These sawflies lay their eggs in developing leaf tissue, causing the edge to fold and thereby providing a feeding site for the larva. At times the folds are quite abundant but because so

# Aphids and leaf hoppers

little of the leaf surface is involved they are seldom noticed. Larvae can be found skeletonizing the leaf surface inside the fold from June to August. Winter is spent as a prepupal larva in a cocoon in the soil.

Few moth species are responsible for gall formation on trees. The poplar petiolegall moth, *Ectoedemia populella* Busck, is one. It makes a petiole gall (page 46) close to the leaf blade on trembling and largetooth aspen. It has been found from Quebec to Manitoba and in the northeastern United States.

Smoky winged poplar aphid, p. 49

*Asiphum* species, p. 49

*Idiocerus* species, p. 49

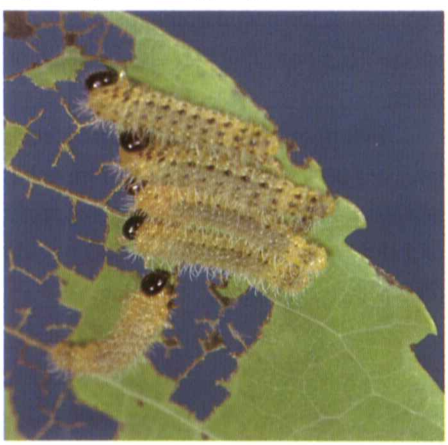
In addition to those aphids causing galls (see page 45), other aphids, often in dense colonies attended by ants, feed on developing leaves and shoots. These aphids as a group have caused little damage to forest trees, and feeding injury varies for different species from leaf discoloration or distortion to withered shoots. Although the aphids described here are leaf feeders, they may also be found on shoots and twigs. The spotted poplar aphid, *Aphis maculatae* Oestlund, is a dark-colored aphid less than 3 mm long with powdery patches along the side of the body. It has been abundant on succulent growth of aspen suckers in Minnesota but will be found on other poplars in summer and on common dogwood shrubs in winter. Other aphid leaf feeders are the smoky winged poplar aphid, *Chaitophorus populicola* Thomas, and *Asiphum* species. The nymphs and adults of the latter species have considerable flocculence. Little is known about their life histories.

A number of leaf hopper species feed on the leaves of aspen in Ontario and the Prairie provinces. They are usually pale-colored agile insects that move quickly on the leaf when disturbed. The two most common species are in the genus *Idiocerus*, and they have similar life histories and habits. Damage is caused by the feeding of both adults and nymphs on the leaves (see page 126), and by the slits cut in the twigs to receive the eggs. Winter is passed in the egg stage and the tiny nymphs, which have the general shape of the adult, feed from early May to the end of July. The adults, about 6 mm long, fly in late summer. Migrant species of leaf hoppers such as the potato leafhopper *Empoasca* species ( page 126) may also be found on aspen.

High populations of *Idiocerus* species have not persisted in the past and there has been no need for control. The migrant species of leaf hoppers have appeared suddenly and disappeared as abruptly.

# Sawflies

Poplar sawfly larvae and egg slits, p. 50



*Trichiocampus gregarius* larvae, p. 51

*Nematus hudsoniimagnus* larvae, p. 51

Sawflies are related to bees and wasps and like them have two pairs of more or less transparent wings in the adult stage. There are a number of species that feed openly on poplar foliage in eastern North America. In Ontario, they are mainly in two genera and include hairy, black-spotted yellow larvae in the genus *Trichiocampus* and smooth, variously colored or spotted larvae, primarily in the genus *Nematus*. The conspicuously large larvae of the elm sawfly are also occasionally found on poplar. They are about 40 mm long when full grown and have a black stripe down the back (see page 68).

The poplar sawfly, *Trichiocampus viminalis* (Fallén), has been reported frequently in Canada from the Atlantic to the Pacific and in the northern United States. It feeds on all poplars, both native and introduced, but prefers Lombardy poplar. Winter is passed in a cocoon and the adults emerge from late May to mid-July. The eggs are laid in the petiole in a double row along the side. They hatch after about 3 weeks. The larval stage also lasts about 3 weeks and at certain periods colonies arrange themselves in characteristic aggregations with bodies parallel and touching and the head directed to the feeding site or, like the spokes of a wheel, with heads in the center. In Ontario, feeding larvae may be found from June to September. They are hairy, and yellow in color with two rows of black spots. When full grown, about 20 mm long, they crawl down the tree and spin cocoons in the soil. Some of them continue development and change to pupae and then to adults. The adults lay eggs that hatch to produce a partial second generation in the fall.

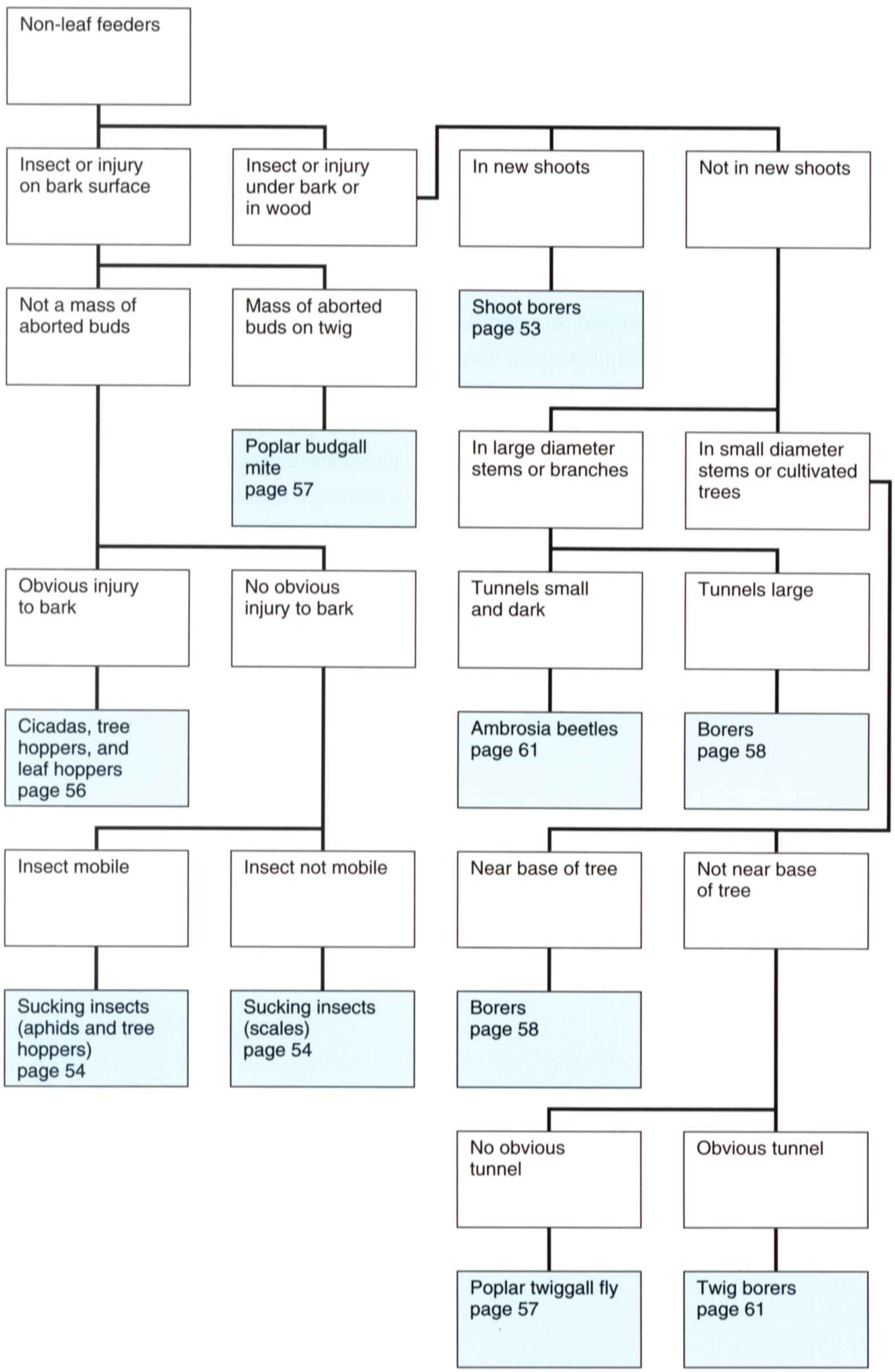
Most larvae, however, overwinter in a cocoon and complete the life cycle by changing to pupae and then to adults in the following year.

Because most colonies are found on the lowest branches, damage is readily detected and colonies can be destroyed. An outbreak in Quebec was terminated by a naturally occurring virus disease. Such diseases are probably also present elsewhere and therefore it is unlikely that other control measures will be necessary.

Another sawfly in this genus, *T. gregarius* (Dyar), is occasionally found on poplar. The larvae are only slightly different from those of the poplar sawfly in that they have three rows of black spots on the body, two rows about the spiracles and a row of less distinctive spots above the base of the abdominal legs. The life cycle and habits of this species may be similar to those of the poplar sawfly.

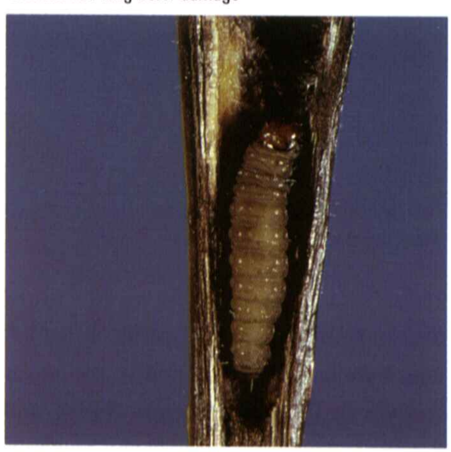
The larvae of a number of species in the genus *Nematus* are sometimes found on poplar but their feeding is usually of little consequence. *N. hudsoniimagnus* Dyar is the most common member of this group in Ontario. Small numbers of larvae, about 18 mm long when full grown, are usually found throughout the summer and early fall. *N. oligospilus* Förster, a somewhat smaller species, is less abundant. Its larva has a yellowish head with variable dark markings and a green body. Larvae of several other species in this group, found only rarely, are usually pale with black spots or blotches, see *N. limbatus* on page 196.

# Poplar: non-leaf feeders



# Shoot borers

Cottonwood twig borer damage



Cottonwood twig borer larva

The cottonwood twig borer, *Gypsonoma haimbachiana* (Kearfott), is an important pest in hybrid poplar plantations because it causes stunting, crooking, and forking of tree stems. This is especially so in the southern United States where it has more than one generation a year. In natural forests of aspen or other poplar species it is apparently of little importance. It is believed that there is a single generation in Canada and that the tiny larvae overwinter in niches on the tree. On emerging, about mid-May, they make a protective mat of silk and excreta on the shoot and then tunnel down the shoot, completing development by early June. The mature larva is about 12 mm long. The moths are in flight in late June and early August.

The willow shoot sawfly is also important in hybrid poplar cultivation (see page 205).

# Sucking insects

There are a number of sucking insects that feed on twigs and small branches of poplar. These include aphids, tree hoppers, and scale insects, all of which have a fine tube-like structure that is inserted through the bark into the sap stream.

The aphid species found on the bark of young stems or twigs are important mainly in poplar cultivation. One such aphid is *Pterocomma populifoliae* (Fitch), which is sometimes found in sucker growth in large colonies similar to that shown on page 208. Other aphids such as *Aphis maculatae* Oestlund (page 49) and *Chaitophorus populicola* Thomas (page 49) feed on both foliage and twigs. All aphids have a number of generations each year.

Tree hoppers are relatively rare insects in the forest proper and are usually observed only on its fringes. Damage is caused by feeding as well as by the egg slits that adults cut in the twigs. Subsequent growth of twigs produces typical scars. All tree hoppers have a peculiar body shape characterized by extreme development, with sharp projections either vertically or horizontally on that portion of the body ahead of the wings. Adults and nymphs often feed together, their color and shape usually providing effective camouflage. The aspen treehopper, *Telamona tremulata* (Ball), is typical of the group. The adult cuts a row of slits in the bark in midsummer and inserts a number of eggs into each of them. The slit is then covered with a conspicuous sticky white frothy mass. The eggs overwinter and hatch in the spring.

Tree hopper egg slit scars

Aspen treehopper adult

Scale insects have little importance in the forest and damage is generally confined to open-growing trees. Two species of *Diaspidiotus* have been found on poplar, the poplar scurfy scale, *D. popularum* Marlatt, and Putnam scale, *D. ancylus* Putnam. The former has occurred in high numbers on clumps of trees in Alberta and the latter has caused tree mortality in Saskatchewan. Winter is spent as an immature scale, which matures in June in Ontario. If the scale is lifted off at that time, the mature female with eggs and the young, known as crawlers, will usually be present. Apparently the crawler stage does not leave the twigs as many other crawlers do. The mature scale cover is dark and disk-shaped with an off-center yellow to orange nipple. The life cycle and shape of both these scales is quite similar.


Poplar scurfy scale


*Chionaspis* species

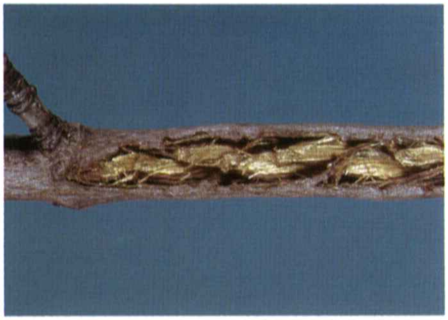
The scurfy scale, *Chionaspis furfura* (Fitch) will also be found on poplar but it feeds on many forest and horticultural trees. It occurs in southern Canada as well as in parts of the United States. The mature scale cover is white to gray and is frequently pear-shaped, similar to the *Chionaspis* species illustrated. This scale overwinters in the egg stage. The closely related Lintner's scale, *C. lintneri* Comstock, has on occasion been abundant on birch trees in Quebec and the mature scale is similar to that of the scurfy scale.

Another scale that is common on poplar is the *Parthenolecanium* scale, which is described on page 187.

# Cicadas, tree hoppers, and leaf hoppers

Although feeding damage by cicadas is not usually evident, the damage caused by the insertion of eggs into ragged slits along twigs is quite noticeable. These large-bodied insects have aroused considerable curiosity because of their shrill song on hot days in summer, when they can be heard but are seldom seen.

Common cicadas in Ontario belong to two genera, *Okanagana* and *Tibicen*, and members of both of them are referred to as "dog-day" cicadas. Quebec, Ontario, and British Columbia have reported sporadic damage by cicadas. Although their life cycles may last from 2 to 5 years, cicadas will be heard every year because the progeny of different broods are involved. We describe a typical life cycle. In early June, mature nymphs crawl out of the soil and up whatever trees or shrubs are available and fasten themselves with their claws to the bark. They then cast their skin, which remains behind after the adult has flown away. Adults live for a month or more. The female cuts ragged slits with her saw-like ovipositor along small twigs and deposits clusters of spindle-shaped eggs in them, usually in a double row. On hatching, the tiny nymphs drop to the ground and using their powerful front legs burrow deeply in the soil to feed with their sucking mouth parts on roots of various plants. They remain deep in the soil through a number of molts over several years until they are ready to change to the adult stage. When there is a large emergence of adults, their oviposition slits will kill twigs on a variety of trees and the leaves on damaged twigs will appear scorched.



Cicada egg slits

Cicada adult

Other insects causing damage by egg laying include the tree hoppers (page 54) and leaf hoppers (page 125). However, the slits caused by leaf hoppers are not usually noticed because the scars are not large.

# Poplar twiggall fly

Poplar twiggall fly

The galls of the poplar twiggall fly, *Hexomyza (=Napomyza) shineri* (Giraud), are probably found on small twigs of young poplar trees throughout their range but serious injury has not been reported. The swelling usually is most apparent on one side of the twig.

In Ontario this insect passes the winter as a tiny larva inside the gall and changes to a pupa in late May. The adults emerge in early June and lay their eggs in another growing shoot. The larvae are present just beneath the gall surface in late June and development proceeds throughout the summer. Just before the change to the pupal stage the tiny larva, about 3 mm long, tunnels almost to the surface, leaving just a thin layer of tissue to be cut later by the emerging adult.

# Poplar budgall mite

Poplar budgall mite

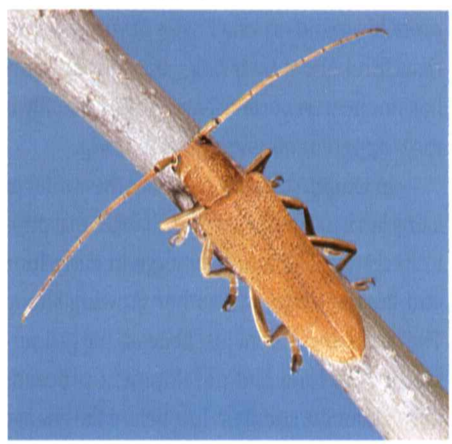
The galls of the poplar budgall mite, *Aceria parapopuli* Keifer, are formed initially by bud proliferation on new shoots. Later the galls continue to increase in size, usually for several years, in some instances causing the death of twigs. Although galls may be found on most poplars, some of the hybrids are especially susceptible. In Canada, injury is more prevalent in the Prairie provinces than elsewhere. A closely related species, *A. neoessigi* Keifer, may also be found in buds. Little is known about the life history of these mites. They become active in the galls during the first warm weather in spring and mating and egg laying begin shortly after. A short life cycle involving eggs, two larval stages, and the adult means that numerous generations will occur throughout the summer and large populations can develop. Mites leave the galls in early summer to initiate new galls in other developing buds.

# Borers

The poplar borer, *Saperda calcarata* Say, tunnels in larger branches and in the stem down to the root collar. It occurs throughout the range of poplar in Canada and the United States. Damage is more prevalent in open than in dense aspen stands, and young trees about 10 mm in diameter are generally favored. The insect's life cycle is a long one, usually requiring 4 years on the Prairies. Most eggs are laid in the lower tree crown, at the bottom of slits chewed in the bark by the adults. Egg laying begins in early July and hatching occurs about 3 weeks later. The first-stage larva feeds in the bark at its juncture with the wood and while there cuts an opening through the egg slit from which to expel excrement and other materials to the outside. Winter is passed in the feeding chamber and in the spring the larva begins tunneling upward into the sap and heartwood. Feeding and tunneling continue in an upward direction throughout the summer and the larva spends the second winter at the upper end of the tunnel behind a plug of wood chips. Feeding continues in the third summer and the tunnel and outside opening are enlarged to accommodate the large legless larva, which may be 50 mm long. The third winter is also spent at the upper end of the tunnel behind a plug of wood chips. Change to a pupa occurs in the spring and the adult beetles begin to emerge by mid-June. The adults live a month or more, feeding on leaves and the bark of young twigs.

Another roundheaded borer, the poplar-butt borer, *Xylotrechus obliteratus* LeConte, as its name implies may be found in various poplars

Poplar borer with chip plug



Poplar borer adult

at or below ground level. It has not been a common borer to date.

A few borers that are the larvae of moths, with five pairs of legs on the abdomen, may also be found near ground level or in the roots. These borers are assuming more importance because of the current emphasis on poplar cultivation. The larvae of ghost moths, *Sthenopis* species, are large, up to 50 mm long, and their tunnels in the wood are associated with considerable rot. Larvae of a number of clearwing moths of

Ghost moth larva

*Paranthrene tabaniformis* moth

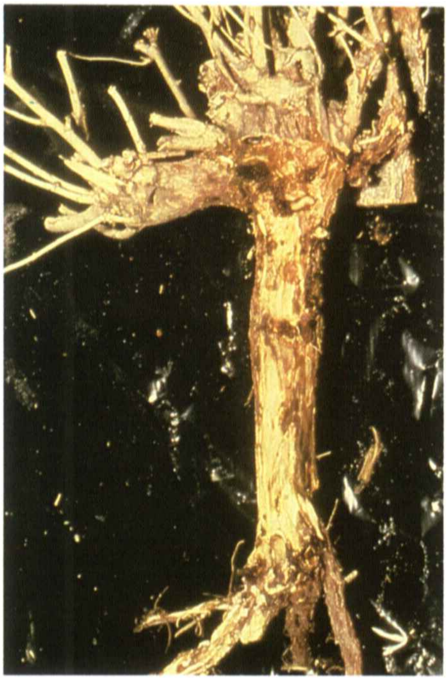
the genus *Paranthrene* are smaller (up to about 25 mm) and they attack both at the base of the tree and in the stem. They, too, are a pest in cultivated poplar. A moth of *P. tabaniformis* (Rottemberg) is illustrated.

The cottonwood crown borer (page 60), *Sesia tibialis* (Harris), another clearwing moth, is an important pest of poplar being cultivated in nurseries in the Prairie provinces. Although it has a wide distribution from coast to coast it is relatively uncommon in natural forests. The adults are in flight from late June to the end of August and lay their eggs near ground level on the root stalks used in poplar cultivation. The larvae tunnel through the bark into the wood and down into the root for 2 years or more. Eventually the stool is girdled and no further suckers for cuttings are produced. A full-grown larva reaches 40 mm in length.

Two flatheaded borers that are important pests of poplar are the bronze poplar borer, *Agrilus liragus* Barter & W.J. Brown, and the poplar sucker borer, *A. horni* Kerremans. The former generally feeds in the crown and down into the stem of weakened trees of all species of poplar. On hot days, the eggs are laid in small groups in bark crevices on the sunny side of the tree. Following hatching the young larvae tunnel directly through the bark and then feed in the cambial layer. As the larvae feed they create patches of tight zigzag galleries in the cambial region as they progress down the trunk. The larvae are pale, legless, and somewhat flattened though long and slender except for a wide segment behind the head. The last abdominal segment bears a pair of forcep-like structures (see page 95 for a similar larva). The larval stages last two summers in Canada. Pupae develop in the spring and adults are present from mid-June to the end of August.

The poplar sucker borer breeds in young healthy sucker growth and can kill such stems. The eggs are laid low on the stem and the larvae tunnel in the bark down into the root and then turn around and construct a tunnel on the wood surface in a relatively tight spiral upward into the stem. As a result the stem dies. It is

* Photo courtesy of the Indian Head Tree Nursery, Department of Regional Economic Expansion, Canada.

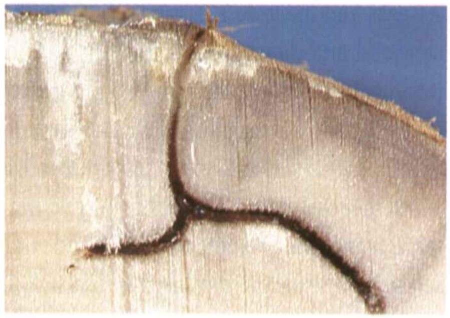


Cottonwood crown borer damage*

Poplar sucker borer tunnel

believed that the change to the pupal stage occurs in the center of the stem in the second spring after the eggs are laid.

# Ambrosia beetles



Poplar ambrosia beetle tunnel

The poplar ambrosia beetle, *Trypodendron retusum* (LeConte), has a transcontinental range in Canada and the northern United States. It feeds mainly on poplar and is one of our largest ambrosia beetles, reaching a length of up to 4.5 mm. Like all ambrosia beetles it cuts a small round tunnel directly through the bark and then into the wood, where the tunnel branches. These tunnels are lined with a black mold fungus known as ambrosia, which is introduced by the beetle adults. Although the adults feed on wood and the fungus, the larvae usually feed on the fungus only. Because they require wood with a high moisture content in order to complete development, the beetles attack only recently dead trees or cut logs, not seasoned wood. Although the strength of wood containing ambrosia beetle damage is not diminished, the black stain created by the fungus, which may extend for some distance beyond the tunnel, is undesirable.

# Twig borers

Poplar gall borer egg slit

The poplar gall borer, *Mecas (=Saperda) inornata* (Say), feeds on a number of poplar and willow species from Quebec to Saskatchewan and in the adjacent parts of the United States. The damage has been considered inconsequential because only twigs or sucker growth are attacked, and they are not killed. However, because the mines permit the entrance of wood-rotting fungi, the importance of this borer will increase as poplar is more intensively cultivated. The adult beetles are present from early June to July in Ontario, when they feed on the leaf edge or along the midrib on the lower leaf surface. They cut characteristic horseshoe-shaped slits in the bark, generally with the open end up, in which to lay their eggs. Eggs hatch in about 2 weeks and the legless larvae feed initially in the outer sapwood, causing the development of callus tissue that results in a spindle-shaped gall. Later the larvae tunnel in the heartwood and, with the approach of cold weather, construct a plug of fibrous material at the end of the tunnel, where they pass the winter. In the north, two summers of larval feeding occur, but in the south the life cycle is completed in 1 year. The change to the pupal stage occurs in the spring.

The poplar branch borer, *Oberea schaumii* LeConte, attacks most poplar species from Quebec to Alberta and in both the eastern and western United States. The eggs are laid singly, in rectangular patches chewed by the adults, in sunny parts of small twigs or stems up to 15 mm in diameter. They hatch in about 2 weeks and the legless larvae tunnel into the sapwood and then proceed downward. After passing the first winter as larvae, they continue tunneling and enlarge the gallery. Late in summer the larvae cut holes to the outside through which they eject debris. Following a second winter as larvae, they resume tunneling and cut a second hole to the outside. Later they cut a third hole lower on the stem or branch, and finally move back up the tunnel beyond the egg niche and cut a tunnel almost to the bark surface. The larvae overwinter a third time before changing to pupae and finally to adult beetles in mid- to late June of the following year.

Poplar branch borer egg slit

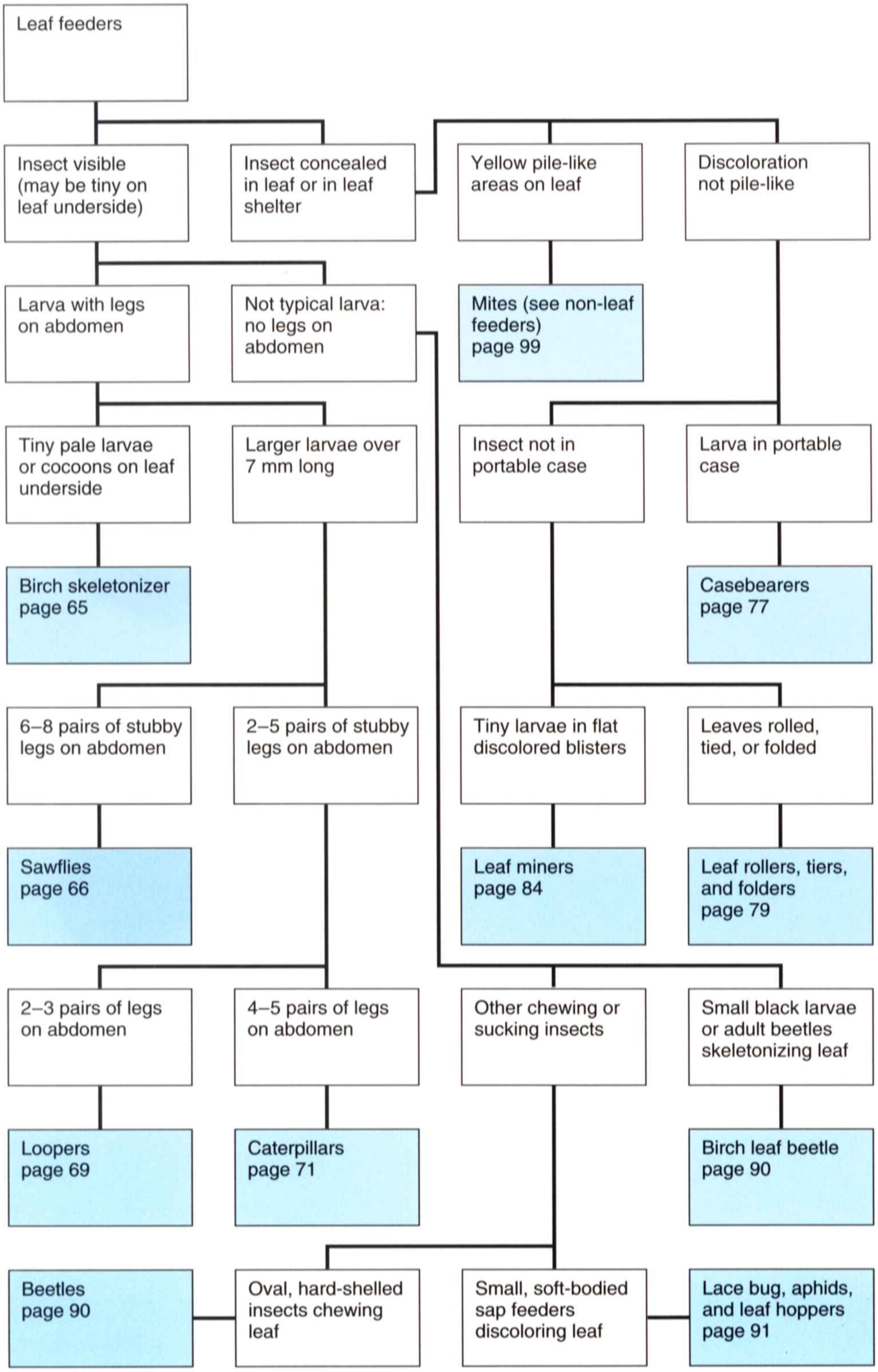
# BIRCH

White

Yellow

Gray

# Birch: leaf feeders



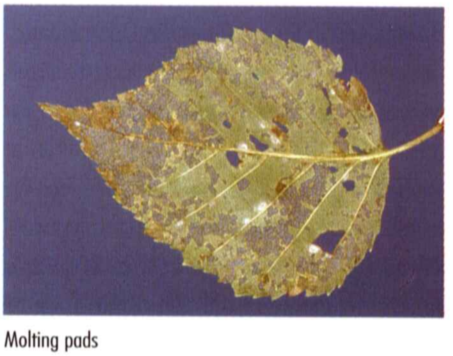
# Birch skeletonizer

The birch skeletonizer, *Bucculatrix canadensisella* Chambers, occurs across the continent throughout most of the range of its principal host tree, white birch. However, the larvae also feed on other species of birch. Periodic epidemics of this pest, often over large areas, have caused late summer browning of foliage and premature leaf drop from Newfoundland to Alberta as well as in the northeastern United States.

Birch skeletonizer larva

Cocoon

The birch skeletonizers overwinter as pupae in cocoons among debris on the ground. The tiny moths have been observed from late June to late July in Ontario. The eggs are laid singly on either side of the leaf and hatch in about 2 weeks. The young larvae bore through the bottom of the egg into the leaf, where they feed and form narrow winding tunnels. They emerge from the tunnels 3 or 4 weeks later to skeletonize the undersurface of leaves. The larvae subsequently molt twice in tiny white silken webs commonly referred to as molting pads. When they are full grown, about 6 mm long, the slender greenish larvae drop to the ground on silken threads and spin their characteristic ribbed cocoons in the ground litter. The insect overwinters as a pupa inside the cocoon.

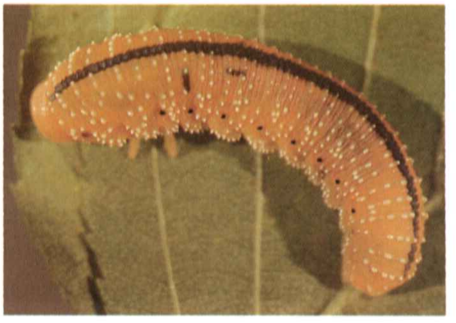


Molting pads

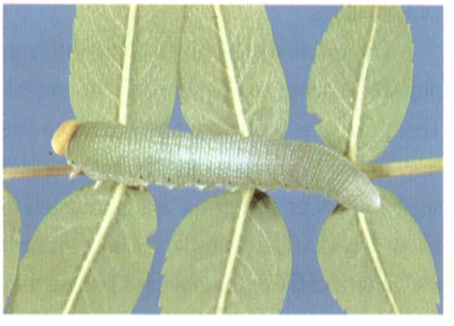
As this skeletonizer mainly feeds late in the season, no large-scale control measures have been initiated to date. On ornamental trees, population levels could be reduced by raking and burning leaves and debris in late fall or early spring.

# Sawflies


Fringed birch sawfly larvae, p. 66


Elm sawfly larva, p. 68


Birch sawfly larva, p. 67


Large willow sawfly larva, p. 68


Dusky birch sawfly larvae, p. 67


Striped alder sawfly larvae, p. 67

**Another sawfly found on birch:**
**Slug sawflies, page 149**

Although a number of species of *Dimorphopteryx* have been recorded on birch, the most common of them is the fringed birch sawfly, *D. melanognathus* Rohwer. It has been reported from Newfoundland to Saskatchewan and in the northeastern United States. Large-scale damaging epidemics have occurred only in north central Ontario, principally on yellow birch and to a lesser extent on white birch. During epidemics the larvae also feed on maple, alder, and willow. The insect overwinters in cells in the ground and the adult sawflies apparently emerge from about mid-June to late July. The eggs are laid under the epidermis on the upper leaf surface and the larvae feed from late June to early September. Early feeding is on the upper layers of the leaf but later the entire leaf is eaten except the midrib and the major lateral veins. When they are full grown, about 18 mm long, they drop to the ground and enter the soil where they form a small oval cell at an average depth of about 75 mm. The larvae remain in the ground over winter or often for periods of up to 5 years before changing to pupae and subsequently to adult sawflies. Preliminary studies of this sawfly at Sault Ste. Marie, Ontario, suggest that even a single year's defoliation may adversely affect mature yellow birch. Consequently, if they cannot be harvested in the near future these valuable trees should be protected early in the year of infestation with a pesticide registered for use against sawfly larvae.

The birch sawfly, *Arge pectoralis* (Leach), occasionally causes severe defoliation of birch from Nova Scotia west to interior British Columbia and in the northeastern United States. A similar *Arge* species with darker larvae feeds on alder. The insect overwinters in cocoons on the ground and the smoky-winged adult sawflies emerge in June and July. The female lays her eggs from July to late September in a row of slits cut along the edge of the leaf. When the larvae are full grown, about 27 mm long, they drop to the ground where they spin dense, silken, oval cocoons in the litter, and overwinter in them. Large-scale abatement measures have not been attempted for this insect. Solitary larvae of the closely related *A. clavicornis* (Fabricius), which have a dark line on the head and lack black spots on the body, are also often found on birch.

The dusky birch sawfly, *Croesus latitarsus* Norton, has been reported from Newfoundland to Saskatchewan, and from Alaska, Utah, and the eastern United States. Epidemics of this insect have occurred rarely and only over very small areas. Larvae have been reported from June to late September in Ontario, which indicates there are probably two generations in that province. The larvae are gregarious and usually feed in a row around the leaf edge. When they are full grown, about 24 mm long, they drop to the ground where they form cocoons. The overwintering stage is the cocooned larva in the litter or soil.

The striped alder sawfly, *Hemichroa crocea* (Geoffroy), an introduced species, occurs occasionally in epidemic numbers across Canada and the northern United States. Although alder is the usual host tree, severe defoliation of birch is also recorded. There are two generations each year in British Columbia. In Ontario it seems likely there is at least a partial second generation, as larvae are present from late June to early October. Winter is spent as a cocooned larva inside an earthen cell in the soil. The female lays her eggs in a row of slits cut on either side of the midrib on the undersurface of the leaf. The larvae feed in groups, initially eating holes through the leaf from the underside. Later, the rest of the leaf, except the heavier veins, is consumed. The full-grown larva is about 20 mm long. Control measures have not been deemed necessary for this sawfly.

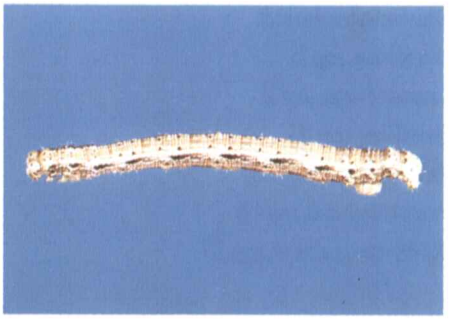
The elm sawfly ( page 66), *Cimbex americana* Leach, is transcontinental in Canada and the northern United States and ranges north to Alaska and south to Texas and Florida. Elm and willow are considered to be the principal host trees, but in Ontario the insect is found more often on birch, and to a lesser extent on willow, poplar, alder, elm, and a few other deciduous tree species. In Ontario the stout-bodied adults , about 25 mm long, fly from early June to early August. The eggs are laid in pocket-like slits cut on the undersurface of leaves. The larvae may be found from late June to mid-September. They vary in color from pale green to yellow to pale orange, but all have a black stripe down the back.

When full grown, about 45 mm long, the larvae drop to the ground where they spin tough papery cocoons in which to overwinter. Some change to pupae and subsequently to adults the following spring, while others remain in their cocoons over a second winter. With the exception of an infestation in a park in Dolbeau, Quebec, in the early 1950s, no epidemics of this sawfly are recorded in Canada. However, serious defoliation is recorded occasionally on elm and willow in the United States, particularly in urban areas and in windbreaks on the Great Plains. When adults are numerous they can kill tree tops by girdling small twigs as they feed on the sap. If control information is required for the elm sawfly consult your nearest government forest information office (see map on page 11).

The large willow sawfly, ( page 66), *Trichiosoma triangulum* Kirby, is apparently also a transcontinental species. Feeding injury is usually negligible except in Manitoba and Saskatchewan where light defoliation was reported in the 1960s. Host trees are mainly willow, birch, aspen, and alder. The life cycle is similar to that of the elm sawfly. The full-grown larva is about 37 mm long. It is uniformly green in body color and lacks the black stripe characteristic of the elm sawfly.

Elm sawfly adult

# Loopers


Hemlock looper, p. 70


Maple spanworm, p. 70


Purplish-brown looper, p. 70


*Plagodis alcoolaria* larva, p. 70

Other loopers found on birch:
Fringed looper, page 35
Twopronged looper, page 35
Linden looper, page 109
Redcheeked looper, page 110
Pepper-and-salt moth, page 199
Variable redmarked looper, page 227

The hemlock looper (page 69), *Lambdina fiscellaria fiscellaria* (Guenée), occurs from Newfoundland to Alberta and in the northeastern United States. Although epidemics are associated with the principal host trees, balsam fir, hemlock, and spruce, the larvae will also feed on birch, maple, and many other deciduous trees. In Ontario larvae may be found from June to September, but the main feeding period is from July to mid-August. When they are full grown, about 30 mm long, the larvae change to pupae in protected niches on the tree or in debris on the ground. The moths fly from mid-August to late September. The females lay their eggs, one to three in each site, in a variety of locations on the ground or among lichens or bark irregularities on tree stems or branches. The eggs overwinter. This insect is treated in greater detail in *Insects of Eastern Spruces, Fir and Hemlock*, an earlier handbook in this series.

The maple spanworm (page 69), *Ennomos magnaria* (Guenée), is found from Quebec to British Columbia and in the northern United States, but rarely in the Maritimes. The larvae feed on the foliage of birch, aspen, maple, and many other deciduous trees from June to late August. Feeding injury is usually of little consequence. The twig-like larvae are yellow-green or brownish and about 50 mm long when full grown. They change to pupae in folded leaves and the large yellow and brown moths fly in August and September. The insect overwinters in the egg stage on the tree.

The purplish-brown looper (page 69) *Eutrapela clemetaria* (J.E. Smith), is a general feeder on a variety of deciduous and coniferous trees from the Maritimes to Saskatchewan and in the northeastern United States. There is no record of severe feeding injury. The insects overwinter as pupae in cocoons in the ground litter and the moths are active from May to late June in Ontario. The eggs are laid on twigs and the larvae feed from early June to mid-August. The full-grown larva is about 60 mm long.

A number of species of humpbacked loopers in the genus *Plagodis* occur on birch and some other deciduous trees across Canada and the northeastern United States. Feeding injury, however, has been of little consequence to date. Some species have a single generation each year, others apparently have two. Consequently, larvae of one or more species may be found from early June to late September. In Ontario, considerable numbers of *P. alcoolaria* (Guenée) larvae (page 69) have occurred in conjunction with epidemic numbers of the saddled prominent. Larvae of species in the genus *Plagodis* all have a characteristic broad rounded swelling on the fifth segment of the abdomen. Full-grown larvae vary in length from about 25 to 35 mm.

# Caterpillars


Yellownecked caterpillar, p. 72

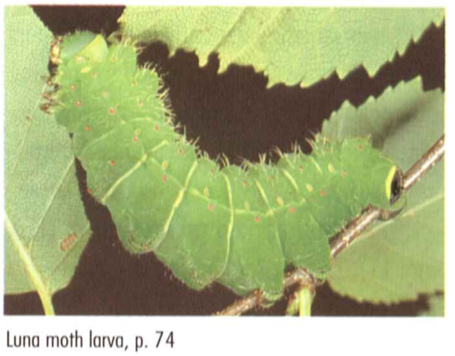

Polyphemus moth larva, p. 74


Whitemarked tussock moth larva, p. 73


Tiger swallowtail larva, p. 74


Rusty tussock moth larva, p. 73

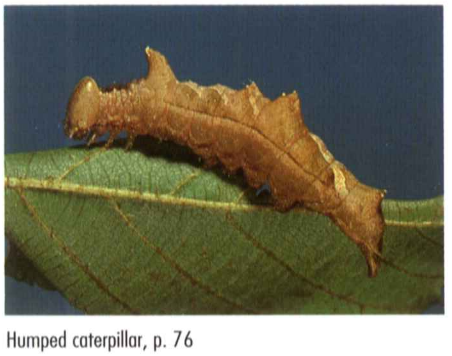

Yellowlined caterpillar, p. 75


Luna moth larva, p. 74


Pale tussock moth larva, p. 76

Alder dagger moth larva, p. 76

Warty birch caterpillar, p. 76



Humped caterpillar, p. 76

**Other caterpillars found on birch:**

Forest tent caterpillar, page 19
Speckled green fruitworm, page 19
Redhumped caterpillar, page 19
Lappet moth, page 20
Pinkstriped oakworm, page 141
Gypsy moth, page 141
Lacecapped caterpillar, page 141
Spotted tussock moth, page 197
Rusty whitesided caterpillar, page 197
Fall webworm, page 226
Northern tent caterpillar, page 245
Saddled prominent, page 258

The yellownecked caterpillar (page 71), *Datana ministra* (Drury), is found from the Maritimes to British Columbia and is distributed widely in the United States. It feeds on a variety of hardwood trees and shrubs in Canada and severe defoliation has occurred on white birch, white elm, hawthorn, serviceberry, and others. The overwintering stage is the pupa and in Ontario the moths fly in June and July. The eggs are laid in masses of 100 or more on the underside of leaves. Large dense groups of larvae, clustered around the twigs and branches, feed on leaves from July to late September and, when disturbed, characteristically raise both ends of the body. Young larvae are reddish-brown with paler lines, but when they are full grown, about 50 mm long, the head is black, the thoracic shield orange-yellow, and the remainder of the body is black with yellowish lines and long, white, soft hairs. In the fall the larvae drop to the ground and change to pupae in the soil.

On ornamental trees and shrubs, clusters of feeding larvae can be removed by pruning or they can be handpicked and destroyed. Pesticides recommended for use against caterpillars would be most effective against young larvae.

The whitemarked tussock moth (page 71), *Orgyia leucostigma intermedia* Fitch, occurs from Newfoundland to Alberta


Yellownecked caterpillars

and in the northern United States. The larvae feed on a wide variety of coniferous and deciduous trees. Epidemic numbers of larvae have been reported on birch, cherry, alder, apple, beech, and maple in the Maritimes. In Ontario, infestations have often occurred in urban areas, primarily on Manitoba maple and elm, but also on other species. This insect overwinters in


Whitemarked tussock moth cocoon, egg mass, adult

the egg stage and the larvae may be found from spring to fall, but mainly in July and August. Young larvae feed on the surface layer of the leaves; later they eat entire leaves except the larger veins. When they are full grown, about 35 mm long, the larvae change to pupae in grayish cocoons of silk and body hairs spun in bark crevices or other suitable niches. The moths, wingless females and winged males, emerge in about 2 weeks. After mating, the female lays her eggs in a foamy white mass on the cocoon from which she emerged.

Epidemics of this species in forest stands are usually terminated by a naturally occurring virus disease and by parasites. The small but conspicuous white egg masses can be removed from ornamental trees or daubed with creosote in the fall.

The rusty tussock moth (page 71), *Orgyia antiqua nova* Fitch, is found from Newfoundland to Alberta and in the northern United States. Epidemics of larvae have occurred on tamarack, balsam fir, and birch but feeding is also common on a wide variety of other tree species. The eggs overwinter on the tree and hatch in the spring. Feeding larvae can be found in June, July, and August and when full grown are about 28 mm long. They change to pupae in yellow-gray cocoons in a variety of niches. The moths, winged males and wingless females, emerge mainly in August and September. The eggs are laid in a single-layered mass on the cocoon from which the female emerged.

Large-scale control measures are usually not required. On ornamental trees, the larvae or egg masses can be handpicked and destroyed.

Pesticides registered for use against caterpillars on trees are most effective when applied to young caterpillars.

The luna moth (▭ page 71), *Actias luna* (Linnaeus), is found from Nova Scotia to Saskatchewan and south to Florida and Texas. In Canada the larvae are found primarily on white birch but they will feed on a wide range of other deciduous hosts. Localized minor epidemics have occurred, but they have been of short duration. The insect overwinters as a pupa and the large beautiful green moths (see cover photo) fly from late May to late July. The large brown and white eggs are laid in rows along twigs. In Ontario, larvae feed from mid-June to late September but are found mainly in late July and early August. When full grown, about 75 mm long, the larvae drop to the ground where they spin thin-walled shapeless cocoons ▭ among the dead leaves.

There is little justification for control measures against the luna moth. Injury to trees caused by larval feeding has, so far, been negligible. Furthermore, the moths, probably the most beautiful and "exotic" creatures in our northern climate, should be assured a permanent niche in our forests so that their beauty is not lost to future generations.

Luna moth cocoon

The polyphemus moth ▭, *Antheraea polyphemus* (Cramer), is widely distributed throughout Canada and the United States. The larvae feed on the leaves of birch, maple, and to a lesser extent on other tree species. Serious feeding injury is unknown. Winter is spent as a pupa in a tough, dense cocoon, usually enclosed in a leaf ▭ on the ground. The buff-colored moths, with a wing expanse of about 125 mm and a translucent eyespot in each wing, fly in June or early July. The large eggs ▭, which are laid on the foliage, are round, somewhat flattened, and pale with a dark band around the edge. In Ontario, larvae (▭ page 71) may be found from early July well into September. When full grown they are about 75 mm long.

The tiger swallowtail (▭ page 71), *Pterourus glaucus* (Linnaeus), occurs commonly in eastern and central North America. The subspecies *canadensis* (Rothschild & Jordan), with a single generation each year, is the common one in Canada, whereas the subspecies *glaucus* occurs in the southern tip of Ontario and in the United States. The latter has two or more broods each year. The common Canadian tiger swallowtail overwinters as a chrysalis on or near the ground. The striking yellow and black butterflies ▭ fly from late May to early July and are often seen clustered around mud puddles or decaying animal matter. The larvae feed singly, primarily on birch, poplar, cherry, and willow, and less frequently on other deciduous trees. They are unusual in that they have a pair of retractable "horns" behind the head and conspicuous "eyespots" on the swollen front portion of the body.

Polyphemus moth

Polyphemus moth cocoon

Polyphemus moth egg

There have been no reports of noticeable damage to trees by the larvae of the tiger swallowtail. Consequently, the beauty of the butterflies should be enjoyed and their place in nature's scheme of things accepted.

Tiger swallowtail

The yellowlined caterpillar (page 71), *Nadata gibbosa* (J.E. Smith), is widely distributed in Canada and the United States. In

Ontario, the primary host species is white birch, although maple, oak, and many other tree species are also fed upon. In the United States, oak and maple are recorded as primary host trees. Winter is spent as a pupa in the ground and the moths emerge in June and July. The larvae, usually feeding singly, may be found from mid-June to late September. When full grown they are about 40 mm long. No epidemics of this insect are recorded.

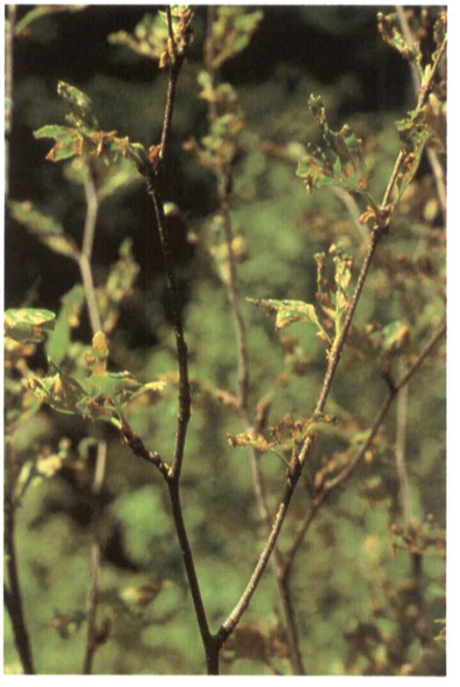
The pale tussock moth (page 71), *Halysidota tessellaris* (J.E. Smith), is found in southern regions of Quebec and Ontario and in the eastern United States. The larvae feed on most common deciduous trees and shrubs, but no serious injury has been reported. In Ontario, the moths fly from late June to early August and the females lay their eggs in masses on the underside of leaves. The larvae feed from mid-July to late September and attain a length of about 35 mm. Winter is spent as a pupa in a gray hairy cocoon.

The alder dagger moth (page 72), *Acronicta dactylina* Grote, occurs from Newfoundland to Alberta and in the northern United States. The larvae feed mainly on alder, birch, and willow; epidemics are unknown. In Ontario, moths have been reported in June and July. Larvae may be found from mid-July to early October. When full grown, about 40 mm long, the larvae drop to the ground and spin elliptical cocoons of coarse silk and hair among leaves or debris. They change to pupae in the cocoons and overwinter there.

The warty birch caterpillar (page 72), *Drepana bilineata* (Packard), and its relative, the masked birch caterpillar, *D. arcuata* Walker, feed on birch and occasionally alder, from the Maritimes to British Columbia and in the northeastern United States. Serious feeding injury has not been recorded. There appear to be two generations each year in Ontario with moths in flight from early May to late June and from July to early September. Larvae have been found from early June to early October. They are unusual in that the legless posterior end terminates in a small fleshy protuberance. When full grown they are about 20 mm long. The two dark lines, suggesting a mask, across the face of *D. arcuata* are lacking on *D. bilineata* and differentiate the larvae of the two species.

A number of species of humped caterpillars in the genus *Schizura* feed on birch and maple as well as on many other kinds of trees in eastern North America. The species illustrated on page 72 is S. *leptinoides* (Grote). The larvae of the other species are similar in shape but have fewer humps and some have more green color along the sides. Usually only single larvae are found and feeding damage is rarely noticeable. When they are full grown, about 25 mm long, the larvae drop to the ground and change to pupae in thin cocoons in the litter. The pupae overwinter on the ground and the grayish moths emerge the following spring. Some species may have more than one generation each year.

# Casebearers



Birch casebearer damage

Overwintering cases

Birch casebearer

* The account of the birch casebearer and its illustrations were kindly supplied by F.A. Titus of the Atlantic Forestry Centre.

A large group of insect larvae construct cigar-shaped cases from leaf fragments and feed on foliage from within the case. The case increases in size as the larva develops and when the leaf tissue is consumed in one area the larva moves to another, carrying its case with it; hence, the name "casebearer". The shape and color of the cases will generally identify the species, some of which are illustrated.

A number of species of casebearers feed on the foliage of birch in North America. The most important of these is the birch casebearer* (page 77), *Coleophora serratella* (Linnaeus), an introduced species first reported in North America in 1927 from the state of Maine. It can now be found from Newfoundland to northwestern Ontario, and the northeastern United States; it prefers white birch but also attacks other species of birch and alder. Twig and branch mortality are common in severe outbreaks, and if attacks continue unabated the trees will die.

The insect has one generation a year. The tiny moths emerge in July and the eggs are deposited along the midribs and the larger veins on the underside of the leaves. On hatching, the young larva enters the leaf and feeds as a miner for 2 or 3 weeks. It then vacates the mine and constructs a case in which it lives and feeds. With the onset of cold weather it crawls to the crotch of a twig or small branch, fastens the case down with webbing and hibernates for the winter (page 77). In spring the larva resumes feeding on buds and developing leaves, mining as far as it can reach without leaving the case. After each molt it constructs a new case from a mined portion of a leaf. When the larva has finished feeding it attaches the case to a leaf, twig, or branch, or to the stem of the host tree, pupates within, and subsequently emerges as an adult.

Leaves damaged while developing tend to shrivel and the transparent mined portion falls out; those severely mined turn brown later, giving the tree a scorched appearance (page 77). Ornamental trees that are severely or repeatedly damaged may require the application of an insecticide. Because of its leaf-mining habits this insect is not easily killed, but fair control may be obtained if systemic insecticides are applied early in the season.

Two additional species of casebearers feed on many hosts, including birch, and are found generally in Ontario and eastward. They are *C. comptoniella* (McDunnough) (=*C. betulivora* McDunnough), and *C. pruniella* Clemens (page 251). Their life cycles are similar to that of *C. serratella* but injury caused to trees has been of little consequence to date.

*Coleophora comptoniella*

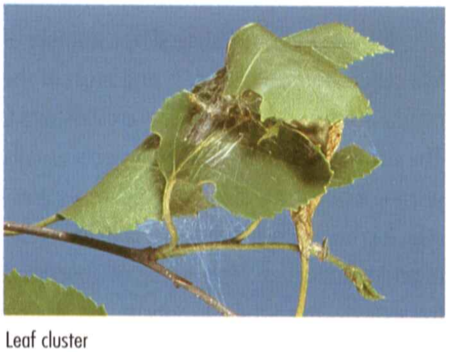
# Leaf rollers, tiers, and folders

Tied leaves

Spearmarked black moth larva, p. 81

Leaf roll

Birch-aspen leafroller, p. 81

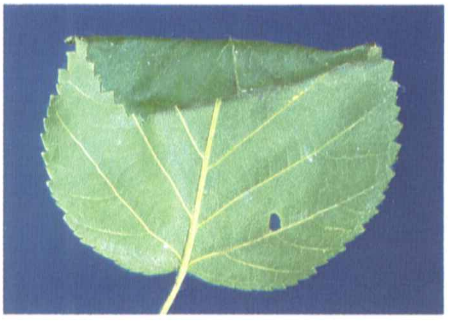


Leaf cluster

Birch tubemaker, p. 81

Folded leaf

Blackheaded birch leaffolder, p. 82



Leaf cone

Birch leafcone caterpillar

Birch-aspen noctuid larva

Striped birch pyralid larva

Blackdotted birch leaftier

Other leaf rollers, tiers, and folders found on birch:
Green aspen leafroller, page 28
Dusky leafroller, page 28
Fruittree leafroller, page 29
Obliquebanded leafroller, page 29
Flat leaftier, page 153
Birch leaffolder (not illust.), page 82

Birch leaves are damaged by a number of leaf rollers, tiers, and folders and most of the common ones and their damage are illustrated. The structures created by these insects usually provide a clue to the identity of the insect; however, it is necessary to see the larva to be certain of an identification. This group of concealed feeders does not appear to constitute a serious threat to birch in North America except possibly in the far north where large-scale epidemics have been reported for two species. Elsewhere local epidemics have been of short duration and control measures are unwarranted. On ornamental trees the larvae can be handpicked and destroyed.

The spearmarked black moth (page 79), *Rheumaptera hastata* (Linnaeus), occurs on white birch throughout Canada, Alaska, and the northern and central United States. Other recorded host plants are alder, willow, rose, and sweetgale. In Alaska, epidemic populations have developed at 15- to 17-year intervals since 1941, affecting areas of up to 2 million hectares. In Ontario, smaller severe outbreaks occurred east of Lake Nipigon in 1953 and again from 1960 to 1963. The moths fly from June to early August, depending on locality. Shortly after emerging they seek water and often congregate in large numbers in moist depressions or along stream banks or drainage ditches. The eggs are laid singly or in clusters on the upper surface of leaves or in folds of leaves rolled by other leaf rollers. In Ontario, these looper-type larvae feed from late June to late August, usually singly, but occasionally in groups of as many as five, between two leaves webbed together (page 79). Feeding is usually confined to the upper layers of leaf tissue. When the larvae are full grown, about 16 mm long, they drop to the ground and change to pupae, which overwinter in the ground litter. Control measures have not been required, as epidemic numbers of insects usually decline from natural causes within 2 years. A closely related species, *R. subhastata* (Nolcken), is found over most of the range of the preceding species. Its larvae are light brown with darker lines and are found primarily on alder but also on birch and willow.

The birch-aspen leafroller (page 79), *Epinotia solandriana* (Linnaeus), occurs throughout the range of white birch in Canada, Alaska, and other northern states. It also feeds on trembling aspen, balsam poplar, alder, and yellow birch. Large numbers of this leaf roller have been found in Ontario, the Northwest Territories, and Alaska.

The insect overwinters in the egg stage on the tree. Hatching occurs in late April or early May in Ontario and the young larvae enter and feed in swollen leaf buds. Later they construct leaf rolls (page 79) from which they feed. By mid- to late June they are full grown, about 16 mm long, and drop to the ground. The larvae change to pupae in fragile soil-encrusted cocoons between the humus layer and the mineral soil. The moths emerge from about mid-July to early August. There is an unusual degree of variation in forewing color patterns. The moths lay their tiny reddish-brown eggs singly, usually on the roughened bud stalks on the previous year's twigs.

The birch tubemaker (page 79), *Acrobasis betulella* Hulst, occurs widely in Canada and the northern United States. Although this tubemaker is common in Quebec, Ontario, and Manitoba, serious injury to birch is unknown. The tubemaker overwinters as a young larva and resumes feeding in the spring, as the new leaves are unfurling, in a leaf furrow or tube of silk and excreta. Later the larvae feed from tubes in clusters of leaves tied together with silk (page 79) and complete their feeding in June or early July. When full grown, about 20 mm long, the dusky larvae change to brown pupae in tough, gray, oval balls of silk and excreta in the damaged leaf cluster. The moths emerge in about 14 days, mainly in July. The rose-spotted pale eggs are laid in small, slightly overlapping clusters, apparently anywhere on the tree.

The larvae hatch in about a week and move to the ends of shoots to construct their first shelter and to feed on the new leaves. They feed until the onset of cold weather in the fall when they spin overwintering sites known as hibernacula on the leaf or twig.

The larvae of a number of species of *Acleris* feed on birch foliage. They are slender, active, greenish larvae, less than 16 mm in length. There are apparently two generations each year and the species is reported to hibernate in the moth stage. Serious feeding injury by members of this group is unknown.

The most common *Acleris* species in Ontario is the blackheaded birch leaffolder ( page 79), *A. logiana placidana* (Robinson). The larvae occur from June to September but are most often found in August. They feed singly in folded leaves ( page 79) which they skeletonize.

Another insect that lives in folded leaves of birch is the birch leaffolder, *Ancylis (=Anchylopera) discigerana* (Walker). The larvae feed in August and September. Large numbers were present in central and eastern Ontario in the early 1970s. No illustrations are available but the full-grown larvae are smaller than those of the *Acleris* species, being only about 9 mm long. Also, they have a characteristic marking, namely a pair of black spots on the thoracic shield.

The birch shootworm, *Epinotia solicitana* (Walker), should also be mentioned here as the nearly full-grown larva vacates the shoot in the fall and feeds for a short time in a folded leaf. This larva is yellow-green with a light brown head. For further information on this species see page 100.

The birch leafcone caterpillar ( page 80), *Caloptilia* or *Gracillaria* species, is occasionally abundant in Ontario north of Lake Superior, and presumably the same species is also known in Quebec. In Ontario, larvae or pupae have been found in leaf rolls from late May to late August. The moths are reported to be active from late July to mid-September in Quebec. The eggs are laid, usually singly, on the upper surface of the leaf. On hatching, the larvae at first tunnel in the leaf, forming small blotch mines. Later they drop to a lower leaf where they form the typical cone-shaped leaf roll ( page 80). When the whitish larva is full grown, about 9 mm long, it pupates in a gray silk cocoon inside the leaf roll.

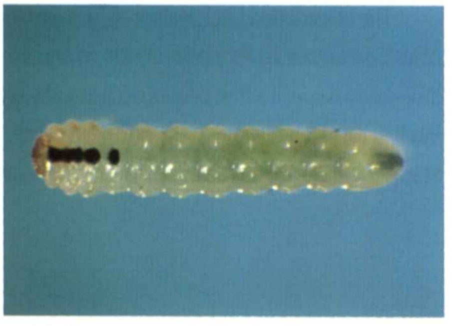
The birch-aspen noctuid ( page 80), *Enargia infumata* (Grote), although known to occur widely in North America, is generally a rare species and serious feeding injury is unknown. The larvae feed on birch and aspen from late May to late July. The full-grown larva is about 35 mm long. The life cycle of this species is probably similar to that of *E. decolor* (see page 30).

The striped birch pyralid ( page 80), *Ortholepis pasadamia* (Dyar), a little-known species, occurs from Nova Scotia to British Columbia but has been reported to be abundant locally only in Quebec. The larvae are apparently leaf rollers, feeding on birch in May and June. When full grown they are about 15 mm long. The small dark moths fly in late June and July.

The blackdotted birch leaftier (page 80), *Nites (=Depressaria) betulella* (Busck), is another little-known species that occurs occasionally on birch across Canada and in the northern United States. In Ontario, larvae are present from late May to early July and are reported to live singly in silken tubes in tied leaves. The full-grown larva is about 17 mm long. The adult insect is a small moth with narrow gray-brown forewings.

# Leaf miners

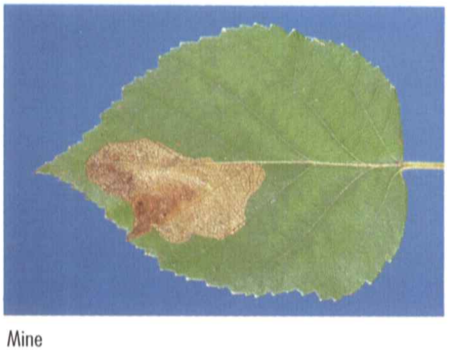
Mines



Birch leafminer, p. 85

Mine

Ambermarked birch leafminer, p.86



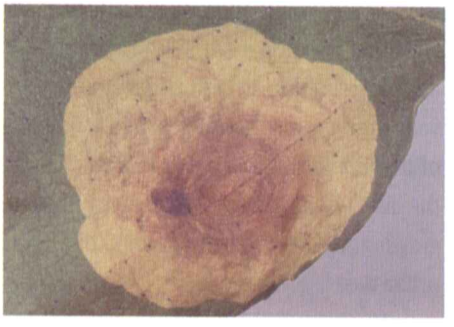
Mine

Early birch leaf edgeminer, p. 87

Mine

Late birch leaf edgeminer, p. 87

Small birch leafminer, p. 88



Birch leafblotch miner, p. 88

*Eriocrania* species leaf mine, p. 88

Other leaf miners occasionally found on birch:
Small whitish mine in leaf underside, between two veins........
............................ a moth, *Phyllonorycter* species
Elongate meandering blotch mine; pale larva, about 5 mm long with legs and prolegs in July and August....................
............................... a moth, *Lyonetia* species
Narrow linear mine widening at one end, excreta in a row along either side of mine.................. a fly, *Agromyza* species
Small brown edge mine near tip; larva whitish, legless, about 5 mm long, in June and July...................... birch and alder flea weevil, see pages 200 and 276 for similar species

Birch is host to an unusually large number of different leafminers. Four of the more common ones are sawflies and their fully developed mines and the larvae are illustrated. Three other kinds of mines, made by the larvae of moths, are also illustrated. A key to less common miners is presented. Epidemic numbers are common, especially of the first species, and control measures are often required on ornamental trees. Banding or spraying trees with a systemic insecticide is effective if label instructions are followed carefully.

The most bothersome of these insects is the birch leafminer (page 84), *Fenusa pusilla* (Lepeletier). Since its introduction into North America in 1923 in Connecticut, this miner has spread across the northern United States, and in Canada is now found from Newfoundland to Alberta. There are two to four generations each year depending on the length of the growing season and tree age. Severe browning of foliage (page 86) is reported regularly from many areas.

The miners overwinter as prepupal larvae in cocoons in the soil and the tiny black four-winged adults, known as sawflies, appear in May and early June. Males are rare and mating is not required. Subsequent generations of adults follow throughout the summer season. The eggs are laid in individual slits cut into the upper

Birch leafminer damage

Birch leafminer early mines

surface of young developing leaves, 3 to 14 per leaf. As the leaves mature they are no longer attractive for oviposition. Consequently, eggs of later generation adults are laid mainly at twig terminals where new leaves are produced throughout the summer, particularly on young trees. The feeding larvae of the various generations cause the formation of blotch mines, initially whitish and usually containing larvae, and later brown (page 84) and somewhat wrinkled. New mines may be found from May to late September. The larvae of this species are characterized by four black spots on the underside of the body. When full grown, about 6 mm long, they leave the mines and drop to the ground, burrow into the soil, and construct oval pupal cells of soil or debris and a sticky secretion. The final generation each year overwinters there. Although epidemics of the birch leafminer occur in forest stands, the insect is perhaps most damaging to open-growing trees such as ornamental birches in urban areas.

An attempt at biological control of this pest has been made in Newfoundland and Quebec with the introduction of ichneumon parasites from Europe. The success of this venture is not yet established. Information on the latest control procedures for the leafminer is available from forest protection representatives or Forestry Centres listed on page 11.

The ambermarked birch leafminer (page 84), *Profenusa thomsoni* (Konow), is probably an introduced species and occurs, often in epidemic numbers, from Nova Scotia to the Prairie Provinces and in the northeastern United States. There is one generation each year. Serious lasting injury to trees has not been reported. The tiny black adult sawflies have characteristic white tibiae and tarsi, and all are apparently females. They emerge from overwintering cocoons about mid-July and may be found on the trees until early August. The eggs are laid singly in microscopic slits in the upper surface of the leaves, but often large numbers are laid on a single leaf. Suckers growing in partial shade are preferred for egg laying, but when adults are numerous eggs are laid anywhere on larger trees except on young growing leaves at the tips of the stems. Open-growing ornamental birches are seldom heavily infested. Later, the larvae are found in groups in irregularly shaped light-brown blotch mines (page 84). When they are full grown, about 7 mm long, the larvae leave the mines and drop to the ground, burrow through openings into the humus, and construct cocoons in which they overwinter.

Although the late summer feeding by this leaf miner has been considered unimportant, a 1936 study in Maine on another fall leafminer suggests that late feeding does indeed result in considerable radial growth loss and the formation of an increased percentage of heartwood in years following severe infestations. In Ontario, infestations have been terminated by predation by ants and spiders, egg mortality due to larval undermining, starvation from crowding, and by parasitism.

The early birch leaf edgeminer (page 84), *Messa nana* (Klug), is a European species first found on this continent in the states of Maine and New York in 1966. In 1967, it was found on the north shore of Lake Ontario. Since then it has spread throughout southeastern Ontario and Quebec with some localized severe infestations reported. The tiny black adult sawflies emerge from the overwintered cocoons from early May to mid-June. The eggs are laid singly, usually one to three per leaf, in a slit at the leaf edge near the tip of a leaf tooth. The larvae mine singly in the leaf causing brownish blisters on the upper surface near the edge (page 84) where the egg was laid. The larva of this species is characterized by the dark, distinctly segmented thoracic legs and the numerous dark markings on the underside of the body. In late June or early July, when it is full grown, about 7 mm long, the larva drops to the ground and spins a soil-encrusted cocoon in the topsoil. It overwinters there and changes to a pupa in the spring. The continuing spread of this species is being closely watched by Forest Insect and Disease Survey staff in eastern Canada.

The late birch leaf edgeminer (page 84), *Heterarthrus nemoratus* (Fallén), is another introduced species now established from Newfoundland to Thunder Bay, Ontario, and in the northeastern United States. It arrived on this continent about 1905. Severe browning of foliage was caused by this miner in the Maritimes, Quebec, Maine, New Hampshire, and Massachusetts in the 1920s and 1930s, and on the Bruce Peninsula of Ontario in the 1950s.

The insects overwinter as prepupal larvae in mined leaves on the ground. They change to pupae in June or early July and to small black and white adult female sawflies (there are no males) in June or July. The eggs are laid in small pockets in a leaf tooth on the leaf margin. The larvae feed in brown blotch mines on the upper surface of the leaf (page 84) from early July until leaf drop in October. The mines are clean inside with little or no excrement. When the larva is full grown, about 8 mm long, it changes to a prepupal stage and constructs a round silken hibernation cell, usually in the center of the mine. The cell inside is clearly indicated by a circular marking on the mine surface. The leaf miner overwinters on the ground in the mined leaf. In Maine, the annual growth loss in birch the year following an infestation was calculated as about 20 percent.

Parasites and predators are important natural regulators of leaf miner populations. Native parasites and some that have been introduced from Europe attack all stages except the adults. It seems that birds, particularly warblers, vireos, sparrows, and chickadees, are important predators. Insect predators feed on larvae, pupae, and adults.

The small birch leafminer (□ page 85), *Ectoedemia lindquisti* (Freeman), is known only from Ontario, where severe localized leaf browning occurred in a large area, mostly in the southwestern part of the province, from 1957 to 1962. This insect overwinters as a larva in a cocoon on the ground, changing to a pupa between early June and early July. The adults, tiny dark moths with a white bar across the forewing, fly from late June to late July. The eggs are laid singly on the undersurface of the leaf, usually 1 to 10 per leaf, but many more during epidemics. The larvae tunnel in the leaf from late July to early October, forming small, more or less rectangular mines between two lateral veins. Blackish excreta, concentrated in a small circular area in the mine, is visible from both sides of the leaf. When full grown, about 4 mm long, the legless pale larva vacates the mine and drops to the ground where it spins a brownish, somewhat oyster-shaped, flattened cocoon on the forest floor. The eventual collapse of the Ontario infestations was attributed to a combination of parasites, disease, and perhaps most important, competition by the birch leaf skeletonizer, *Bucculatrix canadensisella* Chambers.

The birch leafblotch miner (□ page 85), *Cameraria (=Lithocolletis) betulivora* (Walsingham), is a little-known, unimportant species occasionally found in eastern North America. In Ontario, upper surface leaf mines with feeding larvae are reported from early July to mid-September. The adults are tiny moths.

Leaf mines made by *Eriocrania* species (□ page 85) are sometimes common in spring on birch in eastern North America. This species overwinters as a larva in a cocoon in the soil and changes to a pupa and subsequently to a small moth in spring. Feeding larvae are found in bulgy blotch mines from late May to early July. Full-grown larvae are whitish and about 9 mm long. A unique feature of the larvae is that the black excrement is voided in long irregularly curled threads, readily seen through the translucent mine. There is one generation each year and the insects spend nearly 11 months as dormant larvae in the soil.

The birch leaf edgeminer, *Scolioneura betuleti* (Klug), is another European species first collected on this continent in 1983 near Newmarket, Ontario. It can now be found in scattered locations throughout southern Ontario where defoliation is sometimes found to be severe.

Adults can be seen flying from the first of May until the first of June. The female adult sawflies lay eggs in the leaf tissue near the margin of the leaf. Larvae feed singly in the blotch mines from late May to late June. The mines are similar to those made by the early birch leaf edgeminer, *Messa nana*. The larvae are distinctly marked with a goblet shaped light area on the dark prothoracic shield and head, dark segmented thoracic legs, dark markings on the underside, and dark lateral spots. After passing through several instars, a hole is cut in the lower surface of the leaf epidermis and the larvae drop to the ground to pupate and to spend the winter. Pupation probably occurs in the spring.

# Beetles

Chafer beetle

**Other adult beetles found on birch:**
**Chafer beetle, page 42**
**Pale green weevil, page 42**
**Rose chafer, page 182**

Adults of chafer beetles and of other leaf beetles and weevils sometimes cause feeding injury to the foliage of forest trees. Four species of chafer beetles in the genus *Dichelonyx* are found on birch in Ontario. These, or other members of the genus, are widely distributed on this continent. The larvae feed on roots of plants and apparently 2 or 3 years are required to complete a generation. In Ontario, the adults are present from late May to late July. They are about 11 mm long and usually metallic green or brownish. Some species apparently feed mainly at night.

The birch leaf beetle, *Phratora hudsonia* Brown, is a northern species occurring from the eastern shore of Hudson Bay to western Alaska. However, the insect has been collected in southwestern Manitoba, and localized epidemics have occurred in north central Ontario. The non-flying adults are small, shiny, greenish-black, oval beetles about 4 mm long and are similar in appearance to the aspen skeletonizer. They overwinter in niches on the trunk of the tree or on the ground and are active on the trees from the time the first leaves appear in spring until fall. The black larvae feed in groups, skeletonizing the undersurface of the leaf from early July until late fall. When full grown, about 6 mm long, they move down the tree to pupate, usually on the trunk or near its base. The new adults climb the trees and feed in groups, skeletonizing the upper surface of leaves from late August to about mid-September.

# Lace bugs, aphids, and leaf hoppers

Birch lace bug nymphs

Discolored leaves

This is a group of sap-sucking insects that occasionally cause discoloration of birch foliage. Serious injury by these insects is unknown and control measures are not usually required.

The birch lace bug, *Corythucha pallipes* Parshley, is probably transcontinental in the northern United States and southern Canada. Although local infestations are recorded, large-scale epidemics are apparently unknown. Host trees are yellow birch, white birch, beech, and ironwood. There are two generations a year in New York State. In Ontario, adults have been found from late May to mid-September. However, the largest numbers of both adults and nymphs are recorded in August.

The adults hibernate among fallen leaves on the ground. The elongate eggs are placed on end, usually in groups of 4 to 10, on the underside of the leaves. The dark brown nymphs feed in groups in spring on the underside of leaves. Their mouth parts are adapted for piercing and sucking and they rob the leaf of its sap. The upper surface of the leaves becomes discolored by the feeding, and the lower surface by fine dark excrement and shed skins. When the nymphs are full grown, about 2 mm long, they shed their skin for the final time and emerge as adults with unique lace-like wings. The adults are about 4 mm long. They feed in a manner similar to that of the nymphs. Other species of lace bugs occasionally feed on birch but usually not in significant numbers.

A number of species of aphids feed on the leaves of birch but are not usually considered serious pests. A few are mentioned here but specific identification in this group, if required, is best left to a specialist. A relatively common species is the European birch aphid, *Euceraphis punctipennis* (Zetterstedt). It is a large black and green aphid that secretes a cottony white wax. The nymphs feed on the undersurface of the leaves. The adults are winged and there are a number of generations each year,

Birch lace bug adult

feeding from spring to fall. The egg is the overwintering stage. Other species occasionally found on birch are the common birch aphids, *Calaphis betulaecolens* (Fitch) and *Betulaphis quadrituberculata* (Kaltenbach). The witch hazel gall aphid, *Hamamelistes spinosus* Shimer, alternates between birch and witch hazel. On birch, the nymphs feed in leaves corrugated by interveinal swellings.

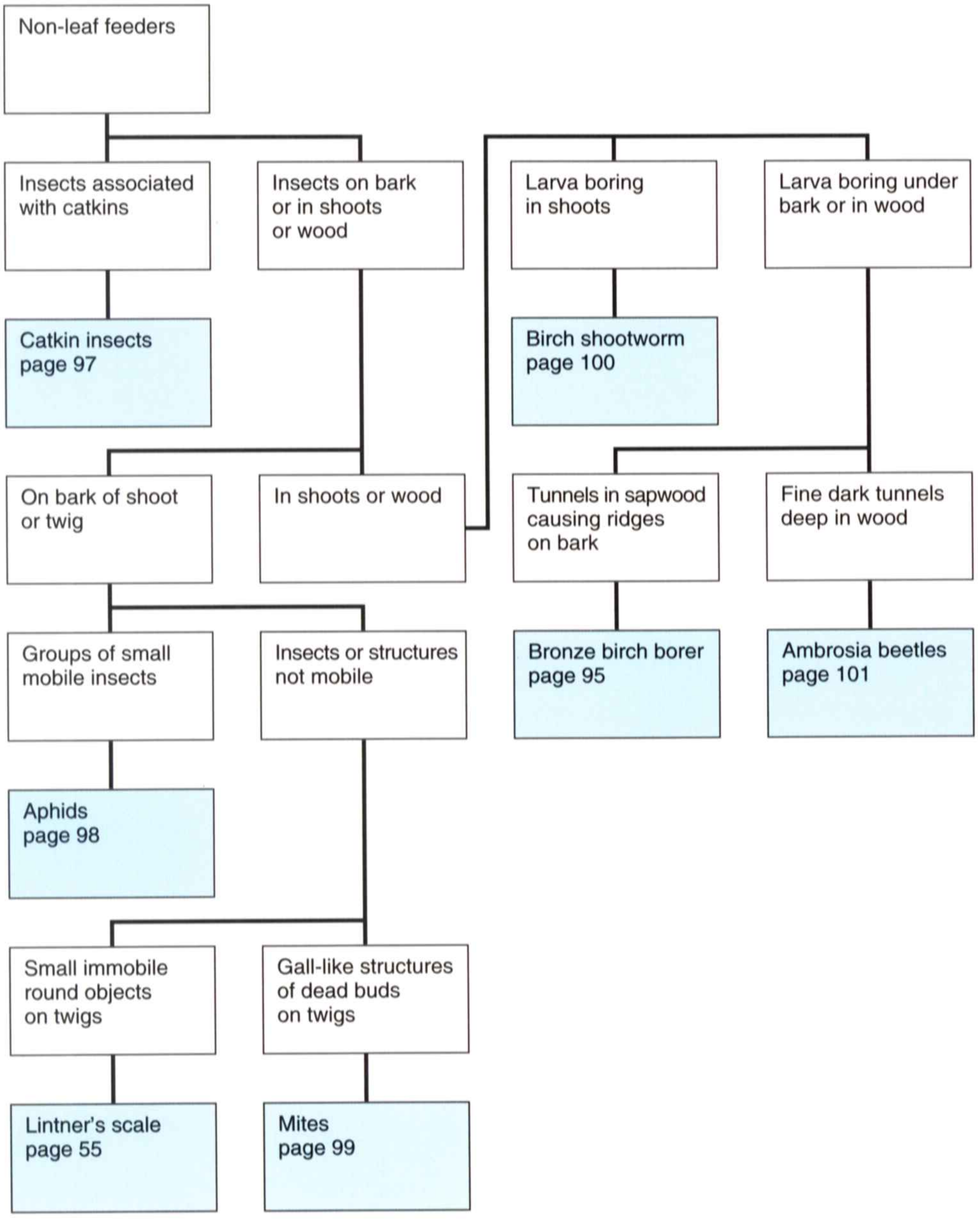
Psyllids, near relatives of aphids that look like miniature cicadas, also occur on birch. In Quebec, the birch psyllid, *Cacopsylla striata* (Patch), has been reported as common on gray birch. The eggs overwinter on buds and hatch in the spring as the buds are opening. The nymphs, covered with a white woolly substance, feed at the base of buds and later on the undersurface of leaves near the larger veins. Winged adults, apparently reluctant flyers, are present from late June until fall. Other psyllids are known from white birch.

Leaf hoppers are small, elongate, active insects with opaque wing covers sloping from the middle of the back to the sides. They rarely cause injury to birch. For more general information on this group of insects see page 125.

*Betulaphis quadrituberculata* colony

Psyllids

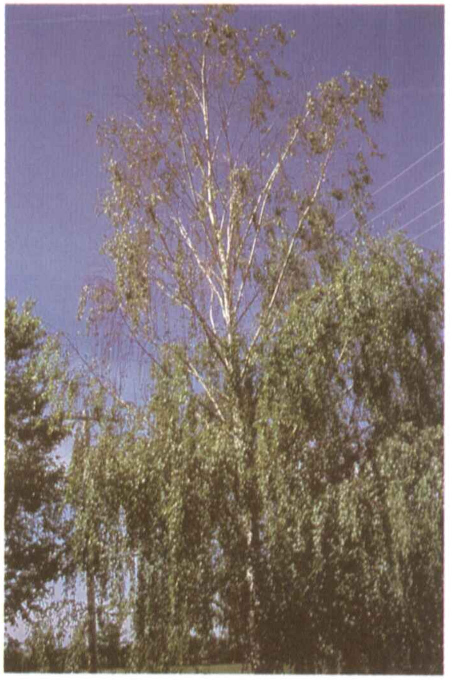
# Birch: non-leaf feeders

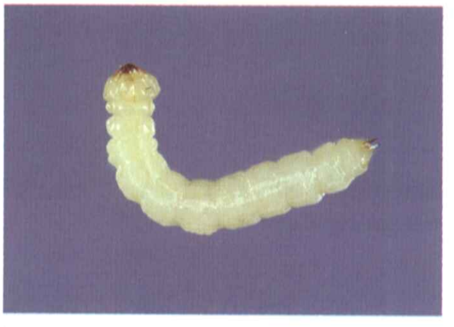


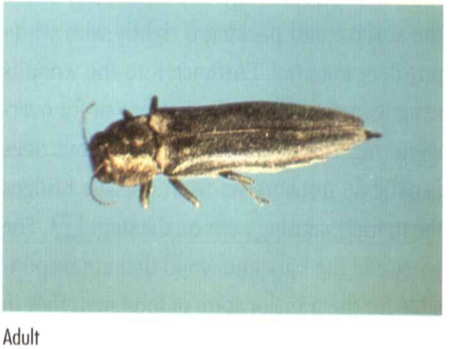
# Bronze birch borer

The bronze birch borer, *Agrilus anxius* Gory, is probably the most destructive pest of birch in North America, as its repeated attacks can kill trees. The borer has been associated with an extensive decline of birch in northeastern North America, beginning in the 1930s and extending into the 1950s. Ornamental trees, especially the cutleaf forms, are particularly susceptible to attack, so the use of these attractive trees in long-term plantings cannot be recommended. Although weakened trees or those growing in stressful situations are most readily attacked, this borer is also capable of attacking apparently healthy trees, but repeated attacks are necessary to kill the latter.

The length of the life cycle is variable, depending on the time of egg laying and condition of the tree. In the north, 2 years are usually required to complete the life cycle, whereas in the south only 1 year is necessary. The winter is passed in the larval stage and apparently only full-grown larvae survive. Change to the pupal stage occurs in the spring and the adults emerge through D-shaped holes beginning in June. They feed on foliage for a while and, after mating, lay eggs on warm days, singly or in small groups, under bark scales or in bark crevices in sunny locations on the stem. The first attack is usually up in the small branches or stem and it is there that the first evidence of injury will be seen. As the attack continues in succeeding years the eggs are laid in successively lower portions of the tree. On hatching, about 2 weeks after the eggs are laid, the tiny flat white larvae tunnel through the bark to the wood surface and construct meandering


Bronze birch borer early damage


Larva


Adult

Larval tunnel

Welts on damaged stem

tunnels there. The larvae periodically enter the wood, boring a flat tunnel just below the surface and packing it tightly with white powdery material. Entrance into the wood is usually in preparation for molting or for overwintering. Larvae that bore into vigorous trees usually do not survive; wound tissue bridges the tunnels, causing welts on the stem. The vessels in the bark and wood that are responsible for the translocation of food materials in the tree are severed after repeated attacks and death of the branch or stem ensues. In the fall the mature larvae, about 35 mm long, cut a cell in which to pupate, either in the outer wood or in the bark. They then dig a tunnel almost to the bark surface and return to overwinter in the cell.

There is at present no pesticide that will control this destructive borer. If we wish to sustain these attractive trees in an urban environment it will be necessary to maintain healthy vigorous growth. In the forest, trees of declining vigor will succumb to the borer's attacks.

# Catkin insects

A number of species of insect feed on catkins but none of them are of much importance at present because regeneration of birch appears to be adequate.

The birch catkin bug, *Kleidocerys resedae geminatus* (Say), is probably the most commonly encountered catkin insect because on occasion it becomes a nuisance on ornamental birches and on a number of other ornamental trees and shrubs. It feeds on the seeds of many woody plants in both America and Europe, but high populations appear and disappear in a single year.

More than one generation a year is reported in the United States but in Ontario there seems to be only one. The red to dark brown nymphs, similar in shape to the adults, are present from late July to late August and the adults, up to 5 mm long, from mid-June to early September. Feeding by these bugs causes the catkins to turn brown early and kills the seed.

The mottled stink bug, *Elasmucha lateralis* (Say), is found, occasionally in very large numbers, on clumps of trees on both the catkins and leaves. Both the appearance and disappearance of this insect can be abrupt. The nymphs have been present in Ontario from late June to early August; the adults, up to 8 mm long, lay their eggs in early June but are present until early September.

The birch catkin weevil, *Apion simile* Kirby, is occasionally abundant in birch catkins in northeastern North America as well as elsewhere in the world. It is believed to overwinter in the ground litter and to emerge in

Birch catkin bug

Mottled stink bug nymphs

Mottled stink bug adult and eggs

Birch catkin weevil

# Aphids

the spring. The larvae have been found tunneling in the developing catkins by late June and some are present until early August. Adults are about 4 mm long (including the snout) and have been collected from mid-June to late September.

There are also a number of species of small moth larvae that feed in catkins. They are not common and little is known about them.

*Symydobius* species aphids

Aphids that feed on twigs of birch are relatively uncommon. However, there are two species of *Symydobius* that do so; one a tawny olive green color, the other brown, both with darker transverse bands on the abdomen. Little is known about their life histories. Both feeding colonies and nymphs have been present from early June to early September in Ontario. A typical aphid colony is illustrated.

# Mites


Birch budgall mite


Birchleaf pilemite

The birch budgall mite, *Aceria rudis* complex, causes a bud proliferation on the small twigs of birch. Extensive damage has never been reported. The gall may increase in size each year for a number of years with little apparent effect on the twigs.

These primitive microscopic mites are found inside the newest bud-shaped structures and there may be many in each of them. The pale wormlike creatures have two pairs of legs and a body made up of ringed segments. They appear to overwinter as adults inside the gall.

The birchleaf pilemite, *Aceria* species, causes the development of light patches on the upper leaf surface. Early in the season, eggs and both the worm-like pale larvae and yellow-colored adults may be found if the pile material is parted. Later in the season no mites will be found because the adults will have sought hibernation sites.

Additional information on mite galls will be found on page 15.

# Birch shootworm


Birch shootworm

The birch shootworm, *Epinotia solicitana* (Walker), feeds in the shoots of white and gray birch in northeastern North America. It has on one occasion caused noticeable defoliation in Quebec, but damage is generally negligible.

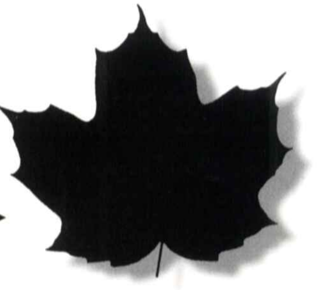
There is one generation a year; winter is spent as a pupa, usually in the soil. The adults are present during the month of June and lay their eggs, usually singly, on a leaf. Larvae hatch about a week later, move down the leaf petiole, bore into the shoot above the petiole base, and then tunnel down the shoot. Once established in the shoot, the larva constructs a brown tube of excreta over the entrance hole and continues to feed until the end of August. It leaves the shoot in September and folds a leaf in which to shelter. The shoot beyond the mine is often killed. When the leaves fall the larvae enter the soil to pupate, completing the life cycle.

# Ambrosia beetles

Two or three species of ambrosia beetles feed in recently dead or cut trees in which there is a high moisture content. One of the most common is the birch ambrosia beetle, *Trypodendron betulae* Swaine. The adult of this species is smaller (about 3.5 mm) than *T. retusum* (LeConte) (page 61) but the darkly stained tunnel leading directly through the bark and into the wood is similar.

# MAPLE

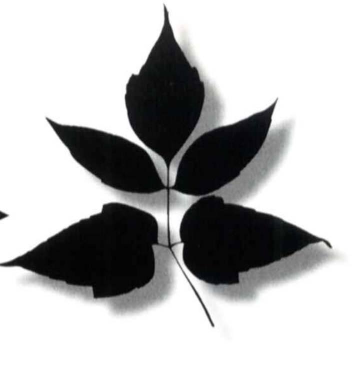
Sugar



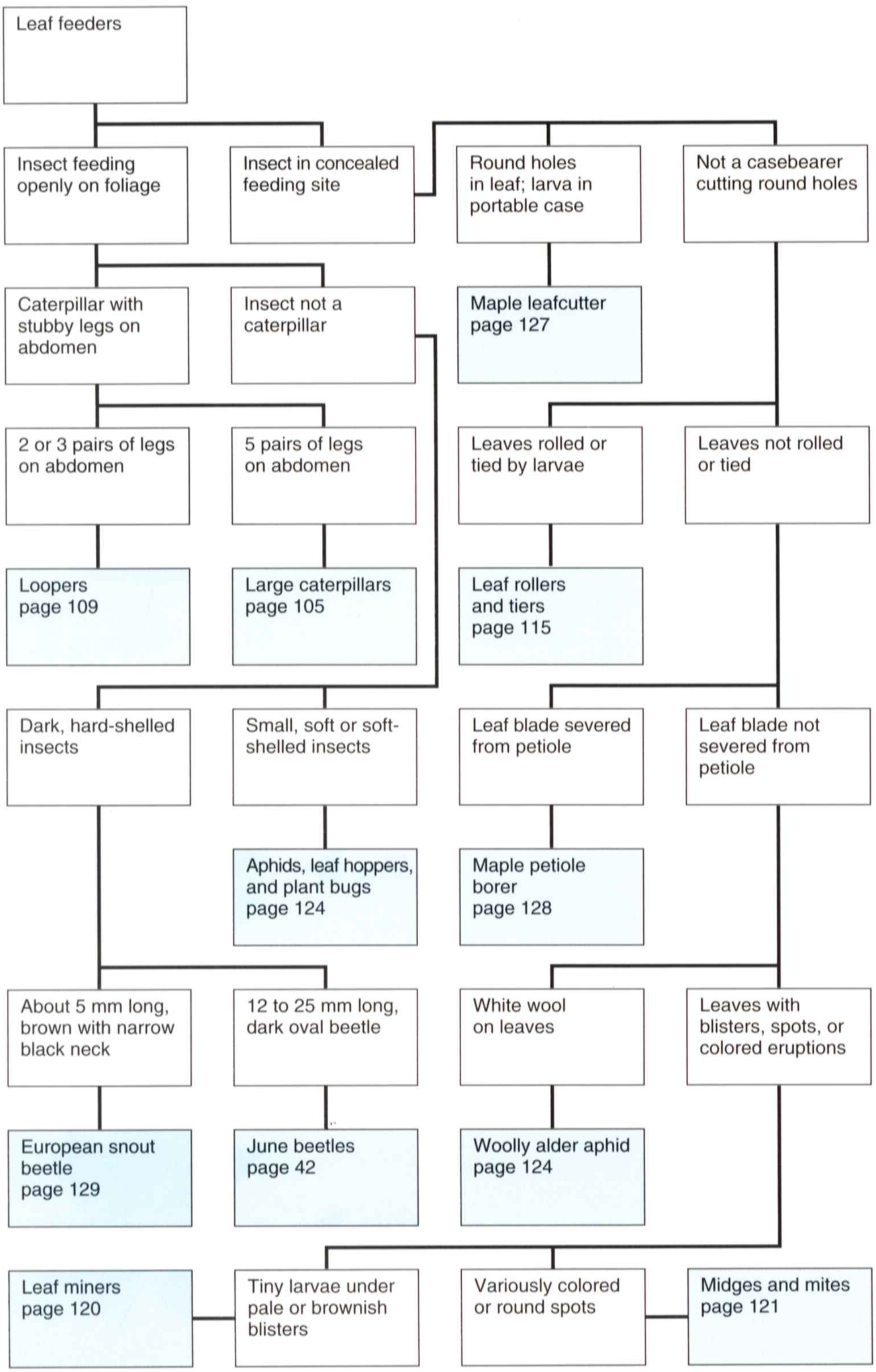
Red

Silver

Manitoba



# Maple: leaf feeders



# Large caterpillars

Greenstriped mapleworm, p. 105

Cecropia moth larva, p. 107

Saddled prominent larva, p. 108

American dagger moth larva, p. 108

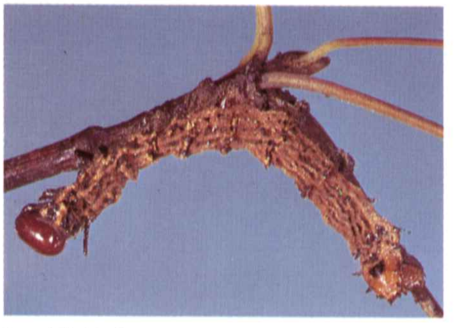
Forest tent caterpillar, p. 108

Orangehumped mapleworm, p. 107

**Other large caterpillars found on maple:**
**Whitemarked tussock moth, page 71**
**Polyphemus moth, page 71**
**Yellowlined caterpillar, page 71**
**Humped caterpillar, page 72**
**Spotted tussock moth, page 197**

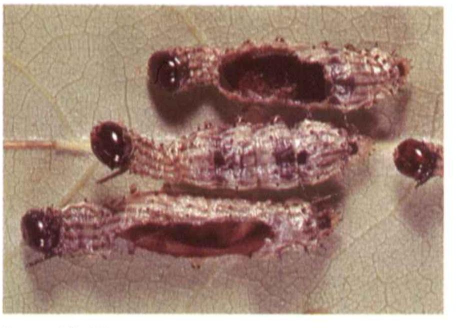
The greenstriped mapleworm ▭, *Dryocampa rubicunda rubicunda* (Fabricius), probably occurs over most of the range of its primary host trees, red and sugar maples. Epidemics have occurred in Nova Scotia, New Brunswick, western Quebec, and eastern Ontario as well as in the eastern United States. The sap quality of sugar maple is usually lowered after heavy defoliation, and trees have died after 3 years of severe defoliation.

Greenstriped mapleworm adult



Larva killed by fungus

Feeding damage



Larvae killed by parasite

The mapleworm overwinters as a pupa in the ground litter and, in Ontario, changes to an adult in June and early July. After mating, the female lays about 150 eggs in clusters, often of 40 or more, on the underside of leaves. The eggs are globular, slightly flattened with a central depression, and initially a glossy golden yellow, but as they develop they become speckled with red. The larvae hatch in about 10 days and at first feed in groups on the leaves, but as they near maturity they tend to scatter. Mature larvae, about 40 mm long, are pale green with dark stripes but the intensity of this coloring can vary considerably; for instance, dark specimens have a dark red or near black head and light specimens have a pale red head. The larvae may be found on trees from June to September but are most common in late July and early August; they eat entire leaves except the heavy veins. When feeding is completed they drop to the ground where they change to pupae.

Outbreaks of the mapleworm are usually regulated by natural control factors, which differ from place to place. Fungus and bacterial diseases, a number of parasite species , and bird and small rodent predators all take their toll of larvae and pupae. Consequently, large-scale chemical control measures have not been undertaken to date. On trees around the home, groups of larvae can be handpicked and destroyed or a contact or stomach type of insecticide, registered for use against caterpillars, can be used.

The orangehumped mapleworm ( page 105), *Symmerista leucitys* Franclemont, is an occasional pest of sugar maple and, to a lesser extent, beech, basswood, and a number of other deciduous trees, from Nova Scotia to Sault Ste. Marie, Ontario. In the United States it occurs throughout the northern tier of states from Maine to Minnesota. Outbreaks of this insect have occurred in Nova Scotia, Quebec, Vermont, New York, and Michigan.

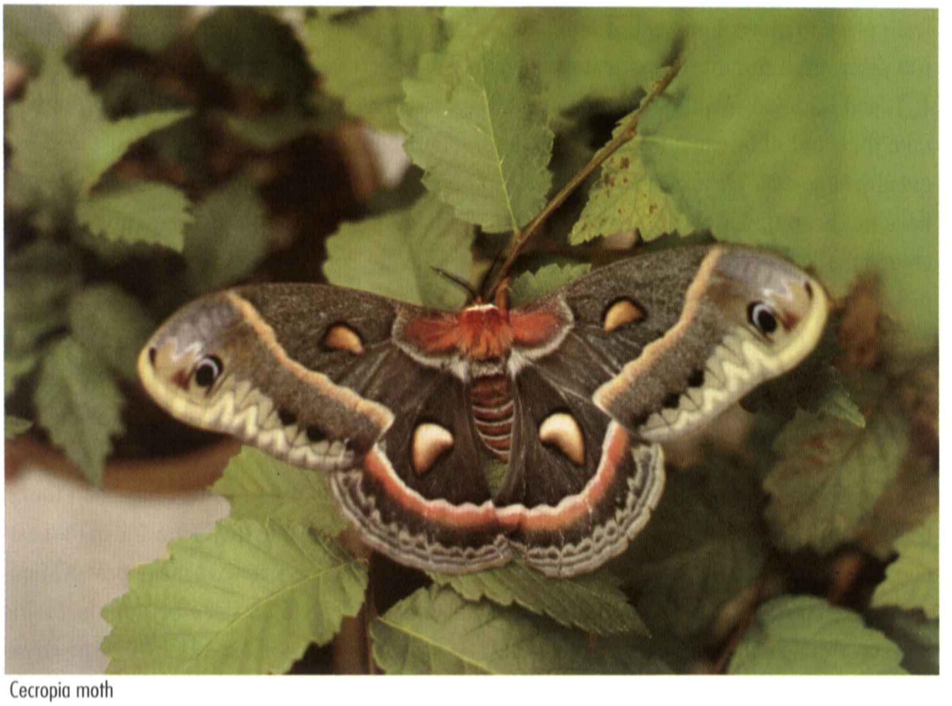
This mapleworm overwinters in the pupal stage in the ground litter. The adult moths, gray with a white streak at the leading edge of the forewing, emerge from the pupae over an extended period in summer and, after mating, the female lays her eggs in clusters on the foliage. The larvae usually feed in groups and may be present on the trees from July to late September. When full grown they are about 40 mm long with three black lines on the back and a posterior orange hump. The larvae spin silk-lined cocoons between two leaves on the ground, change to pupae, and overwinter.

Late season feeding by the orangehumped mapleworm is usually not too serious unless infestations persist over a number of years or if other early feeding insects are also present. In Quebec, local infestations on sugar maple were terminated mainly by a naturally occurring bacterial disease. Elsewhere, where host trees had been denuded of foliage, starvation, as well as parasites, helped control the outbreak. Consequently, control measures are probably rarely necessary. For aesthetic reasons, clusters of larvae on trees around the home should be handpicked if possible or a bacterial insecticide should be applied while the caterpillars are small.

The cecropia moth ( page 108), *Hyalophora cecropia* (Linnaeus), has been found from the Maritimes to Alberta and in the eastern United States. It was a major pest of Manitoba maple in farm shelterbelts in the Prairie provinces from 1927 to the 1940s. The larvae also feed on a wide variety of other hardwoods.

This insect overwinters as a pupa in a cocoon on a twig. The large showy adult moth, one of the largest in North America, may achieve a wing spread of more than 15 cm. It emerges from its cocoon between May and mid-July. Eggs are laid in groups of 3 to 30 on the undersurface of leaves. Larvae ( page 105) are present on the trees from late June to late September and when full grown, about 90 mm long, they spin gray to brown spindleshaped cocoons with pointed ends. The cocoons are formed lengthwise on a branch or stem, often less than a metre above ground level.

Disease has been the most important natural control factor in checking past epidemics. Parasites, and insect, bird, and rodent predators also help to control the numbers of this large and potentially damaging insect, so


Cecropia moth

that chemical control measures are seldom warranted.

The American dagger moth (□ page 105), *Acronicta americana* (Harris), is found across Canada east of the Rocky Mountains and throughout the eastern United States. However, serious feeding injury has been recorded in only a few isolated instances on shelterbelt trees in Saskatchewan in the 1940s. Manitoba maple is apparently the preferred host tree but other maples, birch, and other deciduous trees are also fed upon.

This insect overwinters as a pupa in the ground litter in a cocoon of silk and hair. The large gray adult moths emerge from the cocoons in early summer and the larvae feed, usually singly, on the foliage from July to September. The long pale hairs of the larvae vary from yellow to white. The head and long "hair pencils" are black. The full-grown larva is about 37 mm long.

The forest tent caterpillar (□ page 105), *Malacosoma disstria* Hübner, is a major pest of trembling aspen, sugar maple, oak, and many other deciduous trees in North America. This insect is described in detail on page 21.

The saddled prominent (□ page 105), *Heterocampa guttivitta* (Walker), is a major pest of beech, maple, birch, and other tree species. This insect is discussed in detail on page 257.

# Loopers

Fall cankerworms, p. 110

Bruce spanworm (pale type), p. 111

Linden looper, p. 112

Lesser maple spanworm, p. 112

Elm spanworm, p. 113

Redcheeked looper, p. 114

**Other loopers found on maple:**
**Hemlock looper, page 69**
**Maple spanworm, page 69**
***Plagodis alcoolaria*, page 69**
**Winter moth, page 146**
**Spring cankerworm, page 177**
**Pepper-and-salt moth, page 199**
**Spiny looper, page 234**

The fall cankerworm (page 109), *Alsophila pometaria* (Harris), periodically reaches epidemic proportions throughout its range in North America. It occurs commonly from the Maritimes south to North Carolina and west to Alberta, Montana, and Missouri. In Quebec and Ontario its distribution more or less coincides with that of basswood, one of its favored host trees. In the prairie region it is a serious pest of shelterbelt plantings, particularly Manitoba maple. It also feeds on elm, oak, ash, other maples, and fruit trees, as well as many other trees and shrubs. Shade trees in urban areas seem to be particularly susceptible to heavy feeding and can consequently suffer serious damage. Large numbers of larvae dropping on silk threads are particularly annoying in recreational areas.

The fall cankerworm overwinters in the egg stage on the tree and hatches in late April or early May. Larvae initially skeletonize the young leaves but later they consume all but the midrib or larger veins of the leaf. The larvae are quite variable in color and markings. When full grown, about 25 mm long, they are usually striped green or blackish but a few may be mainly pale green or with a lateral row of dark spots. A small third pair of legs at the posterior end helps to distinguish this species from most other loopers. The larvae usually complete their feeding by the end of June and drop to the ground, where they change to pupae in cocoons in the soil. The gray moths, winged males and wingless females, emerge from the

Fall cankerworm eggs

cocoons in October or November. After mating, the female climbs the nearest suitable tree and lays her eggs in a compact area in uniform rows and in a single layer on twigs and branches. There is one generation each year.

Many contact or stomach insecticides are registered for use against cankerworms. Among them are the bacterial insecticides, which are highly selective and not harmful to beneficial insects, birds, or mammals. They are, however, slow acting and must be applied while the larvae are still quite small. Another environmentally safe control, where only a few trees are involved, is the placing of bands of commercially available sticky material around the trunk in the fall. This will trap the females as they climb the tree to lay their eggs.

The Bruce spanworm (page 109), *Operophtera bruceata* (Hulst), is a periodic defoliator of a variety of trees, with a preference for maple, beech, and aspen. It has a transcontinental distribution in Canada, and in the northern United States is found from Wisconsin to the Atlantic Ocean. Severe infestations, ranging in size from small discrete pockets of a few hectares to thousands of square kilometres, usually last 2 to 3 years and then collapse. In eastern Canada a number of other loopers often feed concurrently on maple, beech, and other associated hardwoods. In western Canada, aspen has been the primary host and in recent years infestations on that host have also been reported in Ontario and Quebec.

Overwintering orange eggs are found singly or in small groups, mostly in lichens or bark niches on the lower trunk but also on larger branches. The egg color changes to gray as development proceeds in the spring, generally as the buds are opening. On hatching, larvae climb the tree. If they are disturbed they often spin down from the tree on silken threads and, if the threads break, they may be carried for long distances by wind. This is the main

Bruce spanworm eggs

Bruce spanworm feeding

means of dispersal for the species, as the female is wingless. Early larvae are uniformly pale yellow green. Some later instars remain pale green, others turn dark brown. All have distinct white lines on the back and sides. Feeding continues for 5 to 7 weeks and then the larvae drop to the ground and form pupae in cocoons composed of silk, soil, and humus particles. The pupal stage lasts until after the first heavy frosts in the fall. The winged, gray males may often be seen after there is snow on the ground. The drab wingless females crawl up the tree to mate and lay their eggs.

Although a large number of parasite species attack the spanworm in the egg and larval stages, and predators take their toll, a virus disease appears to be the most important factor in the collapse of outbreaks. In the case of isolated individual trees, a band of sticky material placed low on the trunk in the fall would capture females as they climb the tree and thereby reduce the number of eggs laid.

The linden looper (page 109), *Erannis tiliaria* (Harris), occurs from Newfoundland west to central Alberta, except for northern Ontario from Wawa to the Manitoba border. It is also reported in the northern half of the United States from the Atlantic coast to the Rocky Mountains. In Canada, short-lived epidemics of this looper have occurred occasionally on sugar maple and other hardwoods in the east and on Manitoba maple in shelterbelts on the Prairies. Where it grows, basswood is perhaps the favored food tree but the foliage of most of our other hardwood species may also be eaten.

The linden looper overwinters in the egg stage on the tree. Hatching occurs in May or about the time the buds open and the larvae feed on the foliage until July. The larvae have rusty brown heads and yellow bodies with narrow blackish lines that vary in intensity of color. They are wasteful feeders, eating a leaf only partially before moving to another. When full grown, about 37 mm long, they crawl or drop to the ground and change to pupae in the soil. In Ontario and Quebec the adults, winged males and wingless females, emerge in October or November, often when there is snow on the ground. After mating, the female crawls up a tree, where she lays her eggs singly or in groups in crevices in the bark or in other convenient sites such as hatched eggs of other insects.

Because epidemics of the linden looper do not usually persist for more than 2 or 3 years, large-scale control measures have not been necessary. Naturally occurring virus and fungus diseases appear to be mainly responsible for the collapse of epidemics in the east. If control is required on trees around the home, the highly selective bacterial insecticides are effective provided that the foliage is sprayed in late May while the larvae are still small.

The lesser maple spanworm (page 109), *Itame pustularia* (Guenée), occurs from the Maritimes west to Sault Ste. Marie, Ontario. Epidemics of these spanworms have been reported from New Brunswick and Maine, and lesser numbers occasionally from Quebec and Ontario. The primary host is red maple but the larvae will feed on other maples as well.

The spanworm overwinters in the egg stage and the larvae feed from mid-May to early


Linden looper male moth


Linden looper female moth


Linden looper eggs

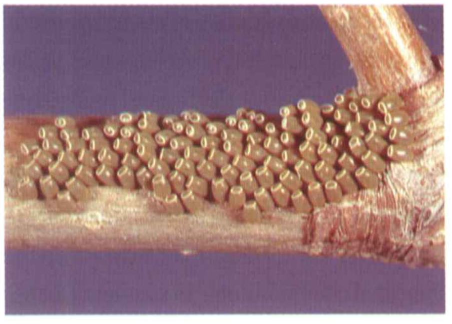
August. The full-grown larva, about 20 mm long, is pale green, later changing to pink. It usually drops to the ground to change to a pupa in the ground litter. The white moths, with faint orange-brown lines across the wings, are in flight from July to September. The eggs are laid singly on the tree bark, on lichens on trees, or in the litter.

For control of the lesser maple spanworm one of the highly selective bacterial insecticides would be effective if applied against young larvae in late May and early June.

Although the elm spanworm (page 110), *Ennomos subsignaria* (Hübner), is known to occur from Nova Scotia to Saskatchewan, it has appeared commonly only in southern Quebec and southeastern Ontario. However, epidemics of the spanworm have occurred throughout the eastern half of the United States. Although it is a general feeder on the foliage of a wide variety of deciduous trees, in Canada it is found most often on sugar maple, oak, elm, and basswood.

The elm spanworm overwinters in the egg stage on the tree. The eggs hatch about the time the buds burst and the young larvae chew small holes from the underside of the leaf. Later the larvae eat most of the leaf, leaving only the midrib and the petiole. The mature spanworm is about 50 mm long and variable in color, frequently dull black, but often pale green, light brown, or rose. When feeding is completed, July or early August in Ontario, the larvae change to pupae in coarse net-like cocoons of silk usually spun on partially eaten leaves. In about 10 days the white adult moths emerge from the pupal cases and, after mating, the females lay their eggs in close irregular masses on the undersides of twigs and branches.

Large-scale control measures have not been required for the elm spanworm in Canada because populations fluctuate at relatively low levels. In the United States a number of parasites on eggs have played significant roles in the collapse of some widespread epidemics.


Elm spanworm eggs

The redcheeked looper (page 110), *Probole (=Hyperetis) amicaria* (Herrich-Schäffer), is found usually in low numbers from coast to coast in Canada, and in the eastern United States. It feeds on a wide variety of trees and shrubs and has been relatively abundant during epidemics of the saddled prominent in southern Ontario. In Ontario, the larvae feed in July and August. They vary in color from yellow or grayish to dull red, and are about 30 mm long when full grown. Winter is spent as a pupa in the ground. The adults are pale gray-brown moths with a dark angular border across the wing tips. Severe feeding injury by this insect is unknown.

# Leaf rollers and tiers

Primarily on sugar or red maple:

Greenish larva in typical leaf rolls .......................... Maple leafroller

or .......................... Maple-basswood leafroller

or .......................... Obliquebanded leafroller, page 29

or .......................... Lesser maple leafroller, page 116

Pale larva in blackish tube in pleated leaf.......................... Maple trumpet skeletonizer, page 116

Larvae with narrow dark stripes among leaves webbed together .......................... Maple webworm, page 117

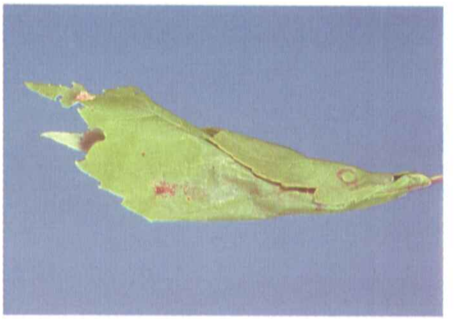
Green or red larva between two leaves tied one on top of the other .......................... Flat leaftier, page 153

Primarily on Manitoba maple (boxelder):

Green larva up to 20 mm long in leaf roll; eats leaves .......................... Larger boxelder leafroller, page 117

Pale larva up to 8 mm long in leaf curled at tip; does not chew through leaf .......................... Boxelder leafroller, page 119

Pale green larva usually with pink shade, up to 12 mm long, probably in small curl at edge of leaf; eats leaves.......................... Boxelder leafworm, page 119



Maple leafroller larva

Pupal chamber

Leaf rollers in the genus *Sparganothis* occur on maple over much of eastern North America but there is some question about the identity of the species involved. However, at this time the maple leafroller, *S. acerivorana* MacKay, is believed to feed almost exclusively on various species of maple, and large-scale epidemics have been reported in Quebec, and on sugar maple specifically in Wisconsin. The so-called maple-basswood leafroller (page 116), *S. pettitana* (Robinson), has occurred in epidemic numbers on sugar maple and basswood in Quebec and Ontario.

Although the biology of the two species is essentially similar, the following account applies particularly to the maple leafroller. There is one generation a year and the eggs overwinter on the tree and hatch in early spring. The young larvae feed initially in swollen buds and later,

Maple leafroller

Maple-basswood leafroller

in May and June, construct loosely conical leaf rolls from which they emerge to feed on surrounding foliage. When the larva is full grown, about 23 mm long, it changes to a pupa in a purse-like chamber (page 115) inside the rolled leaf. The moths emerge from late June to early August, and after mating, the female lays her eggs singly on twigs and small branches.

The lesser maple leafroller, *Acleris chalybeana* (Fernald), is found occasionally in Quebec and Ontario. It also occurs in the northeastern United States and has, in conjunction with other defoliators, caused serious injury to sugar maple in Wisconsin. Young larvae hibernate on the tree and in the following year feed inside leaf rolls from June to early August. Larvae

Lesser maple leafroller

are pale green with black spots on either side of the thorax. When full grown, about 22 mm long, they change to pupae in cocoons made of silk and excreta in the leaf rolls. The small gray adult moths emerge in the fall.

If control measures are required for any of these leaf rollers on trees around the home, the leaf rolls with the larva inside should be picked and destroyed. If groves of maples are threatened, a forestry specialist should be consulted for appropriate action.

The maple trumpet skeletonizer, *Epinotia aceriella* (Clemens), is probably found throughout the range of its principal host tree, sugar maple. Epidemic numbers have occurred in southern Quebec, southern Ontario, and the northeastern United States. Although sugar maple appears to be the preferred species, large numbers are occasionally found on red maple.

This insect overwinters as a pupa on the ground. The small gray moths emerge from June to mid-July and, after mating, the female lays her pale, flattened eggs in a random fashion on the undersurface of leaves. The eggs hatch in 4 or 5 days and the larvae feed on the undersurface layers of the leaf between two major veins. The larva constructs a tube of excrement and silk into which it can retreat, and covers the area around the tube with a finely woven sheet of silk. The silken canopy draws the veins together, giving the leaf a crumpled or pleated appearance. In late August or September, when the pale larva is full grown, about 14 mm long, it drops to the ground where it constructs a cocoon between two leaves. The cocoon is formed by cutting ovoid pieces from each leaf

Maple trumpet skeletonizer larva

Maple trumpet skeletonizer damage

and fastening them together with silk. The larva changes to a pupa in the cocoon, completing the life cycle.

Control measures for this insect are rarely necessary. On trees around the home, the skeletonized leaves, with larvae in their protective tubes, can be handpicked and destroyed before they drop. Another method would be to rake and destroy all leaves under affected trees in the fall.

The maple webworm (page 118), *Tetralopha asperatella* (Clemens), is found in Nova Scotia, southwestern Quebec, southern Ontario north to North Bay, and the eastern United States as far south as Florida. It has been of little concern in Canada to date but large numbers have been reported on maple in Wisconsin.

The webworm overwinters as a larva in a white silken cocoon in the soil, changing to a pupa in the spring or early summer. The gray moths emerge between late June and late August and lay their eggs in leaves rolled or tied by other insects feeding earlier in the season. The young larvae feed for a while in the initial oviposition site, and later web together and feed on surrounding leaves. Larvae may be found on the tree from early July to October. They are mottled and striped, vary in color from pale yellow to greenish or brown and are about 20 mm long when full grown. The larvae return to the soil to complete the life cycle.

Many parasites and predators are known to attack the maple webworm and these no doubt help to keep them in check.

The larger boxelder leafroller (page 118), *Archips negundana* (Dyar), is a common pest of Manitoba maple (boxelder) in Manitoba and Saskatchewan. It has also occurred in British Columbia and in recent years has defoliated trees (page 118) in urban areas on the north shore of Lake Huron in Ontario. It is distributed widely in the United States.

This leafroller overwinters in the egg stage on the tree. The larvae apparently hatch at about the time the new leaves appear on Manitoba maple. They feed throughout early summer and roll and web leaves together. The

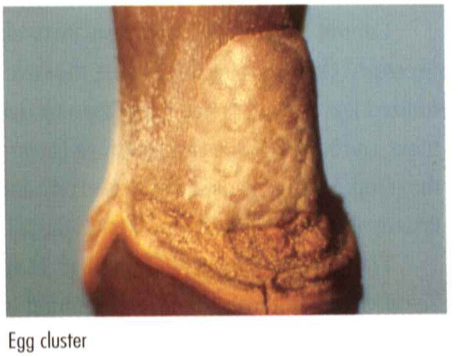

Maple webworm — webbed leaves


Larger boxelder leafroller damage


Maple webworm larva


Larva

larvae are green, and about 20 mm long when full grown. When feeding is completed in June or July, they change to pale green pupae in leaf rolls or shelters, and the pale brown and white moths emerge a little later. After mating, the female lays her eggs in flattened groups of 6 to 48 in forks of branches or in crevices in the bark.


Egg cluster

Boxelder leafroller*

Boxelder leafworm

* Photo courtesy of the Indian Head Tree Nursery, Department of Regional Economic Expansion, Canada.

This leafroller has not caused serious lasting injury to Manitoba maple; in fact, trees defoliated in 3 consecutive years have refoliated with no apparent injury. The insect can, however, be a considerable nuisance on trees around homes.

The boxelder leafroller, *Caloptilia (=Gracillaria) negundella* (Chambers), occurs throughout the range of Manitoba maple in North America. Large numbers have been reported occasionally in shelterbelts in the Prairie provinces but the insect does not appear to be a serious threat to Manitoba maple.

There are apparently two generations of this leafroller each year and larvae may be found on the foliage from mid-May to mid-September. The young larvae at first feed between layers of the leaf, forming narrow, contorted, linear mines. Soon the mine is abruptly widened to form a flat blister, usually less than a square centimetre in area. At this stage the young larva vacates the mine and moves to the tip of one of the lobes, which it turns back upon the lower surface and attaches in that position with silk. This becomes the shelter in which the larva feeds on the inner layers of the leaf, leaving the outer cuticle intact. When the larva is full grown and probably about 8 mm long, it spins a tough whitish cocoon inside the feeding shelter, and changes to a pupa. The adult insect is a tiny moth with very narrow forewings.

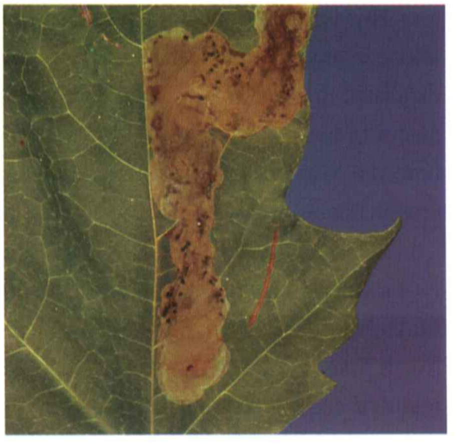
Control of this insect with insecticides would be difficult because the larva is concealed most of the time.

The boxelder leafworm, *Chionodes obscurusella* (Chambers), is found from Quebec to Alberta and in the northeastern United States west to North Dakota. Little is known about this insect but in Ontario it is an occasional serious pest of Manitoba maple in urban centers. It is also known to feed on other maples.

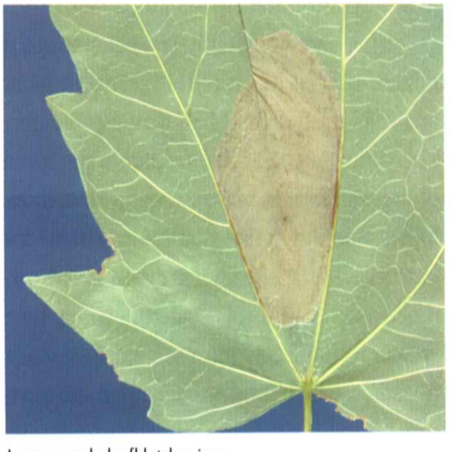
In Ontario, larvae have defoliated trees in June and early July. The larvae are pale green,

# Leaf miners

often suffused with pink, and about 12 mm long when full grown. The adults are small gray moths with narrow wings.



Maple leafblotch miner



Lesser maple leafblotch miner

Three leaf miner species are found on maple; the maple leafblotch miner, *Cameraria (=Lithocolletis) aceriella* (Clemens), is the most common. It is found from New Brunswick to Sault Ste. Marie, Ontario, and in the northeastern United States. Severe mining of leaves of young sugar and red maples has occurred in southern Quebec and southern Ontario. The insect has also been abundant on young mountain maple north of Sault Ste. Marie, Ontario, and occasionally feeds on Manitoba and striped maples.

The small flattened larvae feed in mines in the layer of cells beneath the upper surface from July to September. When feeding is completed they change to pupae in circular flat cocoons in the mine and overwinter there. The adults are tiny reddish-brown moths with narrow silver bands across their wings.

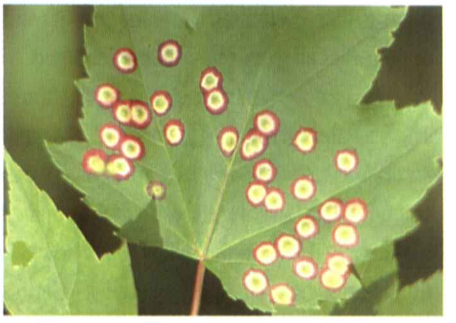
The lesser maple leafblotch miner, *Phyllonorycter (=Lithocolletis) lucidicostella* (Clemens), is found occasionally on sugar maple in eastern and southern Ontario and in the northeastern United States. The mines are small, flat whitish blisters on the undersurface of the leaf. Larvae are present in the mines from July to September. They change to pupae in the mines.

The young larvae of the boxelder leafroller, *Caloptilia negundella* (Chambers), initially construct linear mines in the leaves of Manitoba maple in western Canada. Later the larvae vacate the mines and fold the tips of leaves (page 119).

Control measures have not been necessary for any of the above leaf miners on maple. However, mined leaves found on young recently planted trees should be picked and destroyed.

# Midges and mites

* Photo courtesy of L.F. Wilson, North Central Forest Experimental Station, USDA Forest Service, East Lansing, Mich.



Ocellate gall midge

Gouty vein midge

Boxelder leaf gall midge*

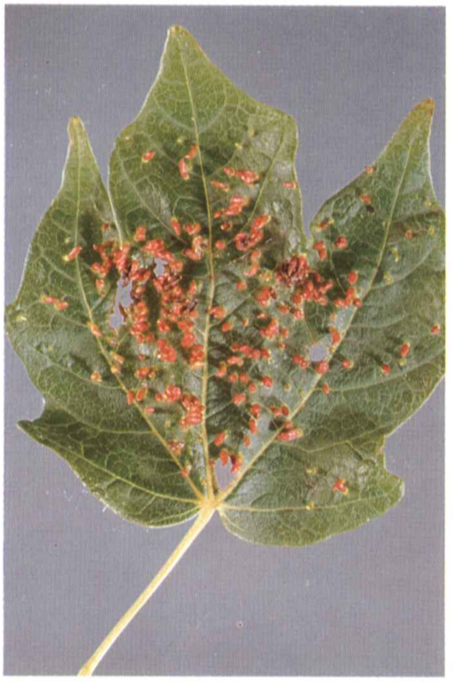
Both midges and mites cause surface eruptions or spots known as galls on the leaves of maple. Most of these gall formers are quite specific, both in the species of tree and the part of the tree they attack. The injured area of the leaf is often a conspicuous yellow or reddish color. Neither the midges nor mites have caused significant injury to date, even though in some years it would appear that all leaves have been damaged.

Three common midge galls are illustrated. The ocellate gall midge (page 121), *Acericecis ocellaris* (Osten Sacken), causes a very conspicuous leaf discoloration on red and sugar maples. By the time the gall is seen, however, the tiny midge larva, which occupies a depression in the lower leaf surface, has usually fallen to the ground. The gouty vein midge (page 121), *Dasineura communis* Felt, is responsible for a green to red pouch gall with an opening on the leaf upper surface, formed usually in the larger veins of Manitoba, sugar, and red maples. These galls have occasionally been abundant on maple in the United States. A very similar gall is made on the leaves of silver maple by the midge *D. aceris* (Shimer). The boxelder leaf gall midge (page 121), *Contarinia negundifolia* Felt, is a pest of Manitoba maple. It is probable that all these galls occur wherever the host tree is naturally present.

All these midges probably have a single generation a year and spend winter in a cocoon in the soil. The tiny two-winged adult midges emerge in the spring and lay their eggs in the developing leaves, where larval feeding and development occur. It is unlikely that control measures will ever be necessary, even for aesthetic reasons, as the amount of leaf tissue affected will be tolerable.

Three of the most common mite galls on maple are illustrated: the maple bladdergall mite, *Vasates quadripedes* (Shimer), on silver and red maples; the maple spindlegall mite, *Vasates (=Phyllocoptes) aceris-crumena* (Riley), on sugar maple; and the red pile mite, *Aceria elongatus* (Hodgkiss), which causes felt-like patches, called erinea, in different colors on either the upper or lower surface of the leaves of various maples. Although there are some variations in the life cycles of these mites, a generalized cycle is as follows. The microscopic adults, less than 0.2 mm long, overwinter in niches on the trunk and branches. Soon after the leaf buds begin to expand the adults move to the leaves and, feeding there, initiate abnormal cell development; as a result the female becomes enclosed in a characteristic structure. Eggs are laid in these protected places; they hatch, feed through two larval stages, and reach the adult stage in a matter of weeks. These


Maple bladdergall mite



Maple spindlegall mite

Red pile mite

adults leave the gall through the hairy opening and may initiate other galls as long as suitable developing tissue is present. As mites are usually very prolific, large numbers of galls may be formed. On the other hand, there must be tremendous losses because the number of galls fluctuates widely from year to year. Except in young or newly planted trees, the loss of leaf surface is generally insignificant, and control measures are unwarranted. If the need arises, early handpicking of damaged leaves, which are frequently most common on the lower branches, will help to keep populations down. If it is desirable to prevent damage, a systemic insecticide applied in spring or early summer will kill the mites in the gall but the galls themselves will remain.

# Aphids, leaf hoppers, and plant bugs

Oval or pear-shaped insects 4 mm or less in length, usually feeding in groups, relatively slow moving. Adults with mainly clear wings .............................................. Aphids

Slender, elongate insects 3 to 10 mm long, very active. Adults with opaque wing covers.................................... ................................ Leaf hoppers, page 125

Red and black nymphs less than 10 mm long causing mottling of leaves on Manitoba maple.............................. ............................... Boxelder bug, page 138


Woolly alder aphid


Norway maple aphid

A large number of aphid species feed on maple. Although they are not considered important in the forest, their presence on or injury to trees around homes often creates concern. Damage is usually sporadic with high populations for a year followed by many years with no sign of the aphids.

Of all the aphids on maple none is more spectacular than the woolly alder aphid, *Prociphilus tessellatus* (Fitch), which moves from alder to silver maple. Its common name is derived from the wool-like waxy filaments that are extruded from its body. The insect overwinters in the egg stage on the bark and the young aphids move to the leaves shortly after they have expanded. Throughout early summer large colonies, produced asexually, are conspicuous in partially curled leaves because of the copious quantities of woolly material extruded. In midsummer the winged adults fly to alder branches where they reproduce asexually. A number of generations may develop on alder, and these are also covered with waxy material. In the fall the sexual forms fly back to maple to lay their eggs and complete the life cycle. As the aphids feed on sap drawn from the trees they excrete large quantities of a pale liquid known as honeydew. Ants, often in large numbers, feed on the honeydew and a sooty mold may develop on leaves with aphid excretions.

The Norway maple aphid, *Periphyllus lyropictus* (Kessler), periodically causes severe leaf drop in the summer as a result of its feeding,

* Photo courtesy of H.F. Cerezke, Northern Forestry Centre.

especially on Norway maple but also on other maples. The honeydew excreted by the aphids will make everything it contacts sticky and when it dries, contacted objects will have a glazed appearance. The development of a black sooty mold on the honeydew adds to the unpleasantness. The colonies of these pale brown aphids, which feed on the leaves in early summer, are often not noticed until the fallen leaves draw attention to the problem. By that time it is usually too late to apply controls.

A closely related species, the boxelder aphid, *P. negundinis* (Thomas), is a common pest of Manitoba maple, especially in the Prairie provinces. This aphid feeds on new shoots as well as leaves but in other respects injury is similar to that caused by the Norway maple aphid.

The boxelder psyllid, *Cacopsylla negundinis* (Mally), feeds on Manitoba maple in the Prairie provinces and the north central United States. It was a common pest during the late 1940s.

A number of other aphids in two genera, feeding on maple throughout its range, occasionally occur in large numbers and cause discoloration and early fall of leaves. As with

Boxelder aphids*

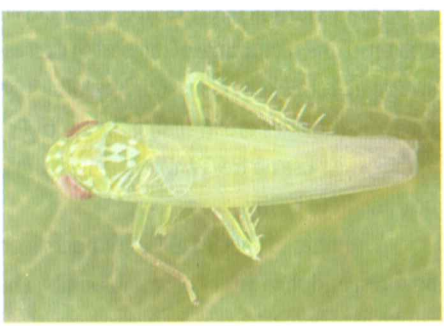
Progressive leaf discoloration by *Drepanaphis* species

other aphids considerable honeydew may be excreted. The painted maple aphid, *Drepanaphis acerifoliae* (Thomas), is widespread and feeds mostly on sugar maple in Ontario. The sycamore maple aphid, *Drepanosiphum platanoides* (Schrank), feeds primarily on the introduced Norway and sycamore maples.

Serious lasting injury to trees by aphids is unknown and recurrence of the pest in successive years is unlikely. Consequently, although many insecticides are available for control of aphids, their use on trees around homes would be difficult to justify.

A number of species of leaf hoppers feed on forest and shade trees of various kinds. The adults are usually less than 10 mm long. Both nymphs and adults have piercing and sucking mouth parts and feed by extracting sap from the leaf. They are very active and are readily dislodged from the host plant. Heavy leaf feeding initially causes leaf stippling and, in young leaves, curling and browning. Injury is also caused by the females of some species as they cut slits in new shoots in which to lay their eggs. Many species of leaf hoppers act as vectors of

Leaf stippling by leaf hoppers



Potato leafhopper

*Typhlocyba albicans*

organisms that cause plant diseases. In the forest, however, feeding by leaf hoppers is seldom serious and usually does not recur the following year.

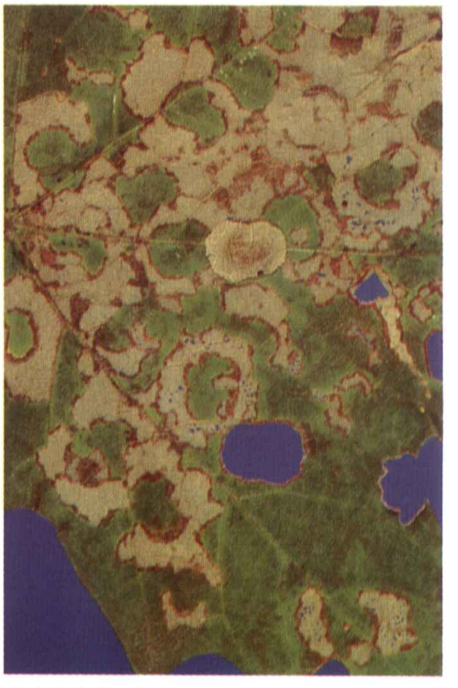
Recently the potato leafhopper , *Empoasca fabae* (Harris), a common agricultural pest, was implicated in damage to nursery grown trees, especially maple and oak. This tiny species, less than 4 mm long, arrives in Canada periodically when atmospheric conditions are favorable for migration from the south. Fortunately, the insects do not survive our Canadian winters.

The leafhopper *Typhlocyba albicans* (Walsh) has caused localized severe discoloration of red maple foliage in July in northeastern Ontario. The tiny adult is about 4 mm long.

# Maple leafcutter

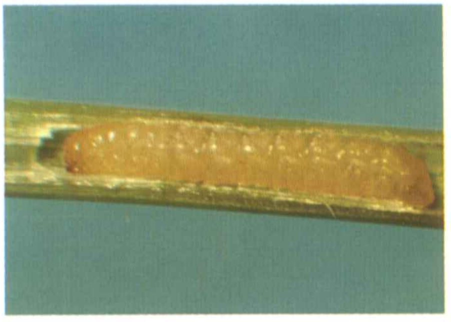
The maple leafcutter, *Paraclemensia acerifoliella* (Fitch), is a small insect with distinctive feeding habits, found on sugar maple in southern Quebec, southern Ontario west to Sault Ste. Marie, and the northeastern United States. In Canada, prolonged epidemics of the leafcutter have occurred in southern Quebec and southeastern Ontario. Sugar maple and black maple are the primary host trees but when the insect is numerous it will be found on other trees such as red maple, beech, ironwood, and elm.

The maple leafcutter overwinters as a pupa on the ground, inside its previously portable larval case. The tiny adult moths, with somewhat iridescent steel blue front wings and a yellow head, emerge from the cases in May when the leaves are unfurling. The eggs are laid singly in minute pockets cut into the tissue on the underside of leaves. Hatching occurs in about 18 days and the young larvae spend the first part of their lives feeding in mines in the inner leaf tissue. The larva completes its mining phase shortly after the first molt, but before leaving the mine it cuts a pair of oval disks, one from the lower surface of the mine and the other directly above it on the upper surface. The larva ties the two disks together with silk to form a portable case, which it positions on the upper surface of the leaf; it then feeds on the nearby upper layer of cells. The larva moves its case periodically to new feeding sites and after each molt usually cuts another oval disk from the leaf to add to its case, causing typical damage to the leaves. In late August or September the full-grown larva, now about 6 mm long, drops with its case to the ground and changes to a pupa inside.


Maple leafcutter damage

If large-scale control measures are being considered, the advice of a forestry specialist should be sought.

# Maple petiole borer



Maple petiole borer

Damaged leaf petioles

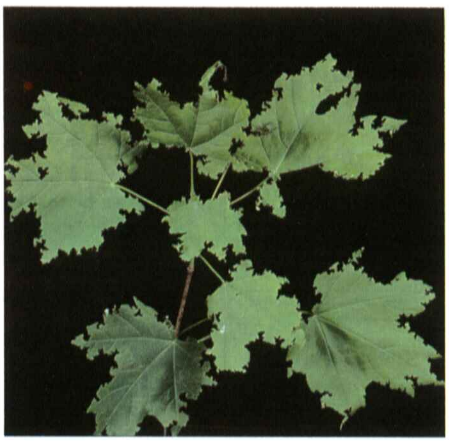
The maple petiole borer, *Caulocampus acericaulis* (MacGillivray), occurs occasionally on sugar maple in central and southern Quebec, southern Ontario west to Sault Ste. Marie, and the northeastern United States.

This insect overwinters as a larva in a cell in the soil. The adults, tiny relatives of the wasps, known as sawflies, emerge from the soil in May and lay their eggs near the base of the petioles of sugar maple leaves. In June the larvae tunnel in the petioles until they break, usually near the leaf blade. When the insect is abundant, the ground under infested trees is strewn with green leaves, most of which have no petiole or stem, or at most a very short one. The larva does not fall with the leaf but continues feeding in the now leafless petiole for about a week; it then falls to the ground inside the petiole and burrows 5 to 8 mm into the soil, where it overwinters.

Control measures have not been required for the maple petiole borer. On trees around homes the presence of the insect would be indicated by green leaves with very short petioles on the ground in June. The leafless petioles on the trees or on the ground, with the larvae inside, can be picked and destroyed.

# European snout beetle

European snout beetle



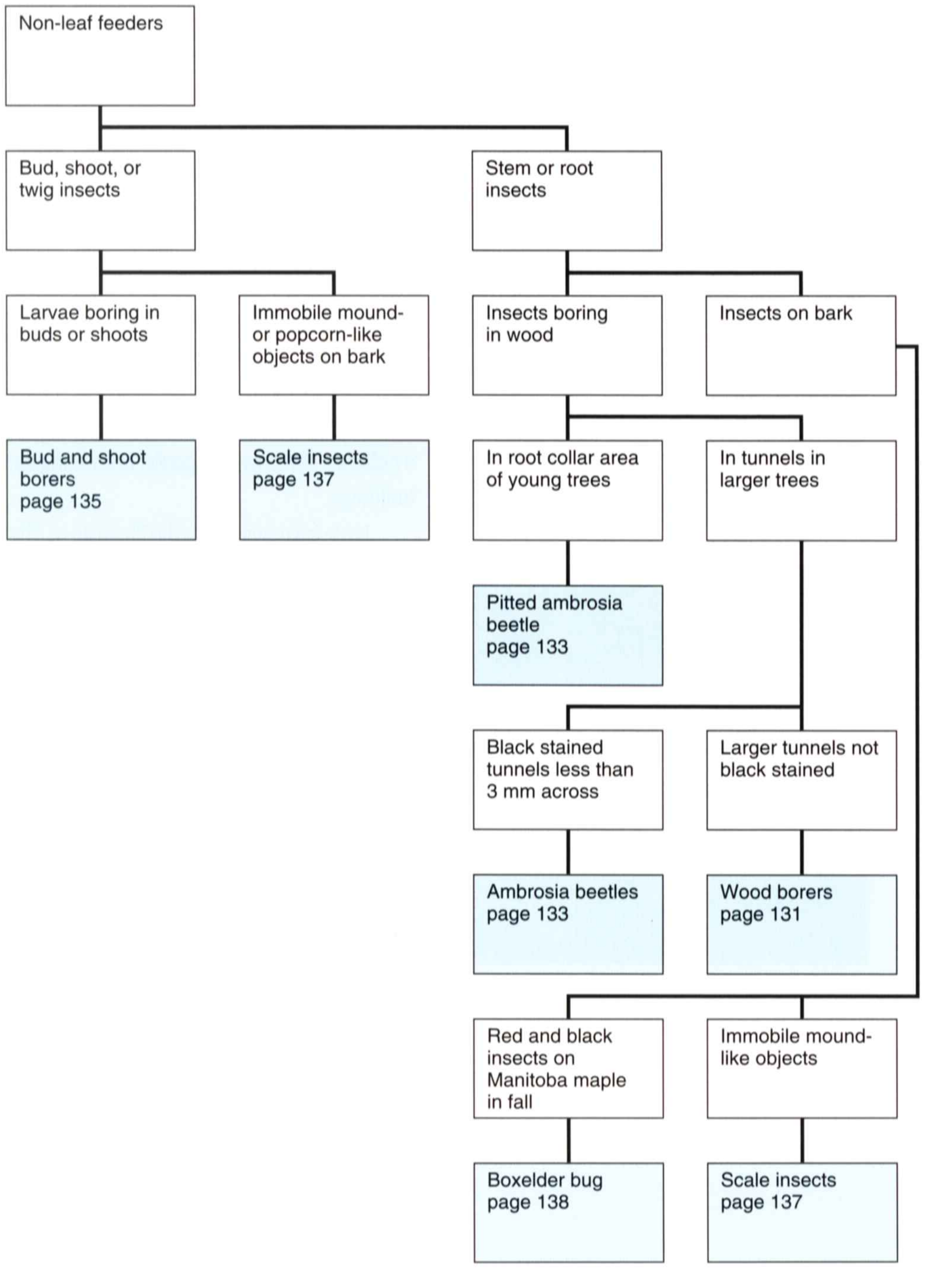
Leaf edge feeding

The European snout beetle, *Phyllobius oblongus* (Linnaeus), is a small introduced weevil that was first found in New York State in 1923 and now occurs east of Ohio and in Ontario south of a line from North Bay to Sault Ste. Marie. It is a common feeder, especially on leaves but also on buds of many trees, both broad-leaved and coniferous. In some instances extremely high populations on trees around homes have created a nuisance as the weevils persist in entering the buildings.

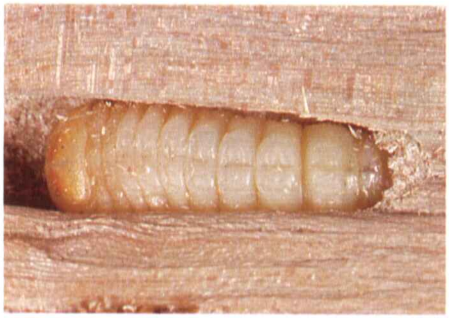
Little is known about the life history. The adults, brown with a narrow black neck and about 5 mm long, appear in the spring and cut notches in the leaf edge. By midsummer they have disappeared. It is believed that the eggs are laid in the soil and that the larvae feed on plant roots.

Attempts to control this weevil with insecticides have not been particularly successful to date. However, although they are a nuisance around homes, the need for control measures is unwarranted.

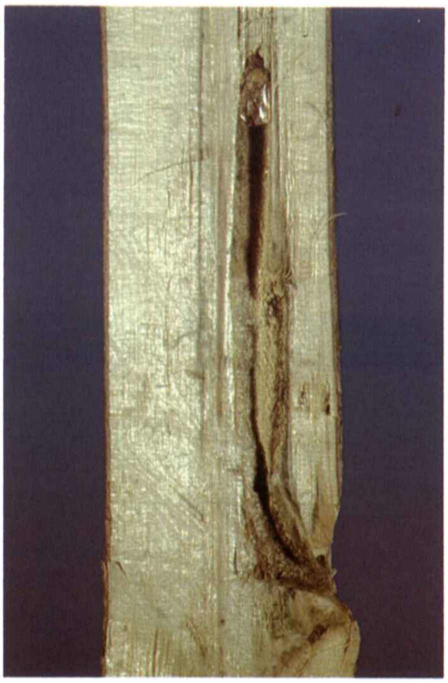
# Maple: non-leaf feeders



# Wood borers



Sugar maple borer



Gallmaking maple borer

**Other borers found in maple:**
**Carpenterworm, page 168**
**Pigeon tremex, page 189**

Several species of wood borers tunnel in living sugar maple trees in the forest, usually in low numbers. However, there have been instances, especially in uneven-aged stands, where large numbers of trees have been damaged by the sugar maple borer, *Glycobius speciosus* (Say). Another important borer, the gallmaking maple borer, *Xylotrechus aceris* Fisher, causes unsightly galls and tunnels in the heartwood, primarily in young maple stems. Although both these borers can kill trees, only infrequently do they cause extensive defects in the wood, thereby reducing its value. In the case of trees around homes, many of which may be under stress, feeding by these species can create unsightly scars (page 132) and hasten tree decline.

The larvae of both the above species spend their first year in the sapwood, and the life cycle apparently takes 2 years. The life history and habits of the sugar maple borer are as follows: the eggs are laid in midsummer, usually on the stem near wounds or scars. On hatching, the larva tunnels through the bark to the wood surface and feeds extensively in the sapwood (page 132). Winter is passed there and feeding is resumed the following year. Late in the season, the larva tunnels deep into the wood, constructs a pupal cell, and finally cuts an exit hole through which the adult will later emerge. Change to the pupa occurs in the spring and the adults emerge in early summer. The sugar maple borer larva, the larger of the two borers, is 50 mm long when full grown.

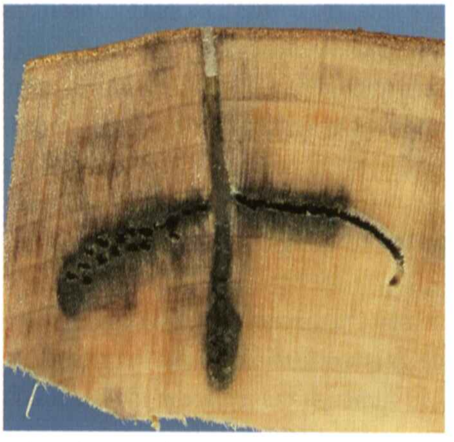
Extensive larval tunnels in the sapwood cause the covering bark to die and become cracked or swollen. In old wounds the bark breaks off and the exposed wood reveals the


Sugar maple borer scarred trunk


Sugar maple borer feeding damage

larval tunnels. Control of the borer is difficult in the forest. For trees around homes constant vigilance and the fumigation of active tunnels should provide protection.

# Ambrosia beetles



Ambrosia beetle tunnel

Pitted ambrosia beetle damage

Dying or recently dead maple trees may be attacked by many species of tiny beetles that tunnel deep in the wood of a wide variety of hardwoods. The tunnels, which go directly through the bark and into the wood, are deeply stained by the ambrosia fungus that develops in the wood on the sides of the tunnels. The fungal spores are carried by the adult beetles in special body organs found in one or both sexes, depending on the species of beetle. Both the adults and the larvae may feed solely on the fungus or on both wood and fungus. In any event there is a very close beneficial relationship between the insect and the fungus. The shape of the tunnels in the wood, and the location of the egg cradles, i.e. the short tunnels at right angles to the long central tunnel, are usually characteristic for the species.

Ambrosia beetles overwinter as adults in the wood tunnels or in the forest litter and emerge in the spring to seek suitable trees; they may attack more than one. Either the male or the female makes the tunnel. One generation is usually completed by midsummer.

Because many of the tunnels extend deep into the wood, its value is greatly reduced. However, as a high level of moisture is necessary for larval development, kiln-drying the wood will prevent additional damage. Chemical controls are not usually attempted.

The pitted ambrosia beetle, *Corthylus punctatissimus* (Zimmerman), is primarily a pest of young trees up to 12 mm in diameter. Although the beetle will feed on many hardwood trees and shrubs in southern Canada, appreciable damage is generally confined to maple. There are reports of other tree species commonly attacked as far south as Carolina.

The following account relates to southern Canada where there is one generation each year and winter is spent in the adult stage, mostly in the tunnels in which these adults developed. The adults, about 4 mm long, are in flight through much of the summer but the flight peak is in

Pitted ambrosia beetle in tunnel

late June. The beetles bore into the tree stems near ground level and tunnel deep into the wood, then form spiral tunnels that girdle the stem. The black fungal stain in the wood is a prominent feature of the tunnels. The males construct most of the tunnels, including the short dead-end cradles for eggs that run with the wood grain. After an egg is laid the beetle plugs the entrance to the cradle; the larva completes its development to the adult stage by September.

Although the impact of the beetles on maple regeneration may appear to be of some consequence in densely stocked stands, it may also be of benefit in thinning those stands. In open stands little mortality of young trees is reported.

# Bud and shoot borers

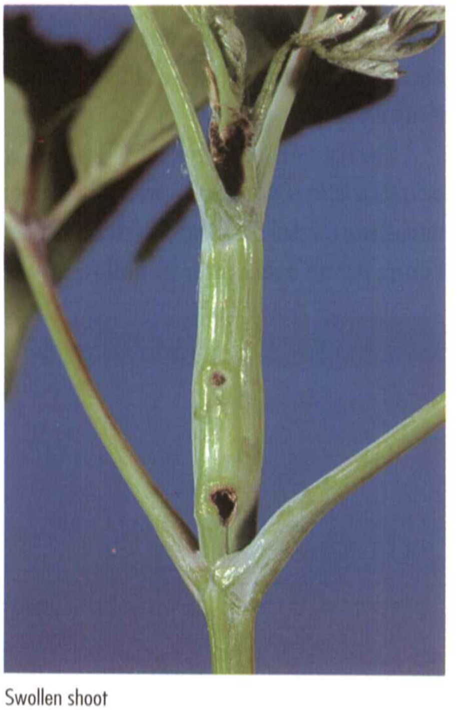
* Photo courtesy of Northern Forestry Centre.

Three members of the genus *Proteoteras* feed mainly in the buds and shoots of maple. The most common species is the boxelder twig borer, *P. willingana* (Kearfott), which occurs in damaging numbers on Manitoba maple throughout the host range. The maple shoot borer, *P. moffatiana* Fernald, has caused deformity by mining the buds of sugar maple trees, notably in Quebec and Michigan. The maple twig borer, *P. aesculana* Riley, feeds in leaf petioles, shoots, and seeds of maple throughout the host range, but is generally found in low numbers.

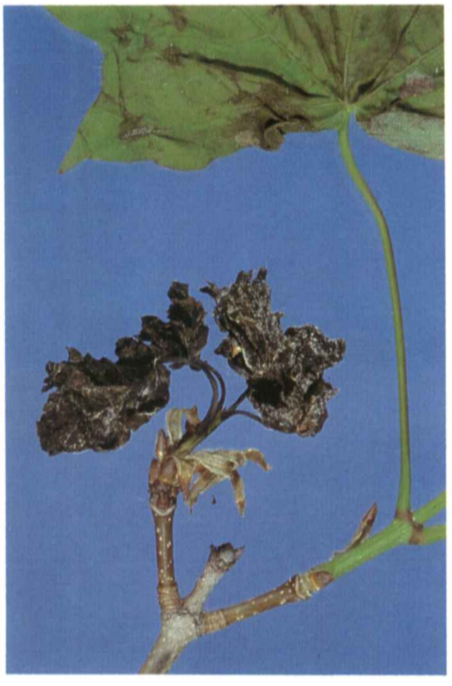
All bud and shoot borers mentioned above have one generation each year and pass the winter as larvae in mined buds. The life history of the boxelder twig borer is typical: on emerging in the spring the larvae may mine two or three other buds. Later they mine the developing shoots, causing a swelling. Dead leaves on new shoots also indicate damage by the borer. On completion of feeding, the larvae, about 12 mm long, drop to the ground and change to pupae. Adults emerge about mid-July and, following mating, the female lays her eggs singly, adjacent to larger veins on the lower surface of the leaf. On hatching, the larvae initially feed on the leaf under a web but as development proceeds they feed beyond the web. In August the larvae mine the base of a leaf petiole and then enter the bud in the leaf axil, leaving a webbed shelter as evidence of attack. Winter is passed in a silken cocoon inside the shelter.

Heavy attack by the boxelder twig borer causes trees to take on a very bushy appearance. Although there are numerous kinds of parasites,

Boxelder twig borer*



Swollen shoot



Hard maple budminer

reports of damage are common most years in the Prairie provinces. However, this twig borer is not likely to kill the tree.

The hard maple budminer, *Obrussa ochrefasciella* (Chambers), probably occurs throughout most of the range of the hard maples. Young larvae overwinter in hollowed-out axillary buds at twig tips and bore into the base of the terminal bud or shoot in the spring. In southern Ontario, the cream-yellow larvae are found in late May in a C configuration, partially girdling the new shoot at its base. Leaves at the end of infested tips are wilted and blackened as if injured by a heavy frost. When the larvae are full grown, about 6 mm long, they drop to the ground and change to pupae in small, flat, tan-colored cocoons on dead leaves in the ground litter. The tiny adult moths, with a forewing ground color of purplish black, emerge in late spring. The eggs are laid in a groove near the base of leaf petioles. As they hatch, the larvae bore back and forth through the petiole and later enter the axillary buds where they eventually overwinter.

The boxelder budgall midge, *Contarinia (=Cecidomyia) negundinis* (Gillette), commonly causes death of the terminal buds of shelterbelt trees on the Prairies. These tiny midges lay their orange eggs between the bud scales early in the spring. Following larval feeding, the buds become swollen but do not open and eventually turn black.

# Scale insects

Scale popcorn-like .................................................................. Cottony maple scale

Scale white to gray, somewhat pear-shaped .................................................................. Scurfy scale, page 55

Scale brown or red, round or oval mounds .................................................................. European fruit lecanium, page 186

Scale a miniature oystershell .................................................................. Oystershell scale, page 229

Cottony maple scale

The cottony maple scale, *Pulvinaria innumerabilis* (Rathvon), is a sporadic native pest, primarily of soft maple, probably wherever silver and Manitoba maples occur. Other maples and several additional tree species such as elm may also be infested when populations are high. Infestations, where the small branches may be covered with the cottony white egg sacs, are usually of 1 or 2 years' duration. However, little serious damage is reported other than branch mortality in severely weakened trees and blackened leaves caused by the sooty mold that develops in crawler excretions.

There is one generation a year. The immature female scales pass the winter on twigs and small branches. In Ontario, the females develop rapidly in early June and produce large numbers of eggs enclosed in a white cottony mass that causes the scale cover to rise. The eggs hatch in about 3 weeks and at the end of June the tiny crawlers begin to move out to the leaves where they usually settle along the prominent veins on the leaf undersurface. The nymphs molt once, increasing in size to about 1 mm long, the male becoming elongate and the female retaining the oval shape. Beginning in late August the female crawlers, after mating with tiny winged males, move from the leaves back onto the twigs and settle down for the winter.

Because infestations are often terminated by fly and beetle predators, which have voracious appetites for the scale eggs and nymphs, and by insects that parasitize developing females, control programs should be instituted only when these natural control organisms will not be harmed. As control is desirable primarily for aesthetic reasons, the situation should be assessed carefully before chemical insecticides are employed.

# Boxelder bug

Boxelder bug adult and nymph

The boxelder bug, *Boisea trivittata* (Say), is periodically a pest of Manitoba maple wherever that tree occurs. However, the damage to the tree is minor compared with the nuisance created by the insect's hibernation habits. In the fall, adults congregate in large numbers in sunny locations and then seek hibernation sites, often inside buildings where their presence is most annoying. Feeding by both the adults and the nymphs causes mottling and distortion of the leaves, particularly on seed-bearing trees, where high populations of this sucking insect occur.

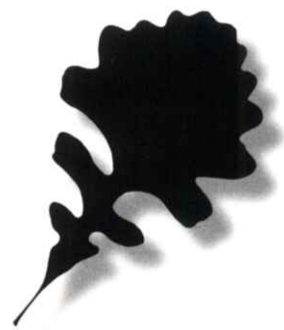
Two generations a year are likely, at least in southern Ontario and farther south. The overwintered adult, about 12 mm long, lays its reddish eggs in a variety of locations, often on grasses and weeds as well as on the host tree. Eggs, nymphs, or adults may be found on Manitoba maple in summer and into the fall.

Infestations of the boxelder bug are not of long duration but the cause of collapse is unknown. Control is desirable primarily because the insect is a nuisance. A number of insecticides are registered for use against it and are most effective against nymphs. As seed-bearing trees are preferred, it would be prudent to replace female trees with other species.

White

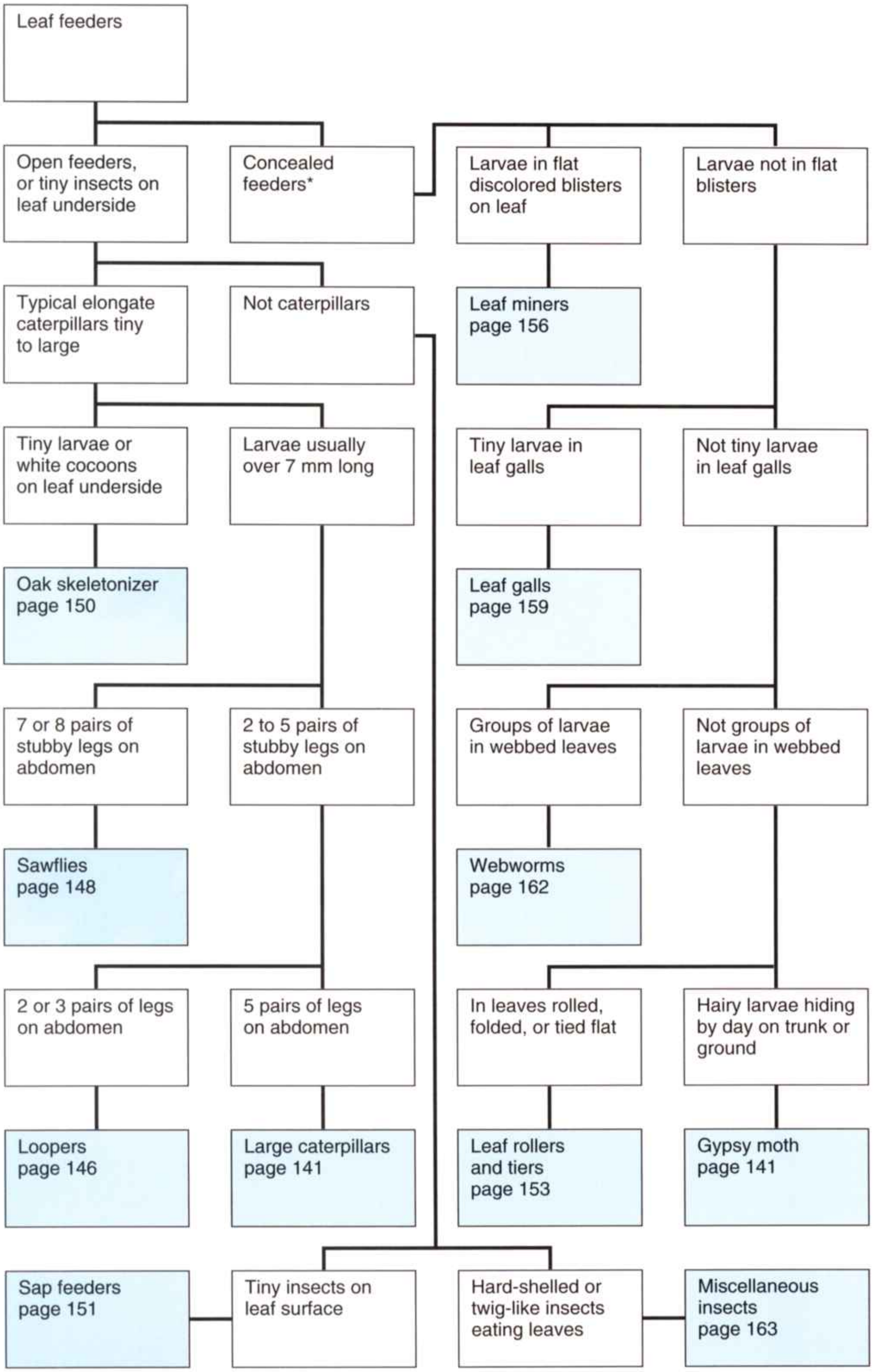
Red

Bur

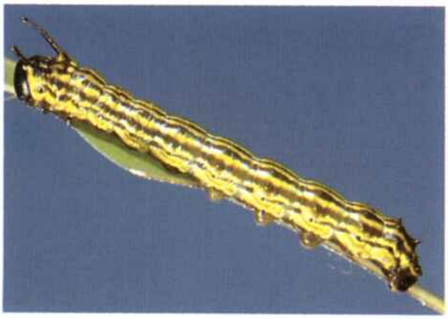


# Oak: leaf feeders

* Late stages of the gypsy moth feed at night.



# Large caterpillars



Orangestriped oakworm

Gypsy moth larva, p. 144

Shorthorned oakworm, p. 142

Lacecapped caterpillar, p. 145

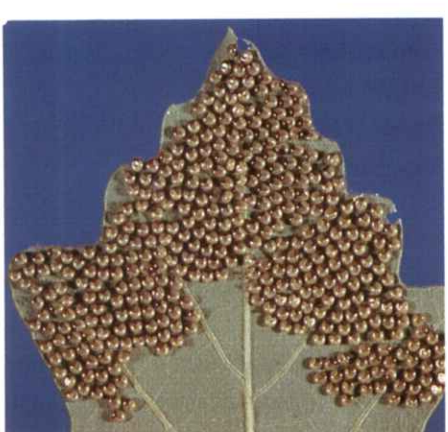
Pinkstriped oakworm, p. 143

Redhumped oakworm, p. 143

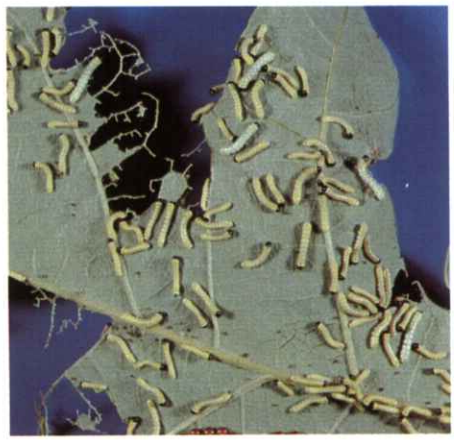
**Other large caterpillars found on oak:**
**Forest tent caterpillar, page 19**
**Speckled green fruitworm, page 19**
**Yellownecked caterpillar, page 71**
**Polyphemus moth, page 71**
**Yellowlined caterpillar, page 71**
**Pale tussock moth, page 71**
**Question mark butterfly, page 175**
**Hickory tussock moth, page 211**

The orangestriped oakworm, *Anisota senatoria* (J.E. Smith), occurs throughout most of the range of white oak in southern Ontario and the eastern United States. The larvae feed on all species of oak, although in Ontario outbreaks have occurred mainly on white oak and to a lesser extent on bur oak. Black oak is mentioned as one of the favored host trees in the United States. Outbreaks seem to occur consistently in the same general areas though often in different localities and in infestations of varying size from year to year.

The oakworm overwinters as a pupa in the soil and the moths emerge in June or July. After mating, the female deposits her eggs on the underside of leaves, usually in groups of 100 to 200 but occasionally more ( egg cluster of shorthorned oakworm). The eggs are usually laid on the lower part of the tree because the females are apparently not strong fliers. Young larvae feed in groups on the foliage in a manner similar to that of the shorthorned oakworm . They are initially greenish-yellow, but later acquire the black and yellow stripes typical of mature larvae. Older larvae scatter and eat entire leaves except the main vein. The prominent pair of "horns" behind the thoracic shield distinguishes this species from the succeeding species, which has shorter horns. When full grown in September, about 45 mm long, the larvae drop to the ground and change to dark brown pupae in the soil.



Shorthorned oakworm egg cluster



Shorthorned oakworm young larvae

A large number of parasites and predators attack eggs, larvae, and pupae of the orange-striped oakworm and generally help to terminate outbreaks. However, if large-scale outbreaks persist, forestry specialists should be consulted on the need for control. On shade or ornamental trees, leaves with groups of larvae can be hand-picked and destroyed in late July or early August. This method is quite feasible because the early larvae usually feed at the lower levels of the tree where the eggs were laid.

The shorthorned oakworm (page 141), *Anisota finlaysoni* Riotte, was for many years confused with the relatively longhorned orange-striped oakworm. This newly described oakworm has defoliated bur and white oak trees in southern Ontario in areas around Kingston, Belleville, and Hamilton. In the United States it has been reported from Wisconsin and Minnesota.

The life stages and habits of this oakworm, the damage caused by its feeding, and recom-

* Photos of the redhumped oakworm courtesy of T.G. Eiber, Lakehead University, Thunder Bay, Ontario.

Pinkstriped oakworm moths

mendations for its control are similar to those for the preceding species.

In Canada, the pinkstriped oakworm (page 141), *Anisota virginiensis* (Drury), is found from Nova Scotia to Manitoba but not in the area between Sault Ste. Marie and Kenora. It also occurs throughout the eastern United States. Epidemic numbers of these caterpillars have been reported on oak and birch in Quebec and eastern Ontario and on bur oak in southern Manitoba. There have been instances of tree mortality where severe feeding injury occurred in consecutive years.

This oakworm also overwinters in the pupal stage in the ground. The pale purple and brown moths emerge in June and lay their eggs on the foliage. The larvae feed in groups until nearly full grown, when they tend to scatter. The mature larva is about 50 mm long with dull reddish and dark gray longitudinal bands, which are covered with fine white granules and sparse, short black spines. The head is red-brown and the pair of horns behind the head is about 5 mm long. In Ontario, the larvae are usually found on the trees in July and August but some feed until mid-September. When feeding is completed they drop to the ground, change to pupae, and stay there over winter.

If large-scale outbreaks of this insect persist, forestry specialists should be consulted on the need for and means of control. Groups of larvae on shade or ornamental trees can be handpicked and destroyed in late July or early August.

Two additional species of *Anisota* occur in very restricted areas of Canada. Both species resemble the pinkstriped oakworm and have similar life cycles and habits. The Manitoba oakworm, *A. manitobensis* McDunnough, is currently known only in that province. A large-scale epidemic occurred on bur oak in the Pembina Valley in the early 1950s. The larvae are only slightly different from the pinkstriped oakworm: when mature they are pinkish tan with a narrow black central line. The most distinctive features are the presence of numerous short white or white-tipped spines on the body and fine white branches on the paired black horns.

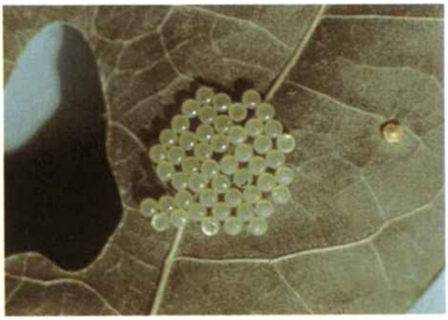
The spiny oakworm, *A. stigma* (Fabricius), is known only in a few scattered locations in southern and eastern Ontario. However, epidemics have been reported from the eastern United States. This oakworm has a pair of unusually long, curved horns, 9 mm long on mature specimens, and the numerous body spines are also relatively long. Tiny white granules similar to those on the pinkstriped oakworm are present on the body. The head is pale yellow-brown.

The redhumped oakworm* (page 141), *Symmerista canicosta* Franclemont, occurs from Nova Scotia to Virginia, west to Manitoba and Minnesota. Occasional localized and some large-scale epidemics of this insect have been reported from southeastern Ontario, Michigan, and Connecticut. In the past, no doubt, this oak feeder was often confused with the orangehumped mapleworm, a species it closely resembles.

The redhumped oakworm overwinters as a pupa in the ground litter. The moths, gray with a distinct whitish border on the front edge of the forewings, emerge over an extended period from June to late August. The eggs, which are laid in groups on the underside of leaves, hatch in about 10 days and the larvae then feed in colonies until they are nearly full grown. The young larvae have three black stripes on the middle of the back and may be mistaken for the orangehumped mapleworm. Mature larvae are about 40 mm long and have five black lines on the back. By the end of September most of the larvae have completed their feeding and have dropped to the ground where they change to pupae.

Epidemics appear to be of short duration because of parasites, predators, and disease organisms; thus there is generally no need for control measures. However, the impact of feeding by this oakworm would be quite severe if it followed an earlier-feeding species. Because of the nuisance created, control measures may be required around homes or in recreational areas; groups of young larvae may be handpicked and destroyed or sprayed with an insecticide registered for use against caterpillars.

The gypsy moth (page 141), *Lymantria dispar* (Linnaeus), is an insect native to the temperate regions of Europe, Africa, and southern Asia. It arrived in North America about 1869 when it was introduced into Massachusetts. It has since spread throughout the eastern United States, into southern Quebec, and the southern and central regions of Ontario. The gypsy moth has also been established, as of 1981, in New Brunswick and Nova Scotia. Although male moths have been captured in baited traps on Prince Edward Island, the insect is apparently not yet established there. It has also been found on the west coast from Vancouver to California. The larvae feed on the leaves of a wide variety of both deciduous and coniferous trees but oak, poplar, and birch are the preferred forest trees. Older larvae also feed readily on hemlock, pine, and spruce. The gypsy moth is known for its wide fluctuations in number, wherever it occurs, with long periods of relative scarcity, and rapid increases to epidemic levels followed by sudden declines. It has long been considered one of the most important forest insects in the United States.



Redhumped oakworm eggs

The insect passes the winter in the egg stage, frequently on the bark of trees but also on numerous other objects. The eggs hatch in spring and the larvae move up the trees to feed


Gypsy moth female


Gypsy moth male


Gypsy moth egg cluster

on the young leaves. Initially the larvae feed during the day but as they grow older they feed mainly at night. During daylight hours they tend to congregate in sheltered niches on the tree and larger larvae may even move down to the ground litter. Feeding is completed in July and the full-grown larvae, 35 to 60 mm long, seek sheltered places in which to pupate. Pupae may be found attached by silken threads to limbs or trunks of trees, rocks, forest debris, buildings, or fences. The moths emerge in 10 to 14 days. The light brown male moth is slender and quite unlike the light-colored heavy-bodied female . Because the female does not fly, mating and egg laying take place near the pupation site. The eggs are laid in oval masses of 100 to 1000 and are covered with a mat of buff-colored hairs from the female's body .

Because female moths are flightless, natural spread can occur only in the caterpillar stage. Recently hatched caterpillars are very light and covered with long hairs, and are readily blown about by the wind, sometimes for considerable distances. Man also involuntarily helps the spread of this pest by transporting logs, trees, wood, lumber, or stone on which eggs have been laid. Recreational and other vehicles travelling in or from infested areas also carry pupae or eggs.

Control of the gypsy moth in large forested areas has proved very difficult and research in this area is continuing. A forestry specialist should be consulted for the latest information. Shade or ornamental trees can be sprayed with insecticides that are registered for use against gypsy moth larvae. These include a newer, more selective, and less environmentally harmful bacterial insecticide.

The lacecapped caterpillar (page 141), *Oligocentria lignicolor* (Walker), has occurred at scattered localities across Ontario, southeastern Manitoba, and the eastern United States. It feeds primarily on oak, beech, and birch, usually in small numbers, and epidemics are apparently unknown. In Ontario, the larvae feed from about mid-July to late September and when full grown are about 37 mm long.

There is one generation each year and the insect spends the winter in a cocoon on the ground. The moths fly in July and August.

# Loopers

* This account and the illustrations were kindly supplied by D.G. Embree of the Atlantic Forestry Centre.

Winter moth larva

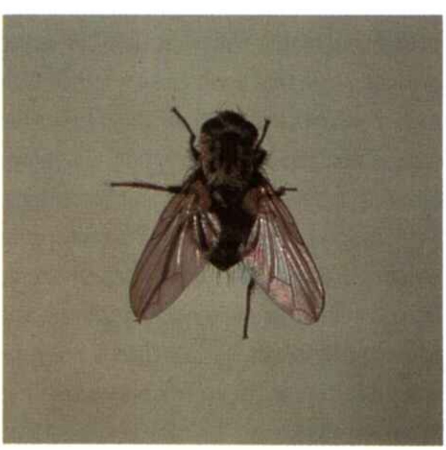
**Other loopers found on oak:**
**Fall cankerworm, page 109**
**Linden looper, page 109**
**Elm spanworm, page 110**
**Spiny looper, page 234**

The winter moth* ▭, *Operophtera brumata* (Linnaeus), is native to Europe and parts of Asia and Africa. First recorded in Canada in 1950 in Nova Scotia, this looper spread to southern New Brunswick and was confined to these areas until recently. In 1977 it was found on Vancouver Island in British Columbia. The following information relates specifically to the situation in Nova Scotia. The larvae thrive best on apple and oak, but attack virtually all deciduous trees. Because feeding is completed early in the

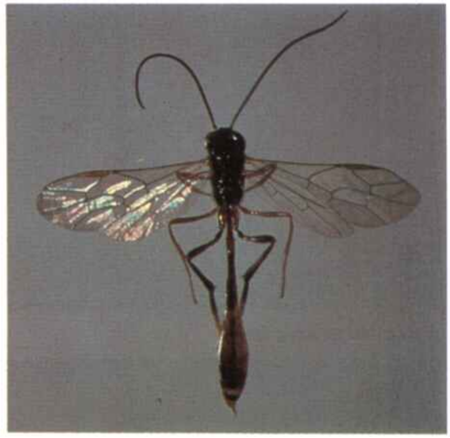
Eggs

growing season, infested trees will produce new leaves and most trees survive persistent attacks. However, red oak and to a lesser extent red maple, begin to succumb after 2 or 3 years of complete defoliation.

Eggs are laid on the boles of host trees in lichens and bark crevices. Hatching occurs in mid-May, beginning at sunrise, and is virtually completed during the first 3 h of daylight. After hatching, the larvae spin downwards and are carried to the foliage by convection currents as the early morning air warms. First-instar larvae feed on opening buds, but as their hatching is generally poorly synchronized with budburst of host trees, with the exception of early leafing species such as apple, many of the larvae starve. There are five larval instars. Mature larvae of the winter moth curl up in the leaves, often forming a small cell, and are difficult to dislodge. Larvae eventually drop to the ground about mid-June, burrow beneath the surface, spin an earthen cocoon and pupate. Adult females with dwarfed wings emerge in late fall. They are active at dusk.



*Cyzenis albicans*



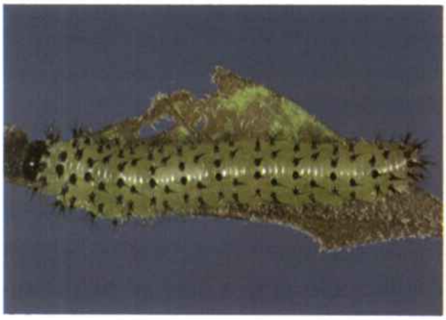
*Agrypon flaveolatum*

The species is controlled in Nova Scotia by two introduced parasites, *Cyzenis albicans* (Fallén), which is most effective at high host densities, and *Agrypon flaveolatum* (Gravenhorst), most effective at low host densities.

Winter moth larvae are easily controlled by any number of contact insecticides. The use of sticky bands to prevent females from ascending the tree is generally an ineffective control measure, unless the trees are isolated or this treatment is carried out on a large scale, because first instar larvae are transported by air currents.

# Sawflies

*Acordulecera* species larvae



*Periclista albicollis* larva

Oak slug sawfly larvae

*Arge* species larva

Although the sawflies in the genus *Acordulecera* occur widely in eastern North America, their feeding is usually of little consequence. They feed on the leaves of red oak and occasionally other oaks, hickory, walnut, chestnut, and ash. The species *A. dorsalis* Say (=*quercus* Rohwer) is known to occur in Ontario. There is usually one generation a year and occasionally a partial second generation. The larvae are found on red oak, the most common host tree in Ontario, mainly in June but occasionally as late as September. They feed in groups on a leaf, leaving the veins intact in a very characteristic manner. The full-grown larva is only about 9 mm long, and has a pale body and darker head. Examination of *Acordulecera* larvae with a microscope reveals unique lateral warts that serve to identify them. Winter is spent in cocoons in the ground. The adults are tiny four-winged flies. Control measures have not been necessary.

A number of species of spiny oak sawflies occur in eastern North America. *Periclista albicollis* (Norton), the more common species in Ontario, feeds on red, white, and bur oaks. *P. diluta* (Cresson) and *P. media* (Norton) have been found on bur and white oak. The larvae are light green or grayish and are armed with rows of two-branched spines. They feed on the foliage from mid-May to early July. Full-grown larvae of Ontario species are about 20 mm long. They drop to the ground and overwinter in cocoons in the soil. The small, relatively stout-bodied adults have two pairs of transparent wings and fly in early spring. There is one generation each year. Control measures have not been necessary.

Oak slug sawfly skeletonizing

Although many species of slug sawflies occur on oak in eastern North America, their feeding has been of little consequence in Canada. Two species with an unclear host preference are known in Ontario, the oak slug sawfly, *Caliroa fasciata* (Norton), apparently associated with red oak, and *C. obsoleta* (Norton), found mainly on white oak. A possible third species is occasionally found on birch. The larvae in this group of sawflies are greenish and typically covered with a transparent or dark slimy substance. The thoracic region is distinctly swollen and sometimes marked with a fine spatter of dark spots. The color of the head and legs varies with the species but is usually either light or dark brown. The larvae usually feed in groups, skeletonizing the leaves from June to October. When full grown, about 13 mm long, they drop to the ground where they change to pupae and later to small adult sawflies. There are one or two generations each year depending on location and climatic conditions. Winter is probably spent as a larva in a cocoon in the soil. Control measures are usually not required but on ornamental trees the larvae may be handpicked or sprayed with an insecticide registered for use against sawfly larvae.

The argid sawflies, *Arge* species, are present on oak and elm in the eastern regions of both Canada and the United States but have not become serious forest pests. Red oak is a favored host tree in Ontario. The larvae overwinter in cocoons in the ground, change to pupae in the spring, and subsequently to stout-bodied sawfly adults with two pairs of smoky membranous wings. The females lay their eggs in a row of tiny slits cut in the leaf tissue around the edge of the leaf. The yellowish, dark-spotted larvae feed in groups on the leaves from early July to early October. When full grown, about 26 mm long, they drop to the ground and spin tough oval cocoons in which they overwinter.

# Oak skeletonizer

Oak skeletonizer damage

Severe leaf damage by the oak skeletonizer, *Bucculatrix ainsliella* Murtfeldt, has occurred in southern areas of Quebec and Ontario and in the eastern United States. Although red oak is the primary host in Canada, the insect has also been reported on chestnut oak in Pennsylvania.

The life cycle and habits of the oak skeletonizer were studied in Lower Michigan. There are two generations each year, the insect overwintering as a pupa on the tree or on undergrowth. The first generation adults of these tiny moths fly in early spring and the second generation in July and early August. The eggs are laid on the underside of leaves and larvae are present from about late April to mid-October. The newly hatched larvae feed for a short period

Oak skeletonizer

in narrow mines in the leaf. Soon they emerge to feed on the lower leaf surface, molting twice in small rounded "tents" of white silk that are often placed against a leaf vein. The shallow feeding by the larvae on the leaf surface is commonly referred to as skeletonizing. When full grown, about 5 mm long, the larva spins a white longitudinally ribbed cocoon in which it changes to a pupa. Summer cocoons are usually found on the foliage of host trees but overwintering cocoons of the second generation are usually on the bark or on undergrowth around infested trees.

If control of the oak skeletonizer becomes necessary on shade trees, a pesticide registered for use against caterpillars should be applied about mid-June and, if need be, repeated in mid-September.

# Sap feeders

Oak lace bug nymphs

A number of different kinds of insects feed on the sap of oak leaves. Eggs develop into wingless nymphal stages that more or less resemble the winged adult. Insects in this group on oak are small, usually less than 5 mm long; they insert their slender tube-like mouth parts into the leaf tissue and feed on the plant juices.

The oak lace bug, *Corythucha arcuata* (Say), is probably present on this continent throughout the natural range of white and bur oak, its two favored host trees. The adults, which are similar to the birch lace bug, (page 91), overwinter under loose bark on the tree or under leaves on the ground. In the spring the females lay their tiny, black, elongate eggs in groups on the underside of leaves. As the eggs hatch, the spiny, dark nymphs tend to feed in groups on the underside of the leaf. Both their feeding and their tar-like excrement discolor the foliage. In Ontario the nymphs may be found from about mid-July to mid-September. The 4 mm long adults, usually associated with groups of nymphs, are found from about mid-July to late September. Control

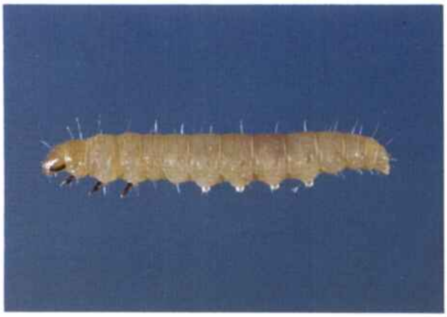
*Myzocallis melanocera*

has not been required for the lace bugs in Canada because severe feeding damage is not persistent.

Aphids, or plant lice, are other sap-feeding insects found on oak but large numbers on this tree are unknown in Ontario. A number of different species, mainly in the genus *Myzocallis,* feed on the leaves. A group of nymphs and a winged adult of the species, *M. melanocera* Boudreaux & Tissot, are illustrated. These aphids feed on the underside of leaves and there are a number of generations each year. A species in the genus *Stegophylla* can be found in curled or crumpled leaves. This is a flocculent species and each aphid is covered with a white woolly material.

A third group of sap feeders consists of the leaf hoppers, which are very active compared to the sedentary lace bugs and aphids. For further information on these insects see page 125.

# Leaf rollers and tiers



Oak leafshredder, p. 154

Oak trumpet skeletonizer, p. 155

Oak olethreutid leafroller, p. 154

Oak leaffolder, p. 155

Flat leaftier, p. 155

Palmerworm, p. 155

*Psilocorsis cryptolechiella*, p. 155

**Other leaf rollers and tiers found on oak:**
**Obliquebanded leafroller, page 29**
**Fruittree leafroller, page 29**
**Oak leafroller, page 154**
**Tortricid oakworm, page 155**
**(last two not illustrated)**

This group of insects includes a number of species of small moths. The only serious pest in the group in Canada is the oak leafshredder ( page 153), *Acleris (=Croesia) semipurpurana* (Kearfott), and epidemics of this insect occur periodically throughout most of the range of red oak in eastern North America.

This pest overwinters in the egg stage on tree branches . In Ontario the eggs hatch in early May and feeding larvae may be found until mid-June. The young larvae, yellow-brown with shiny black heads, tunnel through the young developing leaves, producing a "shot-hole" or shredded effect . Later they tend to feed from folded leaves tied with silk. The full-grown larva, about 12 mm long, is much paler than the earlier stages. The larvae change to pupae in the ground litter or occasionally in folded tips of oak or maple leaves. The small moths  fly in late June or early July.

Control of this insect is difficult and forestry specialists should be consulted for large-scale operations. An insecticide with systemic or fumigant action would be appropriate for use in the spring against young larvae on ornamental trees.

Although the oak leafroller, *Archips semiferana* (Walker), is rarely found in southern Ontario, epidemics have occurred in Michigan and Pennsylvania. The eggs, in compact clusters, overwinter on the twigs and hatch in May. The young larvae feed in webbed expanding leaves. Later they roll parts of the leaf and occasionally the entire leaf. The fullgrown larva is about 20 mm long, pale green with varying intensities of dark markings on the head and thoracic shield. The larvae change to pupae in the leaf rolls from late June to mid-July. The moths fly in July and early August.

Oak leafshredder damage

Oak leafshredder eggs

Oak leafshredder adults

The oak olethreutid leafroller ( page 153), *Pseudexentera cressoniana* (Clemens), is a little-known species that has occurred only rarely in large numbers, mainly on red oak, in Nova Scotia and Ontario. The pupae overwinter in the soil and the moths fly from mid-April to mid-May in Nova Scotia. The larvae feed initially in buds and later roll the leaves, often from the tip down. Feeding is completed at the end of June when the full-grown larva is about 12 mm long.

Another species, usually of minor importance, is the tortricid oakworm, *Argyrotaenia quercifoliana* (Fitch). It is found from Quebec to Manitoba and south to Texas and Florida. This insect overwinters as a very small larva in a silken shelter on the tree. In the spring the larvae feed singly from rolled or tied leaves until early July. Full-grown larvae are about 20 mm long; they are pale green with yellowish heads. They change to pupae either in the leaf roll or on the ground. The moths are in flight from late June to about mid-July and lay their eggs in clusters on the twigs.

The flat leaftier (page 153), *Psilocorsis reflexella* Clemens, and the closely related *P. quercicella* Clemens and *P. cryptolechiella* (Chambers) (page 153) occur on oak and a number of other tree species throughout eastern North America. The larvae have pale bodies and brownish heads. They feed singly between two tied leaves, one flat on top of the other, and in Ontario are found on the trees from late June to late September. When full grown, about 16 mm long, the larvae drop to the ground where they change to pupae. The pupae overwinter and the small moths emerge the following June.

Although the oak trumpet skeletonizer (page 153), *Epinotia timidella* (Clemens), is widely distributed in eastern North America, it has apparently never caused serious injury. The brown-headed, pale green larva feeds in a crumpled leaf from a long slender black tube of silk and excreta (see a similar species on maple, page 115). Feeding larvae occur from about mid-July to mid-September.

The oak leaffolders (page 153) in the genus *Ancylis* are solitary late-season feeders. The larvae, pale with two small black spots on the thoracic shield, feed in leaf folds in August and September. When full grown they are about 13 mm long. Feeding injury by these insects is usually of no consequence.

A number of species in the family of small moths, Gelechiidae, are often found on oak. However, their feeding usually causes little damage. The slender, very active larvae may be found in rolled or tied leaves, often in association with other insects. One of these species is the palmerworm (page 153), *Dichomeris ligulella* Hübner. This is a well-known pest of apple orchards but it has, on rare occasions, also caused serious defoliation of oak in the northeastern United States. The striped larvae, about 14 mm long when full grown, skeletonize the leaves of oak in May and June. The biology of this species is unusual in that the small moths adults overwinter and lay their eggs in the spring.

# Leaf miners

Large, flat, rounded blisters often covering the leaf; dark, flat, legless larvae in mines .......... *Cameraria* group of leaf miners

Large, flat, rounded blisters often covering leaf; pale larvae with stubby black legs .......... *Profenusa* group of leaf miners, page 157

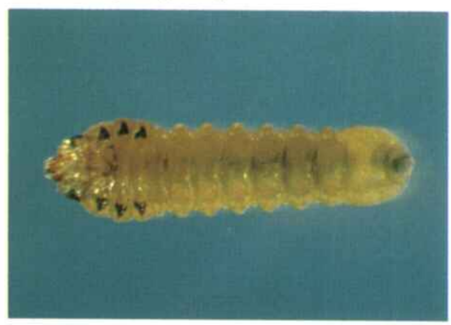
Discolored blisters mainly at tips or along edge of leaf or in the form of narrow meandering mines .......... Miscellaneous oak leaf miners, page 158

A number of species of tiny moths in the *Cameraria (=Lithocolletis)* group mine the leaves of various kinds of oak throughout eastern North America. Serious feeding injury by the solitary oak leafminer, *C. hamadryadella* (Clemens), occurs periodically in southern Ontario. There are apparently two generations each year, with moths flying from late May to early June and again in July and early August. The larvae feed singly but when a number of mines occur on a leaf they tend to merge. The larvae are about 5 mm long when full grown. Second generation larvae are purported to overwinter in the leaf mines on the ground and to change to slender dark pupae in the mines in spring. Consequently this insect may be controlled by raking and burning the mined leaves in the fall. A number of other species of *Cameraria* occasionally mine oak leaves in Ontario. Of these the gregarious oak leafminer, *C. cincinnatiella* (Chambers), has caused severe browning of oak foliage in the central United States. The larvae of this species feed in groups in each mine. Another closely related species, *Phyllonorycter (=Lithocolletis) basistrigella* (Clemens), has occurred commonly in parts of Quebec.

Solitary oak leafminer

Oak leafmining sawfly damage

Solitary oak leafminer



Oak leafmining sawfly larva — underside

Its larvae produce pale rectangular mines between veins on the underside of leaves.

The *Profenusa* group of leaf miners is represented in Ontario by the oak leafmining sawfly, *P. lucifex* (Ross), which occasionally causes severe browning of oak foliage. The adult sawflies emerge from their cocoons in the soil in June and early July. The female lays her eggs in slits that she has cut in the upper surface of the leaf, using the microscopic sawlike structure sheathed in the tip of her abdomen. On hatching, the larvae produce flat blister-like mines from mid-June to late July. When they are full grown, about 6 mm long, they drop to the ground

*Brachys aerosus* mine

*Stigmella latifasciella* mine

*Tischeria citrinipennella* mine

to overwinter. A partial second generation of larvae sometimes occurs in late fall. The closely related species *P. alumna* (MacGillivray) has caused periodic browning of oak in the north-eastern United States.

In Ontario, the miscellaneous oak leaf miner group includes beetles in the *Brachys aerosus* group whose robust larvae are found in rounded mines, usually near the tips of leaves, in August and September. Narrow linear mines are produced by a few species of tiny moths in the genus *Stigmella (=Nepticula)*. Wider meandering mines are made by larvae of a two-winged fly, *Japanagromyza viridula* (Coquillett). Larvae of small moths in the genus *Tischeria* mine along the lower edge of a lobe causing the leaf edge to curl over the narrow mine. A mine of the species *T. citrinipennella* Clemens is illustrated.

Control of leaf miners is rarely necessary, but if it is required a systemic insecticide should be used against young larvae.

# Leaf galls

*Dryocosmus quercuspalustris* gall, p. 160

*Acraspis erinacei* gall, p. 160

*Amphibolips quercusinanis* gall, p. 160

*Andricus* species gall, p. 160

*Andricus quercusflocci* gall, p. 160

*Xystoteras poculum* galls, p. 160

A large number of different galls may be found on each species of oak. We show a few of the most common ones to provide some indication of the variety that can be expected. Identification of other galls is best left to specialists. Additional general information on galls can be found on page 15.

The following galls are caused by cynipids: *Dryocosmus quercuspalustris* (Osten Sacken) (page 159) is a small hollow globular gall, about 10 mm in diameter, containing a free-rolling cell with the cynipid larva inside. It is found on red oak in the spring. Similar galls may be formed on the catkins or buds.

*Amphibolips quercusinanis* (Osten Sacken) (page 159) causes a large globular thin-walled gall, about 30 mm in diameter, with fibers radiating from a central cell to the wall. The insect completes its development from egg to adult inside the cell and the tiny cynipid adult chews its way out of the cell and the gall. These shiny green galls, which develop brown spots later in the season, are often called oak apples and are found on red oak.

*Andricus quercusflocci* (Walsh) (page 159) causes a pale woolly mass about 10 mm in diameter on the mid-vein on the lower leaf surface of white oak. Inside the mass are a number of cells containing larvae.

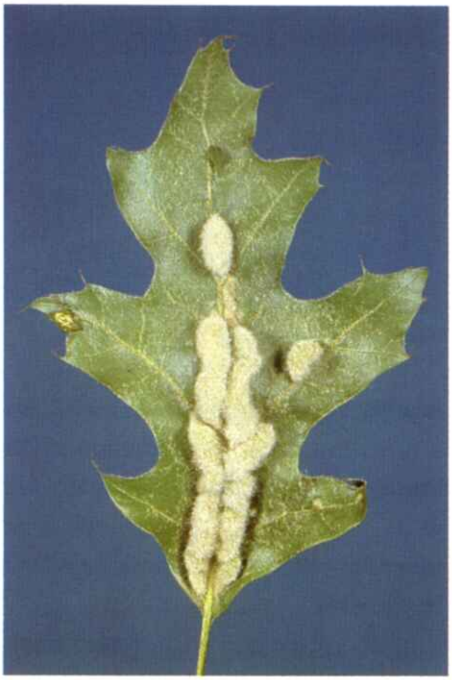
*Acraspis erinacei* (Beutenmueller) (page 159) causes a red-spined gall, about 15 mm in diameter, containing a small number of cells on white oak. This gall is formed in the fall by the asexual generation. The sexual generation causes a gall in the bud scales in the spring.

*Xystoteras poculum* (Osten Sacken) (page 159) causes button-like galls about 4 mm in diameter, each containing a tiny larva, on the lower leaf surface of white oak in the fall. The galls, called spangles, have reddish edges and the whole surface has a white bloom.

*Andricus* species (page 159) causes a bract-like leaf cluster formation on the mid-vein

Cynipid adult

*Cincticornia* species galls



*Macrodiplosis niveipila* galls

of the leaves of bur oak, with a single cell at the base.

Two galls caused by midges are also illustrated. *Cincticornia* species makes a pill-like wrinkled reddish gall about 4 mm in diameter on red oak and other species of oak. *Macrodiplosis niveipila* (Osten Sacken) forms white woolly galls on the upper leaf surface along the midrib of a number of species of oak. The illustration shows a gall on red oak.

None of the galls mentioned above has been sufficiently abundant to cause lasting injury to trees and so should be considered only another fascinating aspect of nature.

# Webworms

Oak webworms

Striped oak webworm damage

Webbed foliage

Striped oak webworm

Larvae hairy; brownish, gregarious in large nests of webbed foliage ............................... Fall webworm, page 226

Larvae not hairy; green to blackish, gregarious in leaves tied with silk .................................... Oak webworm

Larvae not hairy; striped, brownish, a number of individuals in leaves tied with silk .................................. ................................. Striped oak webworm

The oak webworm, *Archips fervidana* (Clemens), is found occasionally throughout the oak regions of eastern North America. The larvae live in groups in nests of foliage tied together with silk. Red oak is the usual host tree in Ontario but numerous nests have also been recorded on bur oak in Manitoba. In Ontario the larvae are usually a dusky dark color; however, farther south they are apparently much lighter-colored. They may be found in their nests from late May to about mid-August. When full grown, about 20 mm long, they change to pupae in the nest. The moths emerge from mid-July to late August and lay their eggs on the twigs. The eggs over-winter.

The striped oak webworm, *Tetralopha expandens* (Walker), probably occurs throughout most of the range of oak in eastern North America.

It is a secondary type of feeder in that the larvae usually web foliage damaged by other species feeding earlier in the season. The nests of brown striped larvae may be found from early July to the end of September. When the larvae are full grown, about 22 mm long, they drop to the ground and spin cocoons in the litter where they overwinter. The moths emerge the following summer.

# Miscellaneous insects

* Illustration courtesy of the Bureau of Forestry, Department of Environmental Resources, Commonwealth of Pennsylvania.

Hard-shelled, robust, roughly oval flying insects ........................................ Beetles, pages 42, 90, and 182

Slender twig-like, wingless insects ........................................ Walkingstick

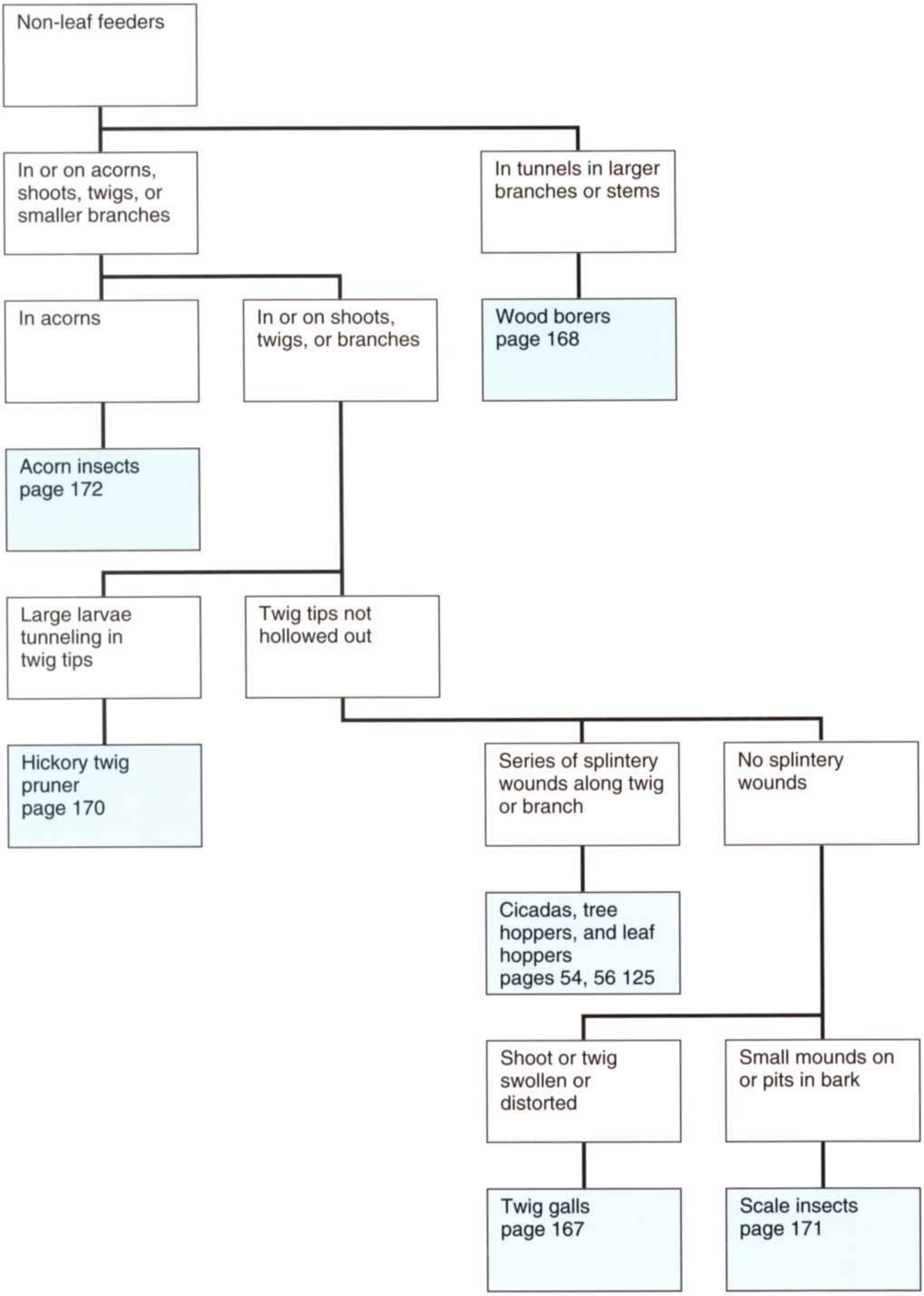
Walkingstick adult*

The walkingstick, *Diapheromera femorata* (Say), is a defoliator of deciduous trees in the eastern half of the United States. Small epidemics have occasionally occurred in southern Ontario and the species has been reported from southern Manitoba. In Ontario, the favored host trees appear to be oak, basswood, birch, elm, and cherry. However, walkingsticks will feed on many other deciduous trees as well as on most conifers.

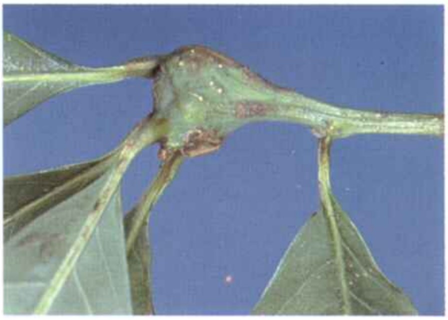
In the northern part of its range the walkingstick overwinters in the egg stage on the ground. Most of the eggs remain on the ground throughout the following summer and do not hatch until May or June of the next year. The nymphs feed on shrubs on the forest floor until about midsummer. After that most of them feed in the trees, eating the entire leaf except the basal parts of the main veins. Adults are present in late July or early August. The adults are from 60 to 90 mm long and vary in color from all brown or green to mottled or multicolored specimens. The female is usually larger and thicker than the male. Egg laying continues until October or the onset of cold weather. Each female lays up to 150 eggs at an average rate of 3 a day, dropping them to the litter from wherever she happens to be on the tree.

Control measures have not been required for walkingsticks in Canada and no chemicals are currently registered for use against this insect.

# Oak: non-leaf feeders



# Twig galls



*Callirhytis clavula* gall, p. 168

*Callirhytis quercusgemmaria* gall, p. 168

Gouty oak galls, p. 168

*Callirhytis cornigera* galls, p. 168

Most of the twig galls on oak are caused by tiny cynipid wasps, but to be certain it would be advisable to open the gall and determine the gall maker. Some cynipids live in cells in twigs and cause little abnormal growth. On the other hand, a variety of galls, most of them encompassing a number of cells, cause considerable swelling or distortion of growth. Additional general information on galls appears on page 15. Four common types are illustrated, all of them belonging to the genus *Callirhytis.*

The white oak club gall wasp, *C. clavula* (Osten Sacken) ( page 167), forms a pronounced woody swelling from which leaves protrude, at the tip of new growth of white oak. The ribbed bud gall wasp, *C. quercusgemmaria* (Ashmead) ( page 167), develops in seed-like capsules that usually protrude in large numbers from twigs of a number of oak species. In the spring the galls exude honeydew and attract bees in large numbers. In the fall when the insects are mature the capsules are shed. The asexual generation of the gouty oak gall wasp ( page 167), *C. quercuspunctata* (Bassett), makes large multicelled galls on a number of oaks. Each gall encircles a twig and becomes woody as it matures. The alternate sexual generation of this cynipid makes small, single, inconspicuous galls on the undersurface of the leaf along the main vein. The horned oak gall wasp, *C. cornigera* (Osten Sacken) ( page 167), produces globular galls on oak twigs. These cynipids are enclosed in seed-like capsules that protrude from the gall and are eventually shed.

Some of the twig gall makers, because of their persistent attack, have caused the death of large branches and even trees. No means of control is known except to prune and destroy the galls before the cynipid adults emerge.

# Wood borers

* Photos courtesy of the Indian Head Tree Nursery, Department of Regional Economic Expansion, Canada.

Carpenterworm

Many insects are known to tunnel in the branches and trunks of oak trees, but because few of them have caused serious injury in Ontario, not many of them have been photographed. The largest of these borers is the carpenterworm* , *Prionoxystus robiniae* (Peck), which has a life cycle of 3 or more years. It feeds primarily in oak, ash, and poplar but also in a number of other tree species. The females are stout-bodied gray moths with slightly translucent, mottled gray and black forewings and smoky hindwings. They have a wing span of about 75 mm. The males are smaller and their hindwings are yellow-orange with black margins. The eggs are laid on living trees near wounds or in bark crevices. The young reddish larvae bore into the trunk and over the next 3 years form a maze of tunnels in the wood . The full-grown larva, 50 to 75 mm long, is usually greenish white with a dark head. It changes to a pupa in a tunnel leading to the outside. Later the pupa wriggles to the mouth of the tunnel, allowing the adult moth to leave the tree in spring or summer. A closely related and similar species, the little carpenterworm, *P. macmurtrei* (Guérin-Méneville), is sometimes locally abundant in branches and stems of red oak.

Carpenterworm tunnels

Full-grown larvae of this species are 38 to 62 mm long. Damage by carpenterworms to trees around the home can be kept to a minimum by good tree maintenance, including pruning dead branches and painting wounds.

Many kinds of beetle larvae tunnel in dying or recently dead oak trees. A number of species of small ambrosia beetles make their blackened tunnels, mainly in the sapwood, in a manner similar to that of the species shown on page 61. Roundheaded borers tunnel deep into the wood (see a related species on page 58). The pigeon tremex which also tunnels deep into decaying wood is described on page 189. Flatheaded borer larvae are usually found in the sapwood (see *Agrilus anxius,* page 95).

# Hickory twig pruner

Hickory twig pruner

The hickory twig pruner, *Anelaphus parallelus* (Newman), probably feeds throughout the range of oak. It is a common pest of roadside and ornamental oak in southern Ontario. Although there may be considerable loss of twigs in some years, injury does not usually persist. This species has been confused with the closely related *A. villosus* (Fabricius), which also feeds on oak.

The life cycle in the northern part of this insect's range takes 2 years to complete. The pupae overwinter in twigs on the ground and the longhorned beetle adults emerge in June. The eggs are laid near a bud cluster and the larva, on hatching, tunnels into the twig and feeds on the wood, moving toward the base of the twigs. It passes the first winter in the larger twigs and in the spring resumes feeding down the twig, cutting a hole through the bark from which to expel excrement. After further tunneling during the summer, it enlarges the tunnel at one point so that only the bark remains. The larva then moves back and plugs the tunnel with shredded wood. Eventually the twig is broken off by the wind and falls to the ground with the larva inside. The larva continues to feed until early fall when it changes to the pupal stage, completing the cycle.

This borer is of concern primarily to homeowners because the fallen twigs create a nuisance. The destruction of these fallen twigs in the fall or early spring is an effective control measure.

# Scale insects

Golden oak scale

Two genera of scale insects that are quite different in appearance are found on oak. Members of one genus are known as pit-making scales; the common species in this group in Ontario is the golden oak scale, *Asterodiaspis variolosa* (Ratzburg). This tiny disk-shaped scale is about 2 mm in diameter. It is found in a depression or pit in the bark that is caused by the insects' feeding. The female scale gives birth to active crawlers that soon settle down on young twigs, insert their slender feeding tubes, and feed on sap until they mature and reproduce. Two other closely related species of pit scales are *A. minus* Lindinger and *A. quercicola* (Bouché).

Members of the second genus, *Parthenolecanium*, in contrast to the more or less hidden pit scales, are readily visible as brown mounds on the twig surface. The most common species in this group is the European fruit lecanium, *P. corni* (Bouché) (page 186). Another oak feeder in this group is the oak lecanium, *P. quercifex* (Fitch), which is similar in appearance to the preceding species.

# Acorn insects

*Conotrachelus* larva

*Conotrachelus* larval exit

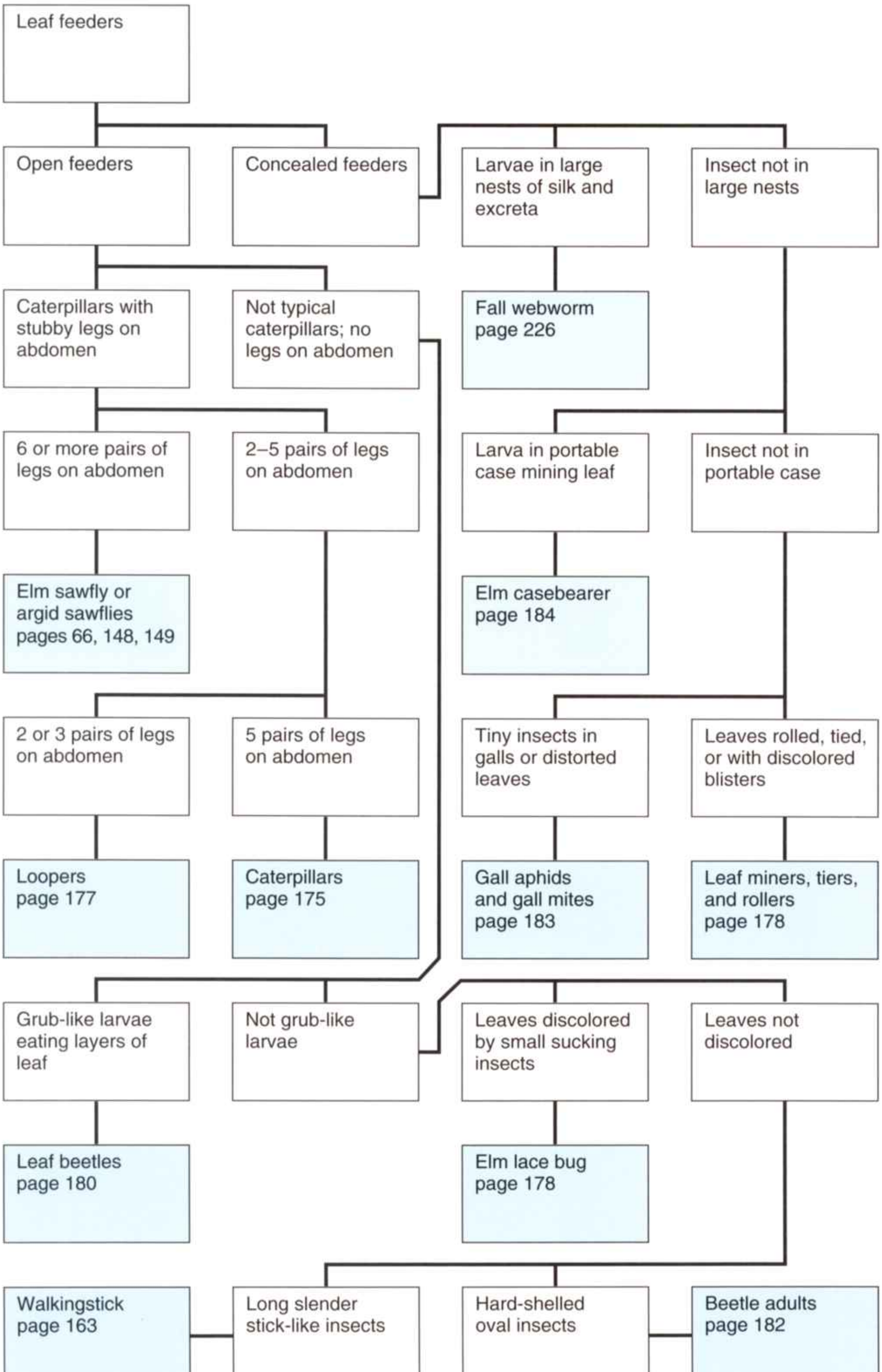
The larvae of a number of beetle and moth genera feed on seed inside oak acorns. Among the beetles are various species of weevils in the genera *Conotrachelus* and *Curculio*. The adults range in length from 5 to 10 mm. The characteristic weevil beak is slender, curved, and very long on *Curculio* species, sometimes longer than the body in the female. *Conotrachelus* species have shorter, stouter, and less curved beaks. The larvae are C-shaped and legless. When they have completed their feeding inside the acorn, they bore through the shell and change to pupae in the soil. Larvae are usually the overwintering stage but adults of some species are known to overwinter.

The filbertworm, *Melissopus latiferreanus* (Walsingham), feeds in acorns and various other nuts. The larvae have legs and are dirty white in color with a yellowish thoracic shield and posterior plate, and a reddish-brown head. When they are full grown in the fall, about 15 mm long, they leave the acorns and spin papery cocoons on the ground, where they overwinter. The pupae form in spring and the reddish-brown adults emerge later.

Larvae of the acorn moth, *Valentinia glandulella* (Riley), also occur commonly in acorns and various other nuts. They are whitish, sometimes with a reddish tinge. The head, thoracic shield, and posterior plate are all brown. When full grown, about 14 mm long, the larvae usually leave the acorns to pupate in the ground. Some, however, apparently change to pupae in the fallen acorns. The adults are light smoky-brown moths with narrow wings.

White ▶ 

# Elm: leaf feeders



# Caterpillars

Mourningcloak butterfly, p. 175

*Acronicta interrupta* larva, p. 176

Spiny elm caterpillars, p. 175

Question mark butterfly larva, p. 176

Other caterpillars found on elm:
Redhumped caterpillar, page 19
Whitemarked tussock moth, page 171
Yellownecked caterpillar, page 71
Pale tussock moth, page 71
Gypsy moth, page 141
Hickory tussock moth, page 211
Fall webworm, page 226
Rearhumped caterpillar, page 233

The mourningcloak butterfly, *Nymphalis antiopa* (Linnaeus), is widely distributed throughout North America as well as in Europe and Britain. In its larval form this insect is also known as the spiny elm caterpillar. It is the most common caterpillar on elm; however, with the loss of so many of our elms to Dutch elm disease, most reports of damage relate to willow or aspen. Although groups of larvae are often widely scattered, their feeding can be severe for a year or two on individual trees or clumps of trees.

Winter is spent as an adult. Individuals hibernating in sheltered places may become active and fly about on warm days before the snow has gone. Eggs are laid early in the spring in clusters around small twigs; on hatching, the larvae feed gregariously, initially in silken shelters and later more openly in clusters, stripping all the leaves on one branch before moving on together to another. When full grown the strikingly marked larva, about 50 mm long, suspends itself from a twig or other object and forms a characteristic chrysalis from which the adult soon emerges. In the United States there may be a second and, in the southern part of its range, even a third generation.

The spiny elm caterpillar is primarily of concern to the home owner with a small number of trees, because the loss of foliage is conspicuous. Colonies are often easily removed and destroyed and although large numbers are sometimes found, foliage loss is not severe enough to pose a threat to the tree.

The question mark butterfly (page 175), *Polygonia interrogationis* (Fabricius), occurs from Nova Scotia to Lake Superior in Canada, feeding primarily on elm. It is also found in the eastern United States on elm, oak, and hackberry. There are no records of extensive damage.

Because it has not been abundant, little has been written about its life history. Apparently it overwinters as an adult in sheltered locations. Larvae have been collected from late June to early September; when full grown they are about 40 mm long. The chrysalis is suspended from twigs of the host tree. There are probably two generations a year in southern parts of its range.

At least two species of daggermoth larvae, *Acronicta* species, feed on elm from the Atlantic Ocean to Manitoba. They have never been found in large numbers, so little is known of their life history. The larvae are rare, solitary feeders and when full grown may be up to 40 mm long. They feed in late summer and the pupae are present in September. The larva illustrated is *A. interrupta* Guenée (page 175).

# Loopers

Spring cankerworm

**Other loopers found on oak:**
Fall cankerworm, page 109
Linden looper, page 109
Elm spanworm, page 110
Spiny looper, page 234

The spring cankerworm, *Paleacrita vernata* (Peck), is a common looper feeding in the spring on a number of broad-leaved trees. It occurs over a wide geographic range in southern Canada, from the Atlantic Ocean to Saskatchewan and in much of the United States. It is called the spring cankerworm because its eggs are laid in spring, whereas the fall cankerworm (see page 109) lays its eggs in the fall. However, the larvae of both cankerworms feed in the spring. Infestations, usually of both the spring and fall cankerworms, with the latter generally predominating, last only 1 or 2 years. They are controlled by naturally occurring virulent disease organisms.

There is one generation a year and winter is spent as a larva in a cell in the soil. The change to a pupa and then to an adult occurs in early spring. Following mating on the tree trunk the drab wingless female deposits loose clusters of spindle-shaped eggs in bark crevices or other protected places on the trunk and larger branches. Hatching occurs about the time the buds are opening and it is then that dispersal of the insect takes place. The tiny larvae, dropping on silken threads, are picked up by the wind and may be transported considerable distances before landing on a suitable host tree. The larvae may initially mine swollen buds; otherwise, early leaf feeding consists of skeletonizing. Later the whole leaf except the midrib may be eaten.

The larvae complete their development by mid-June, when they are about 22 mm long. They then drop to the ground and seek a suitable niche in which to create an earthen cell, thereby completing the life cycle.

Stands of hardwoods are periodically infested with the spring cankerworm and other looper larvae, but generally this insect is not important. Where isolated trees are infested, sticky bands placed on the trunk in early spring will prevent cankerworm females from crawling up the tree to lay their eggs. The application of one of the biological insecticides when larvae are first seen would also keep damage to a minimum.

# Elm lace bug

The elm lace bug, *Corythucha ulmi* Osborn & Drake, is a common pest of native and introduced elms in southern Ontario and in the eastern United States west to the Northern Great Plains. This sucking insect is capable of causing severe browning and early leaf drop in late summer and is seldom noticed until after the damage has occurred.

The adults overwinter in bark crevices or other protected niches throughout the tree and begin laying eggs on the lower leaf surface as soon as the leaves have unfolded. Eggs are laid singly or in clusters. They begin to hatch in late May and the nymphs feed gregariously. There are five nymphal stages, which may be completed in 3 weeks. Both the lace-winged adult and the dark spiny nymphs, similar to the oak lace bug (see page 151) feed with sucking mouth parts, extracting sap from the leaf. The chlorotic flecks on the upper leaf surface and the sticky black excreta and cast nymphal skins on the lower leaf surface are characteristic of lace bug attack. There are two or three generations each year depending on the length of the growing season. In Ontario, peak populations occur in July and August and damage becomes evident then.

Although blighted leaves are unsightly, the effects on the trees appear to be of little long-term consequence. Moreover, damage seldom occurs for more than two successive years.

# Leaf miners, rollers, and tiers

Elm leafminer, p. 179

Elm agromyzid leafminer, p. 179

Two kinds of leaf miners occur commonly on elm and often cause concern, particularly if the trees are ornamental. However, leaf tiers and rollers are relatively scarce and are usually of no consequence.

## Leaf miners

The elm leafminer, *Fenusa ulmi* Sundevall, an introduced insect, is the more common miner of the two. It has caused severe leaf browning on most elm species in the Maritimes and southern Ontario. It is also found across the northern United States east of the Great Plains.

Winter is spent as a prepupal larva in a cocoon in the soil. Transformation to the pupal stage occurs in early May and the tiny four-winged adults, known as sawflies, are present by the middle of the month. The eggs are apparently laid in slits in the lower leaf surface. The larvae, however, move towards the upper surface where they feed on tissue, causing blister-like areas on the leaf. The mines are initially white but later turn brown. Feeding larvae are whitish with a pale brown head. When full grown in late June or early July, about 6 mm long, they leave the mines and drop to the ground where they spin brown papery cocoons in the soil. There is a single generation each year.

Ornamental trees are often under persistent attack by this leaf miner. However, damage can be kept to a minimum by picking the mined leaves on small trees early in the season or, where necessary, using a systemic insecticide recommended for leaf miners on elm.

The elm agromyzid leafminer, *Agromyza aristata* Malloch, is also widely distributed, particularly in the United States but also in Canada. The life cycle and seasonal occurrence of the various stages are very similar to those of the elm leafminer, discussed previously. The mines, however, are quite different, and the adults of the agromyzid miners are tiny two-winged flies. Control measures are rarely necessary for this species but if required they would be the same as for the elm leafminer.

## Leaf tiers and rollers

The elm leaftier, *Canarsia ulmiarrosorella* (Clemens), is found occasionally from Nova Scotia to Manitoba and in the eastern United States. There are two generations each year and the insect overwinters as a pupa on the ground. The larvae usually feed singly among leaves they have webbed with silk. They are green with pale lines and sparse hairs; when full grown they are about 18 mm long. The adults are small grayish moths.

The obliquebanded leafroller, *Choristoneura rosaceana* (Harris), feeds on many kinds of forest trees including elm. Information on this species appears in the section on poplar insects on page 33.

# Leaf beetles


Elm leaf beetle


Eggs

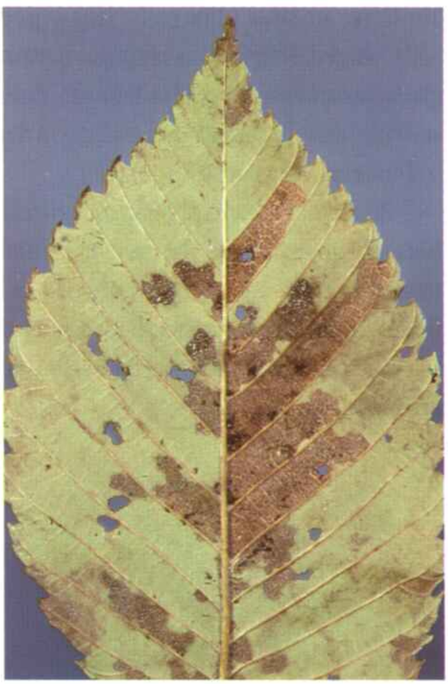

Larvae

Two kinds of leaf beetles commonly cause browning of elm foliage in eastern North America. The elm leaf beetle, *Xanthogaleruca luteola* (O.F. Müller), is an introduced pest that feeds on all species of elm and is now an important pest of shade trees in eastern Canada and much of the United States. Severe leaf feeding is common in southern Ontario. In addition to damaging leaves, adults enter homes to hibernate and cause considerable annoyance.

There are usually two generations a year in southern Ontario. Winter is spent as an adult in dry sheltered locations, often in buildings adjacent to the trees. About the time elm buds swell in the spring, the adults emerge and begin to feed on the buds, later chewing holes through the expanding leaves. Each female lays up to 800 eggs, which she deposits in clusters on the undersurface of the leaf. The grub-like larvae hatch in about a week and skeletonize the lower leaf surface, leaving the veins and upper leaf surface intact. Damaged leaf tissue turns brown and in areas of heavy feeding trees have a scorched appearance. Full-grown larvae are about 10 mm long. When feeding is completed the larvae crawl down the tree and change to pupae in bark crevices or on the ground. Adults emerge in about 10 days and initiate a second generation. Adults of the second generation usually seek hibernation sites in September.

The elm flea beetle, *Altica ulmi* Woods, feeds on elm from southern Ontario to the Maritime provinces and in the northeastern United States. Periodically it has been quite abundant in southern Ontario and leaf loss has been severe over large areas.

Elm flea beetle larva



Elm flea beetle feeding

There is one generation a year. The adults overwinter in sheltered locations near or on the trees, emerge as the buds are swelling, and chew holes in the developing leaves. Following mating, eggs are laid, usually singly, on the underside of the leaf in the junction of major and lateral veins. Mating occurs several times and large numbers of eggs are laid. Larvae, present from early June until late August, skeletonize the lower leaf surface. They change to pupae and adults in the soil. The adults emerge in late summer and chew holes in the leaves, feeding in that manner until early fall.

Because leaf damage may be quite severe and may recur in succeeding years, control measures are frequently required and are justified on ornamental trees. Stomach poisons applied against early larvae, contact poisons against larval aggregations on the trunk, and systemic poisons have all been effective.

# Beetle adults

Rose chafer

**Other beetle adults found on elm:**
**June beetle, page 42**
**European snout beetle, page 129**

The rose chafer, *Macrodactylus subspinosus* (Fabricius), is widely distributed in the eastern United States and Canada. The adult beetles, about 9 mm long, feed sporadically on a wide variety of plants, including many forest and shade trees. They appear in late May or June and feed initially on opening buds, later on flowers or fruit, and finally on leaves, which they skeletonize. When abundant, feeding adults can cause considerable damage to plants. They lay their eggs in the ground, preferring light, sandy soils. The larvae are small white grubs, long-legged and C-shaped. They feed mainly on the roots of grasses but are known to feed on the roots of tree seedlings as well. The larvae overwinter in the soil and change to pupae in the spring.

Because the occurrence of swarming adults is usually unpredictable, the need for control measures cannot be anticipated. However, insecticides are available commercially for control of leaf chafers if large numbers of the beetles are detected on ornamental trees.

# Gall aphids and gall mites

Woolly elm aphid

Woolly apple aphid

Elm cockscombgall aphid

Elm leafgall mite

Four kinds of leaf galls occur commonly on elm and characteristic galls serve to identify individual species. Three of these galls are caused by aphids and one by mites:

Woolly elm aphid , ......... *Eriosoma americanum* (Riley)
Woolly apple aphid , .......... *E. lanigerum* (Hausmann)
Elm cockscombgall aphid ,........ *Colopha ulmicola* (Fitch)
Elm leafgall mite , ............... *Aceria ulmi* (Garman)

The aphids have complicated life cycles; usually two or three generations feed on elm and other generations feed at various locations on a different host. All three species pass the winter in the egg stage in bark crevices. The eggs hatch in the spring and the wingless female of this early generation seeks young developing leaves in which to initiate a gall.

Elm leafgall mites form tiny wart-like galls on the upper surface of the leaf, with a hairy opening on the lower surface. In early summer these are filled with microscopic worm-like creatures. By midsummer these galls are empty as the mite adults have left to seek overwintering niches on the tree.

The amount of injury caused by these gall makers is usually of little consequence. However, large numbers of the woolly aphid galls on trees around the home are unsightly and adults of winged generations are sometimes a nuisance. Handpicking and destroying the distorted leaves and aphids in early spring, where feasible, would be the most effective control for these concealed feeders.

# Elm casebearer

Elm casebearer

The elm casebearer, *Coleophora limosipennella* Duponchel (=*ulmifoliella* McDunnough), is a native insect that has on a few occasions caused severe leaf browning on elm in southern Ontario. It is also a pest in the northeastern United States and as far west as Michigan. All species of elm are attacked.

There is one generation a year and winter is spent as a tiny larva inside a case that is firmly attached to a twig. About the time the leaves begin to appear, the insect moves to a leaf and attaches its case there. The larva mines the leaf area around the case, extending itself as far as it can while retaining its case attachment. The change to a pupa occurs inside the case, which is about 6 mm long. The tiny silvery-flecked moth emerges in July. The eggs are laid on the underside of the leaf and the larvae, on hatching, mine the leaf. The first case is constructed from the leaf tissue covering the mine. At the onset of cooler weather the casebearer moves from the leaves to the twigs where it remains over winter.

If control of the elm casebearer becomes necessary, consult the forestry center in your area (page 11).

# Elm non-leaf feeders

European fruit lecanium

European fruit lecanium eggs

European elm scale

Other scales found on elm:
Scurfy scale, page 55
Putnam scale, page 54
Cottony maple scale, page 137
Oystershell scale, page 229

Immobile mound- or popcorn-like objects on bark. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Scale insects, page 186

Insects less than 4 mm long in series of shallow tunnels between bark and wood . . . . . . . . . . . . . . . . . . . . . Bark beetles, page 187

Large insects, tunnel under bark and into wood . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Borers, page 189

### Scale insects

No fewer than seven species of scale insects have been reported on elm in Ontario but only one of them feeds solely on elm. All are usually found on the thin-barked parts of the native and introduced host trees throughout their ranges. Small branches and twigs, sometimes completely encrusted with scales, are on occasion killed before infestations collapse.

The European elm scale, *Gossyparia spuria* (Modeer), is an introduced species that feeds solely on elm. Winter is spent as a nymph in large bark crevices; development and feeding begin in early spring when the waxy flocculent white crawlers move out to smaller branches and twigs. Eggs are present under the white-margined females in June and the crawlers are present throughout the tree from July through the winter.

The European fruit lecanium, *Parthenolecanium corni* (Bouché), is probably the most commonly encountered scale because it is found on so many trees and shrubs and because the mature scale is such a prominent object. However, there are a number of species in the genus *Parthenolecanium* that are quite similar, and color and size of the mature scale is so variable, depending on the host, that positive identification is best left to specialists.

The life cycle of all of them is essentially similar. Winter is spent as a second-stage nymph that inserts its sucking mouth parts into the bark. In the spring, as the insect resumes feeding on sap drawn from the tree, growth is rapid. Large numbers of powdery white eggs are produced under the shell in June. The tiny flat oval crawlers move out of the shell in July and settle on the undersurface of the leaves. With the advent of cool weather the crawlers return to the bark of twigs and small branches, insert their sucking mouth parts, and settle there for the winter.

The elm scurfy scale, *Chionaspis americana* Johnson, is similar to the *Chionaspis* species shown on page 55. The red eggs overwinter under the scales and hatch in the spring.

Feeding by scales, which often kills small branches, is seldom noticed until very large numbers are present. When high populations do occur, natural control organisms, especially lady beetles, will usually reduce scale numbers before much damage is done. Where chemical control is necessary, a dormant oil spray applied before leafing occurs or the application of a systemic or contact spray against the crawlers should be effective.

## Bark beetles

Two species of bark beetle have played an essential role in the devastation of elm in the eastern half of North America. They are the native elm bark beetle, *Hylurgopinus rufipes* (Eichhoff), and the smaller European elm bark beetle (page 188), *Scolytus multistriatus* (Marsham). Adults of the two species range in length from 2 to 3.5 mm. Both are responsible for transmitting the fungus *Ceratocystis ulmi* (Buisman) C. Moreau, which causes Dutch elm disease. In northern areas the native elm bark beetle is the primary vector of the disease; in southern areas the introduced species is more important. When either of these bark beetles feed or develop in elm trees infected with the fungus, they pick up fungus spores. When they move to a healthy tree they introduce the spores into it, thereby spreading this virulent disease.

Native elm bark beetles overwinter either as adults in the bark of the lower trunk of living trees or as larvae in the branches of dead trees. Overwintering adults emerge and crawl up the tree to feed on the bark of twigs. They later leave living trees to breed in dead or dying trees, creating characteristic tunnels (page 188). Adults of the following generation emerge in August and fly to living trees. Those beetles overwintering as larvae in dead trees complete development in early summer.

Native elm bark beetle

Smaller European elm bark beetle

Smaller European elm bark beetle tunnel

The smaller European elm bark beetle passes the winter in the larval stage and the adults emerge in June and July. There is usually one generation a year with a partial second generation in southern Ontario. The tunnels of this bark beetle differ markedly from those of the native bark beetle.

There are no satisfactory chemical control measures for general use against these beetles. To reduce adult populations we rely heavily on removal and destruction of breeding material before the adults have emerged.

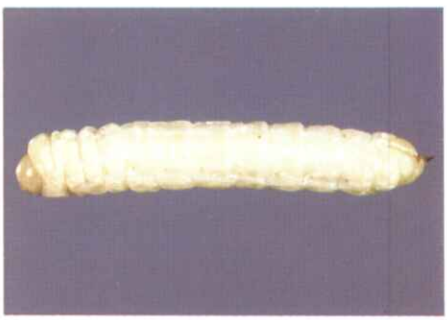
## Borers

A number of borers may be found in elm but most of them are also found in other hardwood trees. However, the elm borer, *Saperda tridentata* Olivier, described below, feeds only on elm throughout the range of this tree in eastern North America and is usually the most common borer in weakened or dead trees.

Native elm bark beetle tunnel

The distinctively marked adults, up to 17 mm long, are present through much of the summer, when they feed on leaves and twigs. Eggs are laid in slits cut in the bark and, on hatching, the tiny larvae bore through the bark to the wood surface, filling the tunnels with fibrous material. The slender, pale, legless larvae with wide thorax and narrow brown head are up to 30 mm long when full grown. Pupation occurs in tunnels in the wood. The life cycle may last 1 or 2 years.

Pigeon tremex adult



Pigeon tremex larva

Elm borer larva

Elm borer adult

Another borer found in elm trees killed by Dutch elm disease, and in other dead or dying hardwoods, is the pigeon tremex, *Tremex columba* (Linnaeus), a member of the horntail family. These large adults, up to 50 mm long, deposit their eggs in the sapwood. The round white larvae, up to 40 mm long, have a tough dark spiny projection on the tail end. They pack the tunnels in the wood tightly with sawdust. These larvae are frequently parasitized by spectacular wasp-like insects (see illustration on page 117, *Insects of Eastern Spruces, Fir and Hemlock*, Forestry Technical Report 23).

Control measures for these borers are not justified.

# WILLOW

Black

Pussy

# Willow: leaf feeders

* The gypsy moth, page 141, hides by day on the trunk and feeds at night.

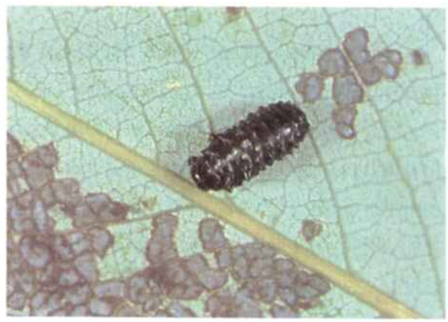
- Leaf feeders
  - Open feeders on leaves
    - Caterpillars with stubby legs on abdomen
      - 7 or 8 pairs of legs on abdomen
        - Sawflies page 196
      - 2 or 5 pairs of legs on abdomen
        - 2 pairs of legs on abdomen
          - Loopers page 199
        - 5 pairs of legs on abdomen
          - Caterpillars page 197
    - No legs on abdomen
      - Small larvae eating layers of leaf
        - Leaf beetles page 193
      - Not larvae
        - Hard-shelled adult insects
          - Leaf beetles page 193
        - Tiny dark or gray insects discoloring leaf
          - Lace bugs page 201
  - Concealed feeders* or not on leaves
    - Tiny insect in wart-like or leafy gall
      - Gall insects page 202
    - Insect not in a gall
      - Tiny larvae in flat blisters on leaf
        - Leaf miners page 200
      - Larvae in rolled or tied leaves
        - Leaf rollers and tiers page 199

# Leaf beetles


Gray willow leaf beetle, p. 194


Larva


Imported willow leaf beetle, p. 194


Larva


*Chrysomela* species adult, p. 195


Larvae


Striped willow leaf beetle, p. 195


Larva

Willow leaf beetle, p. 195

Numerous species of leaf beetles in the family Chrysomelidae feed on the foliage of willow and poplar in North America. Both larvae and adults feed on the leaves; some species eat only the surface layers, while others, at least in the later larval feeding stages, eat entire leaves except the major veins. There are one or more generations a year and the adult beetles hibernate, usually on the ground. If control should be necessary, insecticides registered for use against these insects are available.

Gray willow leaf beetle damage

The gray willow leaf beetle (page 193), *Tricholochmaea decora decora* (Say), has been reported in epidemic numbers on willow in Newfoundland, western Ontario, and the Prairie provinces. The tiny adult beetles emerge from hibernation in late May or early June and begin feeding, often in large groups, on the leaves of willow or poplar. After mating, the females lay their eggs in clusters of about 15. The eggs are covered with fecal matter, and are found at the base of willow bushes, usually on rough bark. The larvae move up to feed on the underside of leaves, which they skeletonize, causing entire bushes to appear gray or brownish in years when the insect is abundant. The larvae complete their feeding about mid-August in Ontario. The full-grown larva (page 193), about 8 mm long, drops to the ground and enters the soil, where it forms a cell in which it changes to a pupa after about 5 days. The adults emerge about 7 days later and feed for a while in the fall on poplar or willow leaves before seeking hibernation sites in protected places near their food plants.

The closely related species, *T. tuberculata* (Say), has been found occasionally in large numbers on willow in southeastern and southern Ontario. It is similar in most respects to the preceding species except that the larvae are uniformly dark in color and the eggs are scattered indiscriminately among the ground debris.

The imported willow leaf beetle (page 193), *Plagiodera versicolora* (Laicharting), was first recorded on this continent about 1911. It is now widely distributed in the eastern United States and Alaska as well as in Canada. Epidemics of these beetles have been reported from Quebec and southeastern Ontario. Although willow is the primary host, feeding may also occur on various species of poplar. Two or three generations may develop in a year. The adults hibernate under loose bark or in debris under the trees; in Ontario they become active in late May or early June. The yellow spindle-shaped eggs are laid vertically on either side of the leaf in groups of 2 to 30. Feeding larvae (page 193), and adults of the various generations, may be found from June to late September. They skeletonize the leaves, causing them to turn brown. When the larva is full grown, about 5.5 mm long, it changes to a pupa on the leaf surface. The pupa is at first yellowish but it darkens quickly to near black and changes to an adult after about 4 days. After a period of feeding, adults of the last generation in the fall go into hibernation.

Another group of beetles found commonly on willow consists of six or seven species in the genus *Chrysomela* (page 193). The larvae of the various entities are similar and the species can usually be identified only in the adult stage. The adults of all these species hibernate, and the feeding habits and life cycles are similar, although the number of generations may vary from one to several. The eggs are laid on the leaves. The larvae feed initially by skeletonizing, but later consume the entire leaf except the major veins. *C. falsa* Brown is the common species in Newfoundland. *C. scripta* Fabricius is an important pest of willow and cottonwood in the Prairie provinces and the eastern United States. *C. aeneicollis* (Schaeffer) has been reported at higher elevations in Alberta. Other species of *Chrysomela* are occasionally found on willow in Canada but serious injury has not been reported.

The striped willow leaf beetle (page 193), *Disonycha alternata* (Illiger), is occasionally abundant on willow shrubs growing on sand or gravel. It is known from eastern Canada west to Alberta and has been reported from South Dakota. In Ontario, the adults apparently overwinter and they have been observed from late May to early September. The eggs are laid in the spring in sand or sandy soil in loose clusters of 15 to 40. The larvae (page 193) feed from late June to late August. The young larvae skeletonize the leaves but older larvae and adults feed from the leaf margin. When the larvae are full grown, about 12 mm long, they drop to the ground where they change to pupae in cells in the soil.

The willow leaf beetle (page 194), *Calligrapha multipunctata bigsbyana* (Kirby), is widely distributed in eastern North America. It feeds mainly on willow and less often on poplar. Large-scale epidemics are unknown. The adult beetles overwinter under surface debris around host trees. They mate in the spring and feed throughout most of the summer, laying their eggs in groups of about seven on the lower leaf surface. The young larvae initially skeletonize the lower leaf surface but later eat the entire leaf, except the main veins. In Ontario, larvae have been found mainly in July. The full-grown larva is about 10 mm long, with black head and legs. The body is white with some small black spots and the abdomen is conspicuously swollen at

# Sawflies

the middle. The larvae change to pupae in cells in the soil and the adults emerge in about 2 weeks. The adults feed on the foliage until the first heavy frost, when they go into hibernation.

Some additional species such as *Altica subplicata* LeConte and *Phratora americana canadensis* Brown are only rarely found on willow in Ontario. Larvae and adults of the former are similar to those of the flea beetle, *A. populi* (page 41). Larvae of *P. americana canadensis* are similar to those of the aspen skeletonizer, *P. purpurea purpurea* (page 41), and the adults are tiny dark metallic green or brown beetles. The poplar-willow leaf weevil (page 41) and the European snout beetle (page 129) also feed on willow.

Sawfly adults, except for the fact that they have two pairs of more or less transparent wings, resemble flies and are only infrequently seen or recognized. However, they are common insects on willow in eastern North America and many species feed on that tree. Most of the species in Canada are in the large Nematinae group, and most of them overwinter in cocoons in the soil or litter. The larvae of this group are less than 20 mm long and have various patterns of black spots and lines. They are usually gregarious feeders, and may be found from June to September. There are also two large sawfly species in the family Cimbicidae that are found on willow. The robust larvae may be up to 45 mm long. One of these, the large willow sawfly, is uniformly green, while the other, the elm sawfly, is variable in color but always has a black central stripe down the back. For information on these large sawflies see page 66.

In the Nematinae group commonly found on willow, only one species has hairy larvae, the hairy willow sawfly, *Trichiocampus simplicicornis* (Norton). The yellow, black-spotted larvae are almost identical with larvae of the poplar sawfly, *T. viminalis*, illustrated on page 50.

The most common species of the smooth-skinned Nematinae on willow in eastern Canada is *Nematus limbatus* Cresson, which has caused noticeable defoliation from Newfoundland to Saskatchewan. Except for an extra row of small black dots the larvae are nearly identical with those of the species *N. fulvicrus* Provancher shown here to represent the group. Another common species is the willow sawfly, *N. ventralis* Say, which has been particularly abundant on some

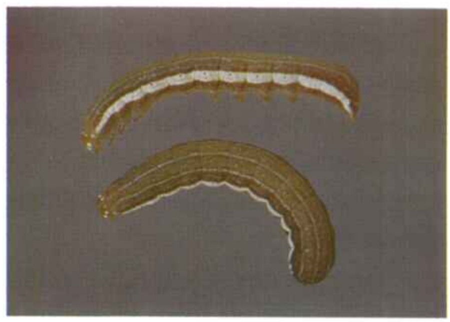
# Caterpillars

*Nematus fulvicrus* larva

occasions in the Prairie provinces. The larvae are similar to those of the closely related poplar-feeding species, *N. hudsoniimagnus* Dyar, illustrated on page 50. The larvae of *N. salicisodoratus* Dyar have black heads and pale bodies with three partial black lines on the back and spots on the side. They feed from July to September.

Two additional species in other genera are sometimes found in Ontario. The larvae of *Pristiphora acidovalva* Wong are pale green with some small dark spots and have pale heads with dark markings. They feed from late May to early July and are about 12 mm long when full grown. Another species, *Eitelius gregarius* (Marlatt), skeletonizes the underside of willow leaves from late June to early September. The larva is gray-green with black lateral spots and the head is pale with variable dark mask-like markings. When full grown the larva is about 10 mm long.

Spotted tussock moth larva, p. 198



Rusty whitesided caterpillar, p. 198

Other caterpillars found on willow:

Larvae with stiff black spines on body

Red hump on back, some short spines .......................... Redhumped caterpillar, page 19

Dark body with red spots on back. .......................... Spiny elm caterpillar, page 175

Larvae with soft hairs

Bluish body with white key-hole markings on back .......................... Forest tent caterpillar, page 19

Row of large creamy white spots on back .......................... Satin moth, page 19

Gray body with two transverse orange and black bars on thorax. .......................... Lappet moth, page 20

Four white hair tufts on back, some long black hair "pencils" .......................... Rusty tussock moth, page 71

Black skin, brownish hair on back, three black hair "pencils" .......................... Alder dagger moth, page 72

Body gray-brown, with blue and red warts on back ............ ................................. Gypsy moth, page 141

Gregarious in silken tent, orange, blue, and black larvae ....... ........................ Northern tent caterpillar, page 245

Larvae without prominent hair or spines on body

Green and brown with long forked tail ..................... ................................ *Cerura* species, page 20

Large, stout, green body with red and yellow warts............ ................................ Cecropia moth, page 105

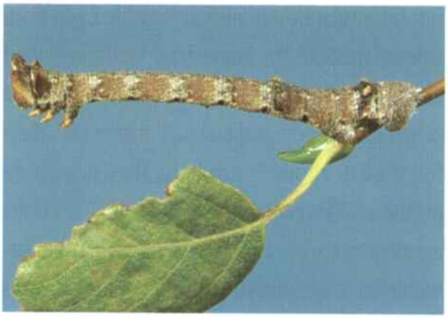
Although many species of caterpillars feed openly on willow foliage, most of them are seen more often on other tree species and, therefore, are dealt with elsewhere in this handbook. Two species that are most common on willow will be discussed here.

The spotted tussock moth (page 197), *Lophocampa maculata* Harris, whose larva is one of the familiar woolly bear caterpillars, has a transcontinental distribution and in Canada is most prevalent west of Ontario. The larva feeds on a wide range of trees but has been collected most frequently on willow, Manitoba maple, birch, and trembling aspen. It is seldom present in sufficient numbers to cause noticeable leaf loss.

Winter is spent as a pupa in a hairy cocoon and the attractive, mottled, winged moths are in flight in late June and early July. The striking larvae, 30 mm long when full grown, are present from July into October but are most common in August.

The rusty whitesided caterpillar (page 197), *Orthosia revicta* (Morrison), has been reported from Newfoundland to the interior of British Columbia and in the northern United States. The larvae are usually solitary feeders on a wide variety of deciduous and some coniferous trees. The pupa overwinters on the ground and the grayish cutworm-type moths are active in early spring. The larvae, about 25 mm long when full grown, have been found from late May to late September but mainly in early summer.

# Loopers

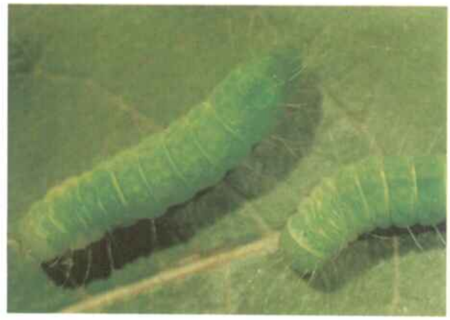


Pepper-and-salt moth larva

**Other loopers found on willow:**
**False Bruce spanworm, page 35**
**Spearmarked black moth, page 79**
**Fall cankerworm, page 109**
**Bruce spanworm, page 109**
**Linden looper, page 109**

Many loopers are general feeders on a number of forest trees and a few species are found in noticeable numbers on willow. Although the host list for larvae of the pepper-and-salt moth, *Biston betularia cognataria* (Guenée), is an extensive one, the insect does show some preference for willow. This looper is widely distributed in Canada and the United States but infestations have been localized and apparently are rare. The pupae overwinter in the soil and the robust, grayish, "pepper sprinkled" moths are in flight in late June and July in Ontario. Larvae have been observed from early July to late September. The length of full-grown larvae varies considerably but may be as much as 50 mm.

# Leaf rollers and tiers



Willow leaftier

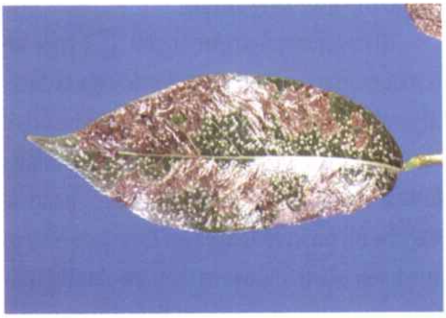
Three insect species are worthy of mention here. The willow leaftier, *Nycteola frigidana* (Walker), occurs across the continent in Canada but is most prevalent in the Prairie provinces. Although it is common, no appreciable injury has been caused. The larvae, usually feeding gregariously, are present in tied leaves from early June to early August and pupae may be found there as early as July.

The spearmarked black moth (page 79) is more common on birch and is described there. *Argyresthia pygmaeella* (Hübner), on the other hand, appears to be specific to willow, although little is known about it. The tiny reddish larvae may be found in rolled leaves from late May to late June; when full grown they are about 8 mm long. The pupae are present in late June.

# Leaf miners

Willow leafminer

Willow leafblotch miner



Willow flea weevil mines

Although many kinds of leaf miner occur on willow they are usually not of great concern. However, the willow leafminer, *Micrurapteryx salicifoliella* (Chambers), has appeared in large numbers in recent years on native willow in northern Ontario. The larvae feed from June to September in blotch mines that are initially pale but later turn brown and are visible from both sides of the leaf. The larvae have well-developed legs on the thorax, three pairs of tiny legs at the center of the body, and one pair at the end. When full grown, about 7 mm long, they change to pupae in silken cocoons on the leaf. The adults are slender dark gray and white moths. The overwintering stage and the number of generations each year are not known.

Another species occasionally common on native willow in Ontario is the willow leafblotch miner, *Phyllonorycter* (=*Lithocolletis*) *kenora* (Freeman). The larvae produce small white round or oval blotch mines on the undersurface of the leaves in summer. The habits and life cycle of this species are probably similar to those of the aspen leafblotch miner, described on page 38. The adults are tiny silvery white moths with glossy fawn and black markings on the forewings.

Although records of the willow flea weevil, *Isochnus rufipes* (LeConte), are scarce for Ontario, the species has occurred in epidemic numbers in parts of eastern Canada and the United States. The tiny black adult beetles, about 2 mm long, overwinter and emerge to feed on opening buds and new leaves in the spring. The larvae produce small individual blotch mines, which often coalesce, on the upper surface of the leaf. The full-grown larva is about 3 mm long, legless and flattened. The body is a dirty flesh color and the head, thoracic shield, and spots on the body are dark brown. The larvae feed from June to early September and change to pupae in the mines. There is one generation each year.

# Lace bugs

There are apparently two species of lace bugs on willow in eastern North America. Epidemics of *Corythucha mollicula* Osborn & Drake have been reported from the eastern United States; epidemics of the willow lace bug *C. elegans* Drake are reported in Canada, particularly in northern Ontario. As the various species of lace bugs are similar, the birch lace bug (page 91) will serve to illustrate the group. Most species have two generations a year and in Ontario adults on willow occur from June to September and nymphs from July to September.

The black spiny nymphs feed in groups on the underside of the leaf. They are equipped with slender beaks for piercing and sucking sap from the leaf. When they are numerous the undersurface of the leaf is speckled with excrement and cast skins of the developing nymphs. The upper surface of the leaf becomes whitened. The adult lace bugs feed in a manner similar to that of the nymphs and both stages are often found feeding together. The adults with their lace-like wing covers are only about 3 mm long. The biology of the willow-feeding species is not well known but it is assumed that the adult is the overwintering stage.

# Gall insects

Pinecone willow gall midge, p. 202

*Pontania* sawfly galls, p. 203

Willow cabbagegall midge, p. 202

Willow twiggall midge, p. 203

Willow beakedgall midge, p. 203

Willow is the host to numerous gall-producing insects and mites, which may be found on leaves, buds, shoots, twigs, and branches. However, they appear to be of little consequence so only the more common species found in Ontario are mentioned. Information on gall development is given on page 15.

The pinecone willow gall midge, *Rhabdophaga strobiloides* (Osten Sacken), produces a green leafy gall, resembling a pine cone or miniature cabbage, on the end of a twig. The legless larvae are tan to orange in color, and are about 4 mm long when full grown. They overwinter singly in grayish galls and pupate in the galls in early spring. The tiny two-winged adult midges emerge as the new willow leaves begin to unfurl and lay their eggs on the new leaves or stem tips. The larvae enter the shoot tips and initiate gall formation there. They feed singly within the developing gall until about early September and remain there over winter.

The willow cabbagegall midge, *R. salicisbrassicoides* (Packard), produces a loose leafy gall. Its life cycle is apparently similar to that of the preceding species.

The willow twiggall midge, *R. salicis* Schrank, is an introduced species that has become established on this continent. It causes the shoot to become distorted and swollen. The adult midges are active in the spring and early summer and lay their eggs on the new shoots. The reddish legless larvae feed in groups in the pith, causing the formation of irregular, elongated swellings up to 30 mm long. The larvae change to pupae in the gall, and after the adult midges emerge the empty pupal cases can be found protruding from the exit holes in the gall.

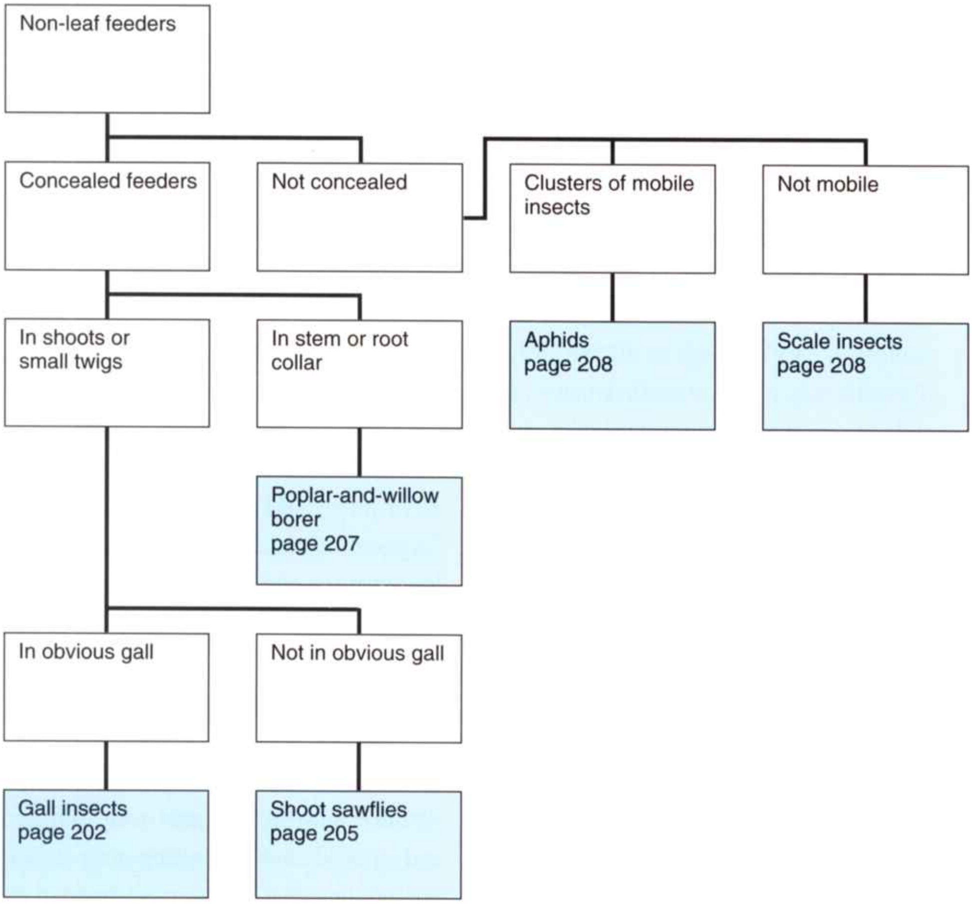
The willow beakedgall midge, *Mayetiola rigidae* (Osten Sacken), is found on many kinds of willow. The orange legless larvae overwinter in the galls in which they developed and change to pupae in early spring. The adult midges emerge in April and lay their eggs singly on or near a leaf bud. Gall development is initiated by the larvae, which then feed singly within the galls until September. These shoot galls are initially green; later they harden and turn red.

A number of species of sawflies in the genus *Pontania* produce small round or oval galls on the leaf. The galls may occur singly or in series on the leaf and may be green, yellow, or red. A single larva feeds in the cavity in each gall. The larvae are pale with a darker head, and legs are present on both thorax and abdomen. Some species are known to have two generations a year. All probably overwinter as full-grown larvae in cocoons, mainly on the ground.

Another group of sawflies in the genus *Euura* produce shoot and twig galls on willow. They occur only rarely in Ontario. The larvae have legs on thorax and abdomen. The life cycle of these gall makers is probably similar to that of a non-gall forming species, the smaller willow-shoot sawfly, discussed on page 205.

Two species of beetle larvae occasionally produce galls on willow. A flat-headed borer, *Agrilus criddlei* Frost, tunnels in the cambium and sapwood causing a swelling on the stem or on larger branches. The larvae are similar to the bronze birch borer larva illustrated on page 95. The poplar gall borer produces swellings and broken bark on smaller branches and stems as described and illustrated on page 61.

# Willow: non-leaf feeders



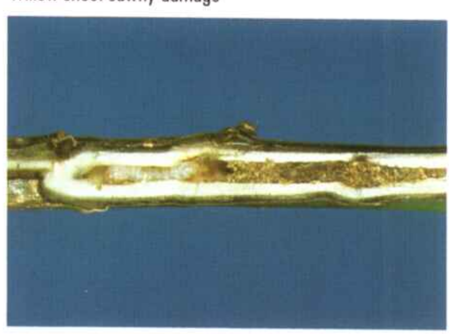
# Shoot sawflies

Two species of shoot-boring sawflies have caused concern in willow and poplar nurseries. The willow shoot sawfly ▭, *Janus abbreviatus* (Say), occurs throughout much of the eastern half of Canada and the United States. It apparently has one generation each year in the north and three in the southern United States. The larvae overwinter in cocoons in the shoots and change to pupae and subsequently to the adult stage in spring or early summer. The adults are small and wasp-like, with a long slender abdomen. At the time of oviposition the female circles the new shoot with a series of punctures made with her ovipositor and lays one or two eggs in additional punctures below the circle. The circular series of punctures causes the tender shoot tips to die and turn black ▭. The young larva initially mines toward the tip but soon reverses and mines down the shoot ▭. It is whitish and typically S-shaped. The thoracic legs are short and fleshy and do not have claws; there are no abdominal legs. There is a brownish, short, tubular prong at the tip of the abdomen. When the larva is full grown, about 10 mm long, it prepares an exit hole for the adult by chewing a hole almost through the bark. It then prepares a cocoon in the shoot tunnel in late fall and overwinters there.

The smaller willow shoot sawfly (▭ page 206), *Euura atra* (Jurine), is reported from the Maritimes to Alberta. It is a pest in tree nurseries because it frequently causes the death of shoot tips. There is one generation a year and the insect overwinters as a full-grown larva in a mined shoot. The change to the pupal stage occurs in early spring and in Alberta the tiny

Willow shoot sawfly adult

Willow shoot sawfly damage



Willow shoot sawfly larva

Smaller willow shoot sawfly damage

slender adult sawflies emerge in late May and early June. The eggs are inserted singly into the new shoots, often near the base. The larvae are greenish-white with black or dark gray shading on the head and they attain a length of about 8 mm. Thoracic legs are well developed and have claws; the abdominal legs, however, are reduced to mere swellings in overwintered larvae. The larvae tunnel in the shoot until late fall when they prepare a cocoon in the tunnel in which to overwinter.

In the past, control of shoot-boring sawflies has been necessary only in tree nurseries and suitable measures for these situations have been developed. However, if these insects should become a problem on planted-out stock, control can be exercised by pruning and destroying the wilted, blackened shoots as they appear. Control of the smaller willow shoot sawfly is more difficult because the injury is not evident until late fall or the following spring and infested shoots would have to be gathered before the adults emerge in the spring.

# Poplar-and-willow borer

The poplar-and-willow borer, *Cryptorhynchus lapathi* (Linnaeus), was probably introduced from Europe. It has become a major pest of willow, but it also attacks some species of birch, alder and hybrid poplars across Canada and the United States. There are few willow clumps that do not show some evidence of current or past injury by this weevil.

Adult

The life cycle can take up to 3 years, with the first winter spent in the early larval or adult stages. Some eggs are laid in the spring but most are laid in the summer and early fall, in holes chewed in the bark, usually in the lower 40 cm of the stem. The larvae initially mine in the bark and indicate their presence there by extruding a fine dark brown dust. Later they bore into the wood, from which they extrude white particles, and direct their tunnel upward. Heavily attacked stems are riddled with tunnels, which weaken them and cause them to break. The robust C-shaped larvae are about 13 mm long when full grown. Change to the pupal stage takes place at the upper end of the tunnel behind a plug of wood chips. The broad adult, with antennae at the end of the short snout, is well camouflaged against the bark of willow.

Larva

Control of damage by this borer on shade trees is best accomplished by vigilant detection of borer activity followed by destruction of the larva. In nurseries the advice of specialists should be sought for currently acceptable measures.

Pupa in damaged stem

# Scale insects

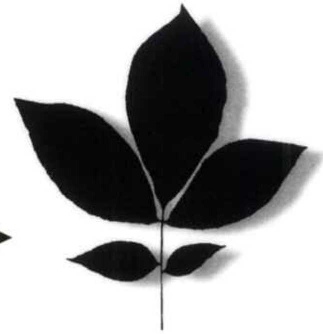
A number of scale insects will be found on willow and in some instances they are responsible for the death of branches. However, most of the scales are general feeders and are described in the sections dealing with their preferred hosts.

The following scale insects have been found on willow:
Scurfy scale, page 55
*Parthenolecanium* scale, page 187
Oystershell scale, page 229

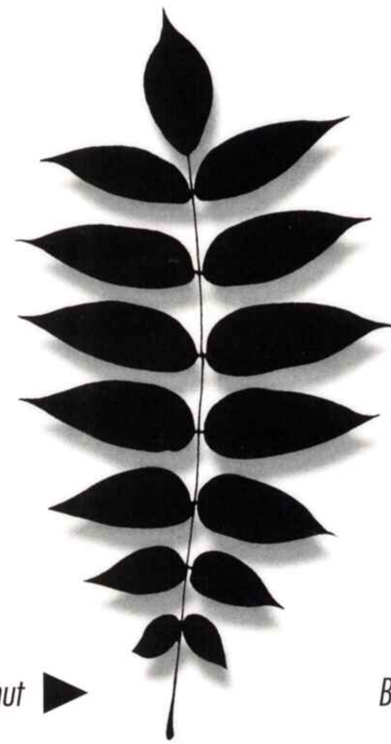
# Aphids

Giant willow aphid

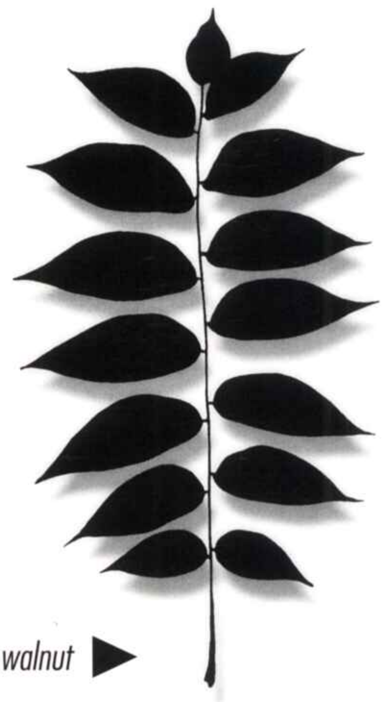
Although a large number of aphid species feed on willow, only two species are common on willow twigs. The largest one, the giant willow aphid, *Tuberolachnus salignis* (Gmelin), feeds only on willow throughout its range. Large colonies of these dark aphids may be found in late summer and fall. Although a number of species of the genus *Pterocomma* feed on poplars and willows, the most common species in Ontario is the black willow aphid, *P. smithiae* (Monell). This dark brown to blue aphid with yellow cornicles is present from May to October.



Shagbark hickory



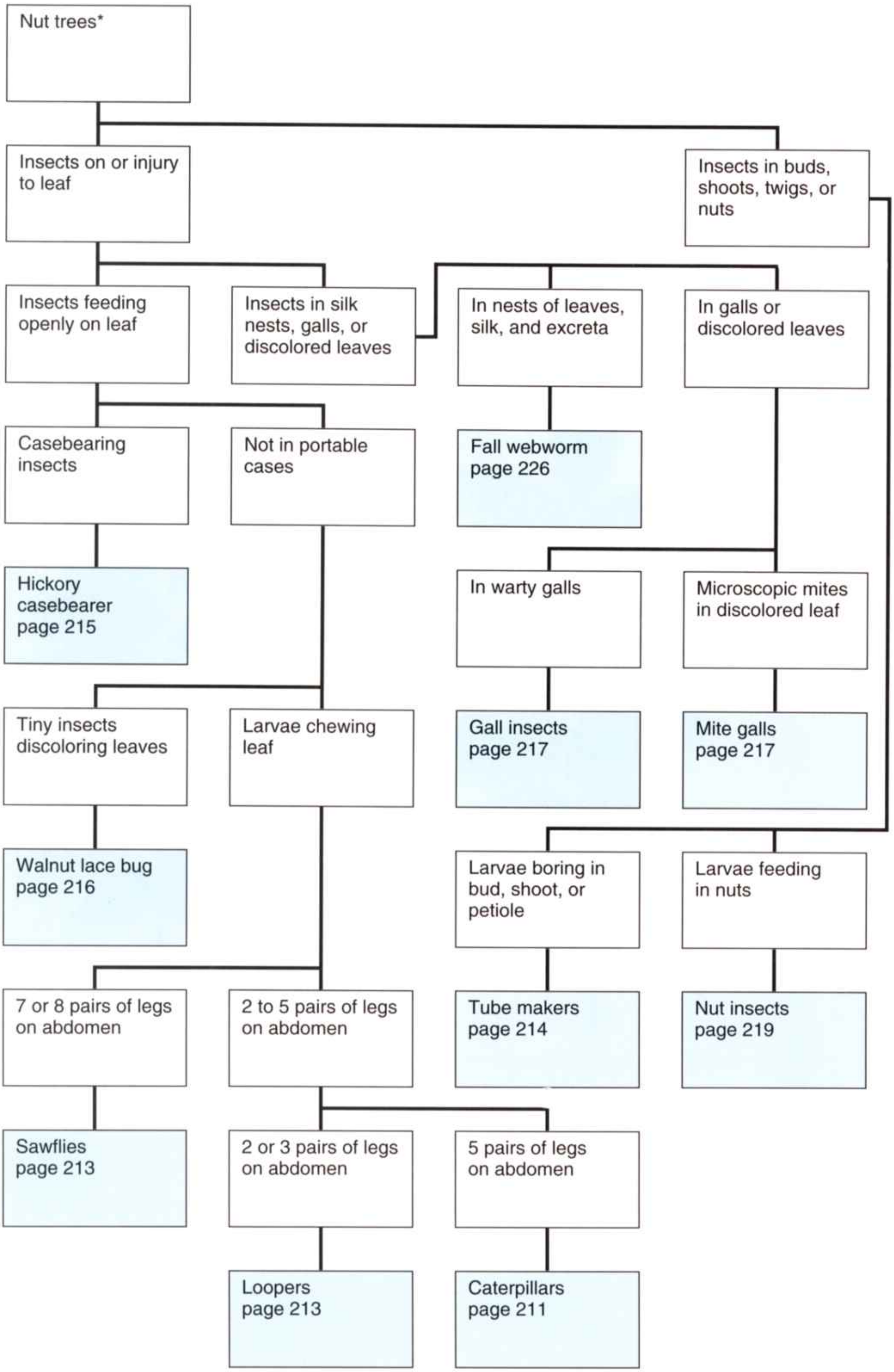
Butternut



Black walnut

# Nut trees

* Walnut, butternut, and hickory trees.



# Caterpillars

* Photo credit W.D. Biggs.

Walnut caterpillar colony, p. 212

Hickory tussock moth colony, p. 212

Walnut caterpillar, p. 211

Larva and cocoon, p. 211

Molting aggregation*, p. 211

The most common species of caterpillar found on nut trees is the walnut caterpillar, *Datana integerrima* Grote & Robinson, which occurs in southern Ontario and much of the eastern United States. Its primary host is walnut but it also feeds on the other nut trees as well as a few other tree species. Single walnut trees or small clumps may be severely defoliated for several consecutive years, and this defoliation may result in branch mortality and, in extreme cases, tree mortality.

There is one generation a year in Ontario. Winter is passed as a pupa in the soil, usually beneath the trees. The adults, cream-gray moths with brown banded forewings, emerge in early summer and lay large clusters of white eggs on the lower leaf surface in late June and early July. The larvae initially skeletonize the leaves but later eat entire leaves. Because they are colonial feeders (page 211) they will eat all the leaves on one branch before moving on to another, usually causing conspicuous damage. The larvae draw further attention by their habit of coming together to molt on the trunk or large branches (page 211). Larvae are present from July to early September and when full grown are up to 50 mm long. The black body, with pale stripes and long pale hairs, and the pose with head and tail ends raised when disturbed, serve to distinguish this caterpillar. Change to the pupal stage occurs in September.

Because severe feeding may continue for a number of years, control measures may be required in some instances. If so, one of the stomach poisons registered for such caterpillars should be applied in July while the larvae are still small.

A closely related species, *D. ministra* (Drury), the yellownecked caterpillar (page 71), which feeds on many tree species, is also found infrequently on nut trees.

The hickory tussock moth (page 211), *Lophocampa caryae* Harris, occurs mainly in southern Ontario in Canada and in much of the eastern United States. Occasionally it becomes abundant on nut trees but at such times it will be common on a number of other broad-leaved trees as well. However, high populations do not persist and little damage results.

There is one generation a year. Winter is spent as a pupa in a furry oval cocoon, usually under debris on the ground. The adults, yellowish moths with a pattern of white spots on the forewing, fly in late May and June and the large, single-layered egg clusters are laid on the lower leaf surface. The larvae are initially gregarious feeders (page 211), skeletonizing the leaf and later consuming whole leaves. They are usually seen in July and August but may also be found in June and September. These attractive larvae, about 40 mm when full grown, scatter before spinning their cocoons.

The redhumped caterpillar, with red head and hump on the back, occasionally feeds in groups on nut trees. It is described on page 19.

# Loopers

A number of looper-type larvae feed on nut trees but they are usually more prevalent on other trees and for that reason they are illustrated and described elsewhere:

Fall cankerworm, page 109
Linden looper, page 109
Elm spanworm, page 110
Spiny looper, page 234

# Sawflies

Butternut woolly sawfly larva

Two kinds of sawflies are occasionally found on nut trees and they can be identified as follows:

Larvae with eight pairs of legs on abdomen and covered with a white woolly material. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Butternut woolly sawfly

Larvae small with seven pairs of legs on abdomen and with no white wool-like covering . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Acordulecera* sawflies, page 148

The butternut woolly sawfly, *Eriocampa juglandis* (Fitch), feeds on the leaves of butternut, black walnut, and hickory in eastern North America. It is not considered a serious pest, although it is sometimes locally abundant. The prepupal larvae overwinter in earthen cells in the ground and change to pupae in the spring. There are probably two generations each year. Adults, small black fly-like insects with two pairs of transparent wings, have been observed from June to mid-September. The larva has a whitish head with black eyespots and the body is covered with a white wool-like waxy material. When full grown the larva is about 18 mm long.

# Tube makers

*Acrobasis angusella* larva

*Acrobasis juglandis* tube

Six species of the genus *Acrobasis* feed in buds, shoots, and leaf stems of nut trees in Ontario. Two of them feed on both walnut and the hickories and the other four feed on the hickories only. These tube makers are relatively unimportant in Canada but are of considerable importance in the eastern United States where pecans are grown commercially. Although all of them seem to have a single generation a year in Ontario, they may have two or three in more southern areas. The larvae of this group are typical moth larvae with three pairs of well-developed legs on the thorax and five pairs of stubby legs on the abdomen. Many larvae are concealed in tubes of silk and dark excreta. Minor differences in habits that may serve to distinguish them are described below.

*A. angusella* Grote on hickory—bores into the leaf stem, constructs a loose tube of excreta.

*A. caryae* Grote on hickory—bores initially into buds and then into shoots, constructs a short loose tube of silk and excreta.

*A. caryivorella* Ragonot on hickory and walnut—bores into shoots and petioles and ties leaves loosely together with silk and excreta.

*A. juglandis* (LeBaron) on hickory and walnut—in tube of excreta, bores into buds and shoots and ties leaflets loosely together.

*A. kearfottella* Dyar on hickory—ties leaflets together and feeds from a white-gray tube of silk with excreta at the ends.

*A. stigmella* Dyar on hickory—initially a budminer, sometimes with loose tube of excreta, later mines in shoots.

The larvae of nut weevils are also reported to feed in shoots and petioles of walnut, butternut, and hickory. Unlike the tube makers, the weevil larvae lack legs and tend to be somewhat C-shaped. Information on this group is given on page 219.

# Hickory casebearer

There is one little-known casebearer, *Coleophora* species, feeding on hickory in southern Ontario. It overwinters on the tree as a partly grown larva in a case and begins feeding on the leaves in spring, mining a small area of the leaf immediately around the base of the portable larval case. The larva completes its feeding in late June or early July, by which time the case is 5 to 8 mm long, deep brown, smooth, and cylindrical. The change to the pupa occurs in the case. When the small moths emerge they lay their eggs on the leaves. The young larvae feed initially as miners but soon construct their first case from the small mined portion of the leaf. With the advent of cold weather they seek hibernation sites on the tree. An unpublished review of North American casebearer moths suggests that the species found on hickory is the pecan cigar casebearer, *C. laticornella* Clemens. Other casebearers are discussed in detail on page 78.

# Walnut lace bug

Walnut lace bug nymphs and adults

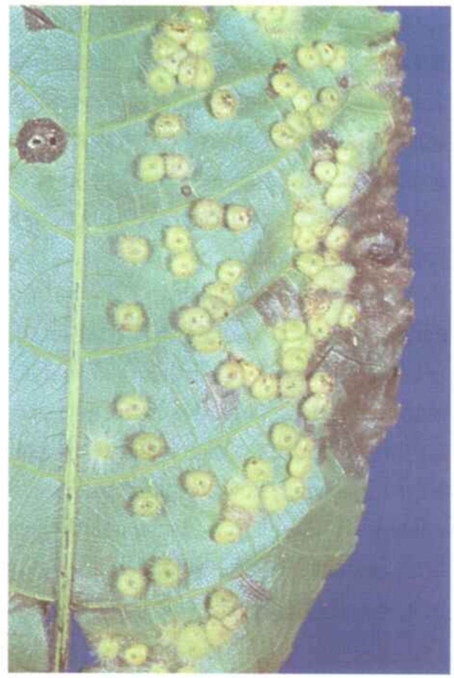
The walnut lace bug, *Corythucha juglandis* (Fitch), can probably be found throughout the range of walnut and butternut in Canada and the United States and occasionally has caused appreciable leaf browning in midsummer.

The adults overwinter in various niches throughout the tree and begin laying eggs on the undersurface of the leaf by early June. Eggs are usually laid singly but may be clustered; however, a cluster may contain the eggs from a number of adults. Adults are about 3.5 mm long. They have been found until late August, but these late adults probably belong to a second or third generation. The tiny black nymphs, about 0.5 mm long, initially feed close together but disperse to some extent when they are full grown and about 2.0 mm long. Although the nymphs feed on the undersurface of the leaf, the upper surface initially becomes mottled with white. Where populations are high the undersurface of the leaf becomes covered with specks of black excreta and spiny cast skins and the leaves turn brown (see lace bug damage to birch, page 91) and are shed early. Nymphs may be present into mid-August.

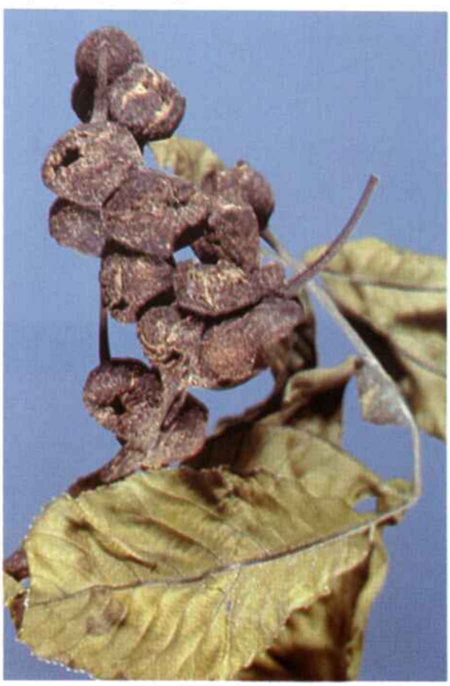
Severe leaf browning does not usually persist for more than a year or two and trees seem able to sustain such damage with little adverse effect.

# Gall insects

*Phylloxera* species leaf galls



*Caryomyia* species galls



*Phylloxera caryaecaulis* petiole galls

*Aceria* species gall

Galls on nut trees are caused by gall aphids in the genus *Phylloxera* and by gall midges, both found mainly on the hickories, and by mites, which occur on all nut trees. Although the galls on hickory leaves are usually small, they are often present in numbers sufficient to distort individual leaflets completely. The *Phylloxera* galls vary in shape from disk-like, globular (page 217), and cone-like on the leaves to nut-like on the petioles (page 217). All these galls contain numerous tiny nymphs and all have a tiny opening through which the mature insect can later escape. The number of generations each year is unknown but it is known that winter is spent in the egg stage. The first nymphs become active as soon as the buds open in the spring and may be found in the galls from late May to mid-July in Ontario.

Midge galls, on the other hand, have a single worm-like larva inside and there is no opening before the adult leaves. The galls can be button-like (*Caryomyia* species galls (page 217)), globular, flask-like, or tubular in shape. Little is known about the life history of these midges.

*Aceria* species mites (page 217), microscopic relatives of spiders, cause galls on petioles and shoots, or on the lower leaf surface. The galls consist of swollen areas covered with pile-like material, which is generally brown in color.

Additional information on galls can be found on page 15.

# Nut insects

Butternut curculio

A number of insect species feed in nuts, particularly beetles in the genera *Conotrachelus* and *Curculio,* commonly known as nut weevils. The adults, with their long beaks, resemble miniature elephants. They vary in length, depending on the species, from about 3 to 8 mm. The pale larvae are legless and tend to be C-shaped.

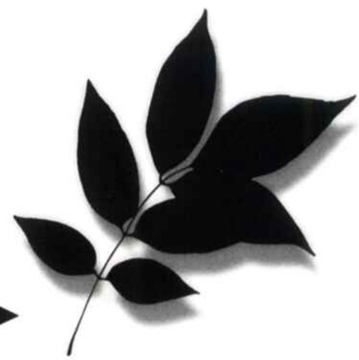
The butternut curculio, *Conotrachelus juglandis* LeConte, feeds in the new shoots, petioles, and nuts of butternut; closely related species feed on other nut trees in Canada. Blackened punctures in the shoots and petioles, caused by feeding and egg laying, are the first evidence of damage. Sunken blackened areas are later found on the developing nuts. Little is known about the life history of this insect in Ontario. Larvae have been found in immature nuts from late June to late July; the change to the pupal stage occurs in the soil. Adults emerge in August and pass the winter in protected locations in the ground litter.

In Ontario, hickory nuts are occasionally attacked by the hickory shuckworm, *Cydia caryana* (Fitch). The moth-type larvae, about 11 mm long when full grown, are present in the husks from early August to mid-September. They presumably fall to the ground with the nuts, change to pupae, and overwinter in that stage.

# Ash

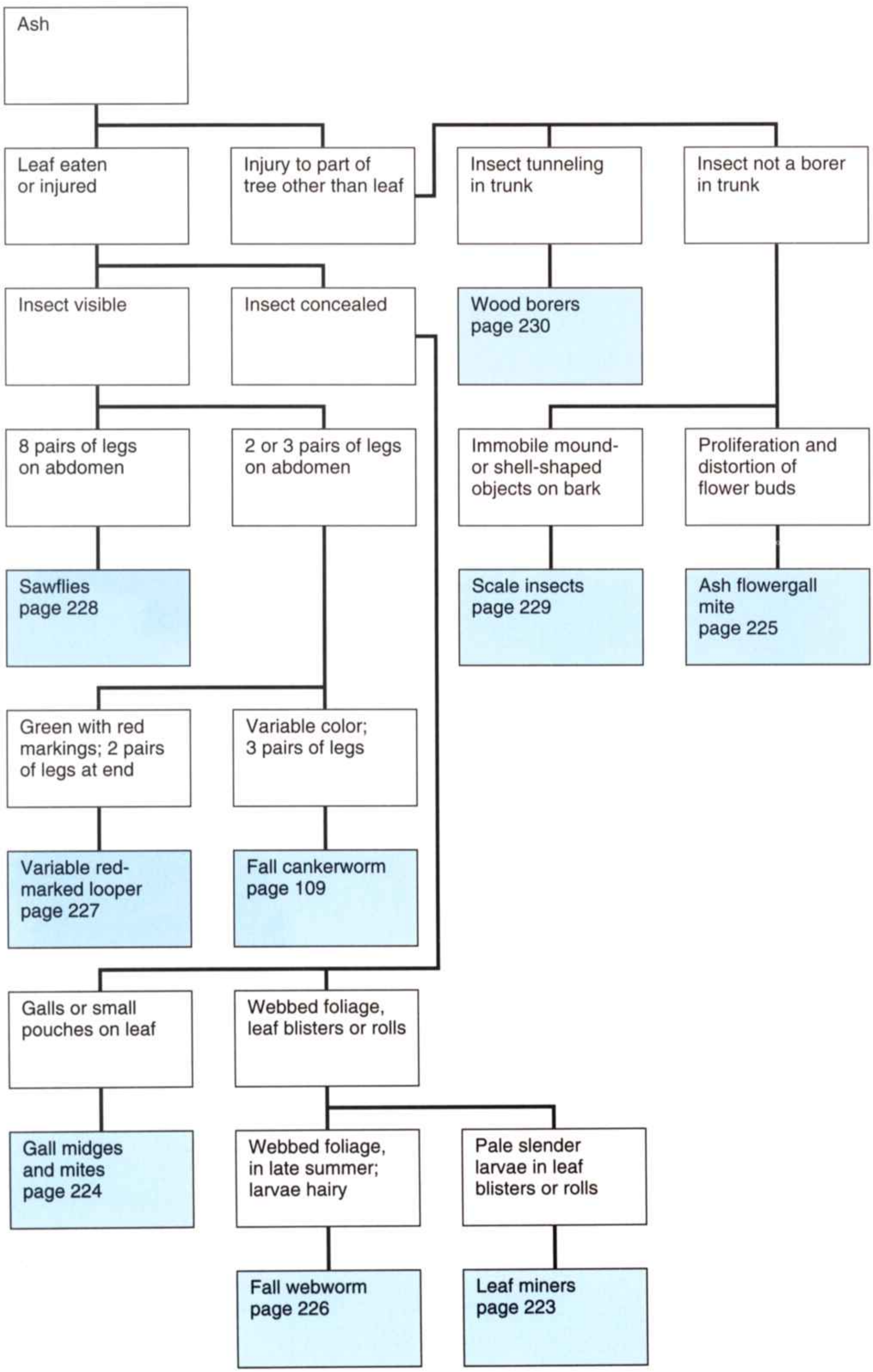
White

Red



Black

# Ash


Ash
Leaf eaten or injured
Injury to part of tree other than leaf
Insect tunneling in trunk
Insect not a borer in trunk
Insect visible
Insect concealed
Wood borers page 230
8 pairs of legs on abdomen
2 or 3 pairs of legs on abdomen
Immobile mound- or shell-shaped objects on bark
Proliferation and distortion of flower buds
Sawflies page 228
Scale insects page 229
Ash flowergall mite page 225
Green with red markings; 2 pairs of legs at end
Variable color; 3 pairs of legs
Variable red-marked looper page 227
Fall cankerworm page 109
Galls or small pouches on leaf
Webbed foliage, leaf blisters or rolls
Gall midges and mites page 224
Webbed foliage, in late summer; larvae hairy
Pale slender larvae in leaf blisters or rolls
Fall webworm page 226
Leaf miners page 223

# Leaf miners

Lilac leafminer

Lilac leafminer roll

At least two leaf miners of the genera *Caloptilia* or *Gracillaria* occasionally disfigure the leaves of ornamental ash trees and one of these species is a major pest of the closely related common lilac. Indeed there are few lilac trees that do not have some mined leaves caused by the lilac leafminer, *G. syringella* (Fabricius), an introduced insect.

Because the lilac leafminer feeds on ash and is more common than the others, it will be treated here. The lilac leafminer has two generations each year. Adults emerge in late May or early June from pupae that have passed the winter in the soil. The eggs are laid in small clusters near vein junctions on the underside of the leaf. On hatching, the larvae enter the leaf, feed in groups, and construct mines. As the mines grow large they appear as buff-colored bladder-like areas in the leaf. Later, the larvae leave the mines and feed together in leaf rolls. The construction of leaf cones or folds by the late stage larvae is typical of most species in this genus. The mature yellow larvae, about 7 mm long, drop on silk threads to the ground to pupate. Second generation moths are present in August and the life cycle is repeated.

When there are many damaged leaves, the tree appears scorched. Damage is seldom severe enough to injure trees permanently and control measures can be justified only on aesthetic grounds. Removing and destroying damaged leaves as soon as they are observed is recommended. However, if control is required, a systemic insecticide applied in early June would be effective.

# Gall midges and mites


Ash midrib gall midge


Ash bullet gall midge


*Aceria chrondriphora*

A number of midge species cause the development of galls in buds and leaves. The most common is the ash midrib gall, from which two species of midges have been reared, *Dasineura tumidosae* Felt and *Contarinia canadensis* Felt, but it is believed that *C. canadensis* forms the gall. Another common gall on ash leaves is the ash bullet gall, caused by the midge *Cecidomyia pellex* Osten Sacken.

The life history of these midges is not fully known. The ash midrib gall midge probably overwinters as a larva in a cocoon in the ground and changes to a pupa in spring. The adult midges emerge and lay their eggs about the time the leaves are appearing. On hatching, the larvae feed in the developing leaves, usually causing a fleshy elongate pouch-like gall along the midvein of a leaflet but sometimes turning the whole leaflet into a gall. There may be more than one white larva, about 2.0 mm long, in each gall. When the leaves are mature the larvae drop to the ground, thereby completing the life cycle.

Two species of eriophyid mites, *Aceria chrondriphora* Keifer and *Aceria fraxinivora* (Nalepa), occasionally cause wart-like galls on leaves or lobed galls on seeds, respectively.

Control measures for these midges and mites are not necessary except for aesthetic reasons.

# Ash flowergall mite

Ash flowergall mite

One of the commonest galls on ash is caused by the ash flowergall mite, *Eriophyes fraxiniflorus* Felt, a tiny primitive worm-like mite 0.5 mm in length. In some years the aborted male flowers, produced as a result of heavy attack by these mites, turn black and remain on the tree after the leaves are shed. They are prominent reminders of the presence of the mite the previous summer. Damage is sporadic, because ash does not produce a flower crop every year.

As with other eriophyid mites, little is known of the life history of the ash flowergall mite and what factors control its numbers. Generally, these mites overwinter as adult females in niches throughout the tree; with the arrival of warm weather they move to the developing flower buds, where they lay their eggs. Two larval stages develop, with a form resembling the adult, followed by male and female adults and further generations. Finally the overwintering female is produced, probably as a result of changes in the food quality.

Control measures have not been necessary to date.

# Fall webworm

Fall webworm

Fall webworm

The fall webworm, *Hyphantria cunea* (Drury), is the most common late summer web maker on a wide variety of broad-leaved trees. Ash trees are usually the first to show a buildup in the relatively frequent infestations that have occurred at different times across much of North America. Although birch, cherry, and elm are other favored hosts in Canada, any tree or shrub that has become partly shrouded in webbing in late summer has probably been attacked by this pest. Several facts are of particular interest: its presence in Europe and Asia as a migrant from America; the great variability in larval color; and the differences in biology which, in the past, were responsible for the belief that two species were involved. It is now known that there are two races of a single species.

The following notes relate to Canada, where there is one generation a year rather than two as in more southern climates. Winter is spent in the litter or soil as a pupa and the adults may be found in June and July. The eggs, laid in masses of 200 or 300 on the underside of the leaf, are covered with white scales from the body of the female. In the course of their gregarious feeding, young larvae skeletonize the upper surface of leaves and produce a small web over them. As the larvae develop the web grows and, where populations are large, whole trees may be enshrouded. Although larvae may be found from late June to October, most are present in August. The hairy, light- to dark-colored larvae with black spots are voracious feeders, consuming most of the leaves inside the web. Ultimately they leave the web and drop to the ground, where they change to pupae, completing the life cycle.

It is highly unlikely that healthy trees will be killed by this webworm, because high populations do not persist for more than 2 or 3 years. Natural control factors, including a host of parasites and predators, as well as disease organisms, appear to be responsible for the collapse of outbreaks. On small ornamental trees, the detection and destruction of small webs containing larvae is effective. A number of insecticides, both chemical and biological, are registered for use against the fall webworm and if it is necessary to use them, they should be applied with sufficient force to penetrate the web.

# Variable redmarked looper

Variable redmarked loopers

The variable redmarked looper, *Melanolophia canadaria* (Guenée), a general feeder on many trees and shrubs, caused heavy defoliation of black ash in one year in Ontario. It has been reported only in low numbers from Nova Scotia to Manitoba and in the eastern half of the United States, where it often feeds with large numbers of the similar *M. signataria* (Walker).

The life history is not well known. The insect is presumed to overwinter in the soil in the pupal stage, and the adults are present from mid-May to mid-June. The egg stage lasts about 2 weeks and the larval stage 6 to 7 weeks. The full-grown larva is about 25 mm long.

No control measures have been necessary to date.

# Sawflies

Spiny ash sawfly larva

Blackheaded ash sawfly larvae

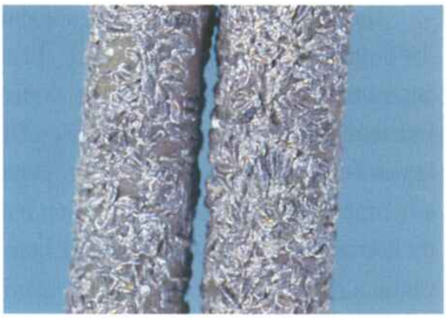
Three species of sawflies are defoliators of ash and the most common one in Ontario is the spiny ash sawfly, *Eupareophora parca* (Cresson). It has a transcontinental range in the United States, and in southern Canada it occurs from the Atlantic Ocean to Saskatchewan. It feeds on all species of ash within its range. Pockets of black ash in northern Ontario have occasionally been severely defoliated by this sawfly.

Little is known of its life history, other than that the adults emerge in the spring and larvae are present from late May to mid-July. Presumably winter is passed in a cocoon in the soil.

The two other sawflies that feed on ash are the blackheaded ash sawfly, *Tethida cordigera* (Beauvais), and the brownheaded ash sawfly, *Tomostethus multicinctus* (Rohwer). To date the former has been more common. In Ontario, larvae of both species may be found from early June to the end of July. The winter is spent in a cocoon in the soil.

No control measures have so far been necessary.

# Scale insects



Oystershell scale

Four species of scale insects feed on ash trees. All of them have a wide geographical range and feed on many different tree species. None of them can be considered a pest in the forest, but they are all pests of individual or small isolated clumps of trees. They often kill branches on a tree and on occasion whole trees can be so weakened by their feeding that they succumb.

A common scale on ash is the oystershell scale, *Lepidosaphes ulmi* (Linnaeus). The insect derives its name from the shape of the scale cover, which is made up of the cast skins of the two nymphal stages and that of the adult. The oystershell scale is an introduced insect of European origin that has been in Canada more than 100 years. Initially it was a major pest of apple, but with active orchard control programs this is no longer the case. The winter is passed in the egg stage under the scale cover. There may be up to 100 tiny white eggs under the scale but the usual number is about 50. Hatching occurs in late May or early June and the tiny flattened crawlers are about 0.3 mm long. They leave the scale and search for a feeding site on twigs or branches, occasionally on leaves or fruit. The first nymphal stage, which has simple eyes, antennae, legs, and segmentation typical of insects, lasts about 2 weeks. The second nymphal stage lasts a little longer and is followed by the adult stage. Most eggs are produced asexually and remain under the scale cover until the following spring.

In spite of numerous parasite and predator species, damage by these scales becomes so severe on ornamental trees that control measures are frequently required. Systemic pesticides have proven effective when applied to developing stages; dormant oils will kill overwintering scales.

Other scales found on ash and treated elsewhere are:
Poplar scurfy scale, page 54
Scurfy scale, page 55
European fruit lecanium, page 186

# Wood borers

Ash borer damage

Two species of moth borers are common in ash as well as in other tree species. Ash trees throughout the Prairie provinces and the United States are commonly attacked by these borers. Open-grown trees are particularly susceptible. The full-grown carpenterworm, *Prionoxystus robiniae* (Peck) (see page 168), up to 70 mm long, is much larger than the ash borer, *Podosesia syringae* (Harris), which is about 25 mm long.

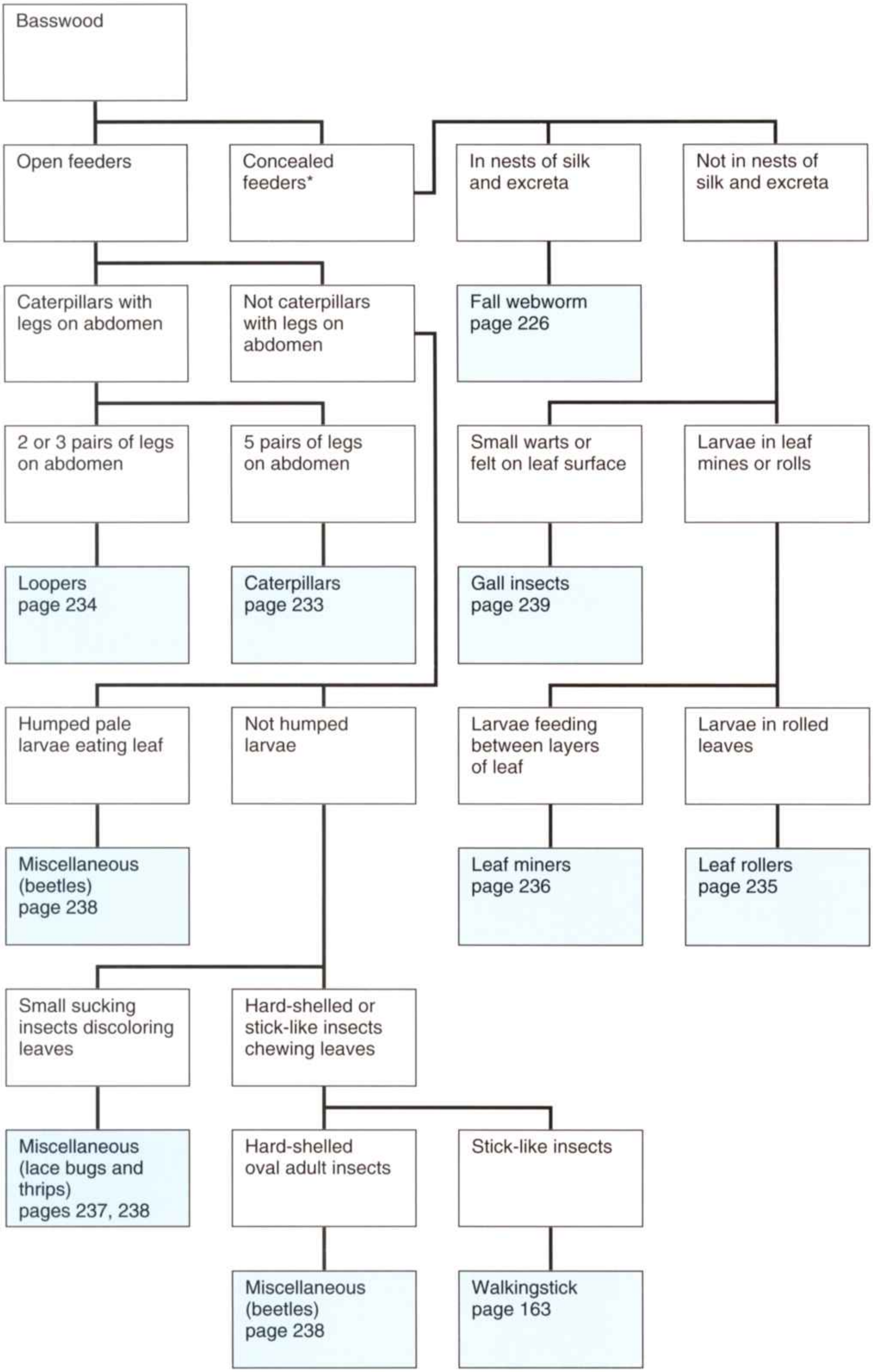
The habits of both species are quite similar in that they tunnel in the trunk and larger branches; damaged trees are reinfested, with most damage occurring near wounds. The larvae of the carpenterworm cause more extensive tunneling injury, extending farther into the heartwood, than the larvae of the ash borer, whose tunnels are more direct and primarily in the sapwood. The carpenterworm requires up to 4 years to complete its life cycle in central Canada and the ash borer 3 years.

Although these borers seldom kill trees, the damage permits the entrance of rot and the trees become more susceptible to breakage by wind. Newly planted trees experience difficulty in becoming established, because they are prone to reinfestation. To prevent attacks on newly planted ornamental trees, the trunks should be wrapped with burlap from May to August for a few years and all wounds should be treated with wound dressing. Badly infested trees should be destroyed; where high value trees have been attacked, bark and larvae may have to be removed from tunnels and the wound covered with dressing.


Basswood

# Basswood

* Borers in bark or wood are discussed on page 240.



# Caterpillars

Rearhumped caterpillar

Yellowbanded underwing larva

The rearhumped caterpillar, *Amphipyra pyramidoides* Guenée, feeds on a wide variety of hardwood trees and shrubs and has been reported from various locations across Canada, particularly in Ontario and Quebec, and also in the United States. Serious feeding injury to trees is not recorded. In Ontario, the larvae feed in May and June and when full grown are about 35 mm long. The adult moth, which has gray forewings and coppery hind wings, is known as the copper underwing. The moths fly in August and September.

The yellowbanded underwing, *Catocala cerogama* Guenée, has been reported from Quebec to Manitoba and in the northeastern United States. Although the larvae are sometimes locally abundant on basswood, serious injury to trees is unknown. They feed in spring and early summer and when full grown are about 50 mm long. The larvae vary in color from light green to gray to brown. The large gray moths, with contrasting yellowbanded black hindwings, fly from August to early September.

Other caterpillars found in basswood:

Forest tent caterpillar, page 19
Speckled green fruitworm, page 19
Yellownecked caterpillar, page 71
Orangehumped mapleworm, page 105
American dagger moth, page 105

# Loopers

Spiny looper

**Other loopers found on basswood:**
**Fall cankerworm, page 109**
**Linden looper, page 109**
**Elm spanworm, page 110**

The spiny looper, *Phigalia titea* (Cramer), occurs on a wide variety of forest trees and shrubs from New Brunswick to Saskatchewan and in the eastern half of the United States. In Ontario, the larvae are found commonly on basswood, elm, maple, oak, and birch, but little feeding injury is reported. Some outbreaks, however, have been reported in the northeastern United States.

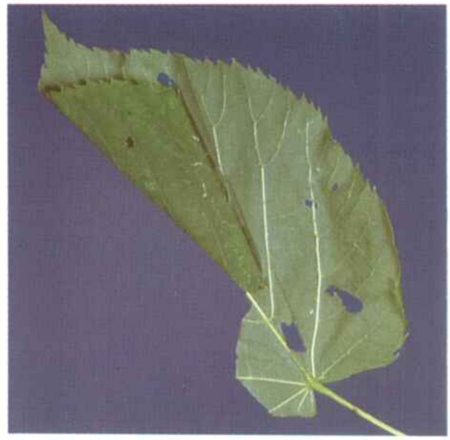
The insect overwinters as a pupa in the leaf litter near or on the soil surface. The adult moths, winged males and wingless females, emerge in early spring. After mating, the female crawls up the tree to lay her oblong eggs on the trunk or branches; the eggs are at first reddish but later turn light green. The young larvae feed on the developing buds and later eat entire leaves except the major veins. In Ontario, the larvae are found mainly in May and June. When full grown, about 37 mm long, they drop to the ground where they change to pupae in the litter.

Natural control factors usually keep numbers of the spiny looper in check. A number of parasites attack the eggs, larvae, or pupae. The carabid beetle, *Calosoma scrutator* (Fabricius), is a known predator on the larvae, and soil insects and rodents are believed to destroy many pupae during the long period they remain in the soil.

# Leaf rollers

Larvae in leaf rolls in spring and early summer. . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . . . . . . . . . . Obliquebanded leafroller, page 29
or Maple-basswood leafroller, see also page 116
Larvae in leaf rolls from late June to late September. . . . . . . . . . .
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Basswood leafroller

The basswood leafroller, *Pantographa limata* (Grote & Robinson), occurs in southeastern Canada and in the eastern United States. Serious feeding injury by the larvae is unknown. Full-grown larvae overwinter on the ground, changing to pupae in the spring. The moths fly from June to August and the larvae live in leaf rolls from late July to late September. When full grown, about 25 mm long, they prepare overwintering cocoons inside folded leaves and drop to the ground with the leaf in the fall.



Basswood leafroller

Maple-basswood leafroller

Basswood leafroller larva

# Leaf miners

Basswood leafminer adult

Basswood leafminer damage

The basswood leafminer, *Baliosus nervosus* (Panzer), is probably present throughout most of the range of basswood, its principal host. It has also been reported on oak, maple, willow, birch, ironwood, apple, and cherry. Although it sometimes occurs in epidemic numbers in the United States, no serious injury has been reported in Canada.

These chrysomelid beetles spend the winter in the adult stage under the forest litter. They emerge in the spring and skeletonize the basswood leaves as they unfold. Soon the eggs are laid, singly, on the leaves. The larvae feed inside the leaf, mainly in July and August, producing gray-green blotch mines. The larva is whitish with a brownish-red head and thorax. Legs are present on the thorax and the body is flattened with lateral V-shaped segmental projections on the abdomen. When full grown, about 6 mm long, the larva changes to a pupa inside the mine. The new generation of adults, small flat wedge-shaped, reddish-yellow beetles, emerge in late

Basswood squareblotch miner

summer. The leaf mines become brown with age and somewhat brittle.

The basswood squareblotch miner, *Phyllonorycter(=Lithocolletis) lucetiella* (Clemens), occurs commonly in the northeastern United States and is occasionally abundant in eastern Canada. Serious injury to trees has not been reported. Two generations a year are believed to occur in Ontario, where larvae have been found in the mines in July and again in September. The mines are transparent, more or less square pale blotches between veins on the underside of leaves, but they are also visible from the upper surface. The pale larva, about 5 mm long when full grown, changes to a pupa in a flat oval cocoon at the center of the mine. The overwintering stage is not known. The adults are tiny strikingly colored moths, silvery white with gold and black markings.

The basswood roundblotch miner, *P. tiliacella* (Chambers), is found commonly throughout the Atlantic states and is known from eastern Canada. The nearly circular mine is white, densely speckled with dark brown, and is found on the upper surface of the leaf. There are two generations a year and the insect overwinters as a pupa in a cocoon inside the mine.

# Miscellaneous

### Lace bugs

The basswood lace bug, *Gargaphia tiliae* (Walsh), occurs in eastern Canada and the eastern and central United States but feeding injury is usually not serious. This insect overwinters in the adult stage and eggs are laid in the leaves of basswood in spring. In Ontario, nymphs and adults feed from about mid-June to late August, piercing and sucking juices from the underside of leaves. This causes a mottling on the upper surface and a fouling of the undersurface

Basswood lace bug

Basswood lace bug excrement

with dark spots of dried excrement . The adult lace bugs are about 4.5 mm long and there are apparently two generations each year.

Other species of lace bugs in the genus *Corythucha,* particularly the walnut lace bug (discussed and illustrated on page 216), also feed on basswood.

### Thrips

Another insect which, by its feeding, causes foliage to discolor is the basswood thrips , *Sericothrips tiliae* Hood. In the 1970s there were epidemics of short duration in southern Ontario. The tiny thrips, about 1 mm long in the adult stage, feed by puncturing leaf cells and sucking the sap as it exudes. The young, in form, resemble their winged adults. Infested leaves darken, curl , dry, and fall prematurely. The life cycle in Ontario is not known because the thrips have been collected there only in May and June, whereas the insect is reported active in August and early September in New York.

Basswood thrips

### Beetles

Leaf beetles in the genus *Calligrapha*  are occasionally found on basswood. They hibernate as adults and lay their eggs on the foilage from mid-May to early June. Throughout early summer the pale humped larvae devour entire leaves except the main veins. When feeding is completed they drop to the ground and change to pupae in the soil. Adults of the new generation are present on the trees from late July to mid-September; they are about 9 mm long, silvery

Basswood thrips damage

*Calligrapha* species leaf beetle

white in color, with a dark green thorax and marking on the wing covers.

Other beetle adults found on basswood:
June beetle, page 42
Chafer beetle, page 42
European snout beetle, page 129
Elm leaf beetle, page 180
Rose chafer, page 182

# Gall insects

Linden wart gall midge

The linden wart gall midge, *Cecidomyia verrucicola* Osten Sacken, commonly causes galls on leaves of basswood in eastern Canada and the eastern United States. In Ontario, tiny white larvae are found in round pale green galls from late June to mid-August. The larvae apparently drop to the ground to pupate. Later the empty galls become brown, hard, and woody. The biology of this species has not been studied and in fact the adult midge is not known. Consequently the scientific name, applied to the gall in 1875, must remain tentative.

The linden gall mite (page 240), *Phytoptus abnormis* Garman, produces a proliferation of fine spindle-shaped galls on the upper leaf surface. Early in the summer numerous microscopic worm-like mites with two pairs

# Borers in bark or wood

Linden gall mite

Linden bark borer larvae

of legs can be found in the galls. The adult mites leave the galls later in the summer to find hibernation sites on the tree.

For additional information on galls see page 15.

## In bark

The linden bark borer, *Glyphipteryx linneella* (Clerck), an introduced European species, was first reported on this continent near New York City in 1928. The only records of its distribution are from St. Catharines and Ottawa in Ontario and from New Jersey and Massachusetts. The larvae feed only on planted European linden.

The partly grown larvae overwinter in the bark, which may be riddled with tunnels. In early spring, when the larvae are full grown and about 6 mm long, they change to tiny pale yellow-brown pupae in the bark. In Ontario the tiny, dusky moths are present mainly in June although a few have been observed in early August. They are conspicuously marked; a yellow-orange oval encloses a number of silver spots on the narrow forewing and the antennae are tipped with white.

Honeycombed bark may be found on the stem from ground level to high in the crown. Usually the first evidence of the presence of the borer is the occurrence of fine grains of larval excreta in bark fissures. Control of the linden bark borer is difficult, so if it becomes necessary the advice of a forestry specialist should be obtained.

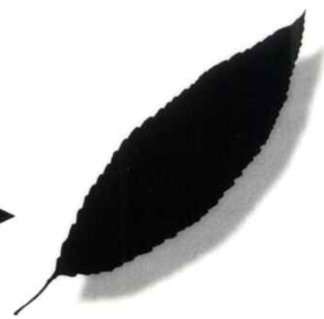
### In wood

Recent reports indicate that the linden borer, *Saperda vestita* Say, is capable of killing established shade trees. The life history of this species would be similar to the roundheaded apple tree borer, page 282.

# CHERRY

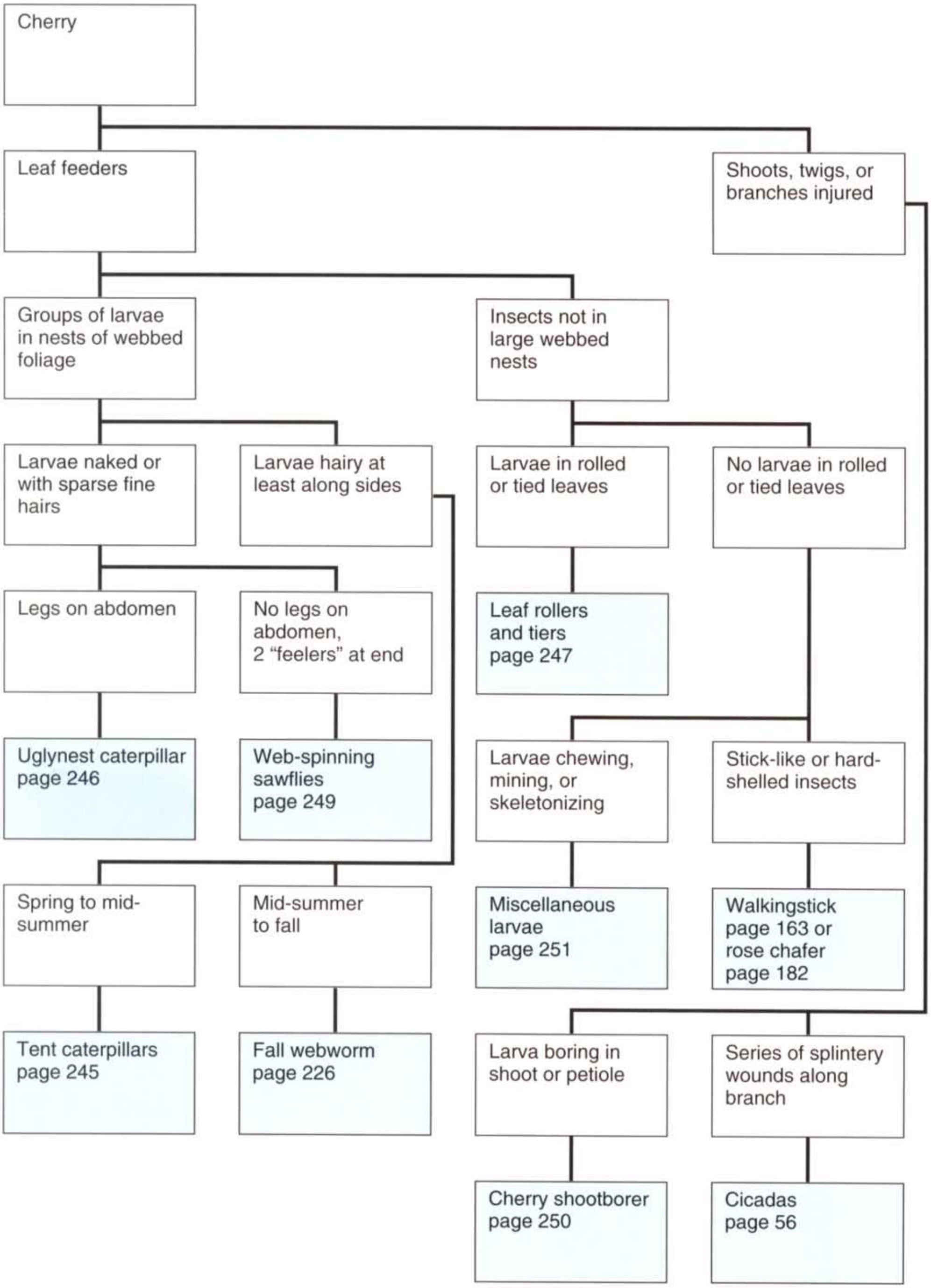
Pin

Black



Choke

# Cherry


Cherry
Leaf feeders
Shoots, twigs, or branches injured
Groups of larvae in nests of webbed foliage
Insects not in large webbed nests
Larvae naked or with sparse fine hairs
Larvae hairy at least along sides
Larvae in rolled or tied leaves
No larvae in rolled or tied leaves
Legs on abdomen
No legs on abdomen, 2 "feelers" at end
Leaf rollers and tiers page 247
Uglynest caterpillar page 246
Web-spinning sawflies page 249
Larvae chewing, mining, or skeletonizing
Stick-like or hard-shelled insects
Spring to mid-summer
Mid-summer to fall
Miscellaneous larvae page 251
Walkingstick page 163 or rose chafer page 182
Tent caterpillars page 245
Fall webworm page 226
Larva boring in shoot or petiole
Series of splintery wounds along branch
Cherry shootborer page 250
Cicadas page 56

# Tent caterpillars


Eastern tent caterpillars


Northern tent caterpillars

Three species of tent caterpillars occur on cherry across Canada. There is little overlap in their distribution and for the most part a single species predominates in any one area. The three species have similar life cycles and habits with a single generation each year, and all make tents.

The eastern tent caterpillar ☐, *Malacosoma americanum* (Fabricius), occurs from the Maritimes to Sault Ste. Marie, Ontario, in the southeastern corner of Manitoba, and throughout the eastern United States. The larvae feed primarily on pin cherry, chokecherry, and apple. The eggs overwinter, hatching in early spring. The larvae are gregarious and soon spin a silken tent in a nearby crotch, from which they feed on the leaves. Later, until the end of June, they may be found in or on larger tents on trees or bushes. When they are full grown, about 50 mm long, they wander away from the nest to pupate. Pupation occurs in tough silken cocoons dusted with a yellowish powder, on stems of trees, in brush or debris on the ground, on fences or on buildings. The adults, chocolate-brown moths with a pair of oblique white lines on the forewing, fly in late June and July in Ontario. The eggs are laid in compact oval masses, often on stems near the ground, or on twigs or branches.

The northern tent caterpillar ☐, *Malacosoma californicum pluviale* (Dyar), previously called the western tent caterpillar, is reported from Quebec, north and west of the Great Lakes in Ontario, across the northern Prairie provinces to British Columbia. It has also been collected from a few localities in the northeastern and northwestern United States. In Canada, the northern tent caterpillar feeds mainly on pin cherry and willow, but also on chokecherry, white birch, aspen, apple, and others. Lateral areas of the larvae are mottled orange and black with some blue color. This species has a more northern distribution than the eastern tent caterpillar and the larvae are usually found later, from June to late July.

# Uglynest caterpillar

The prairie tent caterpillar, *Malacosoma californicum lutescens* (Neumoegen & Dyar), is found in the Great Plains area of Canada and the United States. The primary host in the Prairie provinces is chokecherry but the larvae also feed on rose, currant, willow, and other plant species. The larvae can be distinguished from those of the northern tent caterpillar by the conspicuous blue-gray lateral areas of the body. Feeding larvae may be found from May to about mid-July. The moths fly in early August.

Tent caterpillars can be controlled in recreational areas or on ornamental trees by destroying the egg masses in late fall or winter when they are readily detected on stems or branches. On cold cloudy days, the tents with the larvae inside can be removed and destroyed. Bacterial insecticides now available commercially may be used as biological control agents against young larvae. A number of chemical insecticides are also registered for use against tent caterpillars.

Uglynest caterpillar tent

The uglynest caterpillar, *Archips cerasivorana* Fitch, is found commonly throughout Canada and the United States. In Canada, the primary host is chokecherry but the caterpillars also feed on pin cherry, black cherry, and on occasion a number of other plants. The eggs overwinter on the food plant. The larvae live, often in large numbers, in tents or nests of foliage, silk, and excreta from May to September. The larvae may be light or dark yellow-green with black head, thoracic shield, and legs. When they are full grown, about 22 mm long, the larvae change to pupae in the nest, usually in close proximity to one another. Pupae are found from about mid-June to September. The moths, dull orange with small brown markings, are active

# Leaf rollers and tiers

from late June to September. Control of this insect can be effected in most situations by pruning and destroying the nests while the larvae or pupae are still inside.

Cherry nesting geometer, p. 248

Leaf shelter

Cherry leafcone caterpillar, p. 248

Chokecherry leafroller

Of the five species in this group the most common one is the cherry nesting geometer (page 247), *Hydria prunivorata* (Ferguson). It is found in Nova Scotia, southern Quebec, southern Ontario, and the northeastern United States. The primary host tree is black cherry. Severe outbreaks have been reported from southern Ontario, New York, and Pennsylvania. A New York study suggested that trees weakened by geometer feeding were often attacked and killed by the peach bark beetle, *Phloeotribus liminaris* (Harris).

This geometer overwinters in the pupal stage in the forest litter. The moths, with a characteristic wing pattern of alternating brown and white transverse wavy lines, are known as scallop shell moths. They emerge throughout the summer season, with a peak in June. The eggs are laid in tiered masses one to four layers deep on the underside of leaves. The larvae feed in groups, in shelters made by tying leaves together (page 247), from July to early October. When they are full grown, about 21 mm long, they drop to the ground and change to pupae in the litter.

Naturally occurring parasites, predators, and disease are probably important in keeping populations of the geometer in check. An egg parasite, *Telenomus* species, was responsible for terminating outbreaks studied in New York State. Unsightly nests and larvae on trees grown as ornamentals can be handpicked and destroyed. Chemical control of the concealed larvae is difficult and a forestry specialist should be consulted before it is attempted.

Although the cherry leafcone caterpillar, *Caloptilia invariabilis* (Braun), is known from scattered localities across Canada, it is apparently common only in Ontario. Pin cherry is the usual host, although occasionally this caterpillar feeds on other species of cherry. Serious feeding injury is unknown.

The young larvae feed in linear mines ending in a small underside blotch in the spring. Later they leave the mines and are found in leaf cones, which they make by rolling the leaf from the tip with the underside in. In Ontario, the cream-green larvae, about 8 mm long when full grown, are found in the cones from early June to early August. They change to pupae in cocoons outside the cone. The slender moths with their deep saffron-colored wings emerge in late July or August.

The obliquebanded leafroller and the fruittree leafroller are two more species of leaf rollers or tiers occasionally found on cherry. The larvae of the former are quite variable in color but both are usually green with black heads. For information on these species see page 29. The chokecherry leafroller, *Sparganothis directana* (Walker), is another black-headed species but it is uniformly dark olive green on the upperside of the body and pale on the underside.

# Web-spinning sawflies

The larvae feed primarily on chokecherry in late May and June and are about 17 mm long when full grown. The larvae of *Argyrotaenia quadrifasciana* (Fernald) are green and grow to about 14 mm; they tie the leaves of cherry and serviceberry in early summer.

The cherry leaffolder, *Ancylis burgessiana* (Zeller), is found mainly on pin cherry in Ontario but rarely in large numbers. The pale larvae have a pair of lateral dark spots on the thoracic shield. In late August and September they skeletonize the inside of leaves that they have folded and tied with silk. The full-grown larvae are only about 10 mm long.

Plum webspinning sawfly larva

Two species of webspinning sawflies in the genus *Neurotoma* feed on the foliage of cherry and closely related tree species. The larvae have no legs on the abdomen but have a pair of pointed appendages situated laterally on the end segment. The two species can be separated on the basis of larval head color as follows:

Head yellowish.................... Plum webspinning sawfly
Head black ...................... Cherry webspinning sawfly

The plum webspinning sawfly, *N. inconspicua* (Norton), is found across Canada from Quebec to British Columbia and in the northeastern and north central United States. In Ontario, it is found most often on pin cherry but also occasionally on other cherries. The adults, four-winged "flies" with transparent wings, appear in spring as the leaves are expanding. The elongate yellowish eggs are laid end to end in rows on the underside of the leaf along the midrib or petiole. Feeding larvae may be found in groups from late June to early September, often enclosing entire branches with their webbing (page 250). When full grown, about 17 mm long, they drop to the ground and enter the soil to depths ranging from 2.5 to 25 cm depending on soil texture and hardness. The larva spends the winter in a cell in the soil.

# Cherry shootborer

Webbed leaves

Cherry shootborer damage

The cherry webspinning sawfly, *N. fasciata* (Norton), is restricted to the northeastern United States, Quebec, and Ontario. It occurs only occasionally in Ontario, mainly on pin cherry. The life cycle appears to be the same as that of the plum webspinning sawfly, although a second smaller brood has been reported from New York.

Control measures are usually not necessary for the web-spinning sawflies on cherry. However, in recreational areas or in plantings, the nests and larvae can usually be stripped or pruned from trees or bushes.

The cherry shootborer, *Argyresthia oreasella* Clemens, is a little-known pest reported from Quebec to Alberta, and in the northeastern United States. It is occasionally abundant in small areas of Ontario, where the larvae feed in shoots or petioles of cherry, serviceberry, and hawthorn. The larvae are small, about 7 mm long when full grown. They feed inside the new shoots from May to mid-June, causing the leaves at the tips of shoots to droop and darken. The larvae change to pupae in June or early July. The tiny adults, silvery-white moths with dark gold markings on the forewings, fly in late June and July. The shootborer can be controlled in urban plantings or recreational areas by clipping and destroying infested new shoots in late May.

# Miscellaneous larvae

Large caterpillars

Green with red and yellow warts .......................... .......................... Cecropia moth larvae, page 105

Variously colored, slightly hairy .......................... ......................... *Acronicta* species larvae, page 176

Small slug-like dark larvae skeletonizing leaf................ .................................. Pear sawfly, page 280

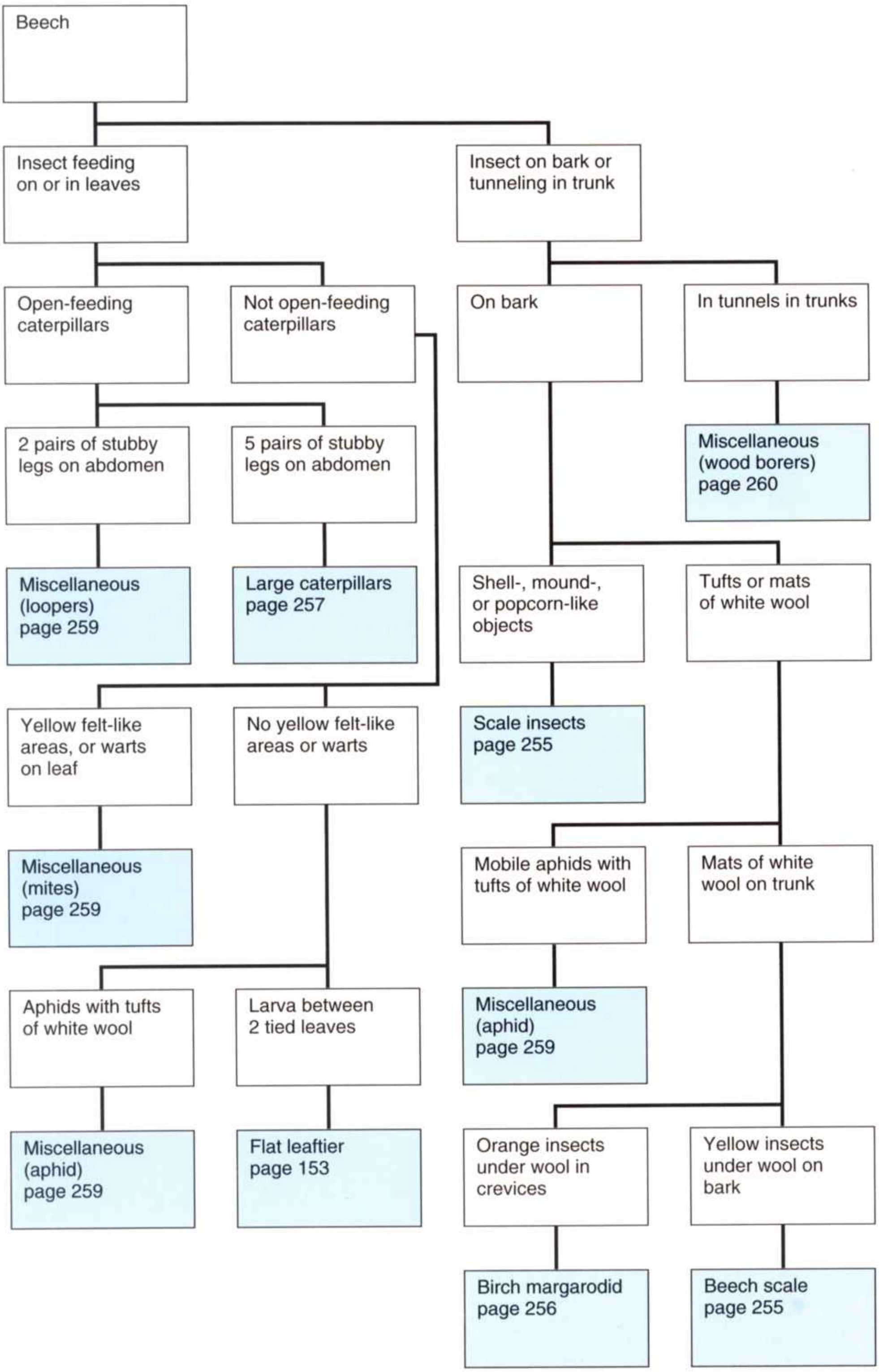
Small larvae in portable brownish cases making small circular mines in leaf .......................... Cherry casebearer

The cherry casebearer, *Coleophora pruniella* Clemens, is found occasionally on pin cherry and black cherry and a number of other hosts in eastern North America. In recent years there have been infestations on trembling aspen and balsam poplar in the Maritimes and Ontario. These infestations had been attributed to *C. innotabilis.* There is one generation a year of *C. pruniella* and the species overwinters as small larvae in portable cases at the crotch of a twig or branch. The larvae move to the leaves in spring, and feed by mining a small area around the case each time they move on the foliage until late June, when they change to pupae in the larval cases. The tiny moths emerge in July or early August and lay their eggs on leaves. The young larva mines the leaf for a short period before constructing its first case from the mined portion of the leaf. With the onset of cold weather it seeks a hibernating site on the twig or branch.

Cherry casebearer

Beech

# Beech


Beech
Insect feeding on or in leaves
Insect on bark or tunneling in trunk
Open-feeding caterpillars
Not open-feeding caterpillars
On bark
In tunnels in trunks
2 pairs of stubby legs on abdomen
5 pairs of stubby legs on abdomen
Miscellaneous (wood borers) page 260
Miscellaneous (loopers) page 259
Large caterpillars page 257
Shell-, mound-, or popcorn-like objects
Tufts or mats of white wool
Yellow felt-like areas, or warts on leaf
No yellow felt-like areas or warts
Scale insects page 255
Miscellaneous (mites) page 259
Mobile aphids with tufts of white wool
Mats of white wool on trunk
Aphids with tufts of white wool
Larva between 2 tied leaves
Miscellaneous (aphid) page 259
Miscellaneous (aphid) page 259
Flat leaftier page 153
Orange insects under wool in crevices
Yellow insects under wool on bark
Birch margarodid page 256
Beech scale page 255

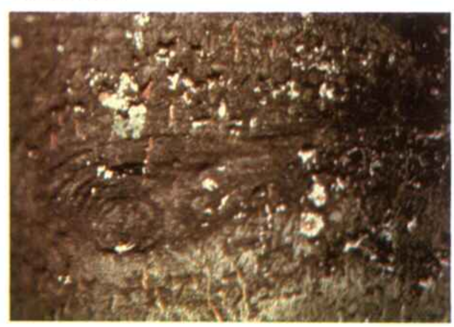
# Scale insects

* The account and illustrations of the beech bark disease and scale were kindly supplied by W.R. Newell of the Atlantic Forestry Centre.

The beech bark disease is attributed to the beech scale* , *Cryptococcus fagisuga* Lindinger, and the fungus *Nectria coccinea* var. *faginata* Lohm., Wats. & Ay. Although other *Nectria* fungi have been found in association with this scale, *N. coccinea* var. *faginata* is the most common one in North America. The disease, of European origin, was first reported in 1920 in Nova Scotia and now affects about 80% of the beech in the Maritime provinces. It also occurs in areas of southern Quebec, near Toronto, and in the northeastern United States. The first sign of injury is the presence of wool-like waxy material on the bark; severely infested trees have white felt-like patches.

The beech scale has one generation a year; reproduction is asexual and males are unknown. In North America the scale overwinters as a partly grown nymph beneath a covering of white wool-like wax with its sucking mouth parts (stylet) inserted in the bark. The pale yellow mature insect appears in early summer. It is almost spherical, about the width of a pinhead. Eggs are laid in late June and July and hatching usually begins in August. The young nymph is motile until early autumn when it inserts its stylet into the bark and secretes the white, wool-like covering . The insect alone is not known to cause tree mortality but undoubtedly it reduces vigor. Moderate or severe infestations are usually followed by *Nectria* fungus infections. The fungus apparently infects the tree through tiny ruptures in the bark created by the shrinkage of cells on which the scale has fed. The fungus kills bark tissue, cambium, and sapwood, thereby disrupting the transport and storage of food within the tree. Dead areas merge and some trees may die 1 or 2 years after infection. Vigorous trees often produce callus tissue around infected areas and crater-like cankers  are formed, reducing the commercial value of the wood.

Cankered stem



Beech scale with white wool covering

*Nectria* fruit bodies

A year or two after the bark is infected the fungus produces clusters of reddish, lemon-shaped fruit bodies (reproductive structures), about 1 mm in diameter. The fruit bodies mature in the fall and whenever sufficiently moistened, release spores. They continue to do this the following summer whenever conditions are suitable. The fungus also produces other types of spores, which are possibly spread to other trees by wind and rain. The scale insect usually disappears when the *Nectria* fruit bodies appear.

Control of the disease in the forest is not practicable. However, the removal of heavily scale-infested trees in the early stages of an outbreak will check its spread. Furthermore, heavily infested stands should be salvaged during winter months to prevent the spread of the insect. Ornamental beech trees can be protected in the spring by scrubbing trunks and branches with a strong solution of kitchen detergent or spraying with a lime sulphur solution.

Another scale insect on the trunk of beech is the birch margarodid, *Xylococculus betulae* (Pergande), which, as the common name suggests, is also found on birch. The orange-red globular females, covered with waxy material, are found deep in bark crevices and lay their eggs there. The emerging crawlers move elsewhere in the crevice, insert their sucking tube into the bark, and extrude wax around themselves. Each crawler produces a long hair-like wax tube, up to 50 mm long, through which it excretes honeydew. Repeated feeding enlarges the crevices and the surrounding bark becomes swollen. A characteristic fissure develops in the bark.

**Other scale insects found on beech:**

Popcorn-like .................. Cottony maple scale, page 137
Brown mounds ............ *Parthenolecanium* scales, page 187
Shell-like ....................... Oystershell scale, page 229

# Large caterpillars

Defoliation by saddled prominent

Adult

Egg

The saddled prominent (page 258), *Heterocampa guttivitta* (Walker), occurs from Nova Scotia to southeastern Manitoba and across the adjacent United States on a wide variety of hardwood trees. Beech and sugar maple are the preferred hosts; in mixed stands of these two species beech is the more severely defoliated.

Sporadic extensive infestations, usually of short duration, have been recorded since 1907 in eastern North America. The most recent outbreak began in Ontario in 1967, moved eastward through Quebec and into the Maritime provinces in 1970, and into the New England states in 1971. Extensive hardwood stands were severely defoliated, usually for 2 years, after which natural control agents caused an abrupt decline in the population. A closely related species, *H. biundata* Walker, and some other hardwood defoliators, particularly the greenstriped mapleworm, may also be present in large numbers during these outbreaks, resulting in defoliation of other associated hardwoods.

The saddled prominent completes one generation a year; the winter is spent as a pupa in the humus layer. In Ontario, the gray-brown adults (page 257) emerge during June and lay their globular, pale green eggs singly on the lower leaf surface (page 257). Eggs have been found from mid-June to early July; before hatching they turn a rusty color. The young larvae have large antler-like projections at the front of the body; these are shed after the first molt and are not replaced. The larvae initially skeletonize the lower leaf surface but as they grow they feed on the leaf edge, consuming much of the leaf except the larger veins. The mature larvae are strikingly marked and are up to 35 mm long when full grown in August. By mid-August the dark brown pupae can be found in the humus under the host trees.

Large aggregations of larvae can often be found at the base of severely defoliated trees. Many of these larvae succumb to disease; others become food for both larvae and adult carabid beetles, *Calosoma* species. Many insect parasites kill eggs, larvae, and pupae of the saddled prominent and small rodents take their toll of pupae. The combined action of all of the above organisms is believed to be responsible for the sudden decline in infestations. However, maple syrup producers may consider control measures necessary because it is believed that severe defoliation of sugar maple reduces the flow of sap. In such an event the advice of specialists should be sought concerning the most effective and currently acceptable method. However, because infestations are of short duration there should be no tree mortality in healthy

Larva

Pupa

*Calosoma* predator

# Miscellaneous

Beech caterpillars

Beech blight aphid

vigorous stands and the need for control measures generally is questionable.

In a recent saddled prominent infestation, appreciable numbers of the little-known beech caterpillar, *Dasylophia thyatiroides* (Walker), were found feeding only on the beech trees in the stand. Young larvae show considerable variation in color and markings but are mainly reddish-brown or greenish. When full grown they are about 48 mm long.

Other large caterpillars found on beech:
Orangehumped mapleworm, page 105
Lacecapped caterpillar, page 141

## Aphid

The beech blight aphid, *Fagiphagus imbricator* (Fitch), probably occurs throughout the range of beech and pockets of infestation have occurred occasionally in Ontario and Quebec. These showy aphids, covered with long waxy white filaments, appear very suddenly, mainly on the stem and branches but also on the leaves, and are gone the following year, seemingly without effect on the tree.

## Loopers

The so-called loopers are the larvae of geometrid moths, and many of them are general feeders on a variety of forest trees. Two species occasionally found on beech are discussed elsewhere:

Bruce spanworm, page 109
Redcheeked looper, page 110

## Mites

Leaves of beech are often disfigured by eriophyid mites (page 260). Both brown and yellow pile-like patches, the former on the undersurface and the latter on the upper surface

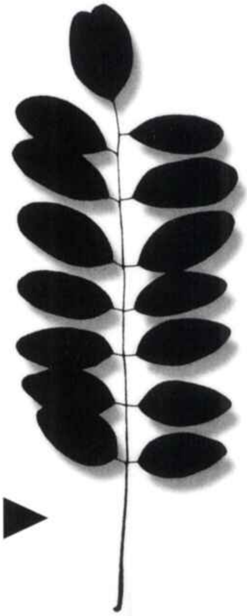
Eriophyid mite galls

of the leaf, are caused by the feeding of some species of these primitive microscopic four-legged mites. Other species cause wart-like galls on the upper leaf surface. Little is known about the life history of these mites because they have not caused damage to the trees and also because their occurrence is so sporadic. For further information on mites see page 15.

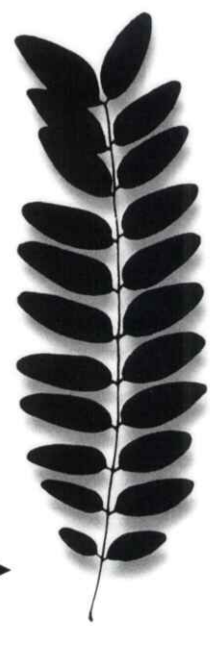
## Wood borers

Of the numerous kinds of wood borers that feed in beech only two are commonly encountered, the pigeon tremex (page 189) and an ambrosia beetle (page 133). Both feed in a number of different host trees.

# LOCUST

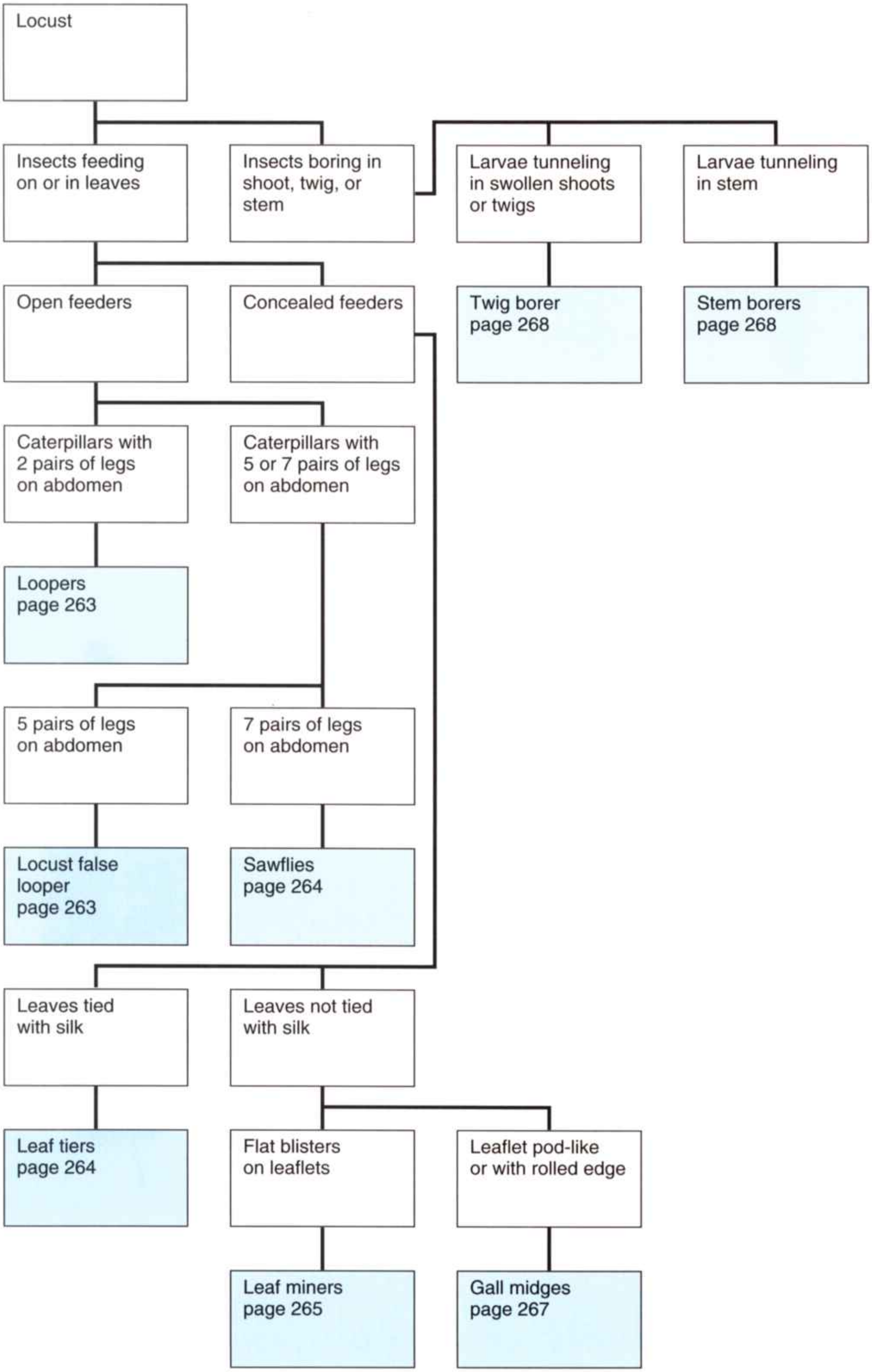


Black



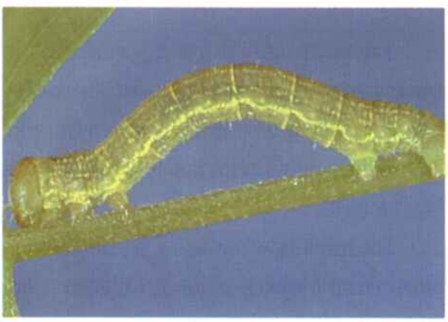
Honey

# Locust


Locust
Insects feeding on or in leaves
Insects boring in shoot, twig, or stem
Larvae tunneling in swollen shoots or twigs
Larvae tunneling in stem
Open feeders
Concealed feeders
Twig borer page 268
Stem borers page 268
Caterpillars with 2 pairs of legs on abdomen
Caterpillars with 5 or 7 pairs of legs on abdomen
Loopers page 263
5 pairs of legs on abdomen
7 pairs of legs on abdomen
Locust false looper page 263
Sawflies page 264
Leaves tied with silk
Leaves not tied with silk
Leaf tiers page 264
Flat blisters on leaflets
Leaflet pod-like or with rolled edge
Leaf miners page 265
Gall midges page 267

# Loopers

Locust false looper



Stout locust looper

Three kinds of looper-type larvae feed on honey locust and black locust in southern Ontario. They tend to be solitary feeders and although they are sometimes numerous on individual trees, serious feeding damage has not been recorded.

The locust false looper, *Zale undularis* (Drury), is the most common of the trio. The large brownish larvae, which have the first one or two pairs of legs on the abdomen shortened, move somewhat like the true loopers. They feed from about mid-June to late August and when full grown are up to 30 mm long. These insects overwinter as pupae on the ground, and the adults, dusky moths, emerge in the spring.

The locust looper, *Semiothisa ocellinata* (Guenée) is slender and green or gray-green with broken white and dark lines along the back. A single series of hooks is found at the end of the abdominal legs. Larvae may be found from late May to mid-September and are about 25 mm long when full grown. The pupa is assumed to be the overwintering stage. The slender pale gray moths are reported from May to August.

The stout locust looper, *Heliomata cycladata* Grote and Robinson, is greenish with brown stripes or spots. Although similar to the locust looper, it is stouter and the hooks on the abdominal legs are in two groups on each leg. The larvae feed in June and July. They change to pupae on the ground and overwinter there. The adults, black and white moths with fine metallic markings, emerge in the spring.

## Sawflies

*Nematus* species larva

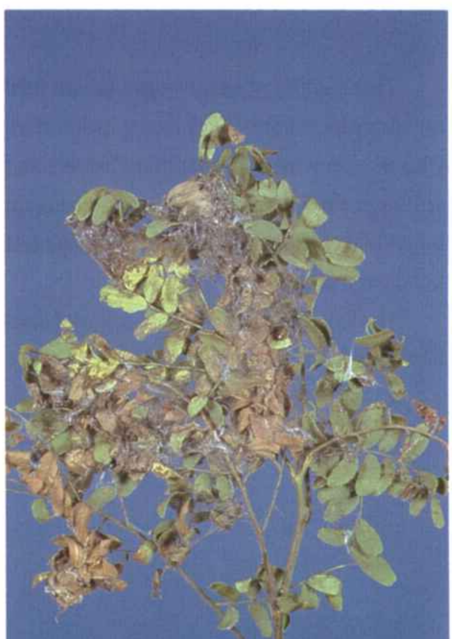
The larvae of three species of sawflies in the genus *Nematus* feed on the leaves of locust in eastern North America. Although widespread epidemics are unknown, young plantings of black locust have sometimes been severely defoliated. The larvae feed on the trees from late May to early August, usually in groups. When they are full grown, up to 20 mm long, they drop to the ground to spin their overwintering cocoons. The adults, small fly-like insects with two pairs of transparent wings, emerge in spring.

## Leaf tiers

Mimosa webworm

The larvae of four insect species feed in leaves tied or webbed with silk. In Canada they have been reported only in southern Ontario, and more commonly on honey locust than on black locust.

The mimosa webworm , *Homadaula anisocentra* Meyrick, is an introduced Asian



Webbed leaves

species that now occurs widely in the United States and was found recently in southwestern Ontario. It spread rapidly after its introduction in the early 1940s and is now considered a major pest of ornamental locusts. Winter is spent in the pupal stage in the soil and first generation adults are in flight in June. The eggs are laid on the leaves and the larvae initially skeletonize the leaves inside the web, causing them to turn brown. Older larvae, about 16 mm long, feed on the young developing leaves and flowers and change to pupae in the webbed leaves. A second generation of larvae feeds in the webs in late July and August, when the webbed leaves become quite noticeable. If high populations are present the tree appears scorched. A partial third generation may develop in some years.

Two species of the genus *Nephopterix* are occasionally found between tied leaflets of honey locust in late summer. These robust green larvae, about 18 mm long, turn red just before they change to pupae.

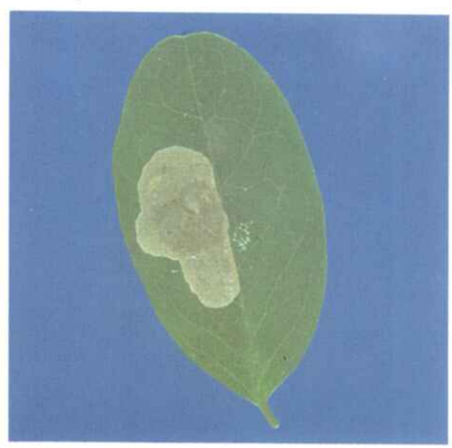
*Agonopterix robiniella* (Packard) larvae feed in colonies in rolled leaves, mainly of black locust, in June. They are pale with black heads and are about 15 mm long when full grown.

# Leaf miners

* Photo courtesy of the Bureau of Forestry, Department of Environmental Resources, Commonwealth of Pennsylvania.

Locust leafminer*

Locust digitate leafminer



A locust blotch miner

Leaf miners often cause extensive damage to black locust in eastern North America. The locust leafminer (page 265), *Odontota (=Chalepus) dorsalis* (Thunberg), is the most common species. Damage by this beetle is widespread in some years, especially in Ohio, Pennsylvania, and West Virginia. Winter is spent as an adult, usually in the litter under the tree. Adults emerge as the leaves are developing, and lay small clusters of overlapping eggs covered with excrement on the lower surface of the leaf. On hatching, the larvae form a common mine that is initially white, but turns brown as it becomes larger. In a few days the larvae separate and each one mines a number of other leaflets before changing to a pupa inside the last mine. The adults, about 6 mm long, skeletonize the lower surface of leaves, mainly of locust but also of other trees, before seeking hibernation sites. In more southern locations there may be a second generation each year. Parasites of the larvae and pupae of this leafminer reduce high populations.

The locust digitate leafminer (page 265), *Parectopa robiniella* Clemens, is another common leaf miner on black locust and honey locust. Larvae are present in the mines, which are bladdery and free of excrement, from late May to mid-September in Ontario. The larvae enter the leaf near the midrib on the undersurface, where they do their initial mining. Later they tunnel to the upper tissue and follow the midrib for a short distance before creating typical finger-shaped mines. The pale green larvae leave the mine to change to pupae in cocoons constructed in a leaf curl, a crevice in the bark, or on the ground. The adults are tiny moths.

The larvae of at least two species of the moth genera *Phyllonorycter* and *Chrysaster (=Lithocolletis)* are blotch miners (page 265) of locust. The mines are formed either in the upper or lower leaf surface tissue. *P. robiniella* (Clemens) forms a white silken cocoon in the mine, whereas *C. ostensackenella* (Fitch) forms its yellow-brown silken cocoon outside the mine in any suitable niche.

# Gall midges

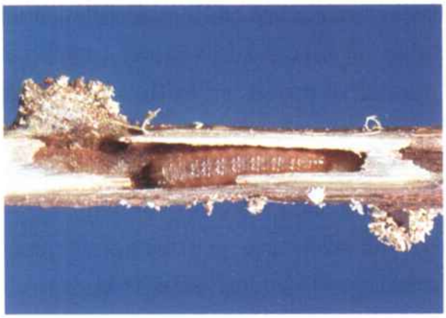
Honey locust pod gall midge

Locust gall midge

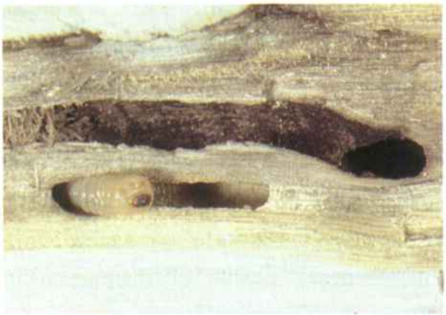
The honey locust pod gall midge, *Dasineura gleditchiae* Osten Sacken, is a most troublesome pest of all varieties of this attractive ornamental tree, and is particularly difficult to control. Repeated damage over a number of years can kill small branches. The adults emerge from the soil as the new shoots are developing in the spring and lay their yellow eggs in the unfolding leaflets. Surface feeding by the tiny maggot-like, pale yellow larvae prevents the leaflet from unfolding and each attacked leaflet forms a pod-like gall in which the larvae complete their development in about 3 weeks; the galls turn brown and are unsightly. The dark pupae are present in the gall for about a week before changing to tiny midge adults. As new leaves develop they in turn are attacked by succeeding generations of midges, and further damage results. At the end of the season the larvae leave the galled leaves and presumably enter the soil. There are no satisfactory chemical control measures for this pest. Black locust leaflets are damaged in the same manner by the closely related midge, *D. pseudacaciae* (Fitch).

The locust gall midge, *Obolodiplosis robiniae* (Haldeman), is a common gall maker on black locust. The pale white larvae feed on the leaf edges, causing them to curl. Larvae are present from late May to late September and change to pupae in the leaf edge galls. There are a number of generations each year.

# Twig and stem borers



Locust twig borer



Locust borer larva in tunnel

Locust borer adult

## Twig borer

The locust twig borer, *Ecdytolopha insiticiana* Zeller, occurs on black locust throughout its natural range in eastern North America and wherever it has been planted in other areas. It has also been found in honey locust in Ontario. Seedlings are especially prone to damage.

Winter is spent as a prepupal larva in a cocoon among leaves on the ground. Pupation occurs in the spring and the small grayish brown moths soon emerge to mate and lay their eggs on the trees. In Ontario, larvae have been found boring in shoots from early July to late October. Infested shoots become slightly swollen over a distance of 25 to 70 mm and there is a small hole at one end through which excrement is ejected. When the reddish-brown larva is full grown, about 18 mm long, it drops to the ground to spin a cocoon in which it later changes to a pupa. The number of generations each year in Ontario is not known but two are reported in the northern United States.

If ornamental trees become disfigured by this borer, control can be effected by pruning the infested shoots while larvae are still inside and by raking and destroying the leaves under infested trees in the fall.

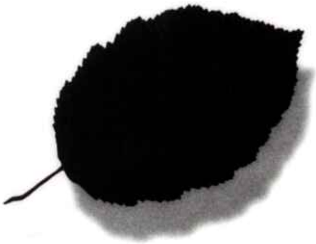
## Stem borers

There are two common kinds of borers in the stems of black locust. One is the larva of a moth and has abdominal legs, the other is the larva of a roundheaded borer and does not have abdominal legs. The former, the carpenterworm, *Prionoxystus robiniae* (Peck), bores in many hardwoods and is described on page 168. The latter, the locust borer, *Megacyllene robiniae* (Forster), bores mainly in black locust but has also been found in honey locust and willow.

The locust borer has one generation each year; winter is spent as a young larva in a hibernation cell under the bark on the wood surface. In the spring the oozing sap on the bark indicates the resumption of feeding on the wood surface. Soon the larvae push out fine white sawdust and excrement from the entrance hole, marking their tunneling in the sapwood. Later, when they enter the heartwood, the color of extruded material darkens and the tunnels become quite large. The larvae feed until late July when they are about 25 mm long and then change to pupae in their tunnels. The striking adult beetles may be found from late July to the end of August in Ontario, often feeding early in the day on goldenrod flowers. They lay their oval white eggs near bark wounds.

Young trees are often riddled with borer tunnels and thus are prone to breakage by wind. Infested trees should be destroyed during the winter or spring and only vigorously growing trees retained. The bark around wounds on ornamental trees should be examined in the spring for oozing sap and the entrance hole probed with a sharp wire to kill the young larva before it enters the wood.

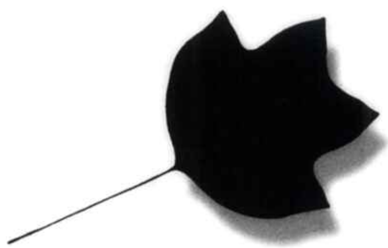
# MISCELLANEOUS



▲ *Alder*

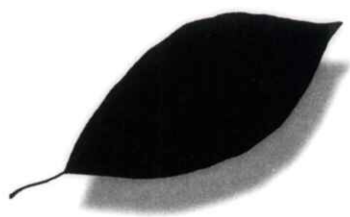
▲ *Ironwood*

▲ *Mountain ash*



▲ *Tulip tree*

▲ *Apple*



▲ *Black gum*

▲ *Hackberry*

▲ *Sycamore*

# Alder insects

A number of insects of different species that feed on alder also feed on birch or other trees and are included in the appropriate sections. All species causing appreciable damage to alder appear in the following list, but only those of primary importance to alder are described in detail.

Small grub-like larvae without legs on the abdomen, or adult beetles eating the leaf surface or entire leaves.................................................... Leaf beetles, page 273

Larvae with 6 to 8 pairs of legs on abdomen feeding in groups on the leaves.................................... Sawflies

Larvae with a white woolly covering.................................................. Alder woolly sawfly, page 275

Black striped larvae............. Striped alder sawfly, page 66

Dusky larvae.................. Dusky birch sawfly, page 66

Yellow, black-spotted larvae ............ *Arge* species, page 67

Larvae with 5 pairs of legs on abdomen............ Caterpillars

Larva with orange hairs and 3 long black hair pencils......................................... Alder dagger moth, page 72

Hairy brown larvae in nests of silk and excreta............................................... Fall webworm, page 226

Small blackish larvae in individual gray tubes of silk and excreta.................................. Alder tubemaker, page 277

Larvae with 2 pairs of legs on abdomen .............. Loopers

Blackish loopers between two tied leaves .......................................... Spearmarked black moth, page 79

Redcheeked red-brown looper ...................................................... Redcheeked looper, page 110

White woolly aphids covering twigs and/or leaves........................................ Woolly alder aphid, page 276

Brownish areas on leaf caused by mining insects

Large brownish blotch mines .................................................. European alder leaf miner, page 274

Small brown edge mine near tip of leaf ........................................ Birch and alder flea weevil, page 276

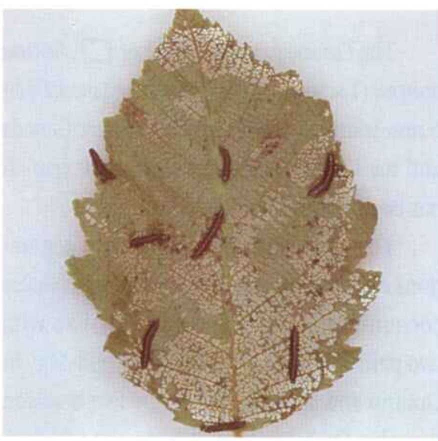
Tiny black or gray insects feeding in groups on underside of leaves causing discoloration ................................................ Alder lace bug, *Corythucha heidemanni* Drake

This species is infrequently abundant in Canada. Its appearance and life history are similar to those of the birch lace bug, page 91

Large larvae boring in roots ........... Ghost moths, page 58

# Leaf beetles


Alder flea beetle larvae


Skeletonized leaf


Alder leaf beetle larva

The alder flea beetle, *Altica ambiens* LeConte, has a transcontinental range in Canada and is found from Maine to Minnesota in the United States. High populations have periodically caused severe leaf browning, especially in the Maritime provinces. Infestations, usually of 2 to 3 years' duration, have been followed by relatively long periods with no reports of damage.

Winter is apparently spent as an adult in the litter and Ontario records indicate a single generation each year. The oval, blue-green adults, about 5 mm long, have been collected from early June to late September. They chew small holes in the leaf and lay their eggs in small groups on the lower leaf surface. The larvae may be present from mid-June to late August but are most common in July. They have a dark upper surface and yellowish undersurface and are about 10 mm long when full grown. They skeletonize both surfaces of the leaf, creating a scorched appearance.

There is no known method of control but, in any case, control measures probably are not needed.

The alder leaf beetle, *Chrysomela mainensis mainensis* Bechstein, is found in a broad band from Newfoundland and the northeastern United States to the Northwest Territories. Information on its life history is limited. However, it is probable that there is a single generation each year and that winter is spent as an adult because these beetles have been found as early as mid-April and again in mid-August in Ontario. The adults are buff colored with variously patterned dark patches, and are about 6 mm long. They feed and lay their pale-colored eggs in small masses on the leaves. The larvae are dusky yellow with dark patches and are up to 9 mm long when full grown. They eat all the leaf except the veins and are commonly found from mid-June to early August.

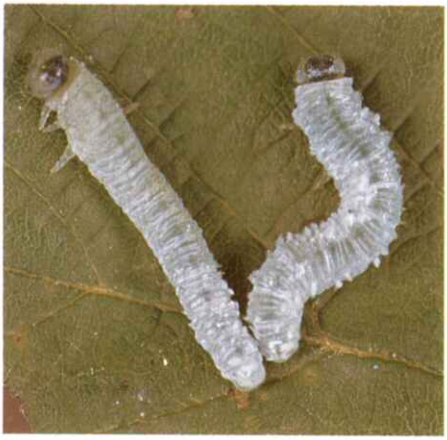
# European alder leafminer

European alder leafminer

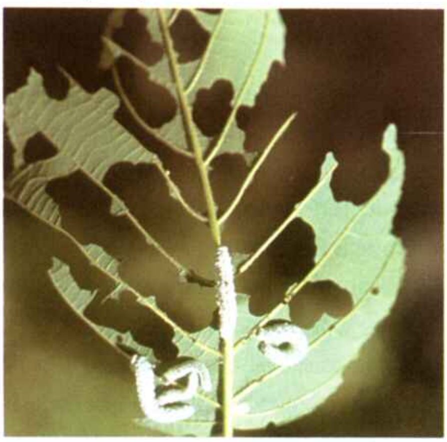
The European alder leafminer, *Fenusa dohrnii* (Tischbein), is an introduced insect that is now widely distributed on alder across Canada and the United States. For the last 20 years it has been a common defoliator.

There are probably at least two generations each year; the winter is spent in a papery cocoon in the soil. The adults, fly-like with two pairs of wings, are in flight by mid-May in Ontario and lay their eggs in the leaf between the veins. On hatching, the larvae mine the leaf, usually remaining in the tissue between a pair of veins. Larval development can be completed in 3 weeks, when the larvae can be up to 6 mm long. However, as larvae may be found in blister-like mines from mid-June to mid-September, there are probably two or three generations as in other *Fenusa* species.

# Alder woolly sawfly



Alder woolly sawfly larvae

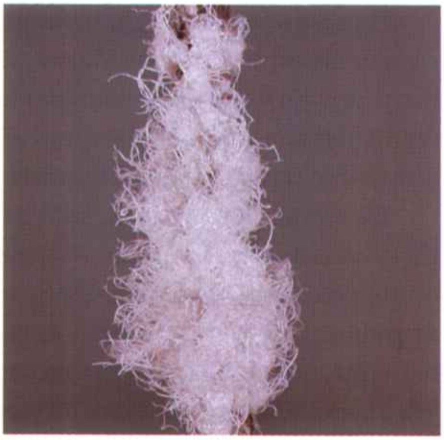


Larval feeding

The alder woolly sawfly, *Eriocampa ovata* (Linnaeus), is an introduced sawfly of European origin that is widely distributed in Canada. High populations have been reported from Quebec, Ontario, and British Columbia.

There are two generations a year in Quebec but the second generation may not complete development in some years. Winter is spent as a pupa in a cocoon spun in the litter or on the soil surface. In Ontario, adults have been collected from late May to mid-July and the eggs are present along the main vein of leaves from early June. The larval stages can be completed in about 3 weeks. Initially the tiny larvae are naked but as they develop they become partially covered with a white woolly flocculence. When full grown they are about 16 mm long. They consume the whole leaf except the main veins. Some larvae spin cocoons and development continues to the adult stage to produce a second generation. However, other larvae produce cocoons and remain as pre-pupae until the following spring.

# Woolly alder aphid



Woolly alder aphid

The woolly alder aphid, *Prociphilus tessellatus* (Fitch), feeds on two hosts. In early summer it is found primarily on silver maple leaves (page 124). In late summer and fall it is found mainly on the twigs and small branches, but also on the leaves, of alder. The woolly flocculence excreted by these aphids is quite striking. Even though there have occasionally been high populations in the past, they were of short duration and caused no obvious damage.

# Birch and alder flea weevil

Birch and alder flea weevil

The birch and alder flea weevil, *Rhynchaenus testaceus* [=*canus* (Horn)] [=*pallidior* (Leng)] O.F. Müller, and the willow flea weevil, *Isochnus rufipes* (LeConte), are leaf miners on their respective hosts and their mines are similar. They have not been destructive pests to date. They are found mainly in eastern North America and occasionally are a nuisance because the adults often enter homes to hibernate. In Ontario, adults, larvae, and pupae seem to be present throughout the summer so it is probable that there is more than one generation each year.

# Alder tubemaker

Alder tubemaker damage

The alder tubemaker, *Acrobasis rubrifasciella* Packard, has been found on various alder species from Nova Scotia to Manitoba and in adjacent areas of the United States. It has occasionally caused localized severe leaf browning in parts of Ontario but high populations were of short duration. Although this tubemaker is attacked by many species of parasites and some predators, the cause of population collapse remains unknown.

Winter is passed as tiny larvae in niches on the tree. In the spring larvae may be found in mined buds or leaf petioles before they begin constructing their tube-like shelters, made of excrement lined with silk, in the expanding leaves. The larva feeds from the tube, which it gradually lengthens and enlarges. The larvae tie clusters of leaves together to form tents in which a number of them exist. When full grown the variously colored larvae are about 15 mm long and the tube with its enlarged bulb-like pupal chamber at the end has a total length of 35 mm. The pupal stage is entered near the end of June. It is of short duration and the adults are in flight in July. The moths, following mating, lay their eggs on the leaf undersurface, usually near veins. The tiny larvae feed gregariously, skeletonizing the leaf undersurface under a loose silken tube-like cover until late summer when they scatter to hibernate.

# Mountain ash

There are three common insects that are found regularly on mountain ash and two others that are occasionally found in damaging numbers. They may be distinguished as follows:

Groups of yellow and black naked larvae eating leaves. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Mountain ash sawfly

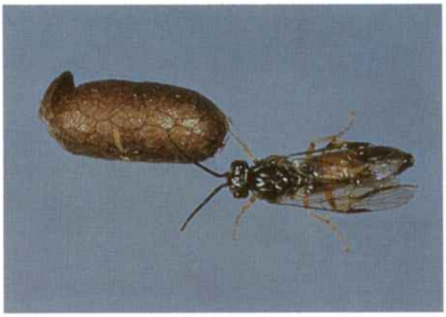
Slimy dark larvae eating the upper layers of leaf . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Pear sawfly

Dark blue-black hairy larvae with white marking on the back, often in groups . . . . . . . . . . . . . . . Forest tent caterpillar, page 19

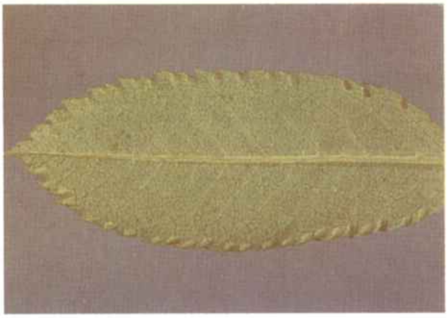
Tiny wedge-shaped active insects feeding on leaf underside but causing white mottling on the upper leaf surface. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Leaf hoppers, page 125

Larvae boring into the base of small trees, often killing them . . . . . . . . . . . . . . . . . . . . . . . Roundheaded apple tree borer, page 282

# Mountain ash sawfly



Adult (female) and cocoon



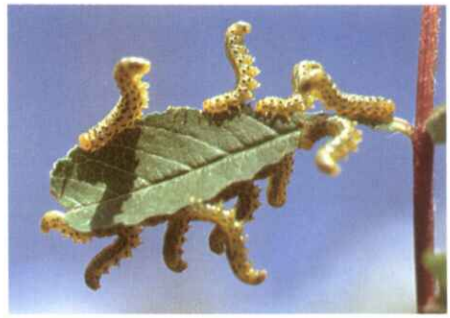
Eggs in leaflet edge

The mountain ash sawfly, *Pristiphora geniculata* (Hartig), is the most prevalent insect on mountain ash throughout most of the tree's range in Canada. Since its introduction to North America it has spread steadily westward, relentlessly finding its widely scattered host trees, and its commonly planted cultivars. Damage is most severe shortly after the insect moves into a new area. Later the amount of damage fluctuates annually, presumably as a result of unfavorable weather conditions, because none of the numerous biological control agents appears to be abundant.

Two generations a year are common, except at the northern limit of its range. The insect overwinters as a larva in a cocoon in the ground and changes to a pupa in the spring. Adults emerge

* Photo credit W.D. Biggs.

throughout June, laying their eggs soon after emergence. Mating is not necessary for the production of eggs, but the progeny of unmated females are male. Females outnumber males 3:2 in the population. The eggs, deposited in slits cut in the toothed edge of leaflets, initially cause a slight swelling and later become more evident as development occurs. Incubation requires a week of favorable conditions. Initially larvae are yellow-green with dark heads and legs; later they are yellow with prominent black spots. Early larvae feed together on a single leaflet and consume all but the main vein. Later all the leaflets on a leaf and finally whole branches may be stripped of their leaves by larvae that have lost their gregarious habit. Larvae, when disturbed, assume the characteristic S-shaped stance typical of many sawflies. Because female larvae have one more larval stage than males, the duration of the stages and amount of feeding of the sexes differ. On the completion of feeding the larvae enter the soil to pupate and some will complete development to the adult stage and begin a second generation. Feeding by the first generation larvae is completed by August and second generation feeding occurs from late August to the end of September.



Larvae*

Defoliated branch

On many ornamental trees populations can be controlled by removing either leaflets in which eggs have been laid or individual leaves containing larvae. Initially the majority of eggs and larval colonies will be found in the lower crown and their removal is simple. With periodic examination, especially during July when highest populations occur, and again in September, little foliage should be lost. Alternatively, any insecticide registered for use against sawflies, if applied when larvae are small, will prevent the loss of leaves on larger trees.

# Pear sawfly

Pear sawfly larva

The pear sawfly, *Caliroa cerasi* (Linnaeus), is a common cause of leaf damage to mountain ash and most fruit trees in urban settings. Although it is an introduced species, it now has a transcontinental distribution in southern Canada and much of the United States. In some years severe larval feeding may give the leaves of ornamental trees and shrubs a scorched appearance and cause them to fall prematurely. However, because infestations are seldom persistent little injury results.

Winter is spent as a full-grown larva in a cocoon in the soil beneath the tree. Following pupation in the spring the adults emerge between mid-June and mid-July and lay their eggs on the lower surface of the leaf. After an incubation period of about 2 weeks, the larvae emerge and move to the upper surface of the leaf to begin feeding as skeletonizers, a habit they retain throughout their development. Initially, damaged portions of leaves are white but later they turn brown and are quite noticeable. The larvae are slug-like and shiny black until shortly before they finish feeding, when they change to a yellow-green color. The mature larvae, about 10 mm long, drop to the ground. Some change to pupae and adults, thereby initiating a second generation that is present in late summer and fall; the remainder overwinter. Whether the late larvae complete their development depends on favorable weather conditions, especially in more northern areas.

Control on ornamentals is necessary for aesthetic reasons only. If control is required, a contact insecticide applied when larvae and damage appear in early July and again in early September should be effective.

# Apple insects

Although forest insects of many species feed on apple, most of them feed primarily on other trees and are described elsewhere in this handbook. The insects listed are not those generally associated with orchards but rather those found on flower- and fruit-bearing apple and crab apple trees in ornamental settings. To facilitate identification of the insects they are grouped below by their appearance and habits.

Hairy caterpillars feeding from silken nests or tents ...........
............................... Fall webworm, page 226
......................... Eastern tent caterpillar, page 245

Groups of large caterpillars .............................
........................... Forest tent caterpillar, page 19
.......................... Redhumped caterpillar, page 19
......................... Yellownecked caterpillar, page 71

Slender caterpillars walking with a looping motion ............
............................... Linden looper, page 109
............................. Fall cankerworm, page 109
................................. Winter moth, page 146

Leaf rollers and tiers ..................................
......................... Obliquebanded leafroller, page 29
.............................. Fruittree leafroller, page 29
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Beetle adults feeding on leaf ............................
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.............................. Oystershell scale, page 229

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The apple-and-thorn skeletonizer (page 282), *Choreutis pariana* (Clerck), an introduced insect, is found from New Brunswick to Ontario and in British Columbia, as well as in the adjacent parts of the United States. It feeds mainly on apple but has also been found on a number of other fruit trees in Ontario. The larvae initially skeletonize the lower leaf surface and later move to the upper surface where they fold the leaf or tie leaves together and continue to skeletonize inside the resulting shelter, causing the leaves to turn brown. Larvae will be found through much of the summer but are most common in July and August. These prominently marked larvae are about 12 mm long when full grown. In late July and August they spin white silken cocoons in any convenient niche and the small, dark moths are in flight shortly after. The number of generations a year varies. Damage caused over the years has usually been of little consequence.


Apple-and-thorn skeletonizer

Recently planted apple trees are subject to attack by the roundheaded appletree borer, *Saperda candida candida* Fabricius, which is a common pest of many fruit and ornamental trees, especially those weakened by adverse conditions. Small trees may be girdled and killed by the tunneling larvae.

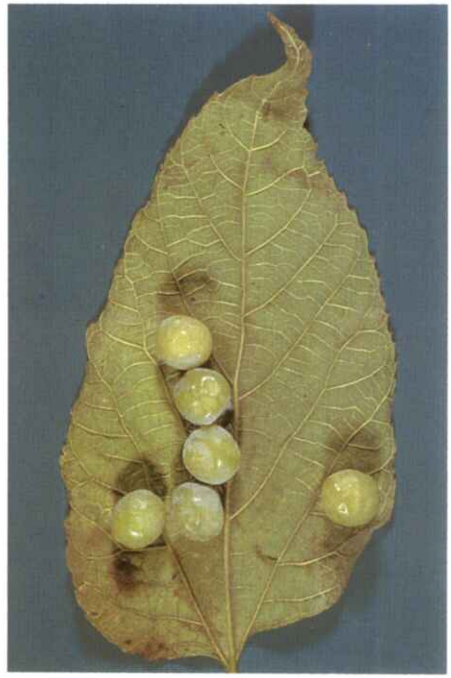
As is the case with many other borers, the roundheaded appletree borer requires 2 to 3 years to complete its life cycle. The strikingly-marked adult beetles may be found throughout much of the summer. The eggs are laid in slits cut by the female near the base of the tree. On hatching, the larvae tunnel through the bark to the wood surface and feed there for the remainder of the year. The following year the larvae enter the wood where they excavate large tunnels. Attacked trees show little evidence of the presence of this borer except for the wood fibers extruded from holes near the tree base. However, if a number of larvae are present the tree may be killed within the year. Larval feeding continues for a 2nd or 3rd year before the adults emerge to complete the cycle.

Injury to trees may be kept to a minimum by maintaining tree vigor and by wrapping the lower trunk of newly planted trees with tarred paper for a year or two until the tree is well


Roundheaded appletree borer adult

# Hackberry insects

established. Borers already in valuable trees can be killed by injecting a fumigant into tunnels where fresh wood fibers are being extruded.



Hackberry nipple gall

Although hackberry is widely distributed in the eastern half of the United States, its Canadian distribution is limited to three widely separated areas and it is seldom found in pure stands. As a result, the number of insect species that feed on it in Canada is small.

The most commonly encountered insects of hackberry are the jumping plant lice in the genus *Pachypsylla.* Four species are known to produce galls on buds, leaves, and twigs. The small winged adults, similar to aphids, are frequently more of a nuisance than the galls they make because of their habit of invading homes near infested trees when they are seeking hibernation sites in the fall.

The hackberry nipple gall psyllid, *P. celtidismamma* (Fletcher), is the common species

Late stage psyllid nymph

Spiny hackberry gall

in Ontario and Manitoba. The adults lay their eggs in the unfolding leaves. When the eggs hatch, the nymphs feed and grow rapidly, while galls up to 4 mm in diameter form around each individual. Nymphs develop through a number of stages inside the galls from early June to late September.

About 12 species of midges also cause galls on both twigs and leaves but they are relatively uncommon. The presence of tiny maggot-like insects inside the gall, rather than a nymph as in the psyllid galls, will serve to distinguish the two groups. A typical midge gall on the leaf is the spiny hackberry gall, *Celticecis* (=*Cecidomyia*) *spiniformis* (Patton). Little is known about the life history of this midge.

The following insects have been recorded on hackberry:

Groups of spiny caterpillars eating leaves ..................
........................ Mourning cloak butterfly, page 175
........................ Question mark butterfly, page 175

Shell-like or popcorn-like objects on bark ..................
............................ Cottony maple scale, page 137
.............................. Elm scurfy scale, page 187
......................... *Parthenolecanium* scale, page 187

# Ironwood insects

Ironwood or hop-hornbeam is a relatively small tree usually found scattered throughout stands of larger hardwoods. Insects specific to this host seem to be few and of little importance. However, when hardwood stands of maple and beech are infested by insects like the linden looper (page 109), the elm spanworm (page 110), or the saddled prominent (pages 105 and 257), the scattered ironwood trees are often completely denuded.

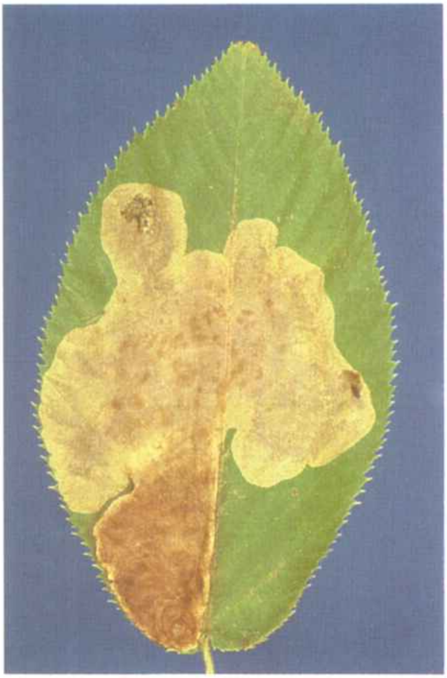
Other insects specific to ironwood are:
Discolored areas or blisters on leaf. . . . . . . . . . . . . . . . Leafminers
Small larvae feeding in fruit. . . . . . . . . . . . . . Ironwood fruitworm

Two species of leafminers are found on ironwood in Ontario. The first Canadian record of the ironwood leaf miner, *Stilbosis ostryaeella* (Chambers), was from southern Ontario in 1962 although the insect was previously known from Kentucky, Ohio, and New York. The pupae overwinter and the tiny grayish moths are active from late June to about mid-July. After mating, the females lay their eggs, usually singly, on the undersurface of leaves along the midrib. The larvae tunnel in the leaf between two veins, leaving their dark excreta in tidy rows. The mined areas turn brownish and are visible from both sides of the leaf. The cream-gray larvae may be found in the mines from mid-July to early October. When they are full grown, about 5 mm long, they drop to the ground and spin loosely woven silken cocoons in the ground litter, where they change to pupae.

Ironwood leafminer

The second species occasionally found in Ontario is the ironwood leafblotch miner (page 286), *Cameraria (=Lithocolletis) ostryarella* (Chambers). The larvae feed in blotch mines on the upper surface of the leaf from July to September. They hibernate on the ground as full-grown larvae in a circular silk-lined chamber in the mine. The adults are tiny bronze moths with black and white markings. Other related species produce blotch mines on ironwood in the eastern United States.

The ironwood fruitworm (page 286), *Gretchena delicatana* Heinrich, is a little-known species occasionally abundant in Ontario and also known from New Jersey and Pennsylvania. The pale yellow to green larvae, about 12 mm long when full grown, are found in and around the fruit sacs containing the nuts in July and

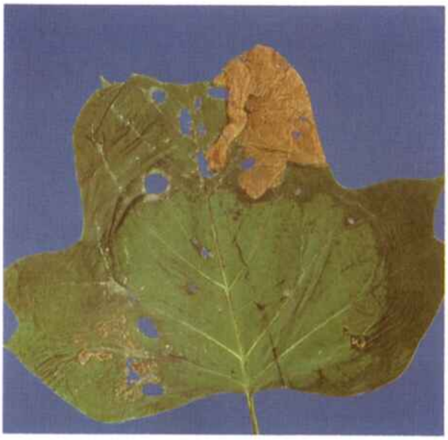


Ironwood leafblotch miner

Ironwood fruitworm

early August. The insects apparently overwinter as pupae on the ground. Adult moths are reported active in the spring.

# Tulip tree insects


Tuliptree leafminer


Tuliptree scale


Midge gall

Because tulip trees have only a scattered distribution in southwestern Ontario, relatively few insect species have been reported.

The tuliptree leafminer, *Odontopus calceatus* (Say), is considered a serious occasional pest of tulip, magnolia, and sassafras trees in the eastern United States, but has only recently been found in Ontario. Adults spend the winter in the leaf litter and emerge in early spring; they feed initially on unopened buds and later on the unfolding leaves, making characteristic feeding punctures in both buds and leaves. Following mating, the eggs are laid in the midrib on the underside of the leaf, often causing leaves to break at that point. On hatching, the larvae mine the leaves, creating bladder-like mines where they change to pupae inside silken cocoons. The adults emerge in July and feed on the leaves, creating irregularly shaped holes. They then enter the litter to complete the life cycle. Parasites and cold spring weather have apparently played an important role in reducing populations.

The tuliptree scale, *Toumeyella liriodendri* (Gmelin), is found on tulip trees throughout their range as well as on basswood, magnolia, walnut, and a few other trees. It is often locally abundant and high populations can kill branches and young trees. There is one generation a year in Ontario; winter is spent as an immature circular flat scale, mainly on the twigs and small branches. The scale is reddish with black markings; it grows rapidly in the summer and soon assumes a hemispherical shape. The scales excrete copious amounts of honeydew in which black mold develops if attending ants are unable to remove it fast

# Gum insects

enough. The black mold gives infested trees an unhealthy appearance. By mid-August, the fully developed female scale, often more than 10 mm in diameter, gives birth to thousands of tiny crawlers. The crawlers move out to settle on twigs but many are lost before a suitable site is found.

In spite of numerous parasitic wasps, lady beetles, and syrphid fly and moth larval predators that normally play an important role in controlling this scale, other control measures may be necessary on ornamental trees.

Three species of midges cause galls (page 287) to form on tulip tree leaves. One causes purplish leaf blisters; another causes globular galls on the midrib or veins; and the third is an irregular gall, about 15 mm long, on the midrib, containing a number of pale orange larvae. The number of galls varies widely from year to year and damage to the leaves is of little consequence.

Tupelo leafminer

Eriophyid mite galls

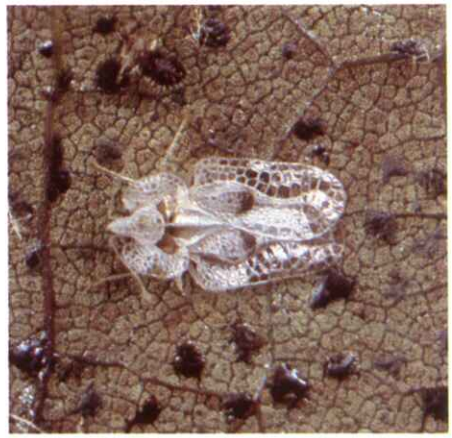
In Canada, black gum or tupelo is found only in the southern tip of Ontario and then usually as scattered individuals in hardwood stands. Few insect pests are recorded for this tree species.

The tupelo leafminer, *Antispila nyssaefoliella* Clemens, occurs on black gum throughout the eastern United States and the southern tip of Ontario. There are occasional reports of severe browning of foliage caused by this insect. Injury occurs first as a small linear mine, which is later enlarged and often obscured by a blotch-like mine. The legless larva is cream-gray with sooty-colored areas. When it is full grown, about 5 mm long, it prepares a case from two oval pieces of leaf cut from the mined area. It then drops to the ground inside this flattened case and changes to a pupa, and then to an adult, a tiny dark brown moth. Several generations of this insect may occur each year.

Small wart-like galls caused by eriophyid mites are sometimes abundant on the leaf surface of black gum. The mites, visible only under considerable magnification, feed inside the galls in summer. Further information on gall makers in general, as well as on eriophyids in particular, is given on page 14.

Large caterpillars sometimes injurious to black gum:
Forest tent caterpillar, see page 19
Gypsy moth, see page 141.

# Sycamore insects



Sycamore lace bug

Sycamore has a very limited range in Canada. It is restricted mainly to the southern tip of Ontario, although there are some planted specimens as far north as Ottawa. Only a few insect pests have been reported on this species in Canada.

The sycamore lace bug, *Corythucha ciliata* (Say), is a common pest throughout the eastern United States. The white adult lace bugs, about 3 mm long, emerge from hibernation about the time sycamore leaves begin to develop in the spring. Eggs are attached to the underside of leaves and hatch into tiny black spiny, more or less oval nymphs, which feed in groups on the underside of leaves. They feed by piercing the epidermis with their beaks and sucking the leaf juices, causing chlorotic whitish flecks on the upper surface of the leaf. After 5 or 6 weeks the nymphs change to adults. There appear to be two generations each year in Ontario. Heavily infested leaves, dark on the underside where the insects feed and white on the upper surface, drop prematurely. If control measures are required, an insecticide registered for use against lace bugs should be used. The foliage would have to be sprayed so as to cover the underside of the leaves.

The sycamore tussock moth, *Halysidota harrisii* Walsh, probably occurs throughout the natural range of its host tree and the larvae are often abundant on shade and ornamental trees, feeding from mid-July to late September. They are covered with whitish to yellow hairs and the longer hair "pencils" at either end of the body are white or orange. The head is yellow-orange. The larvae of a closely related species, the pale tussock moth, are shown on page 71. The life cycles of the two species are also similar.

The sycamore webworm, *Tetralopha militella* Zeller, is sometimes abundant, feeding in groups in late summer in leaves tied with silk. The larvae are pale green or yellow with indistinct striping; they are about 25 mm long when full grown.

Other insects found on sycamore:
Whitemarked tussock moth, page 71
Scale insects, *Parthenolecanium* sp., page 187

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# Acknowledgments


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In this, the last handbook of the series, special mention should be made of the contribution to the series by the following: E.R. Rayner, whose untiring patience and great skill made possible such excellent illustrations throughout the series; M.C. Davidson, who cheerfully carried out the seemingly endless typing of drafts, revisions and corrections in all the handbooks; and A. Lavallée, whose meticulous attention to detail added considerably to the quality of the last three handbooks.