Introduction

About 10 000 species of insects and mites, and an equal number of diseases, that attack woody plants in Ontario have been identified. More than 90 per cent of those pests and diseases occur in limited numbers and as such do not threaten the health of plants. Of those known to be potentially injurious to trees, many are transitory, occurring only infrequently in localized outbreaks of short duration. Artificial control of these is often for cosmetic purposes. Pesticides should be applied only against specific pests, and at a time when their abundance or the injury they cause makes spraying justifiable. With most pests only one stage in the lifecycle is controlled with a particular pesticide. Therefore, proper timing of treatment is very important. Calendar dates given in the text are meant to be used as a general guide; the development of a pest will vary from place to place and from year to year, depending on the weather.

All pesticides sold or used in Canada must be registered under the Pest Control Products Act, administered by the Pest Management Regulatory Agency of Health Canada The registration states the type of use (restricted, commercial, domestic), the pests against which the material may be used, the rates and timing of application, and precautions for use. Registered pesticides are, in turn, scheduled (or approved) for sale and use in Ontario by the Ontario Pesticides Advisory Committee, under the Pesticides Act, administered by the Ministry of the Environment. Materials mentioned in this publication are among those presently approved for use by the general public; they are available at most nurseries, garden centres, and hardware stores. When properly handled they present little hazard to the applicator or the environment.

Types of Pest Injury

Most insects and mites can be categorized into one of five main groups according to the way in which they injure trees: defoliators, borers, sucking insects and mites, gall-makers, and root-feeders. *Defoliators* cause the functional loss of leaves, in whole or in part, through destruction of the chlorophyll-bearing tissues. Defoliators may be further classified as: *leaf chewers* which consume all of the leaf tissues, *leaf skeletonizers* which eat the soft outer tissues but leave a skeletal network of veins, and *leaf miners* which feed upon the succulent interior tissues while tunnelling between the upper and lower surfaces of the leaves. *Borers* work mainly in the inner bark and wood, but all parts of a tree, from the buds to the roots, are subject to attack. The main effects of borer activity are deformity of the parts affected and weakening of the supporting fibres. *Sucking insects and mites* extract the cell sap, causing a general devitalization, wilting, distortion, or discolouration of the parts attacked. *Gall-makers* cause plants to produce abnormal growths as a reaction to irritations or stimuli such as feeding, stinging, egg-laying, or injection of toxins. Galls usually have a characteristic shape and location on the host, but in spite of their often conspicuous appearance most affect the appearance rather than the health of trees. *Root-feeders* destroy the tissues whereby the plant absorbs the nutrients necessary for its sustenance and growth. Seedlings and recently transplanted stock with limited root systems are most susceptible to this type of injury.

Tree diseases may be defined as abnormal physiological conditions, or disruptions in the normal life processes, which may, or may not, be fatal. The disruptions are caused by both parasitic, or living, and non-parasitic agents. Parasitic agents of trees are principally fungi but, to a lesser extent, also include bacteria and viruses. Non-parasitic agents include nutrient imbalance, toxic chemicals, adverse weather, and other stress-producing conditions such as mechanical injuries and changes in soil and water levels.

As with insects, parasitic diseases also may be grouped according to the part of the plant attacked, namely below ground in the root, above ground in woody tissues (stems or branches), and in the foliage (leaves or needles).

The presence of disease in trees is shown by the development of visible signs and symptoms. *Signs* are structures produced by parasitic agents. Examples include mushrooms, conks on the trunk, and felt-like layers and “shoestrings” under the bark. Non-parasitic agents do not produce disease signs. Symptoms are changes that occur in trees as a result of injury by both parasitic and non-parasitic agents. Examples include wilted leaves, leaf spots, blotches and curls, foliar discolouration, premature leaf fall, wounds and cankers, swellings and galls, bleeding and gum formation, and deformed, dying, and dead parts.

It is important to be aware that not all tree injuries are caused by insects and diseases. Damage may also be caused by birds (sapsuckers) and rodents such as mice, rabbits, and squirrels. Bird and rodent damage are not discussed in this publication.

Alder *(Alnus)*

Woolly Alder Aphid
(Paraprociphilus tessellatus)

The woolly alder aphid is a pest of alder and silver maple. The most distinctive sign of an infestation is the prolific production of white waxy filaments extruded from the bodies of aphids in closely packed colonies. A number of generations, both sexual and asexual, develop during a complete life cycle. The insect overwinters in the egg stage on the bark of maple trees. As soon as the leaves have expanded, the young aphids, all females, known as stem mothers, migrate to the undersurface and settle near the mid-veins. They produce large colonies which collectively extract great quantities of sap, causing the leaves to curl inward and to form protective feeding shelters. In midsummer, winged adults develop and fly to the branches of alder where a number of generations are produced asexually. In the autumn, winged sexual forms develop and return to maple trees to mate and deposit eggs to perpetuate the species over winter.

Wooly Alder Aphid Colony

The woolly alder aphid is not considered to be particularly injurious to either alder or maple. However, as the aphids feed on sap drawn from the trees, they excrete copious quantities of a sweet sticky liquid known as honeydew. This excretion often attracts large numbers of ants and may serve as a medium for the growth of black sooty mold.

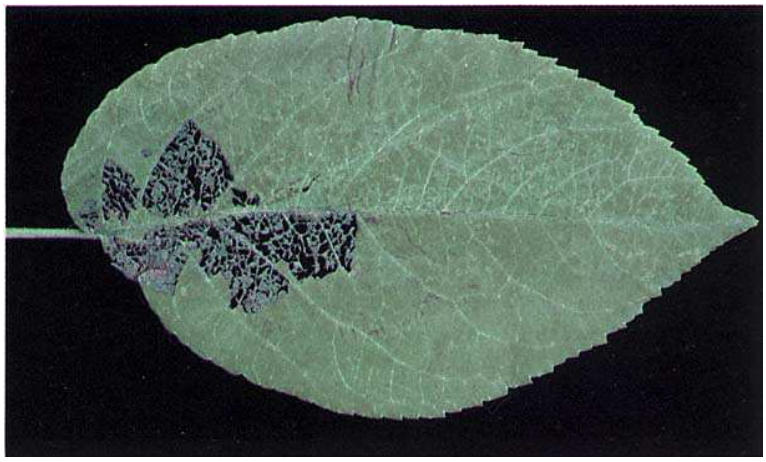
CONTROL

- Predators of the woolly alder aphid are numerous. Infestations usually are not of sufficient duration to warrant the application of chemical sprays.

Apple *(Malus)*

Including Flowering Crab

Apple-and-Thorn Skeletonizer
(Choreutis pariana)



Apple-and-Thorn Skeletonizer

This insect attacks apple, flowering crab, purple plum, hawthorn, and quince. The adult is a small reddish-brown moth. The full-grown larva is a yellowish-green caterpillar with prominent black tubercles.

The larva feeds mainly on the upper surface of the leaf. The edges of the leaf are rolled upward and fastened together with silk. The larva feeds inside the fold, consuming everything but the larger veins and lower epidermis. There are two broods per year, the larvae being present in July and again in August and September. Conspicuous injury is usually caused by the second brood. Damaged leaves curl, turn brown, and fall prematurely. The insect overwinters in cocoons spun in folded leaves, on ground vegetation, or in protected places on buildings.

CONTROL
- Usually no control is required even though infestations may damage a large percentage of the leaves, making the tree unsightly.
- If numbers warrant spraying, almost any of the commonly available garden insecticides will provide a satisfactory means of control.

Eastern Tent Caterpillar

Eastern Tent Caterpillar
(Malacosoma americanum)

Outbreaks of this native insect have been documented ever since the earliest records of colonial times. In addition to apple and cherry, its preferred hosts, it also attacks a wide range of deciduous trees and shrubs.

The moth lays its eggs in a band around small twigs about mid-July. These hatch the following spring about the time the leaves of wild cherry trees are beginning to unfold. The caterpillars form a silken nest or "tent" in a fork of the branches. They forage for food during the warmer parts of the day and return by means of silk threads spun from the nest to the feeding sites. The caterpillars mature in June, wander off individually to sheltered places, and pupate within a loosely woven cocoon. There is a single generation in a year.

The destructiveness of the eastern tent caterpillar is often more apparent than real. Mainly the nests are unsightly and mar the beauty of the landscape. In periods of abundance the caterpillars may completely defoliate trees. Rarely, however, are trees killed.

Eastern tent caterpillar should not be confused with the forest tent caterpillar, which does not form a tent. The latter often rests in the tents of eastern tent caterpillar, attacks oak, aspen, maple, and birch, and undergoes mass migrations in search of food.

CONTROL

- Prune and destroy the egg masses during the winter when they are easily observed and collected.
- Pull the tent from the branch with a gloved hand, or cut the branch below the tent and destroy it.
- If numbers warrant spraying, apply one of the commonly available garden insecticides as soon as feeding starts in May.

Other insect pests of Apple:

Aphids -see Willow
Cankerworms - see *Linden*
Fall webworm - see *Ash*
Oystershell scale - see *Lilac*

Apple Scab

Apple Scab

(Venturia inaequalis)

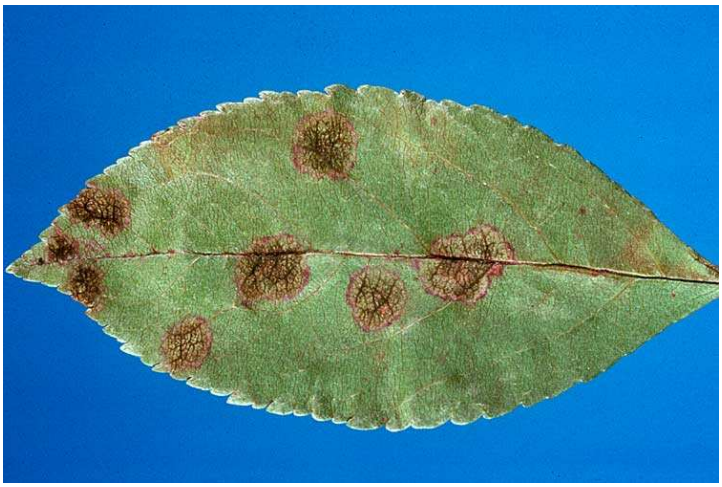
This fungus attacks all varieties of apples and flowering crabs. Related plants may be attacked also, including hawthorn and mountain ash. A closely related fungus, *Venturia pyrina*, causes pear scab.

Both fruit and leaves are infected, and less noticeably the blossoms and twigs. The fruit is undersized, deformed, and has hard, black spots on the skin. Infected leaves are puckered, with dark areas, and fall prematurely. By early summer the remaining foliage appears sparse and unhealthy. The disease is most prevalent and destructive in years when springtime weather continues wet, cloudy, and cool for prolonged periods. Springtime infections are started by spores released from fallen overwintered leaves. If conditions remain favourable, additional infectious spores form in fungal tissue on the new diseased leaves, and this usually perpetuates and intensifies the disease throughout the growing season.

While scab does not injure trees seriously, it may reduce their vigour when infections are numerous, and certainly detracts from the trees' appearance. The main impact is reduction of fruit quality and quantity.

CONTROL

- Rake and destroy leaves in the autumn.
- While the use of chemical protectants is not required in most years, the following method will minimize early infections when there is reason to believe that the problem is serious. Spray leaves thoroughly, first when they are about half-grown, and thereafter at ten-day intervals until end of May. Where the fruit is important, continue spraying throughout the growing season. Use dodine, benomyl, or captan.



Blotches of Apple Scab disease

Other diseases of Apple;

Cedar-apple rust - see *Juniper*
Crown gall - see *Euonymus*
Fire blight - see *Mountain Ash*
Powdery mildew - see *Lilac*

Cedar, Eastern White *(Thuja)*

Cedar (Arborvitae) Leafminers

(Argyresthia thuiella)
(Argyresthia canadensis)
(Argyresthia aureoargentella)
(Pulicalvaria thujaella)

Four closely related species of leaf miners are normally found together in varying proportions attacking the foliage of eastern white cedar, also known as arborvitae. The caterpillars feed within the leaves, causing the branch tips to turn brown. Damage is often conspicuous early in the season and may be confused with other causes, particularly winter injury. However, insect-injured foliage has the interior of the leaflets hollowed out, and if held up to the light the tiny caterpillars can be seen in their feeding tunnels. The adult insects are tiny whitish moths which emerge over an extended period from early June to late July. Each species of miner has one generation per year.

Brown tips caused by Cedar Leafminers

CONTROL

- Trimming and destroying infested branch tips before June gives adequate control on small ornamentals.
- Apply a spray of dimethoate in early May or late August to control the larvae.
- Apply a spray of malathion, dimethoate, or methoxychlor in June to control the moths.

Other insect pests of Cedar:
Spruce spider mite - see Spruce

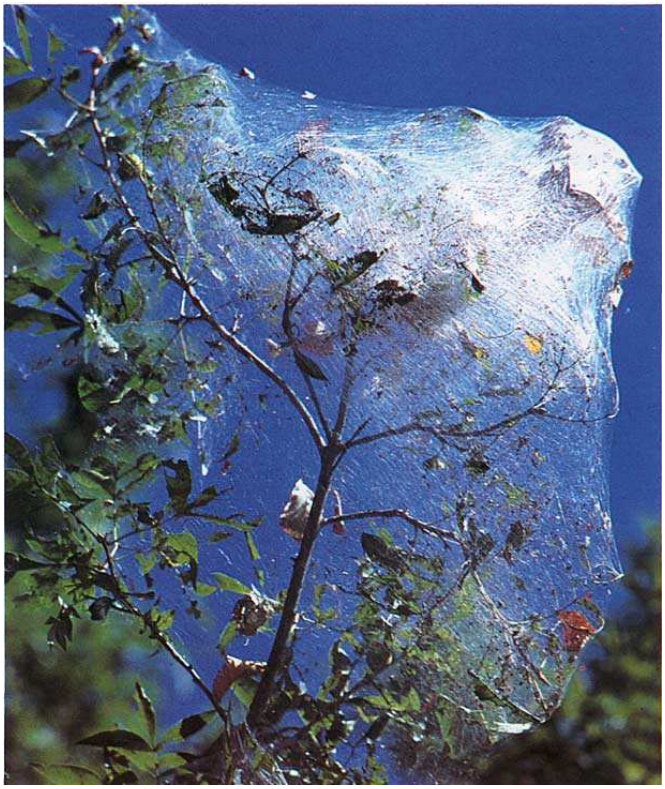
Ash *(Fraxinus)*

Ash Flower Gall Mite

Ash Flower Gall
(Eriophyes fraxiniflora)

The male (staminate) flowers of white ash are sometimes deformed by a mite which causes these flower clusters to become irregularly branched and fringed. The mite becomes active when the flower buds break in the spring and feeds on the unfolding tissues. The galls vary in size, often measuring 25 mm or more in diameter. When they first appear they are green; later they dry and turn black. One of the most objectionable features is that these dark masses remain on the trees over winter. Heavily infested trees are very disfigured but are not killed.

CONTROL
Populations of the ash flower gall mite may be controlled by:
- A dormant spray of superior oil emulsion applied in the spring.
- A spray of malathion or a specific miticide applied when first blossoms begin to form.



Fall Webworm colony

Fall Webworm
(Hyphantria cunea)

The fall webworm is one of the three tent-makers that commonly attack deciduous trees. Its web can readily be distinguished from that of the eastern tent caterpillar which is formed in the axils of branches early in spring, and the uglynest caterpillar which encloses entire low-growing bushes in mid-summer. The fall webworm forms a large web sometimes one metre long over the ends of branches of ash, Manitoba maple, flowering crab, and many shade and forest trees. The webs are conspicuous during August and September. The caterpillars that feed in the webs are pale yellow and very hairy. The adults are white moths with a wingspread of from 30 to 42 mm.

Injury caused by the fall webworm is seldom important on trees. Generally it is only the aesthetic value of the trees that suffers from the unsightly webs which contain excrement, dried leaf fragments, and the cast skins of the larvae.

CONTROL
- Chemical control is seldom required. On small trees, remove and destroy the webs, with their enclosed caterpillars, as soon as they are discovered.
- If sprays are necessary, apply one of the commonly available garden insecticides ensuring that the spray penetrates the webs.

Other insect pests of Ash:
Lilac borer - see *Lilac*
Oystershell scale - see *Lilac*

Linden *(Tilia)*

Fall cankerworm in typical looper posture

Fall Cankerworm
(Alsophila pometaria)

Spring Cankerworm
(Paleacrita vernata)

These insects attack the foliage of nearly all kinds of deciduous forest, shade, and fruit trees, and shrubs. The larvae are commonly called loopers (inch worms) because of their peculiar manner of moving about. They have two or three pairs of false legs, and vary greatly in colour from pale green to almost black, with several longitudinal lines on the body. The adults are greyish moths; the males have a wingspread of 25 mm but the females are wingless.

Eggs of both cankerworm species hatch when the leaves are beginning to unfold in late April or early May. The larvae feed together for a month to six weeks, then drop or crawl to the ground and pupate. Adults of the fall cankerworm emerge during late October and November and remain active until early December. The females crawl up the trunk of the tree and lay their eggs in single layers around small twigs. Adult spring cankerworms do not emerge until the spring and deposit their eggs in irregular clusters in crevices in the thick bark. Each species produces one generation per year.

The caterpillars feed first on the tender unfolding leaves and buds in which they gnaw small pits. Later they consume entire leaves except the midribs or larger veins. Complete defoliation in two or more consecutive years may kill the tree. Cankerworm infestations are sporadic; there may be about ten years between peaks in the cycle of abundance.

CONTROL
- Banding tree trunks with a sticky material may be of value in trapping the wingless females as they ascend to lay their eggs. However, this is dependable only when trees are isolated, and the bands must be applied in both the autumn and early spring to be effective.
- Spray the foliage in the spring when the leaves are about one-quarter grown. Most insecticides give effective control, especially B.t., carbaryl, malathion, methoxychlor, or endosulfan.

June Beetles
(Phyllophaga spp.)

June beetles are the familiar robust, brown, hard-shelled beetles which emerge from the soil in late May. They fly about at dusk and defoliate trees at night. They are especially active in warm, cloudy weather, but are seldom seen actually attacking the foliage. The eggs are laid in the ground, mainly in sod growing upon loose soil. They hatch in about four weeks. The larvae, commonly referred to as white grubs, are soft, plump and usually curled in a half circle. By September the grubs have reached a length of 18 mm and are capable of causing severe damage to plant roots. They descend in the soil to overwinter. In May they come near the surface again and feed vigorously all season, then overwinter a second time, rising again in May to feed for a short time before pupating. The adult beetles emerge the following spring. Thus the life cycle is spread into four calendar years.

While generally considered an agricultural pest of field crops and turf, white grubs injure nursery seedlings and newly transplanted trees by chewing off, or girdling, the roots. The severest damage is inflicted by the second-year grubs. Feeding by adult beetles in years of abundance may completely defoliate trees. There are but few species of hardwood trees that are not subject to some degree of attack. Linden, oak, poplar, elm, and birch are preferred hosts. There are several species of June beetles, and in Ontario they occur as far north as the limits of agriculture.

CONTROL
- In years of high beetle populations spray the foliage in late May and early June. Use malathion or diazinon.

Linden Looper

Linden Looper
(Erannis tiliaria)

The linden looper, more commonly known as the basswood looper, is a general feeder on the foliage of a wide range of deciduous trees, particularly basswood, oak, birch, maple, elm, hickory, and apple. Typically the individual leaves are only partially eaten, but serious defoliation over extensive areas may result when this pest occurs in combination with other species of loopers, particularly cankerworms.

The female moth is wingless and varies in colour from light grey to brown, with two rows of black spots on the back and side. The male is buff coloured with two transverse wavy brown bands on the forewings. The caterpillar is a looper with a rusty brown head and a bright yellow body bearing ten longitudinal wavy black lines along the back.

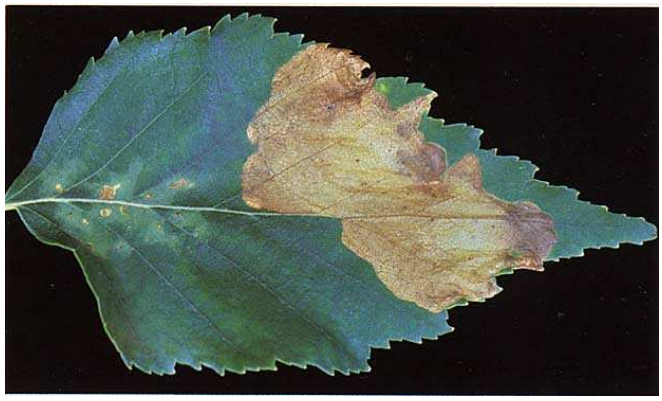
The moths are present from mid-August to late November. The females crawl up the trees and deposit their eggs in crevices of the bark. The eggs overwinter and hatch when the buds begin to burst in the spring. The caterpillars feed on the leaves until late June or July, then descend to the ground and burrow beneath the surface where they pupate in earthen cells. The moths emerge in late summer. There is a single generation annually.

CONTROL
- The trunks of isolated shade trees may be banded with a sticky material in late summer to entrap the wingless females as they ascend to lay their eggs.
- If necessary, spray the foliage about the end of May. Use B.t., carbaryl, malathion, methoxychlor, or endosulfan.

Birch *(Betula)*

Birch Leafminer
(Fenusa pusilla)

The adult of this introduced pest is a tiny black sawfly. About mid-May the sawflies emerge from the soil, and the females start egg-laying soon after the leaves unfold from the bud. The eggs are inserted singly into the tender leaf tissues. The larvae feed between the upper and lower leaf surfaces forming mines which often unite to form one large blotch involving half or more of the leaf. Heavily infested trees take on a scorched appearance. A second generation of leafminers develops in July.



Birch Leafminer damage

All birches may be attacked, particularly white, grey, and cutleaf birches. Alder is occasionally infested. The first brood causes the most damage because it attacks the tender spring foliage which is all favourable for larval development. The second brood attacks only the newly developing leaves in the periphery of the crown and on sucker growth. Leaves that escape infestation during May will usually remain uninfested for the balance of the growing season. The vigorous growth of cultivated trees probably increases their susceptibility to attack by providing young leaves for oviposition over a long period of time.

CONTROL

- Apply dimethoate on trunk and/or larger limbs in the spring as soon as green shows at the tips of the buds. Follow label directions;

OR

- Apply a spray of dimethoate to the foliage about the third week in May and repeat about the end of June.

Birch Skeletonizer larva

Birch Skeletonizer
(Bucculatrix canadensisella)

This insect occurs right across Canada. Its attacks are restricted to the birches and possibly alder. The adults are small brown moths with diagonal white bars on the forewings. The flight period is from late June to late July. Eggs are laid on the leaves, and the larvae at first construct winding mines in them. Later they feed exposed on the undersurface leaving the veins and upper epidermis intact. Leaves so skeletonized turn brown and drop prematurely.

The birch skeletonizer is more spectacular than injurious. Because most feeding occurs in late August and September it is not as detrimental to the trees as it would be earlier in the season.

CONTROL

- Collecting and destroying leaves and other ground litter in the autumn will help to reduce the severity of attack the following year by killing the overwintering pupae.
- If necessary, the foliage may be protected by applying sprays of carbaryl soon after the larval mines appear. Care should be taken to thoroughly cover the underside of the leaves.

Bronze Birch Borer
(Agrilus anxius)

Bronze Birch Borer feeding tunnels under bark

Dieback of the uppermost branches of birch trees, with ridges on trunk and limbs, characterizes the damage caused by the bronze birch borer. Newly transplanted trees, or those in a weakened condition, are often killed.

The adult borer is a slender, olive bronze beetle about 12 mm long. It emerges from June to August through small D-shaped holes in the bark and feeds sparingly on the foliage. Eggs are laid in crevices of the bark, and the larvae burrow to the surface of the wood. Their spiral feeding galleries may cross and re-cross each other, cutting off the circulation of the sap. The tree then dies above the point of infestation. The larvae are white, legless, flattened, elongate grubs which usually require two years to complete their development.

CONTROL
- Elimination of borers once they have become established is difficult. Sprays will not kill borers already under the bark, nor are sprays of the chemicals currently available to the homeowner efficient in killing the adult beetles to prevent egg laying. Suggested aids are:
- Maintain trees in as vigorous a condition as possible. Water during dry periods.
- Cut and destroy dead, dying, or infested branches by mid-May.

Yellownecked Caterpillar
(Datana ministra)

This insect is primarily a pest of fruit trees, but it also attacks a variety of deciduous forest trees, including birch, elm, and serviceberry. The mature larva is 5 cm long, with a jetblack head. The body segment just behind the head is a bright orangish-yellow, a characteristic which gives the insect its common name. The body is striped lengthwise with alternate black and yellow stripes and is thinly covered with long, soft white hairs.

The moths are present from mid June through July. Clusters of eggs are laid on the undersides of the leaves. These hatch by early August and the larvae feed on the foliage near the ends of twigs and branches. When disturbed, the caterpillars stop feeding and elevate both ends of their bodies. They are gregarious and are often found in a solid mass on a limb. They mature in a month, descend to the ground, usually at night, burrow beneath the surface, and transform to pupae without any cocoon.

Newly hatched caterpillars skeletonize the lower surface of leaves, but older ones devour entire leaves with the exception of the stems. Small trees, particularly, may be seriously weakened or killed if severely defoliated. The yellownecked caterpillar, however, is not usually an important pest in the forest.

Yellownecked caterpillars in defensive posture on oak leaves

CONTROL
- In light infestations on small trees, the colonies of caterpillars may be collected by hand and destroyed when they are young and are clustered on the foliage of a single branch.
- Shade trees may be sprayed when the caterpillars first appear in early August. Use malathion, carbaryl, or B.t.

Other insect pests of Birch:
Cankerworms - see *Linden*
Fall webworm - see Ash
Forest tent caterpillar -see *Poplar*
Whitemarked tussock moth – see *Horse-Chestnut*

Boxelder
(Manitoba Maple) *(Acer)*

Boxelder Bug
(Leptocoris trivittatus)

The boxelder bug is about 12 mm long, brownish-black, with three red stripes on the thorax and with red veins on the wings. The nymphs, or immature bugs, are bright red and feed on the flowers, seeds, and sometimes the leaves, of the female (pistillate) tree. Very few insects will develop on the male (staminate) tree. When abundant they may also feed on ash, maple, and some fruitbearing trees. Damage to trees, however, is seldom noticeable.

In the autumn, adult bugs seek dry sheltered overwintering quarters and frequently invade the attics of homes where they are a great nuisance. During warm winter days they become active and come out of hiding, only to retreat again when it turns cold. In the spring the bugs migrate to the trees and lay their reddish eggs on the bark or leaves. These hatch into nymphs which feed throughout the summer. They moult several times as they develop to the adult winged forms.

Boxelder Bug

CONTROL
- Since the important problem is house invasion by these bugs rather than injury to the trees, do not plant boxelder near dwellings. Remove seed-bearing boxelders and replace them with a more suitable type. Bugs that do enter houses may be collected in a vacuum cleaner and destroyed.
- If necessary, apply sprays to the trees in early summer when the nymphs are feeding, or in the autumn to surfaces where the adults are congregating prior to migrating to overwintering sites. Use carbaryl, malathion, or diazinon.

Boxelder Twig Borer
(Proteoteras willingana)

The adult borer is a small white-to-brownish moth, marked with clusters of tan-to-black scales. It emerges from the leaf mold in June and is active during the evenings. Eggs are laid singly on the lower surface of the leaves. Each larva constructs a small web and skeletonizes the leaf area enclosed within this shelter. Later in the season the larva bores into a dormant leaf bud, hollows out a chamber, and hibernates. In the spring the larva generally attacks another bud and then bores into the succulent current twig growth, causing formation of a spindle-shaped gall. In late May and June the mature larva drops to the ground, spins a cocoon in the leaf mold, and pupates. There is one generation per year.

When the galls of the boxelder twig borer dry out, they become woody, usually preventing further terminal growth of the infested twigs. Secondary branching then occurs, and if this growth is also destroyed, the affected tree becomes bushy and undesirable as a shade tree.

CONTROL
- Collect and destroy infested twigs before the larvae vacate the galls in June.
- Chemical control measures are not usually undertaken.

Other insect pests of Boxelder:
Fall webworm - see Ash

Walnut *(Juglans)*

Walnut Caterpillars

Walnut Caterpillar
(Datana integerrima)

The walnut caterpillar is common only in southern Ontario. Walnut, butternut, and hickory are the preferred hosts, but occasionally willow, oak, beech, honey-locust, and several other deciduous trees are attacked.

The adult is an inconspicuous brown moth which is in flight in June and July. The female deposits eggs in masses of 100 or more on the underside of the leaves. Hatching occurs in about two weeks and the caterpillars remain in colonies as they feed. When disturbed, the larvae elevate both ends of the body in a threatening manner. As the caterpillars grow they have a peculiar habit of moving down the trunk en masse to moult. The conspicuous clump of shed skins remains on the tree trunk, having much the appearance of dead worms. Mature caterpillars are about 50 mm long, black-bodied, and covered with long, frowzy grey hairs. They feed until August or September, then descend to the ground to pupate and overwinter. There is a single generation in a year.

This insect is the most important leaf-eater on walnut. Because the caterpillars feed in colonies they can rapidly defoliate branches or entire trees, depending upon the intensity of the infestation. Although feeding occurs comparatively late in the season, several consecutive years of defoliation can cause tree mortality. Isolated trees are especially subject to heavy attack.

CONTROL
- On small trees the colonies of caterpillars can be removed by hand and destroyed.
- Apply a spray in the summer when injury to the foliage is first noticed. Most insecticides are effective.

Yellow Leaf Blotch
(Microstroma juglandis)

This somewhat infrequent fungus causes yellow blotches on the upper surface of leaves, and a snow-white, powdery layer, beneath those spots, on the lower surface. Later, large, brown angular lesions develop in the diseased areas, and premature defoliation may occur. The disease is an aesthetic problem only and does not cause significant injury.

The fungus causes a similar condition on butternut.

CONTROL
- Rake and destroy fallen leaves.
- Use of fungicides is not required.

Catalpa *(Catalpa)*

Comstock Mealybug
(Pseudococcus cornstocki)

Mealy bugs are so named because of the characteristic mealy or waxy exudations that cover their bodies. The full-grown female Comstock mealybug is about 5 mm long, elongate-oval, somewhat flattened, and wingless. Short, soft spines project from the edges of the body, forming a sort of fringe. The two posterior spines are much longer than the others, forming an apparent tail. The male, which has wings, is seldom seen. A wide variety of trees and shrubs are attacked, including catalpa, horse-chestnut, maple, mulberry, poplar, boxwood, holly, privet, yew, and some fruit trees.

The insect overwinters as yellow eggs under white cottony masses in bark crevices and in the axils of twigs. Hatching begins soon after the leaves have unfolded in the spring. The nymphs move to the leaves to feed. There may be several generations in a year. Mealybugs suck out the juices and devitalize the trees. Leaves, twigs, and trunks may be distorted as a result of heavy infestations. Older mealybugs have a tendency to migrate to the branches and main trunk where they congregate at splits in the bark or at pruning scars. As a result of their feeding, knot-like galls form at these sites and interfere with the growth activities of the tree. The mealybugs also excrete honeydew which sticks to the foliage and serves as a medium for the development of black sooty mold.

CONTROL
- Apply a dormant spray of superior oil emulsion in early spring to kill the overwintering eggs.
- Apply a spray when the mealybugs are active, and repeat as required during the summer. Use malathion, dimethoate, carbaryl, or diazinon.

Catalpa Leafspot
(Phyllosticta catalpae)
(Macrosporium catalpae)
(Alternaria catalpae)
(Gloeosporium catalpae)

The fungi act either singly, or jointly, to cause spotting, blotching, or perforation of leaves. Wet springtime conditions favour infection development by spores from fallen, overwintered leaves. Spots are brown to black, usually about 6 mm in diameter, and often run together to cause dark blotches, particularly towards leaf margins; in addition the edges of leaves usually curl. These symptoms first appear in midsummer and become progressively more noticeable as the season advances. Perforations may appear as a result of dead tissues dropping from infected parts of leaf blades. Apart from detracting from the appearance of leaves, and occasioning some premature leaf-fall, leafspot does not cause significant injury.

Most deciduous trees are subject to leafspot conditions to some degree and although the disease symptoms are all similar, many different kinds of fungi are involved. While most leafspot diseases are of little importance, at least one, septoria leafspot of poplar, can lead to damaging branch and stem cankers on certain hybrids.

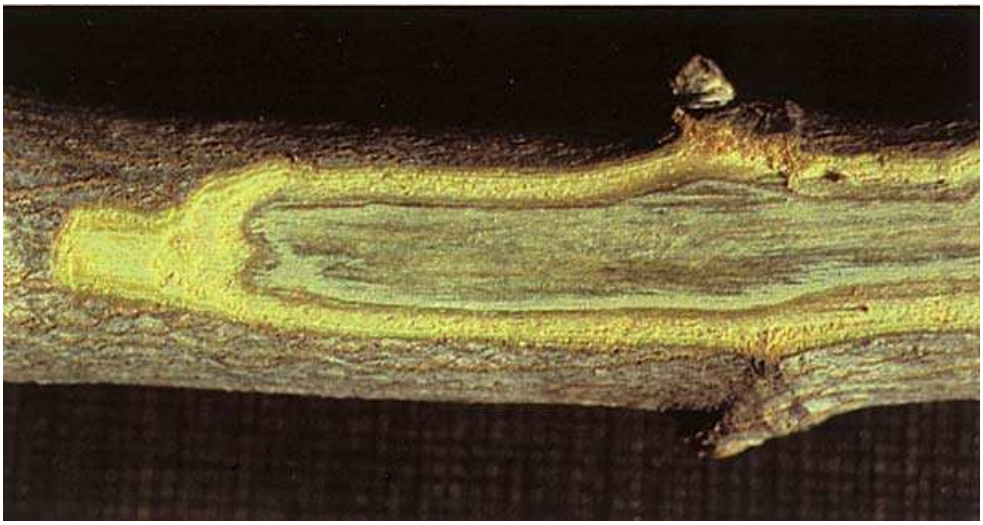
CONTROL
- Rake and destroy fallen leaves.
- In wet years, spray as leaves are unfolding, and thereafter at ten-day intervals: a total of three sprays. Use zineb or captan.

Verticillium Wilt
(Verticillium dahliae)

This soil-inhabiting fungus grows in the conducting tissues of the stems and branches, thus depriving the leaves of essential water and nutrients. Accordingly when water requirements increase during hot weather, leaves suddenly wilt, turn yellow, die, and fall prematurely. Usually only the leaves on one or two branches are affected at first, but later more branches on the same side of the tree show symptoms. Eventually wilting occurs generally throughout the plant and it may die either quickly or after several seasons. Further indications of Verticillium wilt infection are the presence of brownish streaks (for catalpa) in the outer wood, and the exuding of sap from the stem. Colour of streaks varies according to tree species.

Verticillium wilt is also a common disease of maples and occurs less frequently on a great many species of deciduous trees and shrubs.

CONTROL
- Induce increased tree vigour by root-feeding with 10-8-6 or similar fertilizer.
- Remove branches that lose their leaves, but since there is the possibility of recovery, not until the growing season following the first appearance of symptoms. Sterilize pruning tools after each cut with rubbing-alcohol diluted with water to about 70 per cent strength.
- Water frequently in hot, dry weather.
- Avoid replanting at same location where a diseased tree has been removed. Evergreens are permissible as they appear immune to the disease.



Verticillium Wilt stain in branch

Peach, Plum, Cherry *(Prunus)*

Lesser Peachtree Borer
(Synanthedon pictipes)

Peachtree Borer
(Synanthedon exitiosa)

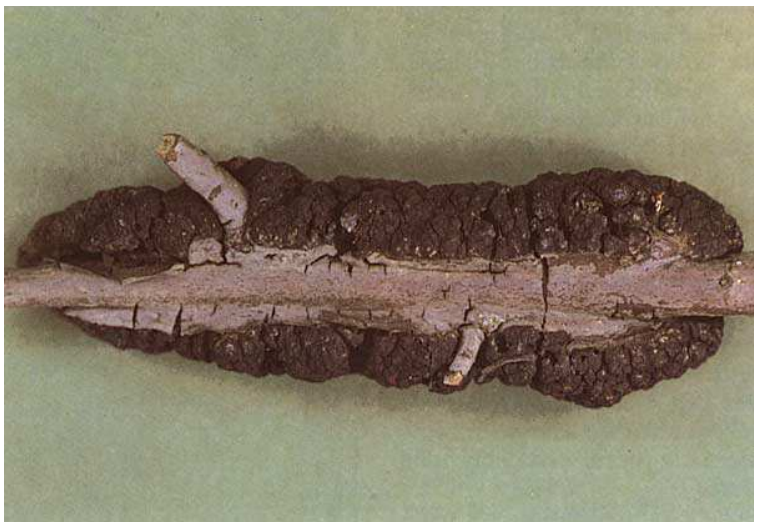
There are two species of borers that attack peach, plum, cherry, flowering almond, and other cultivated and ornamental *Prunus*. The adults of both are clearwinged moths. The peachtree borer is larger and works at the base of the trees. The lesser peachtree borer develops in the lower branches, especially where there is a canker or some other injury.

The life cycle of both species is similar except for the place of attack and development on the trees. The borers spend the winter as partly grown larvae in the bark or wood. They resume feeding in the spring, and masses of gum and castings accumulate in and near the burrows. The moths emerge during the summer and lay eggs on the bark. The larvae bore into the bark immediately on hatching, and remain there until the next season. The lesser peachtree borer completes a generation in one year, but some of the peachtree borers require two years.

CONTROL
- Spray the trunk and lower branches during the summer to destroy the larvae before they bore into the bark. Since there is a prolonged egg-laying period, especially if both species are present, several sprayings are required. Use endosulfan.

Black Knot
(Apiosporina morbosa)

This fungal disease affects most kinds of wild and domestic trees that produce stone-type fruits. Cherry and plum trees are particularly susceptible, but peach, apricot, and flowering almond may also become infected. Infections occur through wounds in the bark of current year's twigs. The following year, hard, black, rough growths appear at infection sites. These are often about 15 cm long, much thicker than the supporting twig, and while they are usually only on one side of the twig they sometimes grow until the twig is encircled. Infection progresses into branches and later into the trunk where a large wound, often with spirally fissured bark, develops.



Black Knot

In the spring a velvety olive-green layer of spores forms over all surfaces of knots. These spores become air-borne and are capable of causing new infections over considerable distances. While knots may become very numerous, diseased plants may survive. However, deformities resulting from trunk cankers usually destroy the aesthetic and commercial value of trees.

CONTROL
- During the dormant season, prune all cankered twigs and branches, using sterile tools, at a point several centimetres beyond the end of knots. All pruned material must be destroyed.
- In most instances it is not practical to treat trees having severe trunk cankers. Such trees should be removed and destroyed.

Elm *(Ulmus)*

Smaller European Elm Bark Beetle
(Scolytus multistriatus)

Native Elm Bark Beetle
(Hylurgopinus rufipes)

These common bark beetles have assumed great importance in recent years because they are carriers of the fungus causing Dutch elm disease. Their role in this connection is described later under Dutch elm disease.

Elm Bark Beetle

Elm Leaf Beetle
(Pyrrhalta luteola)

This insect, first discovered in Ontario in 1945 at St. Catharines, is now distributed across the southern part of the province. The adult is an olivegreen beetle, about 6 mm long, with a black stripe along each wing cover and variable markings on the back. The larva is a black grub which changes as it develops to dull yellow with two black lines down the back.

The beetles overwinter in dry sheltered places, including houses. They become active in the spring, when the buds of elm begin to swell, and feed on the developing foliage. Clusters of yellow eggs are laid on the underside of the leaves. The larvae feed for three to four weeks before descending to pupate near the base of the tree. In about ten days the adults appear. There may be two generations a year.

Elm Leaf Beetle

All species of elm are subject to attack. The foliage may be severely damaged as both the adult beetles and the larvae feed on the leaves. Adult feeding is characterized by oval holes eaten through the leaves, whereas the larvae skeletonize the leaves, leaving only the upper epidermis and coarse veins. Leaves thus damaged become functionless, appear scorched, and drop prematurely. Partially defoliated trees are weakened and become more subject to attack by bark beetles which transmit the causal fungus of Dutch elm disease.

CONTROL

- Apply a spray to thoroughly cover the underside of the leaves when they are about three-quarters expanded. The larvae may also be killed by spraying them when they congregate at the base of trees prior to pupation. Use carbaryl, methoxychlor, or endosulfan.

European Fruit Lecanium
(Parthenolecanium corni)

This widely distributed insect is a pest of all the common fruit trees, as well as a wide range of forest and shade trees and ornamental shrubs. Often referred to as the brown elm scale, it also attacks ash, beech, boxwood, hawthorn, locust, maple, oak, white cedar, and many other trees.

The size, shape, and colour of the adult female scales may vary depending on which host they have developed. Usually they are oval, convex, shiny reddish-brown, and up to 6 mm long. Frequently, however, the body is covered with a whitish pulverescence.

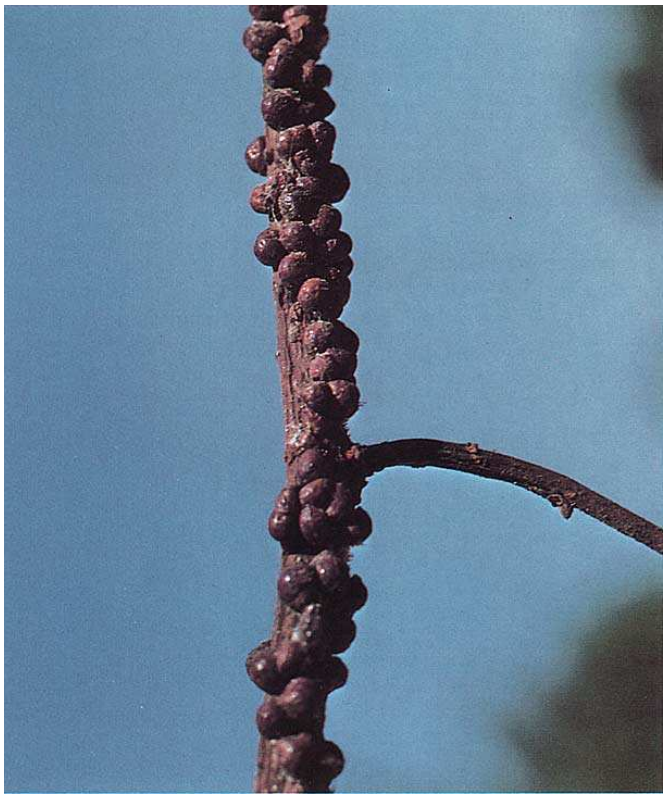
The insect overwinters as immature scales on the twigs of the last year's growth. At this time they are difficult to detect, being very small, flat, and covered with a thin coat of transparent wax. They develop rapidly in the spring and mature about May. After mating, each female lays eggs under her own scale covering and dies. Hatching occurs through June to July. The crawlers migrate to the leaves where they settle on the undersurface along the midrib and veins. They feed there until late summer and then migrate back to the twigs before frost. Any that fall with the leaves perish. There is only one generation per year.

Injury results from the removal of sap and the production of sticky honeydew on which a black sooty mold grows. Infestations may cause premature shedding of the foliage, killing of small branches, and stunting of growth.

CONTROL

This scale is not generally a serious pest of shade trees although it does frequently become abundant on young trees. Where necessary:

- Apply a dormant spray of superior oil before the buds burst in the spring.
- Spray the foliage just after the crawlers have hatched, about late July, and repeat in ten days. Thoroughly cover the branch tips and undersurface of the leaves. Use malathion, carbaryl, or diazinon.



European Fruit Lecanium

Spiny Elm Caterpillar

(Nymphalis antiopa)

The adult of this caterpillar is the well-known and beautiful *Mourningcloak Butterfly*. It is one of the few butterflies causing damage to trees. The preferred hosts of the larvae are elm and willow, but they also attack birch, maple, mountain ash, and several other deciduous trees.

The upper wing surface of the butterfly is brownish-purple, with a yellow border finely dotted with dark blue markings. The mature larva is about 50 mm long, with a black bilobed head covered with tubercles. The body is black, thinly sprinkled with white dots, and bearing several rows of large, branched spines. On the top of each body segment is a red spot.

The butterflies hibernate in sheltered places and are active on warm days in March and April. The females deposit eggs in clusters of up to 450 around small twigs, when the

Spiny Elm Caterpillar

foliage is nearly full grown. The caterpillars feed gregariously, consuming all the leaf tissue except the veins. Usually only terminal branches scattered throughout the crown are defoliated, but when the caterpillars are abundant whole trees may be stripped of their foliage. In late June or early July the caterpillars become mature and wander in search of sites to pupate. The butterflies are in flight in late summer, then go into hibernation in early autumn. Occasionally there is a second generation, which seldom causes much damage and usually goes unnoticed.

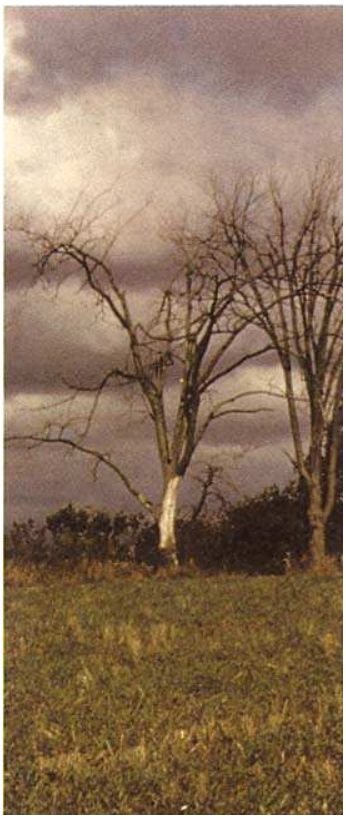
CONTROL

- Spray the foliage as soon as feeding is observed. Use carbaryl, methoxychlor, malathion, diazinon, or B.t.

Other insect pests of Elm:
Cankerworms - see *Linden* Fall webworm - see Ash
Forest tent caterpillar -see Poplar Oystershell scale - see *Lilac*

Dutch Elm Disease

(Ceratocystis ulmi)



Elm dead from Dutch Elm Disease

This highly infectious and devastating foreign fungal disease first appeared in Canada in 1944, and in Ontario in 1946. It now occurs throughout much of the range of elm in this province. Our three native elms are highly susceptible, regardless of age or size. In parts of southern Ontario the elm population has been almost completely eliminated. Elsewhere, mainly to the east and north, the disease is more scattered, but the degree of local infection is intensifying. Consequently, throughout all of southern Ontario the disease has killed most of the mature elms, although there is no basis for believing that elms are threatened with extinction.

The disease is spread by two species of bark beetles. Spores of the fungus are transported from tree to tree by new beetles emerging from infected trees and then feeding in the bark of healthy trees. Infections usually prove fatal in from one to three years. Symptoms of a new infection usually do not appear before late June. Wilting and yellowing of the foliage suddenly occur near the end of a branch. Here, leaves soon turn brown and curl but remain attached; later, all leaves on the branch become affected, and a bare area appears in the crown when the leaves finally fall. The next year, leaves either fail to develop on that branch, or only a few undersized leaves appear that soon wither. Later, infection spreads to other parts of the tree. At any point in time the disease is more widespread in the tree than external symptoms indicate.

Dutch elm disease infections also cause brown discolouration in the outer sapwood of diseased branches. In a cross section of branch, the discolouration appears as a dark brown, partial-to-complete ring, located in the wood just beneath the bark. When the bark is removed, the discolouration appears as dark streaks, running with the grain.

While these symptoms are usually reliable indicators of Dutch elm disease, they may be mistaken for those of other diseases, particularly Verticillium wilt. Accordingly, proof of elm disease infection rests on laboratory testing of branch samples from suspect trees.

CONTROL

- Apply methoxychlor to the crown in early spring, before buds swell. This material prevents infection by killing spore-carrying beetles before they can inoculate healthy trees through feeding wounds.
- Remove dying and recently killed elm trees, because they are the source of new generations of beetles.
- For individual trees of high ornamental value, injecting a fungicide into the roots appears to be effective in controlling the disease. Treatments are available only through some tree-service companies,

Other diseases of Elm:
Verticillium wilt - see Catalpa

Euonymus *(Euonymus)*

Euonymus Scale
(Unaspis euonymi)

This is one of the most serious pests of both evergreen and deciduous species of euonymus. It may also infest bittersweet, English ivy, lilac, and pachysandra.

The insect overwinters as a greyish, pear-shaped, mature female scale. Eggs are laid beneath her covering during early spring. Hatching occurs in early June and the nymphs crawl to the leaves and stems of the new growth. Here they insert their thread-like mouth parts and suck the plant juices. There are two generations per year.

CONTROL
- Apply a dormant spray of superior oil before growth begins.
- Spray about mid-June when the nymphs are emerging. Use diazinon, dimethoate, or malathion.

Euonymus Webworm
(Yponomeuta cognatella)

This pest of European origin has become established in Ontario only in recent years and is still limited in its distribution in the province. Its life cycle and habits have not been studied, but where it does exist in localized infestations it attracts attention because of the massive webs which encompass whole trees or hedges. Complete defoliation of shrubs may occur during June.

CONTROL
- Control measures have not been worked out but it is likely that the recommendations listed for other tent-making caterpillars would also be effective against this species (see Fall webworm under Ash).

Crown Gall
(Agrobacterium tumefaciens)

This bacterial disease causes swellings on the lower stem and branches of certain Euonymus species, as well as on many other trees and shrubs including hickory, rose, willow, apple, cotoneaster, and raspberry. The galls are usually woody, tumour-like, rough-surfaced, and up to 5 cm in diameter.

Infection occurs when the causal bacterium in the soil gains entrance to plant tissues through wounds, caused by garden tools, in the bark of the stem and roots. For

Euonymus Webworm colony

Defoliation and extensive webbing of Euonymus Webworm

this reason, galls often develop at the point of grafting in the vicinity of the root collar. Heavy infections can slow growth and damage branches in large trees, while small trees and shrubs may be killed.

CONTROL

- Avoid planting nursery stock that shows suspicious-appearing swellings.
- Avoid planting susceptible species.
- Destroy young trees and shrubs that develop galls.
- Avoid wounding roots and stems of shrubs and trees during cultivation.
- Prune out affected branches on larger trees.

Other diseases of Euonymus:
Powdery mildew - see Lilac

Crown Gall

Hawthorn *(Crataegus)*

Pear sawfly
(Caliroa cerasi)

Pear Sawfly larvae

The adult is a small, four-winged, black and yellow sawfly. The full-grown larva is tadpole-shaped, with the body covered with a slimy, olivegreen secretion. Hawthorn, mountain ash, serviceberry, cherry, pear, plum, and quince are attacked.

The insect overwinters as a larva in an earthen case a few centimetres below the surface of the ground. It pupates in the spring, and the adult emerges in early June. Eggs are laid singly in small, semi-circular slits cut in the leaves. The soft-bodied larvae feed mainly on the upper surface of the leaves, leaving the veins and lower epidermis. When mature, the larvae drop to the ground and pupate. There may be a partial second generation in July and August. Heavily infested trees appear as if scorched, and the skeletonized leaves drop prematurely. The surface of fruit may also be eaten, leaving a russeted appearance. Trees severely attacked lose vigour, especially if injured in two successive years.

CONTROL
- This insect is sporadic in its attack, therefore artificial control measures should be applied only when infestations warrant them. Almost any insecticide will give effective control.

Other insect pests of Hawthorn:
Eastern tent caterpillar - see *Apple*

Hawthorn Leaf Blight
(Fabraea thuemenii)

This fungus causes leaf spotting and premature defoliation of various hawthorn species, especially English hawthorn. A similar condition, caused by a closely related fungus, affects pear trees. The hawthorn leaf blight is most destructive in wet years when heavily infected trees may become almost bare by late summer.

Symptoms of infection on leaves consist of a few-to-many slightly depressed, angular, brown-to-reddish-brown spots less than 6 mm across. Spots enlarge and merge into relatively large brown areas. In midsummer, the dead areas bear small dark, raised pustules or spore-producing structures on their upper surface.

CONTROL
- Rake and destroy leaves in the autumn.
- In the spring, spray half-grown leaves with zineb; repeat after two weeks.

Other diseases of Hawthorn:
Juniper rusts - see *Juniper*

Honeylocust *(Gleditsia)*

Honeylocust Pod Gall
(Dasyneura gleditschiae)

Leaf deformity by Honeylocust Pod Gall

This species has been a minor pest of honeylocust for many years, but it is only since the introduction of the new thornless varieties that it has assumed importance. Moraine, Shademaster, and Sunburst locusts are particularly susceptible to infestation.

The adult gall-maker is a small, two-winged fly or midge, about 3 mm long. The male is black and the female is characterized by a red abdomen. The larva is a tiny white maggot.

The life history of this pest in Ontario has not been extensively studied. The midge becomes active in late April or May at about the time locusts start growth. Tiny yellow eggs are inserted among the young leaflets and these hatch in just a day or two. Larval feeding on the inner surface of a leaflet stops its development, but the outer surface grows normally. This produces a seed-like pod from which the insect gets its common name. Feeding continues inside the gall for about three weeks. There may be three or more generations per year. Adults emerging in September overwinter in the soil.

Galled leaflets may dry up and drop prematurely. Continued galling and repeated defoliation may cause the death of small branches. However, new growth often develops at the base of dead twigs; hence, trees are seldom ruined by infestation but may become unsightly.

CONTROL

- There is no satisfactory control for this insect. Dimethoate has helped in some instances but individual trees may be injured by the chemical (test single branch to determine safety).

Other insect pests of Honeylocust:
Cottony maple scale- see *Maple*

Horse-Chestnut *(Aesculus)*

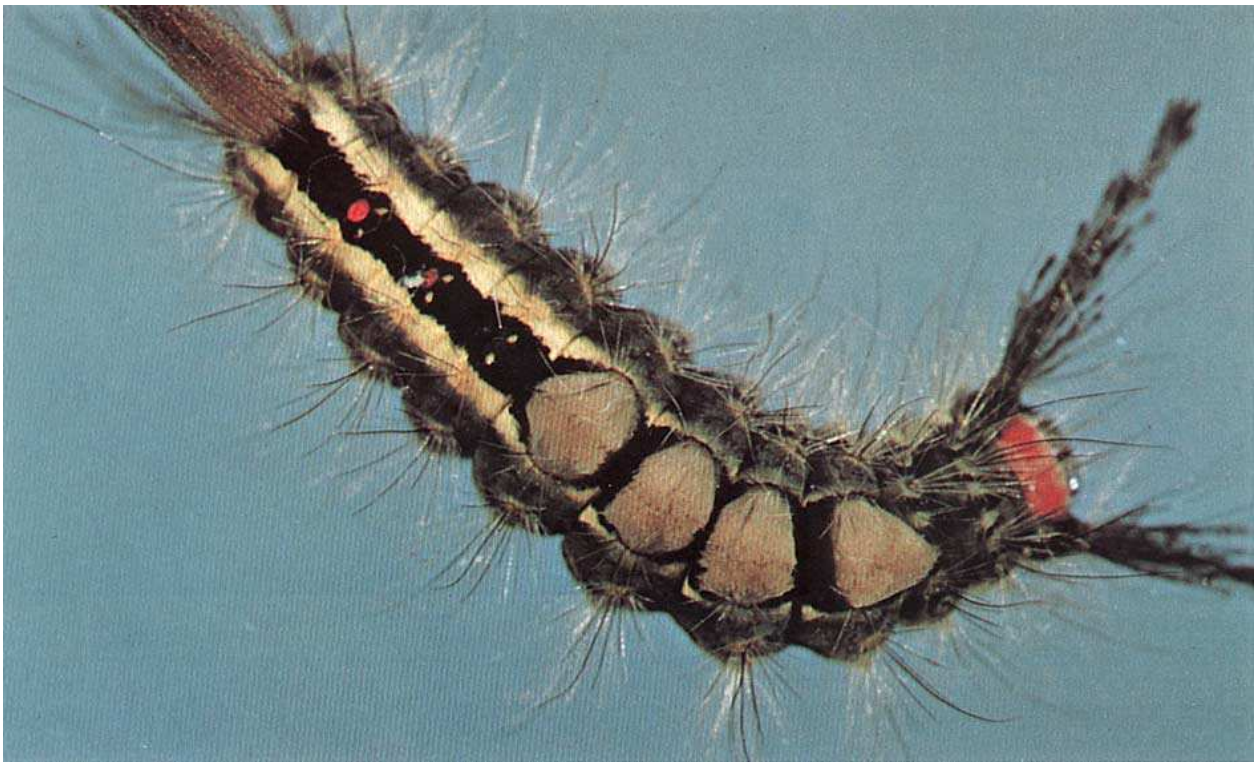
Whitemarked Tussock Moth
(Orgyia leucostigma)

This insect is a general feeder on more than 60 host trees and shrubs, both deciduous and coniferous. It is a much greater pest of shade trees in cities and towns than in the forest. Among the preferred hosts are horsechestnut, elm, linden, maple, and birch. In addition to defoliating the trees, the caterpillars may girdle the twigs by eating the bark near the beginning of the season's growth. The affected tips die, break off, and drop to the ground.

The colourful larva has a coral-red head, two diverging pencils of black hairs just behind the head and one at the rear of the body. Clusters of white bristles radiate from rows of small yellow tubercles on the sides. The female moth is grey, hairy, and wingless.

The insect overwinters as eggs which hatch between April and June. Larvae first skeletonize the undersurface of the leaves, later they consume all but the larger veins. When disturbed, the larvae drop on threads of silk and are sometimes transported considerable distances by the wind. They mature in five or six weeks, then spin cocoons, usually on the trunk. The adult emerges from July to September. The female lays up to 500 eggs in a white, frothy mass on the old cocoon and then dies. The frothy material hardens and becomes brittle, forming an effective protection. There is one generation per year.

CONTROL
- The conspicuous egg masses may be collected during winter and destroyed.
- Apply a spray as soon as larval feeding begins in late May. Use carbaryl or B.t..



Whitemarked Tussock Moth larva

Horse-Chestnut Leaf Blotch

(Guignardia aesculi)

Infections of this common foliar fungal disease appear in the spring as inconspicuous, discoloured, watersoaked spots. By mid-summer these change to small or large, triangular blotches of reddish-brown, dead leaf tissue. The brown areas are surrounded by a bright yellow, narrow band which merges outward into the green of healthy tissue. Most leaflets show one or more blotches which may become so large and numerous that leaves curl, turn brittle, and drop prematurely. These latter symptoms closely resemble those of scorch, a common condition affecting many kinds of trees along city streets. It is attributed to hot, dry, sunny weather, and horse-chestnut is very susceptible. However, in the case of leaf blotch, a distinction can be made by detecting the tiny, black, spore-producing structures on dead leaf tissue. A further distinguishing feature is the development of small, reddish-brown scars on the stalks of leaves and leaflets as a result of leaf-blotch infection.

CONTROL

- Rake and destroy leaves as they fall, and in the autumn, since these are the main source of new infections in the spring.
- Apply dodine or zineb soon after bud-break when leaves are half-grown. Repeat at ten-day intervals if weather remains wet.
- Root-feed trees which have been affected severely for several successive years.

Horse-Chestnut Leaf Scorch

Juniper *(Juniperus)*

Juniper Scale
(Carulaspis juniperi)

The female juniper scale is small, circular, and white with a yellow centre. The male scale is long, narrower and smaller, with a median ridge. Only fertilized females overwinter. Egg-laying occurs in June. The newly hatched larvae, or crawlers, exit from beneath the mother scale and migrate to feeding sites. Once the female crawlers settle down to feed they do not move again. The males, however, develop wings in the adult stage and move from one location to another. They mate with the females and die early in the autumn. There is one generation per year.

All species of juniper are damaged, but Pfitzer, Savin, and Irish junipers are most commonly infested. White cedar is also attacked. The scale is a sucking insect and feeds on the needles, twigs, and cones. Heavily infested plants exhibit poor growth and the foliage becomes greyish-brown. Sometimes a sooty mold fungus develops in the honeydew secreted by the scales, giving the trees a dirty, shabby appearance.

CONTROL
- The overwintering scales may be controlled by a dormant treatment of superior oil before growth starts in the spring.
- Spray when the crawlers are moving on the needles about late June; repeat as needed. Use diazinon, carbaryl, malathion (do not use malathion on Savin or Canaerti junipers).

Juniper Webworm
(Dichomeris marginella)

The juniper webworm has been very destructive to certain of the sharp-needled junipers, such as Meyeri and Suecica. The brownish-grey moths are present from late June to early August. They lay their eggs singly, usually in the axil of a leaf on the new terminal growth. The larvae feed gregariously at the bases of the needles. As they grow they spin webs of silk, tying the foliage together in masses. A nest may contain up to 15 or more brown caterpillars. They are only partly grown by autumn and hibernate within the webs. Development is completed in the spring. There is one generation a year.

Juniper Webworm colony

The juniper webworm is an important pest in nurseries and on ornamental plantings, frequently causing serious losses from defoliation. The young larvae feed on the epidermis of the needles, causing them to turn brown and die. The dead needles are incorporated into the silken webs which are unsightly. Small trees may have the whole top webbed together. Injury is greatest during the period of spring feeding.

CONTROL
- Apply a spray when webs first appear or in the spring. The spray should wet the needles and be applied with sufficient force to penetrate the webs. Use malathion, carbaryl, diazinon, or methoxychlor (do not use malathion on Savin or Canaerti junipers).

Juniper Blight
(Phomopsis juniperovora)

Juniper Blight

This fungus can be very destructive, both on introduced varieties of juniper and on our two native species, red cedar and ground hemlock. In addition, eastern white cedar is somewhat susceptible. Usually the disease is most destructive in nurseries where the high humidity created by watering and plant density favours infection. However, stands of larger trees in low-lying areas near water sometimes become heavily infected and defoliated when unusually favourable conditions for infection prevail.

On diseased trees, branch tips turn brown and dieback progresses until the entire branch or young tree is killed. Sunken lesions cause flattened areas on the stems. Infectious spores, produced by the millions on killed twigs, are spread throughout the tree and to adjacent trees by rain and possibly insects. Living bark of twigs is infected directly.

Junipers are also affected by other diseases such as winter browning and Sphaeropsis twig canker, which produce symptoms resembling those of Juniper blight.

CONTROL
- Prune out twigs and branches with brown foliage after it becomes clear that they have died.

Juniper Rust

Juniper Rusts
(Gymnosporangium spp.)

Most tree rusts require two kinds of plants in order to complete their life cycle. Some seven or eight species of juniper rusts occur in Ontario, all attacking various species and varieties of juniper, as well as apple, crabapple, hawthorn, juneberry, mountain ash, pear, and quince.

Consequently, determining which alternate host is responsible for the rust on juniper in a particular case involves obtaining positive identification in a laboratory. The same requirement for identification holds when the rust is found on its broadleaved host.

One of the more common juniper rusts, and certainly the most important, is the cedar-apple rust *(Gymnosporangium juniperi-virginianae)*. This rust appears to be confined to red cedar *(Juniperus virginiana)* in Ontario and to the alternate hosts apple and crabapple. On red cedar, infections cause greenish-brown galls which, in the following spring, produce orange-coloured gelatinous, spore-producing tentacles. These spores infect apple trees. The galls then dry out and shrink to less than 25 mm in diameter, becoming dark and corky.

The infections on apple leaves produce yellowish-orange spots, which develop whitish hairs projecting from the lower surface. The hairs release spores which infect red cedar leaves, thus completing the lifecycle of the rust.

CONTROL
- If feasible, cut galls from juniper as soon as they appear.
- Spray juniper about May I to prevent galls from releasing spores. Spray again about August I and repeat every two weeks for total of three sprays, to prevent infection. Use ferbam, sulphur, or zineb.
- Grow junipers and the rust-susceptible broad-leaved plants as far apart as possible.

Larch *(Larix)*

Browning of tamarack needles by Larch Casebearer larvae

Larch Casebearer
(Coleophora laricella)

Larch casebearer adults are small grey moths. They emerge in June and deposit eggs singly on the needles. The larva bores directly into a needle, which it mines until late summer. Then it lines a hollowed portion of the needle with silk and detaches the section at both ends. The remaining larval period is spent in this case. In feeding, the larva attaches the fore-end of the case to a needle which it then mines as far as it can reach. It overwinters within the case which it fastens securely to a twig, usually at the base of a bud. Feeding is resumed in early May and continues for three or four weeks.

Feeding by this insect is restricted to larch, including native tamarack. Mining of the needles gives the trees a light brown appearance as though damaged by a late frost. Trees weakened by the casebearer can be susceptible to attack by secondary pests, such as the eastern larch beetle, *Dendroctonus simplex*.

CONTROL
- The case-dwelling habit of this insect makes chemical control somewhat difficult. Spray the foliage thoroughly during the spring feeding period. Use malathion or carbaryl.

Larch Sawfly larval colony

Larch Sawfly
(Pristiphora erichsonii)

This pest is one of the most injurious insects attacking larch. The adult sawflies resemble small bees. They appear in June and early July, and the females lay their eggs in the young tender shoots. Sixty or more eggs are deposited in a series of slits cut along one side of the twig. This stops growth of that side so that the twig bends towards the injured portion, producing a characteristic hook. The presence of these curled tips is one of the first indications of a sawfly infestation. As a general rule the young larvae do not feed on the needles of the current growth on which they hatched but move to the clusters of needles on the woody twig next to the terminal. The larvae feed in colonies and migrate along the branch towards the trunk, stripping the foliage as they go. As defoliation progresses, the trees first appear thin-crowned and lacy. Later in the summer they may be completely denuded. The mature larvae are 20 mm long, greyish-green with conspicuous black heads. They descend to the ground and spin tough, brown cocoons in the litter. Here they overwinter and most emerge as adult sawflies the following June. Some larvae may remain in their cocoons for two or more seasons before transforming to adults. There is one generation per year, with a partial second in warm areas.

CONTROL
- Larvae of the larch sawfly may be controlled by almost any of the commonly available insecticides. Apply sprays to thoroughly cover the foliage when the larvae are about half-grown, sometime in July. Use malathion, carbaryl, or methoxychlor.

Lilac *(Syringa)*

Lilac Borer
(Podosesia syringae syringae)

The lilac borer has been recorded at widely separated points in Ontario but has never been abundant. In addition to lilac it also attacks ash, mountain ash, and privet.

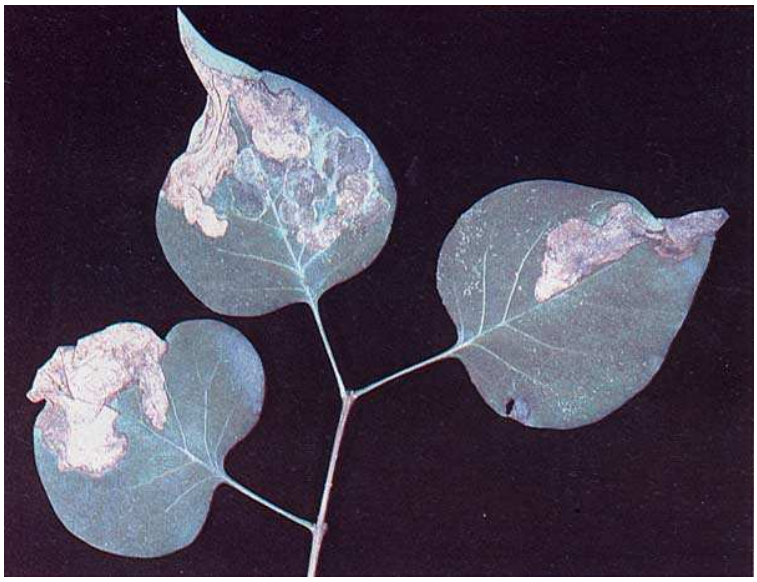
The adult borer is a dark brown, wasp-like moth. The hind wings are transparent, marked with a dark border. The insect overwinters as a white larva within the stem of the host. It resumes feeding in the spring, constructs an exit hole, and pupates in May. About two weeks later the pupa wriggles halfway out of the exit hole, and the adult emerges in June. Moths are active for several days, during which time eggs are laid in rough bark, generally near the base of the tree. The larvae bore through the bark and feed in the sapwood and heartwood until late autumn, then they overwinter. There is a single generation annually.

Signs of borer activity are round holes in the rough bark characterized by protruding sawdust, oozing sap, and in the spring by brown pupal cases at emergence holes. Tunnelling by the larvae causes the leaves to wilt and the stems to break. The older, rough-barked stems are most susceptible to attack, particularly those with wounds or grafting scars.

CONTROL
Control of the lilac borer is difficult.
- Badly infested shoots should be cut off before May and destroyed.
- Crush borers with a flexible wire probe or excise with a knife.
- Spray the woody stem portion to kill adult moths before they lay eggs or to kill larvae before they bore into the bark. Three sprays should be applied at three-week intervals beginning in early May. Use endosulfan.

Lilac Leafminer
(Caloptilia syringella)

Lilac leafminer adults are small, dark-brown moths. They appear in late May or early June and are most active in the early hours of the evening. Eggs are deposited in groups of five to ten in the axils of the veins on the undersides of the leaves. The pale yellowish larvae bore upward into the leaf where they mine between the leaf surfaces. The point of feeding at first appears simply as a discoloured spot but soon becomes irregularly enlarged. As the mines of several larvae coalesce, the leaf takes on a bladdery appearance. After feeding this way for three weeks the larvae come to the exterior and curl the leaf. They retain their gregarious habits and skeletonize the upper surface of the leaf as they roll it. About ten days later they descend on threads of silk and pupate in the debris on the ground. In early August the moths emerge and the life cycle is repeated. The larvae of this generation feed until the middle of September then enter the soil and overwinter as pupae.

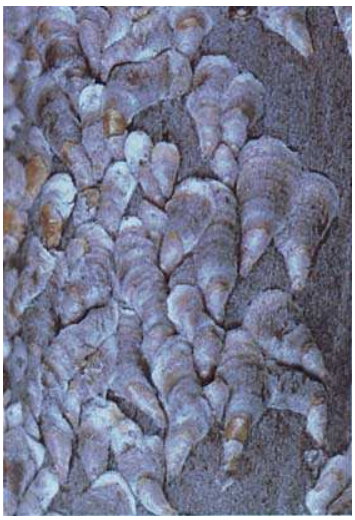


Lilac Leafminer damage

The favoured host is lilac, but ash, privet, euonymus, and deutzia are also attacked. The injury is seldom important so far as plant growth is concerned, but the beauty and symmetry of the trees is often ruined. Damaged leaves dry up, and when the insects are abundant, the foliage may be completely browned as if scorched by fire.

CONTROL
- In light infestations on small shrubs, picking the spotted leaves early in the season and destroying them should hold this pest in check.
- Spray the foliage as soon as leafminer activity is observed, or make first application in early June and repeat six weeks later. Use dimethoate, diazinon, or malathion.

Oystershell Scale
(Lepidosaphes ulmi)


Oystershell Scales

This widespread pest attacks more than 125 species of forest, shade, and fruit trees. In addition to lilac, common hosts are apple, ash, beech, birch, cotoneaster, dogwood, elm, linden, maple, poplar, and willow.

The oystershell scale is referred to as an armoured scale because the body is protected by a covering composed of moulted skins and waxy secretions. Mature females are 3 mm long, narrow in front, and broad and rounded at the rear. The males are similar in shape but smaller and are quite rare. The scales are usually strongly curved but when crowded their shape is considerably distorted. The nymphs are pale yellow to orange, very small, and somewhat flattened.

The insect overwinters as eggs beneath the scale of the dead female. Hatching occurs from late May to mid-June, and the nymphs crawl to younger wood where they settle down to feed. Soon a white flocculent mass of wax is produced which later mats down and becomes the outer scale. This is enlarged from time to time to accommodate the growing insect. The female never moves again. The male develops wings, escapes from the shell, and searches for a mate, although his presence is not necessary for the female to produce fertile eggs. In late August or September the female lays 40 to 100 eggs and then dies. There is a single generation annually.

Because of the small size and bark-like colour of the scales, infestations often pass unnoticed until a retardation of twig and branch growth causes an early yellowing of the foliage as a result of the withdrawal of sap from the tree. Branches are frequently killed back from the tips. Lilacs and ash often become so encrusted with scales that entire trees are killed. Spread of the oystershell scale from tree to tree is quite slow since the females cannot fly.

CONTROL
Natural control factors are very important in reducing scale numbers. Direct control is of two types:
- Apply a dormant spray of superior oil.
- Spray when the crawlers are moving to new feeding sites in late May or June and repeat treatment in ten days. Use malathion or diazinon.

Powdery Mildew
(Microsphaera alni)

This disease affects leaves in late summer and early autumn when growth has ceased. Accordingly, damage is negligible. Infections are often worse in wet weather. The succulent leaves of sucker growth are particularly susceptible.

Leaf surfaces become coated with a white layer of fungal threads that parasitize underlying tissues. Later the colour changes to dirty white as tiny, dark, spore-forming structures develop on the white coating. Eventually leaves turn brown and drop.

Numerous other kinds of trees and shrubs are affected by powdery mildews caused by related fungi. Prominent among these are apple, rose, and euonymus.

CONTROL
- Ordinarily, control measures are not needed. However, if spraying is justified, use benomyl or sulphur.

Locust *(Robinia)*

Locust Borer
(Megacyllene robiniae)

This native insect is a major pest of black locust. Signs of infestation are dead and broken limbs, knotty swellings on the trunk, wet spots on the bark in early spring, and accumulations of wood dust in the crevices of the bark or at the base of the tree in late summer. Thin-barked young trees are more severely damaged than are old trees with coarse thick bark. However, the branches of older trees are often infested. Nursery plantings are sometimes completely destroyed as pruning scars offer ideal sites for egg deposition.

Locust Borer adult

The adult borer is a longhorned beetle, black with yellow bands, one of which is W-shaped. Adults are present during late August and September when they are commonly found feeding on the pollen of goldenrod. Eggs are laid in crevices of the bark or around wounds. The larvae bore into the bark where they feed during the autumn. In the spring they tunnel into the wood, physically weakening the tree and making it susceptible to wind breakage. Mature larvae are robust, white, legless, club-shaped grubs about 20 mm long. There is one generation per year.

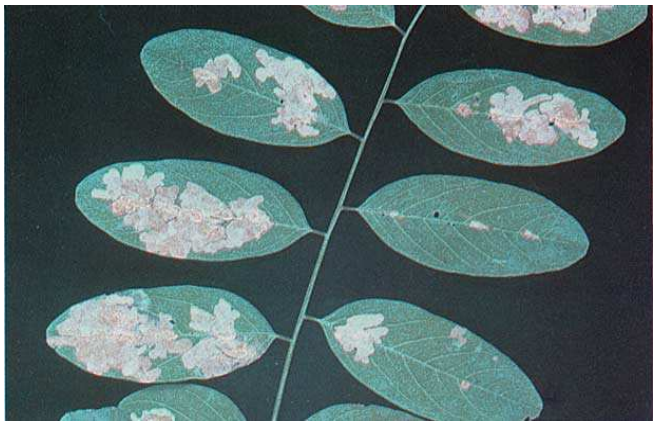
Locust Borer damage by larval stage

CONTROL

- Maintain good tree vigour by planting superior varieties of locust, selecting good planting sites, fertilizing, and watering.
- Remove and destroy heavily infested trees.
- Probe borer tunnels with a flexible wire to kill the larvae.
- Wrap the larger limbs with paper in August to prevent egg laying.
- Chemical control is difficult. Sprays to wet the trunk and limbs in late August may help to kill adult beetles and prevent egg-laying. Use endosulfan.

Locust Leafminer
(Odontota dorsalis)

The adult of this pest is a small, slightly wedge-shaped black beetle; the outer margin of the wing covers is bright orange. It overwinters in bark crevices or under debris on the ground. Emergence from hibernation occurs when the leaves are unfolding. The beetles feed for a short time on the foliage, eating small, irregularly shaped holes in the leaves and skeletonizing the lower surface. Eggs are deposited in small groups on the underside of the leaves, and the larvae from a given group of eggs bore directly into the leaf and feed in a common mine. Later, they separate, and each larva feeds in its own mine. Before reaching maturity a single larva may mine several leaves. The mines eventually turn into brown blotches and infested leaves drop prematurely. Trees



Locust Leafminer damage

are rendered unsightly and are often defoliated but are seldom killed unless the damage is incurred during poor growing seasons. Black locust is the favoured host but apple, beech, birch, cherry, dogwood, elm, hawthorn, and oak are also occasionally attacked. There may be two generations per year.

CONTROL

- Spray the foliage in the spring as soon as the leaves are fully developed, or in early July, to control the adult beetles. Use carbaryl.

Locust Twig Borer

(Ecdytolopha insiticiana)

In Ontario, the locust twig borer, which attacks black locust and honeylocust, is found only in the southern parts of the province. The adult is a small, ashy-brown moth, and the larva is a reddish to straw-yellow caterpillar about 20 mm long.

The moths are present in May and June, and the females deposit their eggs on twigs of locust. The eggs hatch in a week, and the larvae bore for a month in the twigs. When mature, the larvae leave the twigs and drop to the ground where they spin cocoons among the leaf litter and overwinter. There is one generation per year.

Locust twig borer larvae produce irregular, oval galls about 50 mm long on small branches. These split open with age and mar the appearance of the trees. In heavily infested areas seedling mortality may be high.

CONTROL

- Chemical control is difficult. Cut and destroy infested twigs in August before the larvae escape. Rake and destroy leaves in the autumn to kill the pupae.

Locust Twig Borer larva

Maple *(Acer)*

Cottony Maple Scale
(Pulvinaria innumerabilis)

Cottony masses on the twigs of shade trees, principally silver maple, indicate the presence of cottony maple scale. Among the several hosts are ash, beech, locust, oak, sycamore, willow, and several shrubs.

Mature female scales resemble partially popped kernels of corn. The cottony mass is the egg sac composed of long, fine, white threads of wax spun from the wax pores near the end of the body.

In the autumn the immature but fertilized females migrate from the leaves to the twigs, where they spend the winter. In the spring, as soon as the sap starts to flow, they grow rapidly and secrete egg sacs. Each female lays 500 or more eggs which hatch during July. The flattened, yellowish nymphs crawl from the twigs to the undersides of the leaves where they suck the sap along the midribs or veins. Mating occurs in the autumn before the leaves drop, then the males die, and the females migrate to the twigs to overwinter. There is only one generation per year.

This insect has an explosive rate of increase, and the vigour of attacked trees may be reduced rapidly. Feeding damage results in yellowing of the leaves, premature defoliation, and death of individual branches. Large quantities of honeydew are excreted in fine droplets which coat the leaves and on which a sooty fungus grows. This is one of the most destructive scales on soft maple.

CONTROL
- This insect may be abundant for two or three years and then almost disappear for long periods as a result of parasites, predators, and other natural factors. If necessary, sprays may be applied to small trees and shrubs.
- Apply a dormant spray of superior oil before the buds burst in the spring (do not use on Japanese or sugar maples).
- Spray to cover the underside of the leaves when the crawlers are active in early July. Repeat the treatment in ten days. Use carbaryl or malathion.

Cottony Maple Scale

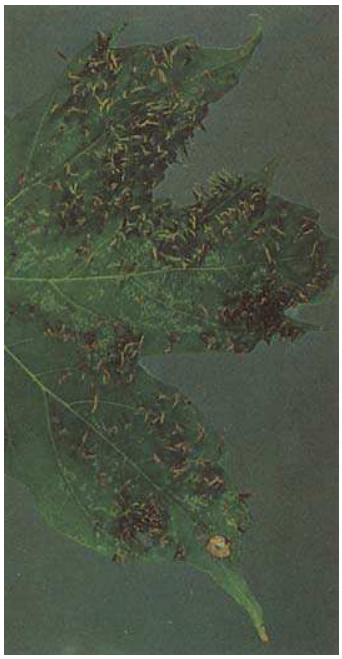
Maple Gall Mites

There are several species of mites that cause galls on the leaves of maples. The mites themselves are so small they can scarcely be observed without the aid of a hand lens. The galls they produce, however, are generally of such characteristic size, shape, and colour as to permit identification of the causal agent. A few of the common species are:

Maple Bladdergall Mite damage

Maple bladdergall mite *(Vasates quadripedes)* - causes small wart-like growths on the upper surface of the leaves of silver and red maple.
Maple spindlegall mite *(Vasates aceris-crummena)* - causes spindle-shaped growths on the upper surface of the leaves of sugar, silver, and red maple.
Crimson erineum mite *(Eriophyes regulus)* -causes red granular patches on either surface of the leaves of sugar, silver, and red maple.

The life cycles of these gall mites are similar. They overwinter at the base of the buds and on the twigs. In the spring they crawl to the unfolding leaves where their activities stimulate the production of the galls. There may be several generations in a year. The appearance of the foliage may be affected adversely, but the health of the trees is not usually impaired.



Maple Spindlegall Mite damage

CONTROL
If necessary, small trees, those of high ornamental value, and nursery stock may be protected by spraying.

- Apply a dormant spray of superior oil in the spring before the buds burst but when the temperature is above 2° C. Do not apply on sugar and Japanese maples.
- Spray the foliage when the leaves are partially expanded. Use any chemical having a mite control recommendation on the label.

Feeding damage by Maple Leafcutter

Maple Leafcutter
(Paraclemensia acerifoliella)

The maple leafcutter is more readily recognized by its distinctive feeding habits than by the appearance of the insect itself. The tiny bluish moth emerges when the maple leaves are unfolding in May. Eggs are laid singly in pockets cut into the undersurface of leaves. The young flattened larvae feed in mines in the inner leaf tissue. After the first moult the larva leaves the mine in a portable case fashioned by cutting a pair of oval discs, one each from the lower and upper surface of the mine, and tying them together with silk. This protective shelter is positioned on the upper surface of the leaf and from it the larva reaches out and feeds in a circle on the nearby upper layer of cells. The uneaten centre of the circle often drops out, leaving a hole up to 12 mm in diameter in the leaf. The case is periodically moved to new feeding sites, and after each moult the larva adds to the case by cutting another oval disc from the leaf, causing characteristic damage. In late summer the larva drops with its case and overwinters as a pupa on the ground.

The maple leafcutter is often a pest in sugar maple bushes and infestations are sometimes of prolonged duration. Severe attack reduces tree vigour, and also reduces the sugar content of the sap. Damage to scattered trees, as in landscape plantings, is seldom serious.

Crimson Erineum Mite damage

CONTROL

- If required, spray the foliage in early June or July when feeding starts. Use carbaryl.

Maple Trumpet Skeletonizer

(Epinotia aceriella)

The maple trumpet skeletonizer attacks mainly sugar, red, and silver maple but has also been recorded on hawthorn and beech. The adult skeletonizer is a small grey moth and the caterpillar is light green with a yellowish head. The moths emerge from June to mid-July, and eggs are laid, generally singly, on the undersurface of the leaves. Larvae are present from late July to September. Each larva spins a silken web which causes the leaf to fold into a protective shelter. In this fold it forms a conspicuous, black, trumpet-shaped tube of webbing covered with excrement which is readily seen on opening folded leaves. The larva feeds from this tube, eating all except the veins and upper surface of the leaf. The tube is enlarged as the larva develops and may reach a length of 50 mm before the larva is fully grown. Pupation occurs on the ground in a cocoon formed from pieces of leaves fastened together with silk. Larval populations are highest on understory trees and on the lower crowns of large maples. Folding and skeletonizing of the leaves causes them to crumple. Although this characteristic injury sometimes attracts attention, it occurs late in the season and is not considered serious, even when the insect is abundant.

CONTROL

- Control measures are rarely necessary and are not normally undertaken in the forest. On shade trees the skeletonized leaves with their contained larvae can be picked and destroyed, or fallen leaves can be raked and burned.
- If required, spray the undersurfaces of the leaves in late July or early August. Use carbaryl.

Norway Maple Aphid

(Periphyllus lyropictus)

The leaves of Norway and sugar maple trees are subject to heavy infestation by these minute, hairy aphids, which are greenish with brown markings. Like other species of aphids they suck the sap from the leaves, and secrete large amounts of sticky honeydew. Foliage in the lower crown of the trees, as well as lawns and any objects beneath the trees, become coated with a glossy film. A black sooty mold develops in the honeydew and further detracts from the appearance of the trees. Infested leaves take on a brownish appearance and become badly wrinkled and reduced in size. Premature defoliation may follow.

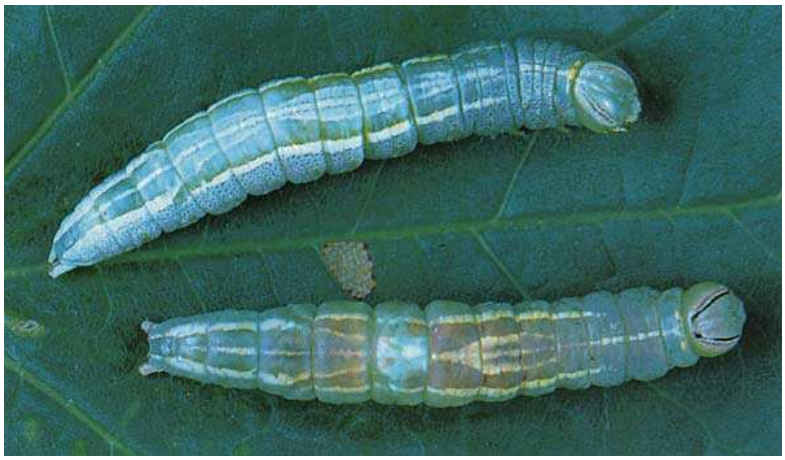
Maple Trumpet Skeletonizer damage

CONTROL

- In heavy infestations spray the foliage when the aphids first appear and before the leaves become curled. Repeat the treatment as often as is needed. Use malathion, diazinon, or endosulfan.

Saddled Prominent

(Heterocampa guttivitta)



Saddled Prominent larvae

This native insect attacks a variety of hardwoods, particularly beech, sugar maple, and apple. Young larvae are ornamented with nine pairs of horns which disappear at the first moult. Mature larvae are 30 mm long, thickest about the middle, and tapered towards each end. They range from yellow to nearly purple, with longitudinal lines interspersed with designs of variable pattern. Most have a saddle-shaped mark on the back.

The moths emerge in June and deposit up to 500 eggs singly on the leaves, mainly in the upper crown of the tree. The larvae at first skeletonize the leaves, later consuming all but the principal veins. They are wasteful feeders, and because they feed from the top of the tree downward, defoliation of hillsides may be seen from a considerable distance during outbreaks. After the first moult the caterpillars have a peculiar habit of resting with the hind end elevated. They lose their hold quite readily and fall to the ground when the tree is jarred. The larvae migrate from tree to tree and, when abundant, may collect by the thousands around the bases of defoliated trees. In late July and August they descend to the ground, pupate, and overwinter.

The saddled prominent has the capacity for rapid and widespread dispersion owing to the ability of the female to fly well and lay a large number of eggs. It is an enemy of woodland trees rather than isolated shade trees. Loss of woody growth and partial top killing are usually the main damage caused. Sugar maples may suffer a reduction in the sweetness of sap in the year immediately following severe defoliation.

CONTROL

- Natural control factors usually check the saddled prominent before it becomes a serious problem.
- Caterpillars congregated around the bases of trees may be killed by mechanical means.
- Outbreaks have been infrequent and of short duration, and control measures have not been undertaken in the forest. If necessary, valuable stands may be protected by spraying the foliage in late June or early July. Use carbaryl or B.t..

Other insect pests of Maple:

Cankerworms - see *Linden*
Fall webworm - see Ash
Forest tent caterpillar - see *Poplar*
June beetles - see *Linden*

Anthracnose

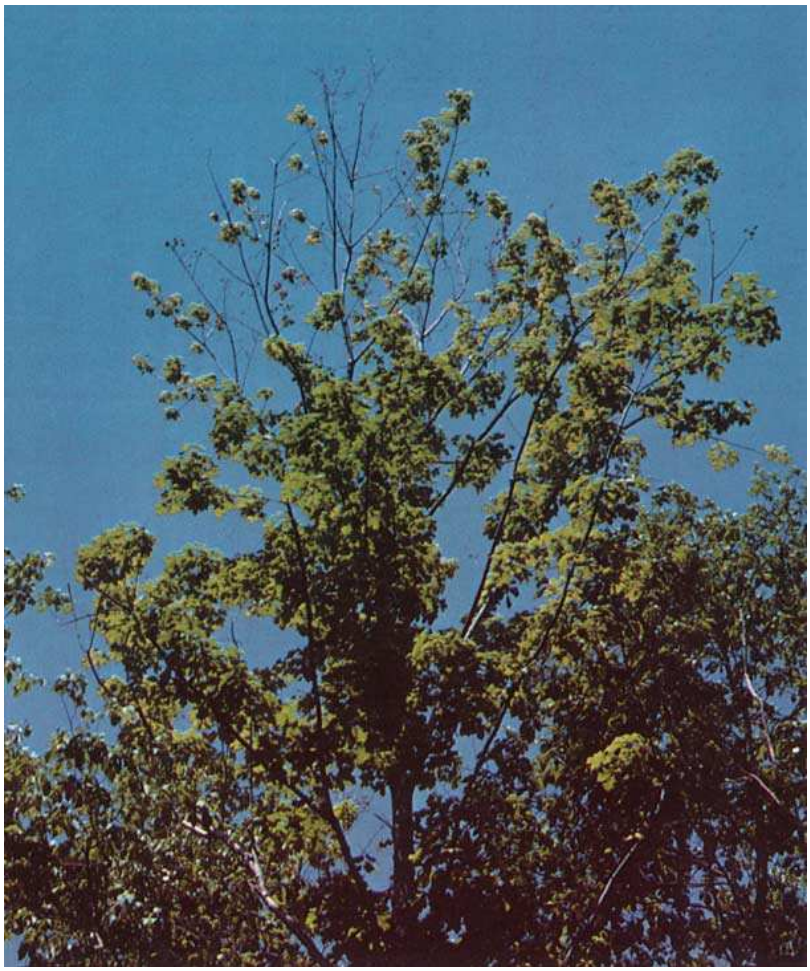
(Aureobasidium apocryptum formerly *Gloeosporium)*

Brown irregular blotches of Anthracnose disease

This common, non-fatal leaf blight affects most species of maple regardless of tree size or age. However, sugar maple seems to be affected most often. Other tree species commonly affected by anthracnose, but caused by different species of *Gloeosporium*, or by other kinds of fungi are: sycamore, ash,

oak, ironwood, and basswood. Infections start in early spring, mainly from spores released from dead, diseased, overwintered leaves on the ground. Infections are most prevalent and destructive in those years when springtime weather continues cool, wet, and cloudy into June.

Disease symptoms first appear in mid-May, while re-infection throughout the remainder of the growing season adds to the injury. Diseased leaves characteristically show light brown spots and irregular blotches between and towards the ends of the main veins and near the margins of leaves. Leaves curl, dry out, and often drop prematurely. Microscopic cream-coloured spore masses develop along the main veins on the underside of leaves and less commonly on the network of veins in the leaf blade. The presence of these aggregated spores is the only sure way to distinguish anthracnose from the similar-appearing environmental condition called Scorch (see Horsechestnut Leaf Blotch).



Dieback of Maple

CONTROL

- In the autumn, rake and destroy fallen leaves beneath infected trees.
- Root-feed trees which have been affected severely for several successive years.
- Sprays are usually not necessary. If required, apply three sprays of zineb or ferbam, first when buds break, followed by two sprays at two-week intervals.

Dieback of Hardwoods

Dieback is characterized by a progressive dying back of a stem or branch from the tip. The condition affects several deciduous trees, particularly sugar maple, white ash, oak, birch, and beech. To what extent dieback is a fungal or physiological disease is not known. In most instances a complex of several interacting biological and climatic factors are involved. Possible contributing causes are insects, fungi, viruses, pollution, weather, and site alteration including high soil temperatures lethal to fine roots, flooding, drought, and soil compaction. Defoliation by insects often precedes the onset of dieback. Trees of all ages may be affected. Early symptoms may include reduced radial stem increment, shortened internodal length of twigs, reduced leaf size, chlorosis of the foliage, and premature leaf drop. As dieback progresses towards the main stem epicormic sprouts may form near the axils of larger limbs and along the trunk. Bark may become loosened and slough off in strips. Trees in advanced stages of dieback rarely recover. Invasion by secondary pests accelerates the death of weakened trees.

CONTROL

- Control measures for dieback usually focus on reducing or preventing the factors that make the tree susceptible. Biotic factors, such as insect infestations, may be suppressed directly by spraying. Abiotic factors are more difficult to alleviate, particularly in the forest. Recommendations for protecting shade and landscape trees emphasize maintaining high tree vigour through watering, fertilizing, and pruning.

Nectria Canker
(Nectria galligena)

Also called target canker because of concentric folds of callus growth, this sometimes fatal disease occurs on both the trunk and branches of most deciduous trees, but in Ontario notably on maples. Trees are susceptible to this disease only when they are low in vigour as a result of poor nutrition and unfavourable growing conditions.

Young cankers are inconspicuous, but their presence is marked by darkened, water-soaked patches of bark. Older cankers vary in shape from circular to irregular wounds according to the species of tree affected. Trunk cankers result from infections which start through wounds in the bark of twigs or branches and later enter the main stem. Therefore the stub of the infecting branch usually can be found at the centre of the trunk canker. The exposed surface of trunk cankers has one to several concentric ridges of callus growth that has annually attempted, but repeatedly failed, to heal the injury. Since each ridge represents one year of growth, the age of cankers can be determined.

If a canker encircles a branch or trunk, all parts beyond it soon die and later break off through structural weakness. Sometimes fruiting bodies of the fungus may be seen on the older callus ridges, and under a hand lens appear as clusters of minute bright-red to brown spherical structures.

CONTROL
- If feasible, eliminate trees showing advanced trunk cankers.
- Surgical removal of small- to medium-sized trunk cankers may save valuable ornamental specimens.
- Root-feed tree to increase vigour.

Other diseases of Maple:
Verticillium wilt - see *Catalpa*

Nectria Canker

Mockorange *(Philadelphus)*

Mockorange Leafminer
(Agromyza melampyga)

The adult of this leafminer is a small two-winged fly. It is present soon after the leaves expand and lays eggs singly on the foliage. The larva at first makes a curved linear mine in the leaf, but later the distal end of the mine is expanded into an irregular blotch about 1-2 cm in diameter.

Infested leaves detract from the appearance of the host, but seldom is the injury severe enough to seriously effect the health of the shrub.

CONTROL
- Chemical control measures are not usually undertaken.

Mockorange Leafminer damage

Mountain Ash *(Sorbus)*

Mountain Ash Sawfly
(Pristiphora geniculata)

This insect is of European origin and was first recorded in Ontario about 1938. The larvae are yellow with numerous black spots on all body segments except the last. The spots are arranged in four longitudinal rows on each side and two broken rows down the middle of the back. Mountain ash is the only host.

The sawfly overwinters as a larva in a capsule-shaped cocoon in the topsoil beneath the trees. Pupation takes place in the spring, and the adult emerges from late May to early July. Eggs are inserted in slits cut at the margin of the leaflets. Larvae feed gregariously at first but tend to disperse as they mature. There is one generation per year and occasionally a partial second. Larvae of the first generation are present from mid-June to early August, while those of the second appear in late August or early September. When feeding is completed, the larvae drop to the soil to pupate. Some larvae may remain in the cocoon up to five years.

Early larval feedings between the veins skeletonizes the leaflets; later feeding consumes all the leaf but the midrib. Injury is usually more prevalent on the lower branches.

CONTROL
- The larvae are readily controlled by sprays of almost any of the commonly available contact insecticides.

Mountain Ash Sawfly larvae

Pearleaf Blister Mite
(Eriophyes pyri)

Injury by this mite is evident soon after the leaves are fully expanded. Affected areas on the underside of the leaves become thickened with a corky growth. The blisters at first are light green, gradually darkening to reddish-brown and eventually black. Where the mites are numerous, injured areas coalesce until the lesioning covers a large portion of the leaf surface. Mountain ash, serviceberry, and cotoneaster, as well as pear and apple, are hosts.

The pearleaf blister mite produces several generations each year. In early autumn the mites hibernate under the outer bud scales and resume activity in the spring about the time the leaves come out. They burrow in the epidermis on the undersurface of the leaves, causing irritation and small blisters. Eggs are laid in the leaf tissue, and nymphs develop within the corky cavity which constitutes the gall. Many young mites leave the old galls and produce other blisters. There are no winged forms. This accounts for some trees becoming heavily infested before nearby trees are attacked.

Pearleaf Blister Mite damage

Rose Chafer adult

CONTROL
- Apply a dormant spray of superior oil emulsion in the spring before the buds burst;

OR
- Apply a spray of carbaryl in spring or summer.

Other insect pests of Mountain Ash:
Cankerworms - see *Linden*

Rose Chafer
(Macrodactylus subspinosus)

This insect is a general feeder attacking a broad range of plants from vegetables and flowers to trees and shrubs. The common woody hosts are: rose, mountain ash, elm, oak, birch, sumac, hawthorn, spirea, elder, pine, and several species of fruit trees.

The adult chafers are slender, fawn-coloured beetles with long, spiny legs. They appear rather suddenly in great numbers in June and attack the buds, blossoms, or foliage of various hosts, feeding for about four weeks. Soon after emerging, the beetles mate and the females burrow into light sandy soil to deposit their eggs in small groups a few inches below the surface. The eggs hatch in about a week, and the white grubs feed on the succulent roots of grasses and other plants for the rest of the summer. In the autumn they descend below the frost line and spend the winter. In late May they work up towards the surface and transform to pupae in earthen cells. In a few weeks they become adults and emerge to attack the aerial parts of plants. There is one generation per year.

The greatest damage is to the foliage of broadleaved trees and shrubs which may be extensively skeletonized and shredded by the beetles. The terminals of young pines may be fed upon, and take on a wilted appearance. The roots of seedlings in nursery beds may be injured by the larvae. Generally the rose chafer is most troublesome in sandy soil areas.

CONTROL
- Adult beetles are quite difficult to control with insecticides. Sprays of methoxychlor, carbaryl, or diazinon should be effective.
- Hand-picking the beetles may be of value in certain cases.

Fire Blight
(Erwinia amylovora)

This bacterium causes a destructive, and sometimes fatal, disease of mountain ash and other ornamental plants of the rose family. Infections occur when pollinating insects contaminated with bacteria from diseased trees visit flowers of healthy trees. Following infection the bacterium multiplies and spreads through the flower stalk and twig into a main branch. Sometimes infection progresses into the trunk where cankers may form in the bark. The pathogen overwinters in such cankers, appearing the following spring as white droplets oozing from the crack in the bark which separates the cankered tissue from healthy tissue.

Leaves on infected twigs and branches suddenly wilt, curl, darken, and shrivel, as though scorched by flame. These leaves remain attached after normal autumn leaf-fall has occurred, thereby marking the presence of the disease.

CONTROL
- Prune out diseased parts of ornamentals as they appear throughout the growing season; pruning cuts should be located at least 30 cm below the point of visible disease symptoms.
- Sterilize pruning tools between successive cuts by dipping them in rubbing alcohol diluted with water to about 70 per cent strength.
- Examine trees carefully during late autumn or winter and remove any cankers found on the trunk or large branches. Since the bacterium occurs only on surface wood, surgical removal of a canker need not penetrate deeply into sound wood.
- Diseased trees should *not* be fertilized or watered.

Other diseases of Mountain Ash:
Juniper rusts - see *Juniper*

Twig canker caused by Fire Blight

Oak *(Quercus)*

Gypsy Moth
(Lymantria dispar)

Gypsy Moth larva

The gypsy moth is a notorious defoliator of a wide range of both hardwoods and conifers but is a particular pest of oak, poplar, and birch. It overwinters in the egg stage, often on the bark of trees, but also in any protected site. In the spring the eggs hatch and the larvae ascend the trees to feed on the expanding foliage. Initially feeding occurs during the day, but as the caterpillars mature they feed mainly at night. An infestation, therefore, often goes undetected until considerable defoliation is evident. Feeding is completed in July. Mature larvae are 50 mm long, dark coloured, and hairy, with a double row of five pairs of blue spots, followed by a double row of six pairs of red spots, down the back. They pupate in sheltered places, attached by silken threads to branches, buildings, or debris. The male moth is light brown and slender-bodied; the female is white and heavy-bodied.

Gypsy Moth egg masses

Eggs are laid in masses of 100 or more and are covered with a mat of buff-coloured hairs from the female's body. Female moths do not fly. Natural spread depends upon the young, buoyant caterpillars being blown considerable distances by the wind. Accidental spread of the pest results from the transport of logs, firewood, lumber, or other outdoor items on which eggs have been laid. Recreational and other vehicles travelling in and from infested areas also carry eggs, larvae, or pupae.

CONTROL

- Control of the gypsy moth over large areas has been conducted in forest and urban areas. Shade and forest trees may be protected by applying sprays to the foliage in June. Acephate, carbaryl, and B.t. are effective insecticides.

Oak Galls

Oaks are subject to infestation by literally hundreds of different types of gall-makers, mainly gall wasps, midges, aphids, and mites. These organisms stimulate the plant cells to produce abnormal growths, each of a characteristic size, colour, shape, and hairiness. Many of the galls are conspicuous and intriguing in form and complexity. They adversely affect the appearance and shape of the tree, but most do not seriously impair the health of the host.

CONTROL

- Populations of many species of gall-makers fluctuate greatly from year to year, and not enough is known of their life cycles to

predict the abundance of specific types of galls during the next growing season. Because the galls serve as a protection for the developing pests, insecticides are seldom effective. Twig and branch galls which may be injurious should be removed and destroyed.

Oak Galls on leaves

Oak Lace Bug

(Corythucha arcuata)

The oak lace bug is a small, broad, flat, rectangular-shaped insect having the wing covers patterned with veins and small cells. When present in large numbers this pest causes a curling, bronzing, and premature dropping of the leaves on various species of oak, particularly white, bur, and chestnut oak. Both the nymphs and adults suck sap from the leaves, causing light yellowish spots which impart a mottled appearance. Heavily infested trees may be defoliated, especially during dry weather.

The oak lace bug overwinters as adults or eggs in crevices and protected places on the host. The eggs hatch about late May or June, and the nymphs and adults feed on the underside of the leaves. Leaves become covered with cast nymphal skins and dark varnish-like excrement which disfigures the foliage. The wingless nymphs feed for three weeks or more, then transform to winged adults. Two generations a year commonly occur.

CONTROL

- When lace bugs are plentiful enough to cause leaf injury, spray the foliage so as to thoroughly cover the underside of the leaves. Use carbaryl or malathion.

Oak Leafshredder

(Acleris semipurpurana formerly *Croesia)*

Oak leaves attacked by Oak Leafshredder

Attacks of this insect are restricted to oaks, particularly red oak. The small yellow-brown moths are in flight during late June and early July. Eggs are laid singly or in small groups on the branches in the vicinity of leaf scars or in areas of rough bark. These overwinter and hatch in early May. The emerging larvae migrate to the expanding buds and tunnel through the developing leaves, producing a shredded effect. The green, semi-transparent larvae later feed more openly but beneath a silk webbing that they secrete. They fold sections of the leaves by tying two of the major veins together or by tying the leaf edge to a major vein. At maturity they spin silken threads on which they drop to the ground to pupate in the litter. Emerging moths settle on low shrubs. When abundant, the moths fly up in large clouds when they are disturbed. This may be the first indication that a population of this insect is building, and that extensive damage may be inflicted upon the oaks the following year.

Defoliation from this pest is usually greater in the upper crown of the tree. New leaves, produced after defoliation, are often stunted and sparser than normal. Epicormic sprouting, branch mortality, and dieback may result from an infestation. Tree killing can occur when severe defoliation recurs in several successive years.

CONTROL

- Oak foliage may be protected by spraying in early spring when the leaves are only partially expanded. Spraying the forest undergrowth when the moths are in flight in early July will help to reduce the number of eggs laid for the succeeding generation. Use malathion, acephate, carbaryl, or B.t. (against larvae).

Oak Skeletonizer

(Bucculatrix ainsliella)

This insect has been a pest in Ontario only since 1951. Its attacks are restricted to various species of oak.

There are two generations annually. The small, white moths appear in late May and lay eggs singly on either surface of the oak leaves. The larva bores through the bottom of the egg into the leaf, where it forms a serpentine mine. In a few weeks it emerges and moults beneath a patch of white silk. It then continues to feed as a skeletonizer on the undersurface of the leaf. After moulting a second time and a further week of feeding, the larva drops to the ground and spins its cocoon on any convenient surface. The second-generation moths emerge in late July or early August and repeat the life cycle. The larvae feed until October and then overwinter in cocoons generally constructed on the leaves where the feeding has taken place.

Oak Skeletonizer damage

Damage usually is not noticed until the larvae are skeletonizing the leaves. The upper surface then becomes brown and translucent and is covered with conspicuous grey webs. When abundant, the oak skeletonizer may completely defoliate trees. On shade trees, caterpillars dropping on silken threads are particularly annoying to the home-owner and recreationist.

CONTROL
Because this insect has two generations a year, the population can sometimes build up to considerable numbers by autumn.

- Apply a spray about mid-June to prevent population build-up, or in late August when injury becomes more noticeable. Use carbaryl or malathion.
- Collecting and destroying the fallen leaves in autumn may give adequate control in residential areas.

Twig pruner damage on oak

Twig Pruner

(Anelaphus villosus formerly *Elaphidionoides)*

The twig pruner breeds in the small branches of several deciduous trees such as oak, hickory, maple, locust, hackberry, elm, walnut, sweet gum, and sumac. The adult is a slender, elongate, greyish-brown "longhorned" beetle. It is in flight in late spring about the time the oak leaves begin to form. Eggs are laid singly near the tip of the twigs in the axil of a leaf or in slits in the bark. The young larva mines beneath the bark, but later enters the wood and tunnels downward through the centre of the twig. In late summer the mature larva squarely severs the branch all but the bark, by making several concentric cuts from the centre outward. The larva then retreats up the stem, sealing the end of the tunnel with a plug of fibrous frass. With the first provocation the thin bark breaks, and the twig falls to the ground with the larva in it. Unless the fallen branches are cleaned up, the larvae will be protected through the winter by a blanket of snow. Pupation may occur in the autumn but generally takes place the following spring. There is one generation per year.

As the common name indicates, this insect is a true twig pruner. Evidence of attack shows up in midsummer when the foliage on infested branches dies, and the twigs fall from the tree to litter the ground. Mature trees are not usually seriously damaged, but young trees may be so severely pruned that they become deformed and their development retarded. The presence of numerous dead twigs hanging in the crown also detracts from the appearance of shade and park trees.

CONTROL
There are no satisfactory insecticide control measures for this pest. The fallen branches should be collected and destroyed in the autumn or early spring before the adult beetles emerge.

Other insect pests of Oak:
Cankerworms - see *Linden*
Fall webworm - see Ash
Forest tent caterpillar -see *Poplar*
June beetles - see *Linden*
Linden looper - see *Linden*
Whitemarked tussock moth - see *Horse-Chestnut*

Armillaria mellea fruiting bodies

Armillaria Root Rot
(Armillaria mellea)

This disease is also called shoestring root rot. Oaks are often affected, but many other deciduous and evergreen trees and shrubs are also susceptible. Although the causal fungus is always present in the soil, it becomes aggressive on trees when unfavourable growing conditions exist. The main factors contributing to such conditions are drought, altered drainage patterns, soil compaction, waterlogging of soil, land fill over roots, wounding of roots, nutrient deficiencies, and insect defoliation.

In affected trees, the upper foliage becomes sparse and the leaves undersized; twigs die. A stag-headed appearance results. Internal wood decay from other fungi develops in the larger branches and in the upper trunk, while the Armillaria fungus causes root and butt rot. Eventually trees die. Occasionally trees die quickly, when the adverse growing conditions occur suddenly and severely.

Armillaria root rot is most reliably diagnosed by examining the lower trunk and large roots near their union with the trunk. Infected trees usually show a felt-like, soggy, whitish layer of fungal threads (mycelial mat) between the surface of the inner bark and that of the outer sapwood. In addition root-like or shoestring-like fungal strands may be found attached to roots. In a modified, flattened form, these structures may constitute a lattice-like network which extends up the trunk for several feet, beneath the loosened bark.

Mycelial mat of Armillaria mellea

A sure sign of this root rot may be found in the autumn when clusters of overlapping honey-coloured mushrooms appear at the base of trees or on the adjacent soil surface. These constitute the spore-forming stage of Armillaria root rot.

In addition to the foregoing effects on older trees, Armillaria root rot is frequently the cause of sudden death of recently transplanted stock located near stumps which may harbour the root-rot fungus.

CONTROL
- A tree with advanced Armillaria is probably not curable. If the disease is detected early, a tree may be saved by correcting the cause or causes noted above and possibly by surgery in diseased parts of roots and the root crown.
- Prevent the disease by avoiding development of the conditions which cause tree vigour to decline. Root-feed every few years.
- Avoid re-planting at a location from which a diseased tree has been removed.

Other diseases of Oak:
Anthracnose - see *Maple*

Pine *(Pinus)*

Eastern Pine Shoot Borer
(Eucosma gloriola)

Shoot Borer damage on Red Pine

The adult insect is a small coppery-red moth with two shining grey transverse bands on the forewings. The larva is a dirty white caterpillar about 12 mm long. The insect overwinters as a pupa in a loosely woven, light brown cocoon in the upper layer of soil. The moths emerge in late April and May and lay eggs on the new shoots, needles, or buds. The larva enters the pith of the new growth and mines downward, gradually widening the feeding gallery until it is the full diameter of the pith. When nearly full grown it reverses direction and notches the woody portion of the stem where the shoot will eventually break. The larva continues to feed in an upward direction beyond the original point of entry. It rarely feeds to the tip or node, but leaves a few centimetres of unmined pith at either end of the terminal. About mid-July the larva bores an exit hole and drops to the ground to pupate.

Larval feeding causes the terminals to fade, turn red, and break off. Injury to lateral shoots may be of little concern on forest trees or in plantations after the crowns close, but it can be a serious problem on Christmas trees or ornamentals where appearance and symmetry are important. Attacks on leaders cause reduced vertical growth or distorted stems. Adventitious buds may be produced below the base of the feeding tunnel.

CONTROL

- No satisfactory artificial control measures have been devised other than the removal and destruction of infested shoots before the larvae drop to the ground. Foliar applications of conventional insecticides must be closely correlated with moth emergence in May. The use of systemic insecticides is not economically feasible except to protect specimen trees.

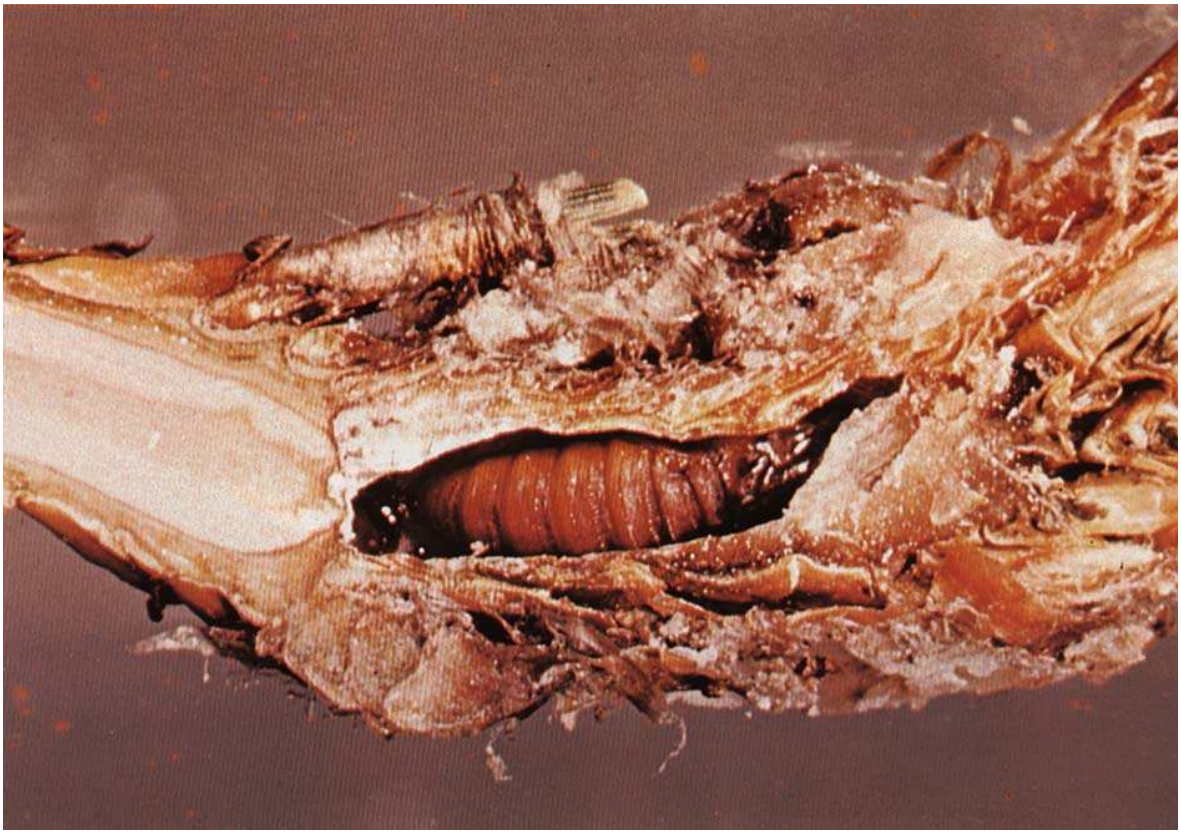
European Pine Sawfly
(Neodiprion sertifer)

European Pine Sawfly larval colony

The European pine sawfly was first found in Ontario at Windsor in 1939.

It is now found commonly on ornamental pines as far north as Thunder Bay.

The larvae are green with black heads and dark longitudinal stripes on the body. They feed in colonies on the old needles and sometimes on the bark of new shoots. Tree growth may be severely reduced, but trees are seldom killed because the current year's needles are not eaten. Trees up to about 5 m high are most severely injured. Scotch, red, jack, and mugho pines are especially subject to attack.



European Pine Shoot Moth larva

Sawfly adults emerge from cocoons in the soil litter in late summer and early autumn. They lay eggs singly in rows of uniformly spaced slits cut in the edges of the current year's needles. These overwinter and hatch about mid-May. The larvae feed until late June, then drop to the ground to spin cocoons. There is one generation per year.

CONTROL

- Apply control measures about the beginning of June when the larvae are still small. If only a few trees are involved, the individual colonies of larvae may be removed by hand and destroyed or spot-treated with sprays. Most of the commonly available chemical insecticides will control sawflies.

European Pine Shoot Moth

(Rhyacionia buoliana)

The shoot moth was undoubtedly established in southern Ontario several years prior to its multiple detection in 1925.

All species of pines may be attacked by this pest, although red, Scotch, and mugho pines are the preferred hosts. The adult is a small moth with rusty-orange forewings marked with irregular bands of silver. The larva is brown with a black head.

Moth emergence begins about mid-June and continues for six weeks. Eggs are laid on the new growth near the tips of the twigs. The larvae feed first within the needle sheath, then bore into a bud and overwinter. In the spring they migrate to growing buds or shoots, under the protection of a web, and resume feeding. Pupation occurs in the buds or resin encrustations. There is one generation per year.

Jack Pine Budworm larva

Infestations are detected by outward signs of injury. Mined needles turn brown, become loosened, droop, and often fall out of the sheath. Infested buds take on a characteristic hook-shaped appearance. Killing of the shoot may stimulate the development of latent buds below the injury. A continuation of this process produces a "witch's broom". The net effect of injury is deformed and stunted trees.

CONTROL

- Control by sprays is difficult and requires careful timing of the application. The spray should cover the buds and new growth either when growth starts in the spring or the first week in July. Use carbaryl, dimethoate, or diazinon.

Jack Pine Budworm

(Choristoneura pinus pinus)

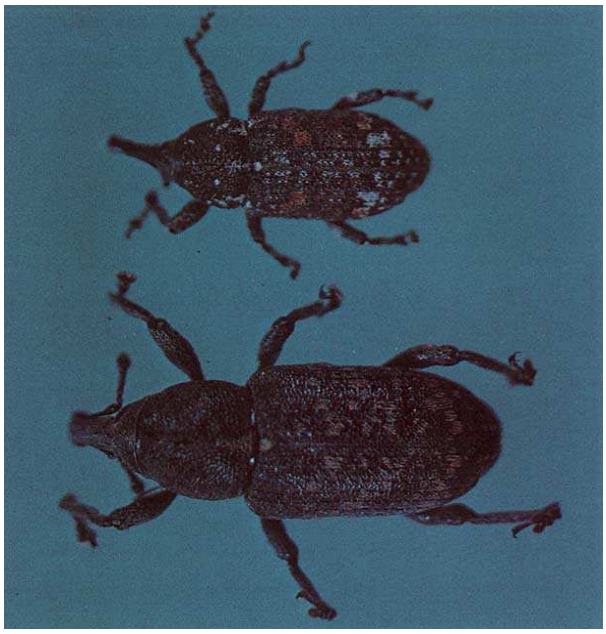
The jack pine budworm so closely resembles the spruce budworm that it was originally considered to be a racial form of that species. Jack pine is the preferred host but the caterpillars will also feed on white, red, and Scotch pine. The insect overwinters as non-feeding second instar larvae in silken cases spun in old male flower bracts, between the needles, or under bark scales. When the male flowers open in the spring the larvae emerge and feed on the pollen or developing foliage of the new shoot. The needles are not consumed entirely but are usually clipped off and loosely webbed together. Pupation occurs between webbed shoots and the moths emerge in July or early August. Eggs are laid in small clusters on the needles. The emergent caterpillars do not feed but spin their overwintering shelters, moult to the next stage, and hibernate.

This insect is one of the most serious pests of jack pine. Fortunately, however, outbreaks are usually of short duration. Budworm feeding results in whole tree mortality, or topkilling of trees and crooked or multiple leaders. Defoliation can be an important factor in the final decadence of drought-weakened trees. Infestations in Christmas-tree plantations can cause serious losses.

CONTROL

- Coarsely branched, large-crowned, suppressed, or slow-growing trees which produce an abundance of male flowers should be removed from a stand to help prevent outbreaks.
- Larval populations can be effectively reduced by sprays applied from mid-June to mid-July. Use acephate, carbaryl, or B.t.

Northern Pine Weevil
(Pisces approximates)
Pales Weevil
(Hylobius pales)



Pales Weevil (bottom) and Northern Pine Weevil

These two weevils breed in the stumps of pine and frequently occur as a mixed infestation, particularly in areas where Scotch pine Christmas trees are being harvested. The northern pine weevil is identical in appearance to the white pine weevil. It constructs shallow larval tunnels and small oval pupal cells in the aboveground portion or root collar of the stumps. The pales weevil is a larger, more robust weevil whose larvae feed in long, irregular tunnels running along the grain of the wood below ground and out on the major roots. The adults of both species feed on the bark of young shoots causing branch-tip discolouration and crooking. The pales weevil is the more destructive. It feeds primarily at night and spends the day beneath the needle litter at the base of the tree. Weevils are attracted to the volatile oils and resins of recently cut stumps and become a special threat where the harvest of trees extends over several years producing a continuous supply of brood material. Stumps more than two years old or stumps kept alive by leaving the basal whorl of live branches are unattractive to weevils.

CONTROL
- Chemical control of larvae developing in the stumps is not practical.
- Brood material should be eliminated by mechanical removal or masking the attractiveness of recently cut stumps before eggs are laid.
- Planting seedlings near fresh stumps provides readily accessible food for adults in the spring. Replanting should be delayed two years after harvest until the stumps are unable to support new infestations. Seedlings should have their tops dipped in a pesticide before planting.
- In heavy infestations feeding on the bark of twigs by adult weevils in August and September may be prevented by applying sprays to the foliage. Use methoxychlor.

Pine Root Collar Weevil
(Hylobius radicis)

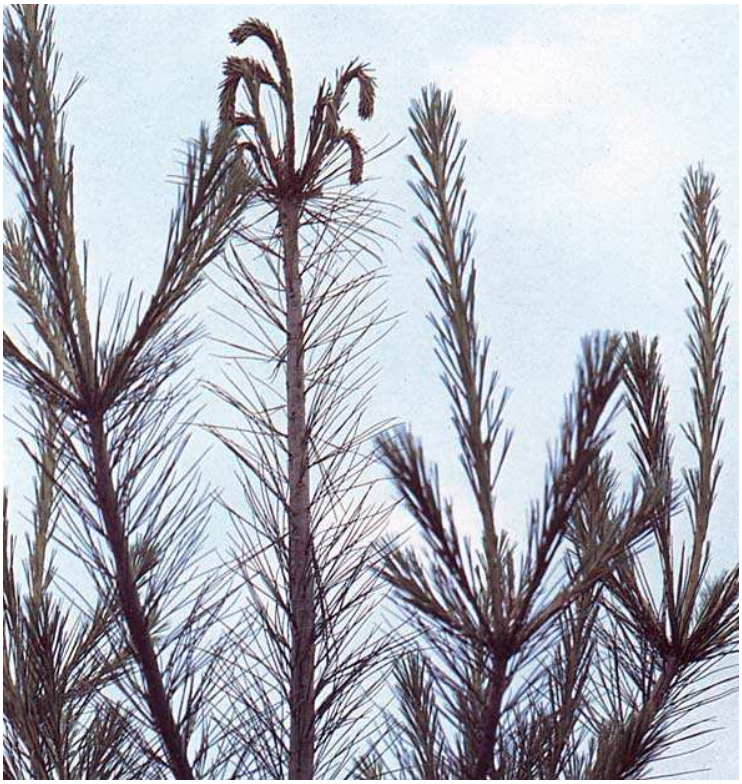
Whole tree mortality caused by girdling by Pine Root Collar Weevil.

This native insect attacks all common pines but infestations are heaviest in the exotic Scotch and Austrian pines. The adult weevil is up to 12 mm long and may vary in colour from chestnut brown to almost black depending upon the age. The insect overwinters in the larval, pupal, and adult stages, and populations of adults and immature stages prevail throughout the growing season. The adults usually overwinter near ground level in bark crevices or in the litter at the base of the trees. They become active during the latter part of April and the egg-laying period may range from May through August. When a tree is first attacked the larvae feed mostly in the inner bark of the root collar, scarring the surface of the wood slightly. Trees are usually reinfested by succeeding generations. Larval feeding wounds are well protected by a copious flow of resin which prevents drying and the entrance of decay organisms, thus making it possible for trees not completely girdled to live indefinitely.

Infestations can be detected by scraping away the duff and soil at the root collar. Symptoms are an enlarged trunk and black masses of pitch, combined with soil, which contain the characteristic larval galleries. Heavily infested trees, and those that support an infestation continuously for a period of years, usually become stunted and have exceptionally large butts in comparison with their height. Adult feeding on the tender bark of small branches may cause deformity and mortality of terminal growth.

CONTROL

- Pruning off the bottom branches and scraping away the duff down to mineral soil 30 cm around the base of each tree creates an unfavourable environment by increasing the light and temperature beyond the limits tolerable to the adult weevils. Chemical control of the larvae is difficult and usually not effective.



Leading shoot killed by White Pine Weevil

White Pine Weevil

(Pissodes strobi)

This native insect is a serious pest of eastern white pine, but all common pines and spruces are subject to attack. Trees are not killed, but serious deformity may occur when the trees are between 1and 8 in high. Usually only the vertical terminal is attacked. The new shoot wilts, bends over, and turns brown. At least two years' terminal growth is destroyed. The result is a crooked, forked, or "cabbage" tree, depending upon the number of lateral branches that turn upward to replace the leader.

The adult weevil is a small, brown snout beetle marked with irregular patches of white scales. It overwinters in the litter and becomes active on warm days in spring as the snow is leaving the ground. Eggs are laid in the upper third of the leading shoot. The larvae feed downward in the inner bark. If there are enough larvae to form a ring around the stem, it is girdled and killed. As the grubs mature they burrow into the centre of the stem and pupate in August. There is one generation per year.

White Pine Weevil larvae

CONTROL

- Remove and destroy infested terminals in June or July. At the same time prune the terminal buds of the uppermost whorl of branches, leaving one branch intact to assume dominance and develop into a new leader.
- Spray vertical terminals when the adult weevils become active in the spring. Use methoxychlor in the form of an emulsion.

Pine Bark Adelgid (Aphid)

(Pineus strobi)

Conspicuous cottony masses on the trunks and undersides of the limbs of white, Scotch, and Austrian pines indicate the presence of the pine bark adelgid. Heavily infested trees have the appearance of having been whitewashed. The adelgids may also appear as white flecks at the bases of the needles, especially at the ends of branches.

These soft-bodied insects overwinter as immature wingless females. In the spring masses of yellow eggs are laid which give rise to a generation of both winged and wingless forms. The winged forms apparently migrate to other pines as no alternate host species has yet been observed. The wingless forms remain on the parent host and begin feeding. About July eggs are laid for a second brood, which in turn produces the generation of wingless nymphs that overwinter. In some seasons it is possible that hibernation occurs in the egg stage.

Injury is caused by the sucking of sap, which reduces the vitality of the trees, often causing them to be stunted and bushy. Infestations are heaviest in well-shaded areas.

Cottony secretion by Pine Bark Adelgid

CONTROL

- Trees may be protected by applying sprays during the latter part of May when the young nymphs are crawling on the bark. Spray applications may have to be repeated at intervals of two or three weeks. Thorough coverage of the affected area is important, and forceful application is necessary to penetrate the waxy secretions. Use malathion, diazinon, endosulfan, or dimethoate.

Pine Engraver

(Ips pini)

The pine engraver is one of the most widespread and aggressive bark beetles attacking pines and spruces in Ontario. Its common name derives from the irregular, meandering egg and larval tunnels which deeply engrave the wood. The insect overwinters in the adult stage in the litter beneath infested trees. The beetle is reddish-brown to black, about 4 mm long, and the rear end of the body is concave with the margins at each side ornamented with four teeth. When the beetles emerge in spring the male bores a hole through the bark of the tree and constructs a nuptial chamber on the surface of the wood. Two to four females join the male and construct the radiating galleries where they deposit the eggs for the first brood. The legless, white larvae feed for four or five weeks, mining at right angles to the egg gallery. Pupal cells are constructed at the end of the mines and adults emerge through small circular holes in the bark. A second generation may be produced the same year, and the original adults may also start a second brood at another site. Under favourable conditions populations may increase rapidly.

Pine Engraver feeding and breeding tunnels

Bark beetles are usually considered to be secondary pests in that they breed in trees that are under stress, dying, or recently dead. Defoliation, disease, drought, and "off-site" planting are factors which predispose trees to attack. Infestations often develop in slash and unmerchantable logs when plantations are thinned. Vigorously growing trees are affected only slightly or not at all, unless attacked simultaneously by large numbers of beetles. However, pines successfully attacked are doomed, both by the effects of girdling in the trunk of the tree and by the action of blue stain fungi often introduced at the time of attack.

CONTROL

- Brood trees should be salvaged, burned, or peeled.

Pine Needle Scale

Pine Needle Scale

(Chionaspis pinifoliae)

The pine needle scale is a sedentary insect found on the needles of pine, spruce, and occasionally on hemlock, fir, and yew. The scales are sucking insects and the needles become spotted in the areas where they remove the sap and chlorophyll. When an infestation is heavy the foliage of the entire tree may have a greyish appearance, and the needles may drop prematurely. If left uncontrolled, infestations can stunt and gradually kill branches.

The insect overwinters as eggs beneath the dead female scales. The eggs hatch in May and the crawlers migrate to new feeding sites on the needles. At first the crawlers are reddish but after feeding they turn yellow and become flattened.

Adult scales are white and roughly pearshaped, with the yellow cast skin attached at the narrow end. This colouration contrasts sharply with the green needles and makes the presence of the insect quite conspicuous. There are two generations per year.

CONTROL

Natural control factors are very important in reducing scale populations. If necessary, sprays may be used to:

- Destroy the overwintering eggs in late April. Use dormant spray of superior oil emulsion.
- Control the crawlers in late May or early June. A second spray in late July may also be needed. Use malathion or dimethoate.

Spittle indicating presence of Pine Spittlebug

Pine Spittlebug

(Aphrophora cribrata)

The pine spittlebug attacks several species of pine, as well as spruce, hemlock, larch, and fir. The adult insect is light brown, dotted with pale and dark spots which form obscure transverse bands. The nymphs are yellow with black legs and are covered with spittle.

The insect overwinters as an egg embedded in the twigs or slits in the scaly bark of the trunk. Hatching occurs in May, and each nymph migrates to the tender growth near the terminal buds where it withdraws sap and covers itself with spittle. This spittle provides protection from natural enemies and from the effects of drying weather. Several nymphs may congregate in a common spittle mass. By the time they are full grown in July they will have migrated back to the main stem. They then leave the spittle mass, crawl to the ends of the needles, and transform to winged adults. They continue to feed for the remainder of the season but adults do not form spittle masses. Eggs are laid in August.

Although the pine spittlebug attacks a wide range of conifers, it rarely causes serious damage except to Scotch pine. Persistent heavy attack causes browning and thinning of the foliage, and progressive killing of the branches from the tips towards the main trunk. There is a constant drip from the frothy masses. After the insects have moved to a new location the spots on the bark where they have fed are invaded by a black sooty mold.

CONTROL

- Spray in late May or June as soon as the spittle masses appear. Use malathion or carbaryl.

Female Pine Tortoise scales (brown), and white lady bird beatle larva (predator)

Pine Tortoise Scale

(Toumeyella parvicornis)

Female pine tortoise scales are wingless, reddish-brown, oval, convex, and about 6 mm long at maturity. The males are fragile, winged insects only 2 mm long. The insect hibernates as immature, fertilized, females wedged among the empty pupal cases of the males, large numbers of which remain over winter in clusters attached to the twigs. The scales become active about the time the buds begin to swell in the spring. They mature by early June and each produces 500 or more eggs. The nymphs appear in late June and begin feeding on the twigs immediately after hatching. A white powdery substance soon develops on the lower margins of the nymphs. The males die soon after fertilizing the immature females which continue to develop until late in the autumn and then go into hibernation.

Injury is caused by the removal of the sap and the secretion of large quantities of honeydew by the immature females. A black sooty mold develops on the honeydew and detracts from the appearance of the tree. The needles of infested trees are much shorter than normal, and the foliage drop may be heavy. Ants attending the scales and feeding on the honeydew may be very numerous.

CONTROL

- Outbreaks may be controlled by spraying when the crawlers are active in June. Use malathion, carbaryl, or diazinon.

Redheaded Pine Sawfly larvae

Redheaded Pine Sawfly
(Neodiprion lecontei)

The main hosts of this native sawfly are the two-needled pines. It is probably the most serious insect pest of red pine plantations in southern Ontario. The adults have fours wings and resemble amber-coloured bees. They are present from late May through June. Eggs are laid in a row of evenly spaced slits along one edge of the needle. Up to 140 eggs may be deposited in a cluster of needles near the tip of the previous year's growth. The larvae have a distinctive colouration of reddish-orange heads and yellow bodies bearing six rows of black spots along the back and sides. The larvae feed in dense colonies until late summer, then drop to the ground to overwinter in cocoons beneath the litter. Early feeding at the ends of mature foliage may be recognized by the reddish straw-like remains of partly consumed needles. Older larvae devour entire needles. Late in the season they attack the current year's foliage and even the tender bark of young shoots. A single complete defoliation usually kills the tree.

CONTROL

- Populations of the redheaded pine sawfly tend to build up gradually and decline suddenly. The collapse of infestations may be effected by a host of natural controls, such as parasitic insects, bird and rodent predators, virulent disease organisms, periods of hot, dry weather when the larvae are migrating to the secondary hosts, or low temperatures before they have completed feeding.
- When branch or tree mortality appears imminent, or when Christmas trees are likely to be disfigured by defoliation, sprays of any of the commonly available chemical insecticides should be applied in early July.

Other Pine Sawflies

At least nine other sawflies commonly attack the foliage of pines in Ontario, most exhibiting a particular host preference. Four native species feed mainly on jack pine; however, with the exception of the Swaine jack pine sawfly *(Neodiprion swainei),* none has caused damage sufficient to require large-scale control measures. The introduced pine sawfly *(Diprion similis)* and the nursery pine sawfly *(D. frutetorum)* are exotic species which attack mainly white pine and Scotch pine, respectively.

The eggs of all pine sawflies are laid singly in slits cut in the edge of the needles, the number and placement serving as identification aids. The relative importance of the feeding injury depends not only upon the intensity of the infestation, but also on whether the larvae feed singly or in colonies, and if the current year's needles as well as the old foliage are consumed.

CONTROL

- Sawflies are quite readily controlled by any of the commonly available chemical insecticides.

Zimmerman Pine Moth
(Dioryctria zimmermani)

The Zimmerman pine moth attacks all species of pine. The larva has a brown head and a pink-to-greenish body, depending upon the host and food supply. The moths emerge from July to September but are nocturnal and hence are seldom observed. They are frequently attracted to wounds and cankers of white pine blister rust or galls of western gall rust. Shearing of Christmas trees seems to make them attractive to this pest. Eggs are deposited in crevices of the bark or at the edge of wounds. During the late summer and autumn the larvae attacking leaders feed on the outside at the base of the terminal buds, and those attacking the trunk feed on the outer bark. The larvae overwinter under tents of resin and bark frass. In the spring major external feeding, tunnelling of the leaders, and damage in the phloem and cambium region of the trunk occur. Pupation takes place in an enlargement of the feeding tunnel in July.

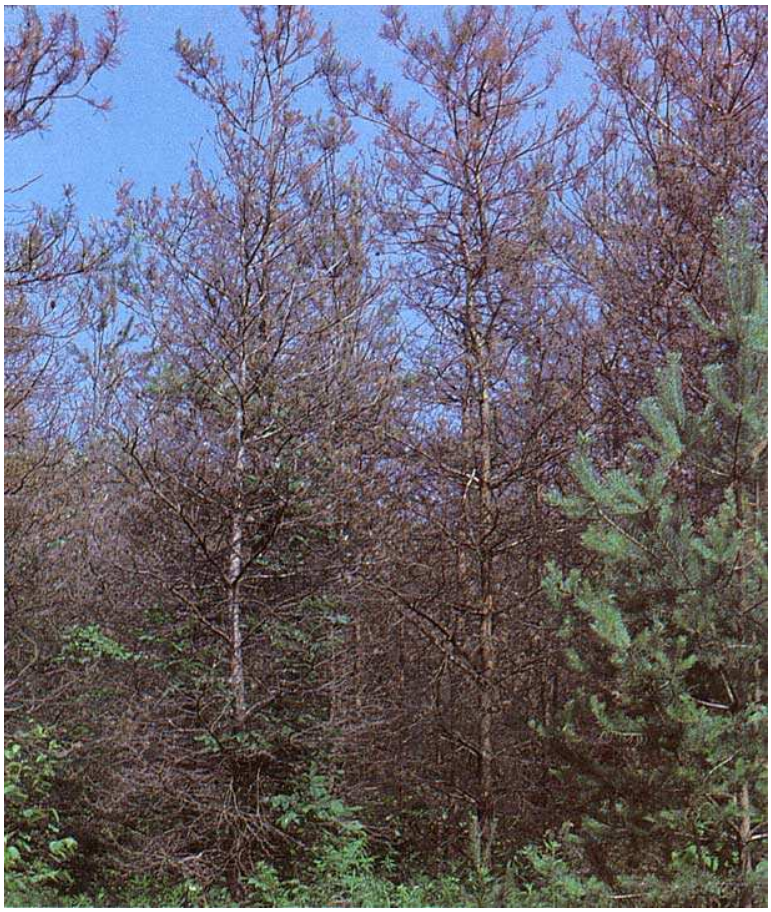
Branch tips that are girdled turn brown and fall from the trees. Tunnelling into the central leader causes browning and "fish-hooking". If two laterals assume the vertical position, a forked tree results. Larvae attacking the trunk at the juncture of the laterals may successfully girdle and kill all branches in the whorl. The trunk may then be so weakened that it breaks at the point of injury. If the trunk is partially girdled, an enlarged burl-like growth may develop. Exudations of resin mixed with sawdust are a sign of trunk infestation. Once infested, trees may be attacked repeatedly and become "brood trees'. Heavy infestations cause the wood to become excessively pitchy.

CONTROL

- Control by chemicals is difficult. Spray to thoroughly wet the bark when the larvae are breaking dormancy (mid-April) or are entering the bark (mid-August). Use lindane or endosulfan.
- Brood trees and infested branches should be pruned and the prunings burned.

Diplodia Tip Blight
(Diplodia pinea)

The fungus causing Diplodia tip blight infects several species of pine, but major damage occurs in plantings of exotics, particularly Austrian and Scotch pine. Commonly the entire new shoot is killed. Older stem tissues also become infected and damage may extend the length of major branches, often resulting in extensive top-killing of trees. The protective value of pines in shelterbelts and the aesthetic value of landscape plantings can be destroyed.



Diplodia Tip Blight damage

Symptoms of the disease are distinctive, but detection usually involves use of a hand lens. On infected new shoots, resin droplets are usually evident before the needles have broken through the fascicle sheath. One or a few needles on such shoots are shorter and darker in colour than the rest. After the needles have broken through the sheath the fungus rapidly invades and kills all needles and tissues of the shoot. Dark fruiting bodies appear on the basal section of the needle covered by the sheath, particularly on needles which are ashen-grey rather than reddish-brown. Fruiting bodies may also be found on the scales of second-year cones which are, in fact, an abundant

source of inoculum for infection of new shoots. Damage to older pines is attributed to this sequence of disease development. When infected new shoots are killed, buds are frequently forced just beneath the dead shoot. Trees that have been infected repeatedly usually have some branches killed back to the main stem.

Fomes annosus fruiting bodies

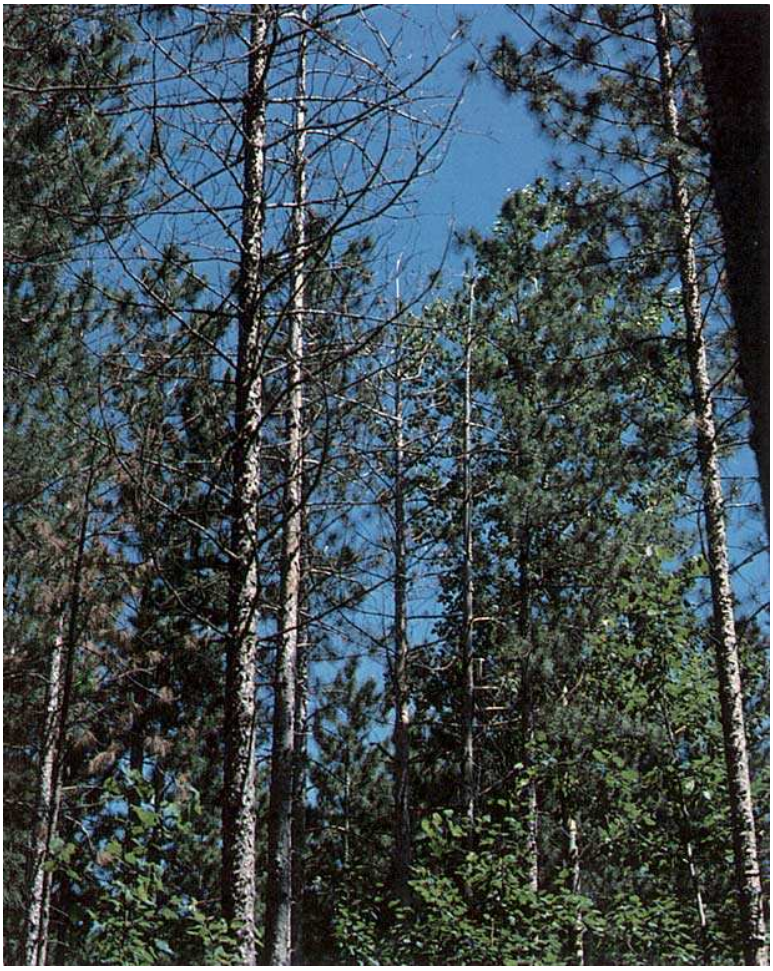
CONTROL

- Application of a fungicide to the foliage when growth is beginning in the spring can effectively reduce infection of new shoots.
- Sanitation removal of infected branches does not have a significant effect on infection intensity as the major portion of spores are produced on the seed cones.

Fomes Root Rot

(Heterobasium annosum)

Annosum root rot is a serious problem in pine plantations in southern Ontario. The fungus affects over 150 hosts, but usually occurs on conifers, particularly in red pine plantations. Fruiting bodies are produced at the base of living trees or infected stumps. These are perennial conks, brown and rough on the upper surface with a lighter-coloured sterile margin. The lower surface is tan coloured with small pores. Spores produced in the pores are most abundant during the late summer and autumn but are present in the air year round. They are released into the air and carried by the wind to cause primary infection of freshly cut or broken stems. The spores germinate and fungal threads penetrate the wood and begin to decay the roots. Where root grafting occurs the fungus is transmitted to healthy trees which in turn become infected. This is known as secondary infection. Subsequent root and root-collar decay results in wind breakage. The infected wood eventually supports fruiting bodies which produce spores to repeat the life cycle. Initial infection is indicated by individual trees or groups of trees showing signs of decline, yellowing of the foliage and tufted growth, followed by death of the trees. Wood rot and breakage of the stem at the root collar are common.



Damage caused by Fomes Root Rot

CONTROL

- Control of Annosum root rot is most practical in the primary stage of fungal infection. When plantations are thinned, the

stumps must be treated to deny the fungus a food base on which to grow. The exposed stump surface should be thoroughly covered with dry borax powder immediately after cutting.
- Heavily infected areas should be clear cut.

Needle discolouration due to Scleroderris Canker

Scleroderris Canker
(Gremmeniella abietina)

The North American strain of this fungus causes a disease of pines, particularly red and Scotch pine. Fortunately, only young trees are attacked and trees over 2.5 m in height generally recover. The first indication of infection is a reddish-orange discolouration at the base of needles in May or June. The needles also bend down. In summer, the needles and branch tips turn yellow to brown. One internode of the branch is killed per year as the fungus grows inward along the branch. Tree mortality results either from massive shoot dieback when trees are small, or from stem girdling by cankers that form where the fungus grows into the main stem from branch infections. A green stain occurs under the bark of the cankers. Infection seldom occurs more than 2.5 m above ground. Light brown fruiting bodies at the base of dead needles or on branch tips are found in the autumn. Cool and moist weather conditions favour sporulation, infection, and the colonization of host tissue. Most foliar-symptom expression occurs in the spring following infection. Because of this delay in symptom expression the disease may be translocated on infected nursery stock which appeared healthy at lifting or shipping time.

The European strain of Scleroderris canker occurs in the northeastern United States and some eastern provinces of Canada. It is capable of causing extensive mortality of seedling, juvenile, and mature trees.

CONTROL
- Pruning the lower branches of pine windbreaks around nurseries aids in eliminating sources of inoculum from infecting planting stock.
- The foliage of seedlings should be thoroughly sprayed as soon as new growth starts in the spring and repeated at two-week intervals until mid-June and thereafter in early July, August, and September. Use maneb or chlorothalonil.

Signs of Sweetfern Blister Rust infection

Sweetfern Blister Rust
(Cronartium comptoniae)

This rust of hard pines may kill a tree outright or make it more susceptible to insect attack, decay, and wind breakage. Jack and Scotch pine are the primary hosts, and seetwfern and sweetgale are alternate hosts required to complete the life cycle of the disease. Infection in pines begins in the needles and the fungus progresses inward to eventually cause long swellings on the stems. Fruiting bodies (aecia) form on the swellings in early spring and produce orange-yellow spores which are disseminated by the wind to sweetfern or sweetgale. The disease is of no importance

on these hosts, but urediospores produced on the underside of the leaves are capable of re-infecting additional sweetfern or sweetgale, serving to intensify the disease locally.

Pines appear to be susceptible to infection by sweetfern blister rust only while they are young. Cankers are seldom found on the stem more than 2.5 m above ground. After a tree attains a basal diameter of 8 cm it appears relatively safe from infection. Damage is usually negligible in natural stands but may be serious in plantations.

CONTROL

- The potential for infection may be reduced by removing infected pines during thinning operations and eradicating sweetfern and sweetgale from the environs of the plantation.
- Careful inspection of nursery stock should be undertaken, and diseased plants culled to prevent spread of the fungus.

White Pine Blister Rust

White Pine Blister Rust

(Cronartium ribicola)

This destructive foreign disease was first officially reported in Ontario in 1914. Only white pines (five needles per cluster) are attacked. The fungus now occurs throughout the range of eastern white pine in the province.

Like most tree-rust fungi, this parasite must infect two unrelated kinds of plants in order to complete its life cycle and survive. In this case the hosts are white pine trees and *Ribes* bushes (both wild and domestic currants and gooseberries). On *Ribes* the infections appear as spots on the underside of the leaves and are harmless, whereas on pines the infections are often fatal if left unattended.

Tree top killed by White Pine Blister Rust

Infection of pine occurs when a fungus spore from a diseased *Ribes* leaf lands on a single pine needle, germinates, and penetrates successfully. The fungus moves into the supporting twig, which dies, causing neighbouring needles to turn a bright brown colour. This small cluster of brown needles may appear anywhere on the tree's crown, is commonly called a "flag," and is the first noticeable symptom of infection. The fungus then moves progressively into larger branches, travelling under the bark at a rate of about 15 cm per year, killing the branch as it advances. Finally it reaches and invades the trunk, where a wound (canker) develops which grows steadily larger over the years and exudes large amounts of resin. As the tree trunk becomes girdled, the needles above that point become short and yellowish; when girdling is complete, the needles fall and the tree top dies. When infections occur at a point high on a large tree, the tree usually continues to live and grow for an indefinite period. Infections reaching the trunk from a lower branch are fatal.

In branches, the point at which the fungus is active becomes swollen and the bark turns yellowish in colour. In May, white blisters (aecia) burst through the bark of the spindle-like swellings, rupture, and release dust-like orange spores. These aeciospores are carried by the wind to infect both nearby and distant *Ribes* leaves. In late summer the *Ribes* leaves release spores (sporidia) which are air-borne over relatively short distances of several metres to infect pine needles, thus completing the life cycle.

CONTROL

- Prune out "flags," cankered branches, and where practical, diseased tree tops, amputating at a point about 30 cm below the canker.
- Prevent infections by eradicating currant and gooseberry bushes in the immediate vicinity of white pine trees. This is accomplished by spraying the bushes with glyphosate.

Winter Browning

(A non-parasitic disease)

Although many kinds of evergreen trees and shrubs suffer from winter browning of the foliage, yews and white pine seem particularly susceptible and the injury is very conspicuous.

The abnormality consists of reddish-brown foliage (a scorched appearance) above ground level, above the snow line, or on one side. Affected twigs and branches seldom refoliate fully, but these are usually replaced by new growth. Perennially affected plants show progressively sparser foliage and an increasing proportion of dead wood.

The condition results from the inability of roots to absorb moisture from the frozen soil to replace the water lost from foliage during sunny days with drying winds in late winter. Being deprived of water, cells and tissues die and the foliage browns.

Plants that suffer most are those exposed to full sunshine and drying winds, and which have entered winter with below-normal content of moisture.

CONTROL

- Protect plants against loss of moisture during the winter by shielding against wind and direct sunlight. Use devices such as shades, wind deflectors, burlap wrapping, or antidesiccant sprays.
- In years of autumn drought water freely before freeze-up.

Winter Browning on Red Pine

Poplar *(Populus)*

Forest Tent Caterpillar
(Malacosoma disstria)

This widely distributed insect has attracted attention since colonial days. A large number of deciduous forest, shade, and fruit trees are attacked, but the preferred hosts are poplar, sugar maple, oak, ash, and birch. Outbreaks usually occur in forested areas at 10- to 12-year intervals.

The adults are buff-brown moths having three darker bands obliquely across each forewing. They are in flight from late June to early August. Eggs are laid in groups of a hundred or more, cemented together in bands which completely encircle a twig, and covered with a glue-like protective coating. The eggs overwinter and hatch about the time the buds are bursting on poplar. The caterpillars from each egg cluster are at first gregarious. They do not form a tent but make a silken mat on the trunk or branch where they congregate during periods of rest or moulting. Full-grown caterpillars are about 50 mm long, hairy, brownish with a slate-blue stripe along each side and a row of keyhole-shaped white spots along the back. After feeding for six weeks the caterpillars spin yellowish cocoons in any sheltered place. There is one generation per year.

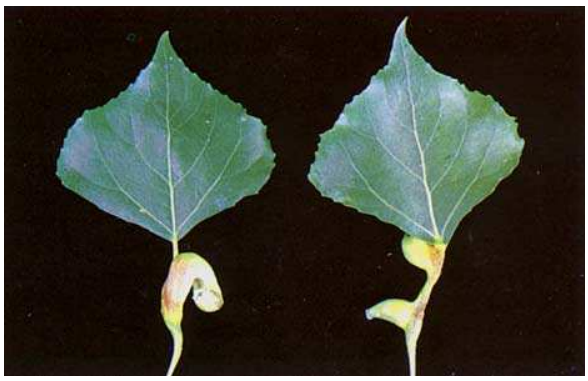
Outbreaks of this insect are periodically very widespread in the forest. Trees in windbreaks and parklands may also be completely defoliated, but they usually put forth a second crop of leaves. Sustained heavy infestation results in growth reduction and branch killing. Some tree can be killed, especially if they are suffering from other stresses such as drought or other insects.

CONTROL

- If an infestation warrants protection, apply a spray as soon as the caterpillars begin feeding in the latter part of May. Use carbaryl, B.t., or methoxychlor. A sticky band (e.g., Tanglefoot) placed on tape around the trunk can prevent re-infestation by migrating larvae.
- Where spraying is not feasible, small trees around homes and in recreational areas may be protected to a degree by removing and destroying the egg clusters during the winter when they are easily observed.

Forest Tent Caterpillar

Poplar Petiolegall Aphid
(Pemphigus populitransversus)



Galls caused by Poplar Petiolegall Aphid

Galls formed by this insect frequently attract attention because of their conspicuous size and location on the leaf stems of poplars, particularly Carolina poplar. Like many of the aphids, this species has a very complicated cycle of development involving alternate hosts in the family *Cruciferae*, mainly turnips, cabbage, and Brussels sprouts. Briefly, the seasonal history begins with the stem mother aphid which appears in late April. She settles on the petiole of a poplar leaf and a gall begins to form around her. The gall grows quickly and by July winged migrants are present within it. These fly to various cruciferous plants. Here on the leaves they give birth to other females which start colonies on the roots. In late autumn winged forms are produced which migrate back to poplar trees in the spring. In crevices of the bark on the trunk they give birth to males and females. After mating, the female lays a single egg. This hatches into the stem mother which goes to the leaf petiole, thus completing the cycle.

Other than perhaps contributing to premature leaf-drop, it is uncommon for significant economic injury to be inflicted on poplar trees by this aphid.

CONTROL
- Populations of this aphid fluctuate considerably from year to year. Control measures are not usually required.

Poplar Sawfly
(Trichiocampus viminalis)

This introduced species is widely distributed across Canada and feeds on all species of poplar, especially Lombardy and Carolina poplar. Eggs are laid in a double row along the side of the leaf petiole. Larvae are present from June to September. Sometimes a partial second generation is produced in the autumn. Young larvae feed side by side in characteristic aggregations like the spokes of a wheel with their heads directed to the centre. Older larvae tend to scatter and consume all the leaf tissue except the midrib and larger veins. Full-grown larvae are about 20 mm long and sparsely clothed with yellow hairs. The body is marked with two rows of rounded black spots. Winter is spent in a prepupal stage in cocoons in the litter beneath the trees. Pupation takes place in the spring and adults emerge from late May to mid-July.

Infestations of the poplar sawfly occur mainly on the lower branches of the tree facilitating detection of the colonies. Larvae migrating from untreated shade trees are often a nuisance as they crawl over the sides of buildings and fences in their search for overwintering sites.

CONTROL
- Artificial control measures are not undertaken in the forest, but shade and nursery trees may be protected by sprays applied to the foliage when the larvae are first observed. Use malathion or carbaryl.

Galls caused by Poplar Vagabond Aphid

Poplar Vagabond Aphid
(Mordwilkoja vagabunda)

The poplar vagabond aphid infests trembling aspen, cottonwood, and other poplars. It has a

variety of forms which differ in both appearance and habits. The complete life cycle has not yet been determined. The insect spends only part of the year on a poplar tree. In summer the aphids migrate to some unknown host, possibly to the roots of grass, but this has not been fully substantiated. In the autumn, probably early September, winged migrants come to the poplars where they re-enter old dry galls from which they migrated in the early summer. In a few days wingless egg-laying females are born, and in early November the males appear. Eggs are deposited in the galls or in nearby bark crevices. These hatch the following spring, and the emergent aphids gather at the tips of new shoots where they pierce the leaf tissues and suck the plant juices. This feeding transforms the leaves into characteristic twisted, hollow galls in which the aphids mature. Early in the summer this gall-making variety leaves the poplar for its unknown secondary-host plant.

As the galls mature they change colour from green to dark brown, then black. These old blackened galls hang on the trees after the leaves have fallen and produce an unsightly appearance in the winter. While they may be extremely numerous, the galls cause little tree injury. Since the aphids return to the old galls and lay eggs in them, the same trees are often infested year after year while trees nearby remain uninfested.

CONTROL

- Prune and destroy the old blackened galls before the first of April to eliminate the eggs overwintering in them.
- Chemical control is seldom undertaken. If necessary, apply sprays as the leaves expand in the spring. Use dimethoate or malathion.

Other insect pests of Poplar:

Cankerworms - see *Linden*
Fall webworm - see Ash
Linden looper - see *Linden*
Poplar-and-willow borer - see Willow
Whitemarked tussock moth - see *Horse-Chestnut*

European Poplar Canker

(Dothichiza populea)

This foreign fungal disease infects most kinds of poplars growing in Ontario, but usually the familiar columnar Lombardy poplar *(Populus nigra* var. *italica)* is the only species that is affected seriously. Specimens of this variety often die from infection, particularly after they have attained a height of 6 to 9 m. Rows of trees planted as windbreaks or screens seem particularly susceptible, and instances where infection has reduced such greenery to skeletons within a period of three or four years are common in southern Ontario.

Trees killed by European Poplar Canker

The first manifestation of disease is browning of the foliage on one, or more, slender branches. Later, a general dieback condition develops in the crown, and eventually trees die. Diseased shoots, branches, and stems show one-to-several small, oval, or elongated swellings in the ruptured bark. Later, during damp weather, microscopic, amber-coloured, water-soluble tendrils emerge from the surface of dead bark. These structures contain infectious spores which are splashed and carried by rain to healthy parts that may become infected.

CONTROL

Since this disease can be expected to develop on plantings of Lombardy poplar, the preferred way to deal with the problem is to avoid planting this variety of tree. However, for specimens already established, the following steps may furnish a measure of relief:

- Prune out diseased parts as they appear. Sterilize pruning tools in rubbing alcohol diluted with water to about 70 per cent strength.
- Severely infected or partly dead trees, when cut near the ground and destroyed, usually produce vigorous new shoots from the stumps. These shoots quickly form new trees and offer a short-term solution to the problem. However, they would be subject to re-infection within a few years.

Hypoxylon Canker

(Hypoxylon mummatum)

While this canker disease has been recorded on several kinds of poplar, it is most common on trembling aspen. The disease affects the trunk of trees, and it appears as a wound ranging up to 1 m in length, by several centimetres in width. Beyond the wound extremities, the bark appears normal except that it is yellowish to orange in colour for a few centimetres. Inward from the edges of the wound, the whitish, paper-thin layer of the outer bark is elevated and broken into loose rectangular segments. The underlying bark is dark and rough with projections. Between the inner bark and the outer wood there are fan-like strands of light-colored fungal threads. At the centre in the older part of the canker, the surface has thick, crusty patches of fungal tissue, and these patches bear raised powdery white, spore-producing domes. A brown exudate may streak the bark around and below the wound.

Fruiting and damage caused by Hypoxylon Canker

Infection may persist for several years depending on trunk diameter. However, when the trunk is finally girdled by the canker, the upper parts die. At this time, infected trees are recognizable from a distance, both in summer and winter, by the presence of dead tops bearing intact dead, brown leaves. The dead part of the trunk is likely to break off at the wound as a result of the activity of wood-rotting fungi which entered through the hypoxylon canker earlier.

The disease is most prevalent where trees grow on poor soil or under other unfavourable site conditions. Trees up to about forty years of age are most commonly infected.

CONTROL

While this is mainly a disease of forest trees, it is sometimes encountered on shade trees. In these instances the following measures are recommended:

- Remove trees that show large wounds. Small cankers may he surgically removed.
- Maintain tree vigour by periodic root-feeding.
- Avoid wounds in the bark; infections seem to occur through wounds.

Other diseases of Poplar:

Septoria leafspot - see *Catalpa*

Spruce *(Picea)*

Cooley Spruce Gall Adelgid
(Adelges cooleyi)

This insect attacks mainly Colorado blue, Koster blue, Engelmann, and Sitka spruces. It usually alternates between spruce and Douglas-fir, but complete cycles may occur on either genus of host. On spruce the adelgids produce thick elongate galls usually covering entire twigs of new growth and causing them to bend. On Douglas-fir they do not make galls but cause yellowing, kinking, and dropping of the needles.

Immature female adelgids overwinter under bark scales near the terminals of twigs of spruce. These mature in early spring and deposit a large number of eggs under masses of white cottony wax. The nymphs migrate to the new growth where they settle down to feed at the bases of young needles. This feeding stimulates formation of galls which develop rapidly and envelop the nymphs. Young galls are green or purple; older ones are reddish-brown. In July the galls open and the nearly mature adelgids emerge and move to the needles. Here they cast their skins and transform to winged adults which fly to Douglas-fir and lay eggs. Eventually a winged generation is produced on this host and it returns to spruce. This alternation of host trees is usual but not absolutely predictable.

CONTROL
- Remove and destroy the spruce galls in June.
- Apply a spray in late September or in the spring before the buds burst. Both spruce and Douglas-fir should be treated. Use carbaryl, malathion, dimethoate, or endosulfan.

Galls of Cooley Spruce Gall Adelgid

Eastern Spruce Gall Adelgid
(Adelges abietis)

Galls of Eastern Spruce Gall Adelgid

The main hosts of this introduced pest are Norway and white spruce, but it also attacks red, black, and Engelmann spruces. The adelgids are small, soft-bodied insects that are difficult to detect, but their presence is indicated by characteristic pineapple-shaped galls borne only at the base of the current shoots. Heavily infested trees have dead branch tips and thin foliage, become stunted, and assume an untidy appearance if the old blackened galls remain attached in the crowns.

Only female adelgids occur. Bluish-grey nymphs overwinter at the base of the buds. In early spring they mature and deposit eggs under a mass of fluffy, wax filaments. During feeding the mature adelgids affect the cells of the bud tissue destined to become the inner bark of the twig and of the little stalks on which needles are borne. The eggs hatch in May and the nymphs crawl into the open bud and settle on those needles at the base of the new shoot that has become swollen by the feeding of the "stem mothers." Their feeding stimulates further development of galls which eventually enclose the young adelgids. The galls become dry and crack open in late July or early August, allowing the adelgids to escape. They cast their skins, acquire wings, and deposit eggs on the terminal needles. These hatch into the nymphs which migrate to the base of the buds, insert their needle-like beaks, and overwinter.

CONTROL

- In light infestations the green galls with their contained adelgids may be removed and destroyed in midsummer.
- Apply a dormant spray of superior oil emulsion before buds burst in the spring.
- Apply a spray in October, or about mid-May, when the nymphs are migrating to overwintering sites or to new shoots. Use malathion, carbaryl, or endosulfan.

Spruce Bud Scale
(Physokermes piceae)

Spruce Bud Scale

The spruce bud scale is a globular, mahogany-brown scale, covered with a delicate coating of powdery wax. It settles in colonies at the base of recent twig growth, particularly on the lower branches. Norway, white, and blue spruces are preferred hosts, but other spruces are also susceptible to attack.

Immature female scales overwinter at the base of the twigs and resume feeding when plant growth begins in the spring. They mature in June, and each lays a hundred or more purplish eggs beneath her body. The flat nymphs, or crawlers, move out from under the parent scale in early July, settle on the new growth, and begin to feed. There is one generation per year.

Spruce Budworm larva

Heavily infested trees show reduced growth. Individual branches may be killed, but rarely the entire tree. The appearance of trees is rendered unsightly by a black sooty mold which grows on the sticky honeydew excreted by the scales when feeding.

CONTROL

- If the scales are numerous enough to cause significant needle damage, apply a spray when the crawlers are emerging about July 10. Repeat the treatment in ten days. Use malathion or diazinon.

Spruce Budworm

(Choristoneura fumiferana)

Spruce Budworm damage

The spruce budworm is a destructive forest pest which sometimes attacks shade trees. It prefers balsam fir and white spruce, but also injures red, black, Norway, Engelmann, and blue spruces, hemlock, and larch.

The adults are dull-grey moths with the forewings overlaid with spots of brown. They are in flight in July or early August and deposit masses of overlapping eggs on the underside of needles near the periphery of the crown. The larvae hibernate without feeding in the autumn. They become active in the spring, generally two weeks before the bursting of the buds of balsam fir. The new buds of staminate flowers are attacked first, if present, otherwise the larvae mine into the old needles before moving to the ends of the branches and boring into the expanding vegetative buds. When half-grown, the larvae tie the tips of two or more twigs together with silk, forming a small nest. The larvae are brown with a yellowish stripe laterally, and light spots on the back. Feeding is completed by the end of June and pupation takes place among the loose webs on the twigs. There is only one generation per year. The beauty of infested trees is temporarily spoiled because as the needles dry they turn brownish. Heavy feeding results in stunted growth, especially in the tops, and tree death.

CONTROL
- Spray the foliage when the caterpillars are actively feeding from mid-May to mid-June. Use dimethoate, malathion, carbaryl, B.t., or acephate.
- Do not use Malathion on blue spruce.

Spruce Needleminer injury

Spruce Needleminer
(Endothenia albolineana)

The spruce needleminer infests most species of spruce but is a pest mainly of blue spruce. The adult is a small, dark brown moth with three irregular greyish bands across the forewings. The larva is a green caterpillar with a brown head.

The moths are in flight from mid-May to mid-June. Eggs are laid in a row on the underside of the needles. The young larvae are gregarious and bore into the bases of old needles, hollowing them out. Later they cut off the mined needles and web them together into a nest of silken strands and frass. Each larva destroys an average of ten needles on blue spruce. Feeding continues until early frost, then recommences in the spring until about late April. Pupation takes place in silken cocoons within the nest during the late spring or early summer. There is one generation per year.

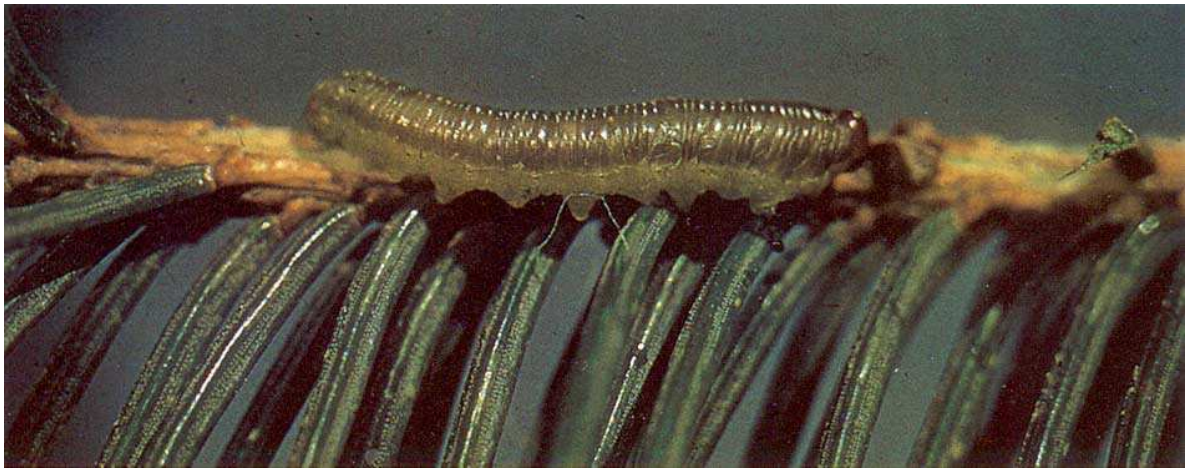
The presence of webs on ornamentals reduces their aesthetic value. The nests are most abundant in the thick growth near the trunk. The entire crown of small trees may be infested, but on large trees the heaviest infestation is usually on the lower branches. Empty nests may persist a year or more. Young trees growing under adverse conditions are particularly susceptible to serious injury.

CONTROL
- Wash the webs from the trees with a strong stream of water in the spring before the buds begin to swell, or in the autumn just before the cold weather sets in. Dislodged nests should be collected and destroyed.
- Apply a spray with sufficient force to penetrate the nests. Treat about mid-June and repeat in late June. Use malathion or carbaryl. Do not use malathion on blue spruce.

Needle browning by Spruce Spider Mite

Spruce Spider Mite
(Oligonychus ununguis)

This is the most common mite on spruce. Infested trees have a bronzed and unthrifty appearance due to removal of cell sap from the needles. Both the immature and adult mites spin webbing of fine silk around the twigs which protects the mites from dislodgement and from some of their natural enemies. Dust particles and dead needles that adhere to the webbing add to the shabby appearance of the trees. Older needles are attacked first, and injury appears initially on the lower branches. This pest is more abundant, and causes more pronounced injury, during hot, dry seasons. Cedar, juniper, hemlock, larch, and certain pines are also attacked.



Yellowheaded Spruce Sawfly larva

The mites are extremely small and scarcely visible to the naked eye. Young mites are pale green, and adults are dark green or nearly black. The pest overwinters as reddish eggs under loose bud scales and at the bases of the needles. Hatching begins in late April. There are several generations of the mite each year. During the summer an average of fifteen days is required to produce one generation. The mites of the spring generation feed on the old foliage, those of the following generations on the current year's needles.

CONTROL
- Apply a dormant spray of superior oil emulsion in the spring, except on blue spruce.
- Apply two sprays at ten-day intervals when mites are present during the summer. Use any chemical having a mite-control recommendation on the label.

Yellowheaded Spruce Sawfly
(Pikonema alaskensis)

This native insect feeds only on spruces. Early in the season the brown stubs of needles eaten on the new growth impart a ragged appearance to heavily infested trees. Later the trees may be completely defoliated. Ornamentals, windbreaks, and nursery stock may be severely damaged. Trees that do not die suffer some branch killing and considerable growth reduction.

The insect overwinters in a cocoon in the soil. Pupation occurs in the spring, and the adults emerge in late May and early June about the time the scales fall from the spruce buds. Eggs are deposited in shallow slits in the current season's needles or in the tender bark between the needles. Larvae at first feed on the new needles, moving later to the old foliage. The larvae are olive-green with conspicuous yellowish-brown heads, and have a waxy appearance. When disturbed, they exude a liquid from their mouths and arch both ends of the body in a manner characteristic of sawflies. Feeding continues for three to eight weeks. Larvae drop to the ground in July and spin cocoons. There is one generation per year.

CONTROL
- Single trees or small groups of trees may be protected by removing the larvae by hand and destroying them.
- Apply a spray in mid-June, and, if necessary, repeat at the end of June. Use malathion, dimethoate, methoxychlor, or diazinon.

Other Spruce Sawflies
(Pikonema dimmockii)
(Diprion hercyniae)

Often found in association with the yellowheaded spruce sawfly is the closely related greenheaded spruce sawfly *(P dimmockii)*. It has a similar distribution and life history but is much less destructive.

A third species, the European spruce sawfly *(Diprion hercyniae)*, infests all spruces, particularly white spruce. There are one or two generations each year. The larvae overwinter in cocoons in the litter and change to pupae, then to adults, in the spring. Eggs are laid in slits cut in the needles. Most eggs are unfertilized because male sawflies are very rare. First-generation larvae feed on the older needles in June and July; those of the second generation feed from mid-August through September. This sawfly occurs only in relatively low numbers due to the combined action of an accidentally introduced virus disease and several species of parasites.

European Spruce Sawfly larva

CONTROL
- Control by chemical insecticides is not necessary.

Spruce Canker
(Cytospora kunzei var. *picea)*

While there are numerous kinds of Cytospora diseases affecting different species of trees, the Cytospora canker on spruce is by far the most serious attacking shade trees. Although the spruce canker is seldom fatal, it disfigures ornamental specimens. Trees in windbreaks and hedges are particularly susceptible because as the trees become older, the competition for nutrients and space leads to an early decline in tree vigour. Prolonged periods of summer drought will also increase susceptibility to the disease. It is generally believed that the fungus invades a tree through breaks in the bark.

Symptoms of infection include browning and loss of needles from scattered, mostly lower, branches. Near the base of diseased branches or twigs are swellings covered with bluish-white resin. Minute, yellowish spore tendrils may appear on bark near these wounds in wet weather.

Sometimes branch infections enter the trunk, where they develop into much larger sunken cankers, ranging up to about 30 cm in length. Such cankers usually result in the trunk becoming almost totally encrusted with resin. Norway spruce is particularly subject to trunk cankers.

Symptoms of Spruce Canker

CONTROL
- Prune out diseased twigs and branches when the bark is dry, using tools sterilized in rubbing alcohol diluted with water to about 70 per cent strength.
- Root-feed every few years.

Willow *(Salix)*

Giant Bark Aphid
(Longistigma caryae)

Willows are subject to attack by several species of aphid throughout the growing season as are most shade trees. The net effect of aphid feeding is generally discolouration of the foliage and wilting of the twigs as a result of removal of sap from the tender tissues.

The giant bark aphid attacks a wide variety of trees, including willow, hickory, elm, oak, maple, linden, birch, and walnut. This large, ash-grey aphid attracts attention when it congregates in masses on the undersides of branches, particularly of weeping willow, in late summer and early autumn. Trees do not appear to be seriously damaged, but honeydew excreted by the aphids attracts ants, bees, and wasps in large numbers, constituting a nuisance problem. Also, a black sooty mold develops on this sticky excretion, and the nuisance is intensified where weeping willows hang over patios, picnic tables, or driveways, or where trees are near the house.

CONTROL
- It may not be practical to spray large willow trees for aphid control. Heavy infestations do not occur every year, but when an infestation does warrant a spray, use malathion, dimethoate, endosulfan, or diazinon.

Imported Willow Leaf Beetle
(Plagiodera versicolora)

The adult insect is a small, oval, metallic blue beetle, which riddles the foliage by eating holes through the leaves, leaving a network of veins. The larva is a black, slug-like grub that skeletonizes areas on either side of the leaves. Several species of willow and poplar are fed upon. Heavily infested trees may become entirely brown as early as mid-June.

The adult beetles overwinter in sheltered places, such as crevices in the bark, and resume activity in the spring about the time the foliage appears. Irregular masses of yellow, spindle-shaped eggs are laid on the leaves. The larvae feed gregariously during their early stages, often forming a line as they move across the leaf. Glands along the sides of the body emit a peculiar odour, which probably affords the grubs some protection from their enemies. When nearly full-grown, the grubs wander about before pupating, usually on the undersurface of the leaf. Two or more generations may complete their development in a season.

CONTROL
- Trees are seldom killed by this insect, but the appearance of ornamentals is adversely affected. If necessary, apply a spray during the latter part of May or early June when the leaves have all unfolded. A second application may be required the first week in July. Use carbaryl, methoxychlor, or malathion.

Poplar-and-Willow Borer
(Cryptorhynchus lapathi)

This pest of European origin is established from coast to coast in southern Canada. It infests several species of willow, poplar, alder, and birch. The pussy willow is often attacked so severely that replacement with other shrubs becomes necessary.

Giant Bark Aphid

The adult is an oval, rough-appearing snout beetle, dark brown mottled with grey, and the outer third of the wing covers are clothed with pinkish scales. The larva is a white, curved, legless grub with a brown head.

Adults appear in July and August. For feeding and egg-laying they cut small holes in the bark. Feeding is most frequent on green, smooth-barked shoots of the current year, and oviposition is mainly in stems more than one year old. The holes usually contain a single egg. The larvae do limited feeding before winter. In the spring they mine actively through the bark around the circumference of the stem and then bore inward and upward into the wood, where pupation takes place. There is one generation per year. When disturbed, adults fold their legs, drop to the ground, and feign death; when handled, they produce a distinct squeaking sound. They rarely fly.

Current attacks are recognized by irregular splits and holes in the bark through which sap and moist boring dust exude. The most serious damage occurs near the base of trees over 30 cm diameter. Heavy mining by the larvae results in the "breakover" of stems.

CONTROL

- Control is difficult. When damage becomes noticeable it is usually too late for control measures to prevent further damage in the current season.
- Badly infested trees, or parts thereof, should be cut and destroyed before the end of June.
- Apply a spray to the bark of the trunk and larger limbs at two-week intervals from mid-July to September. Use endosulfan.

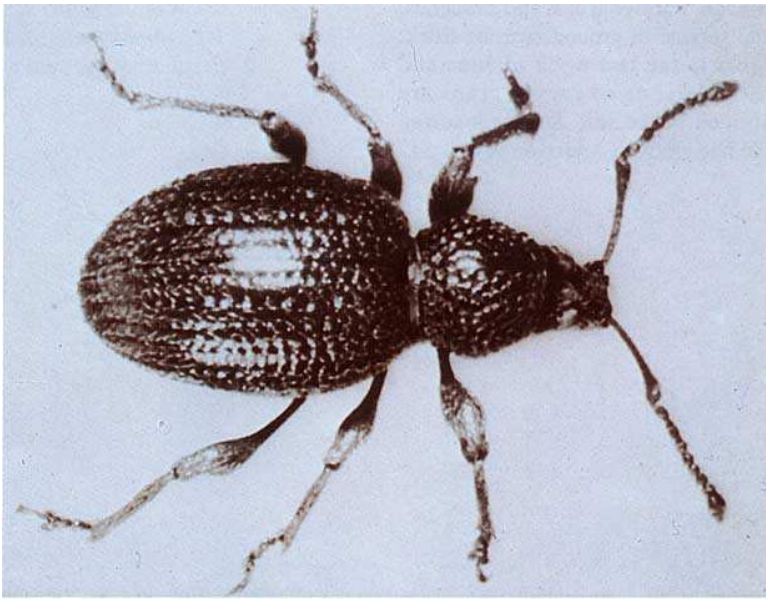
Other insect pests of Willow:

Cankerworms - see *Linden*
Fall webworm - see *Ash*
Forest tent caterpillar - see Poplar Spiny elm caterpillar - see *Elm*
Whitemarked tussock moth - see *Horse-Chestnut*

Sap and sawdust symptoms of attack by Poplar-and-Willow Borer

Yew *(Taxus)*

Black Vine Weevil
(Otiorhynchus sulcatus)



Black Vine Weevil adult

This pest, also referred to as the Taxus weevil, attacks over one hundred cultivated plants, flowers, weeds, and trees. Yew, hemlock, white cedar, pine, and spruce are the main arboreal hosts.

The adult is a small, black snout beetle. Only female beetles occur and they are incapable of flying because the wing covers are fused. They emerge from the soil in late June and early July but are seldom seen as they are active at night. They feed for a few weeks on the foliage, cutting crescent-shaped notches in the margins of the needles, particularly those closest to the soil on the innermost portions of the plant. Eggs are deposited in the soil. The larvae are legless, white grubs that feed on the roots of the plants. Most remain in the soil until the following June, although a few may complete their development in the autumn and overwinter as adults. There is one generation per year.

In the spring, infested plants grow slowly or fail to grow and appear dry and off-colour; they may finally be killed. Newly transplanted stock frequently dies without becoming established.

CONTROL

- Because the larvae are deep in the soil they are not easily controlled. But the adults may be killed as they crawl up through the soil to emerge, or during the extended feeling period before eggs are laid. Apply a spray to the foliage, bark of trunk and branches, and surface of ground near the trunk. Treat in the last week of June and early July, or whenever grubs are noticed in the soil. Use endosulfan (do not apply on Anderson yew).

Embedded Secure Document

The file *http://www.mnr.gov.on.ca/MNR/forests/foresthealth/pests/tree/Appendix-A-B-C.pdf* is a secure document that has been embedded in this document. Double click the pushpin to view Appendix-A-B-C.pdf.

Appendix A
Insect Pests According to Type of Injury

Defoliators

Apple-and-thorn skeletonizer
Birch leafminer
Birch skeletonizer
Black vine weevil
Cankerworms
Cedar (arborvitae) leafminers
Eastern tent caterpillar
Elm leaf beetle
Euonymus webworm
European pine sawfly
European spruce sawfly
Fall webworm
Forest tent caterpillar
Gypsy moth
Imported willow leaf beetle
Jack pine budworm
June beetles
Juniper webworm
Larch casebearer
Larch sawfly
Lilac leafminer
Linden looper
Locust leafminer
Maple leafcutter
Maple trumpet skeletonizer
Mockorange leafminer
Mountain ash sawfly
Oak leafshredder
Oak skeletonizer
Pear sawfly
Poplar sawfly
Redheaded pine sawfly
Rose chafer
Saddled prominent
Spiny elm caterpillar
Spruce budworm,
Spruce needleminer
Walnut caterpillar
Whitemarked tussock moth
Yellowheaded spruce sawfly
Yellownecked caterpillar

Sucking Insects

Boxelder bug
Comstock mealybug
Cottony maple scale
Euonymus scale
European fruit lecanium
Giant bark aphid
Juniper scale
Norway maple aphid
Oak lace bug
Oystershell scale
Pine bark adelgid
Pine needle scale
Pine spittlebug
Pine tortoise scale
Spruce bud scale
Spruce spider mite
Woolly alder aphid

Borers

Boxelder twig borer
Bronze birch borer
Eastern pine shoot borer
Elm bark beetles
European pine shoot moth
Lesser peachtree borer
Lilac borer
Locust borer
Locust twig borer
Northern pine weevil
Pales weevil
Peachtree borer
Pine engraver
Pine root collar weevil
Poplar-and-willow borer
Twig pruner
White pine weevil
Zimmerman pine moth

Gall-Makers

Ash flower gall
Cooley spruce gall adelgid (aphid)
Eastern spruce gall adelgid (aphid)
Honeylocust pod gall
Maple gall mites
Oak galls
Pearleaf blister mite
Poplar petiolegall aphid
Poplar vagabond aphid

Root Feeders

Black vine weevil
White grubs

Appendix B
Diseases According to Location of Injury

Foliage
Anthracnose
Apple scab
Boxelder leaf blight
Catalpa leafspot
Diplodia tip blight
Hawthorn leaf blight
Horse-Chestnut leaf blotch
Powdery mildew
Winter browning
Yellow leaf blotch

Stem or Branch
Black knot
Crown gall
Dieback of hardwoods
Dutch elm disease
European poplar canker
Fire blight
Hypoxylon canker
Juniper blight
Juniper rusts
Nectria canker
Scleroderris canker
Spruce canker
Sweetfern blister rust
Verticillium wilt
White pine blister rust

Root
Armillaria root rot
Annosum root rot

Appendix C
Pesticides and Pest Control Recommendations 1985

Tree pests are capable of causing considerable economic damage. No species of tree, no part of a tree, and no stage in the development of a tree is immune to pest attack. From the time trees are set in the soil they are subject to the attacks, or the effects, of numerous agents which may kill them, retard their growth, deform their shape or symmetry, weaken or degrade the wood, or otherwise adversely affect their functioning or mar their attractiveness. The importance of the injury is relative to the purpose for which the trees are being grown, managed, or utilized. The intensity of control efforts undertaken is similarly determined by the value of the trees at risk and the type or degree of damage.

Prevention of attack is the first line of defense against tree pests. Good cultural practices should be emphasized as a means of maintaining tree vigour. Vigorously growing trees are generally better able to resist attack by insects and diseases or to withstand periods of adverse weather or other stress conditions. If attacked, they are better able to recover from the effects of the infestation or infection. However, when an outbreak or epidemic occurs or appears imminent, direct control through the use of pesticides is sometimes required to mitigate damage.

The use of trade, firm or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the Ministry of Natural Resources of any product or service to the exclusion of others that may be suitable.

Pesticide products mentioned in this publication have been reviewed by the Ontario Pesticides Advisory Committee and have been classified under the Ontario Pesticides Act.

CHEMICAL SAFETY

The usefulness of pesticides rests on their ability to interrupt the life process of insects and fungi. By their very nature, pesticides are poisons and must be handled properly to prevent unwanted and dangerous effects to humans, non-target organisms, and the environment. Pesticides may be taken into the body by breathing, swallowing, or absorption through the skin. However, even the most toxic compounds can be used safely if the recommended precautionary measures are observed.

• Purchase only the quantity of pesticide needed for a particular problem or for a single season.
• Inspect pesticide containers for leaks before handling them. Do not handle containers roughly or carelessly.
• Read the entire product label to ensure that the plants to be treated are not sensitive to the chemical. Follow the directions and safety precautions carefully. If seeking medical aid, take the label and/or container with you.
• Do not rub the eyes, touch the mouth, or smoke while working with pesticides. Wash hands thoroughly before eating, drinking, smoking, or using the toilet.
• Wear clean rubber gloves and protective clothing when handling pesticides, and use a respirator whenever recommended. Thoroughly wash contaminated clothing separately and discard faulty protective clothing.
• Clean up any pesticide spill immediately. Use dry soil, sawdust, or other absorbent material to remove excess liquid.
• Do not leave pesticide containers unguarded while spraying and ensure that children and pets are kept well away.
• Do not work alone with a hazardous chemical.

TOXICITY AND LETHAL DOSE

Pesticides vary widely in their toxicity. Toxic effects may be acute or chronic. The susceptibility of animals to poisoning by a pesticide varies with the type of formulation used, the route of entry into the body (oral, dermal, or respiratory), and the weight, age, sex, and nutritional state of the individual affected. The accepted method of recording the relative toxicity of a pesticide is the Lethal Dose 50% (LD50) value. This is a statistical estimate of a chemical dose which, when administered, will kill 50 per cent of the test animals under stated conditions. The figures which designate the LD50 values are expressed in milligrams of dose per kilogram of body weight of the test animal. Therefore, the higher the LD50 value, the less acutely toxic the material. The acute oral LD50 values to rats of some currently used pesticides, common drugs, and other materials are:

CHEMICAL COMPOUND	ORAL LD_{50} VALUE
endosulfan	43
Gravol	500
2,4-D phenoxy acid	600
ferbam	1000
malathion	1375
aspirin	1750
common salt	3300
methoxychlor	6000
maneb	6750
benomyl	9590
Bacillus thuringiensis	15 000

STORAGE OF PESTICIDES

• Pesticides should be stored in their original containers in a cool, dry, locked, well-ventilated area without floor drains.
• Pesticides should be stored away from food and drink used for human and animal consumption.
• Herbicides should be stored separately from other types of pesticides to prevent cross-contamination.
• A chemical-storage warning sign should be placed on the outside of each entrance leading into the storage area.
• Protective clothing and a first-aid kit should be available in the storage area.

DISPOSAL OF PESTICIDES

• Immediately after emptying a pesticide container, rinse it at least three times with the same dilutent used for mixing the spray. Pour the rinse into the spray tank and puncture the bottom of the container. Do not reuse pesticide containers or convert them to other uses.
• All empty containers and unused amounts of pesticides must be securely held in an isolated storage area until they can be disposed of correctly. Triple-rinsed or jet-rinsed containers of most commonly used pesticides can be disposed of with household garbage.
• Where regular garbage disposal is not practical, dispose of empty pesticide containers in a landfill site or bury under at least 50 cm of soil, away from water.

BENEFIT/RISK RELATIONSHIP OF PEST CONTROL

The aim of pest control is not the eradication of a pest species, but rather the maintenance of a balance between the pests and their host trees at a level below the threshold of serious injury. The decision to invoke control measures depends upon the benefits to be received in relation to the costs incurred. The value of the material saved must justify the expense involved, or the cost of control must be less than the loss that would result if no intervention were made. If the use of pesticides is the most efficient method of control, then:

• Select the least toxic material and use the lowest concentration that will do the job effectively.
• Apply the smallest amount necessary and in a manner that will have minimum effect on non-target organisms and nontarget areas.
• Make application at the weakest point in the pest's life cycle.

PESTICIDE (Common trade name in brackets)	PESTS CONTROLLED	REMARKS
Insecticides and Miticides		
acephate (Orthene)	gypsy moth, oak leafshredder, spruce budworm, tent caterpillars	Material has temporary registration.
Bacillus thuringiensis	cankerworms, gypsy moth, oak leafshredder, spruce budworm, tent caterpillars	A bacterial insecticide for control of larvae that develop into moths. Must be eaten to be effective.
carbaryl (Sevin)	cankerworms, gypsy moth, oak leafshredder, sawflies, skeletonizers, spruce gall aphids, webworms	Effective against exposed defoliators and some sucking insects. Extremely toxic to honey bees.
chlorpyrifos (Dursban)	elm bark beetles, white grubs	
diazinon	European pine shoot moth, white grubs	
dicofol	mites only	Available only as one of the ingredients in a pesticide mixture.
dimethoate (Cygon)	European pine shoot moth, leaf miners, spruce bud-worm, spruce gall adelgids, some mites	A systemic insecticide that is absorbed into the vascular system of the plant and translocated to the site of insect activity.
endosulfan	black vine weevil, bronze birch borer, cankerworms, linden looper, locust borer, spruce gall aphids, strawberry root weevil	For control of exposed defoliators and adult borers. Do not apply on Anderson yew.
lindane	bark beetles, borers, northern pine weevil, pales weevil, pine root collar weevil, white pine weevil	Has long residual activity.
malathion	exposed defoliators. sucking insects, spruce gall adelgids, some mites	One of the most commonly used insect icides. Do not use on Crimson King maple, Canaerti juniper, or blue spruce.
methoxychlor	exposed defoliators, adult bark beetles and borers, rose chafer, white pine weevil	
dormant oil (Superior oil)	aphids, scales, mites	Used as dormant spray to kill eggs and overwintering nymphs. Apply in early spring before buds break, but when temperature will remain above freezing for several hours. Do not apply on sugar maple, blue spruce, or yew.

PESTICIDE (Common trade name in brackets)	PESTS CONTROLLED	REMARKS
Fungicides		
benomyl	apple scab, powdery mildew	A systemic fungicide with protective and eradicant action, for control of a wide range of fungi.
borax (Sodium borate decahydrate)	Fomes root rot	Applied as a stump protectant.
chlorothalonil	Scleroderris canker	A protectant fungicide; so total foliage coverage is vital to ensure effective disease control.
mancozeb	powdery mildew	A general foliage protectant available as one of the ingredients in a pesticide mixture.
ferbam	anthracnose, juniper rusts, apple scab	A general foliage protectant available as one of the ingredients in a pesticide mixture.
sulphur	juniper rusts, powdery mildew	Available as one of the ingredients in a pesticide mixture.
zineb	anthracnose, hawthorn leaf blight, horse-chestnut leaf blotch, juniper rusts, leafspots	A general foliage protectant available as one of the ingredients in a pesticide mixture.