insects affecting woody ornamental shrubs and trees

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WOODY, ORNAMENTAL SHRUBS and shade trees are high-value plants requiring many years of continuous protection and care. Their principal value is their beauty. Hence, any damage to their appearance reduces not only their value, but also the property they adorn.

Replacement of trees and shrubs is costly and sometimes impossible. A more sound approach is to recognize the insects that depreciate their value and control them before they seriously injure the trees.

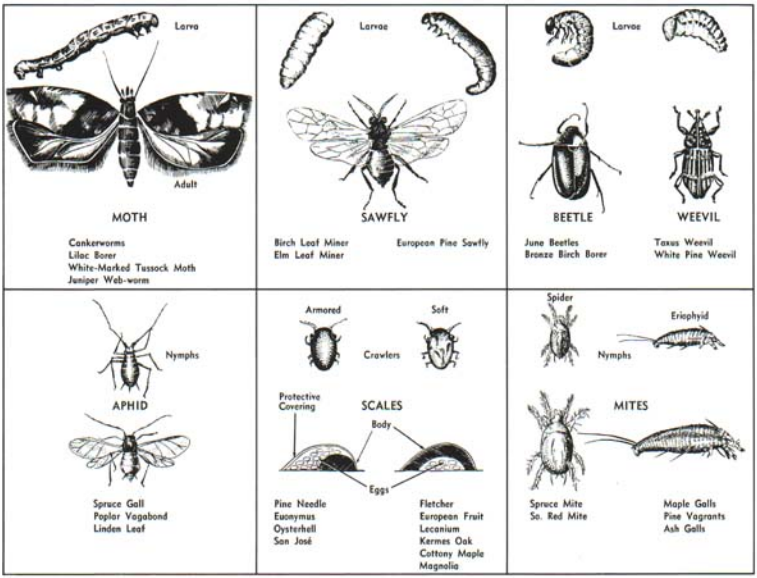
The numerous pests of woody plants all have different habits, are active at different times of the year, and cause different types of plant injury. Only the more common insects are described or illustrated alphabetically in this bulletin, according to host plants. A control treatment, following each description, is given by control programs listed at the end of the publication. When possible, several different controls are given for each pest to enable a greater choice of suitable chemicals.

In most instances, a treatment controls a certain stage of the insect. The timing of control is given for a specified period during the year, or where possible, in relation to the flowering or growth stage of the plants. However, since insect activity is influenced by weather conditions, the time for initiating a control program will depend upon your location within the state. Therefore, an understanding of the insect's life cycle and your ability to recognize the stage in this cycle at which treatments are directed will influence the success of your control program.

Remember, effective insect control is based on PROPER APPLICATION OF AN APPROPRIATE INSECTICIDE AT THE CORRECT TIME. Failure to follow these cardinal control principles will often lead to disappointing results.

Following is a simple guide to enable you to better understand and recognize pests referred to or described in the text of the bulletin.

PESTS OF ORNAMENTAL PLANTS



APPLE

FLAT-HEADED APPLE TREE BORER

Chrysobothris femorata

This pest is particularly destructive to newly transplanted deciduous trees or older weakened or injured trees. The larvae first dig long, winding tunnels in the outer layer of the wood (cambium) and later burrow into the sapwood. A wet or greasy appearance of the bark shows up over their tunnels in the cambium. The tunnels can kill large areas of the barks, individual branches, or the entire tree. This borer attacks some 30 species of woody plants, but maple, linden, oak, sycamore, and apple are most commonly infested.

In late fall, full-grown larvae (creamy-white, legless grubs about one inch long with a flattened enlargement just behind the head) tunnel into the heartwood where they overwinter and pupate the following spring. Adults (broad, flat, dark-bronze, metallic-appearing beetles about ½ inch long) emerge from the first of June to the last of September. Throughout this period, they lay about 100 eggs singly in bark crevices. When the eggs hatch in 15 to 20 days, the young larvae bore into the tree. One generation occurs each year. However, under adverse conditions, more than one year is required to complete a life cycle.

Fig. 2 – Larvae and galleries of flat-headed apple tree borer.

Control Program 5b* – Apply June 1 followed by two more sprays at monthly intervals.

SAN JOSÉ SCALE

Aspidiotus perniciosus

This circular, gray-black scale (1/16 inch in diameter with a black central nipple) is a major pest of fruit trees, but also attacks elm, firethorn, currant, magnolia, redbud, cotoneastor, ash, mountain ash, poplar, linden, dogwood, and others. Heavy infestations may completely encrust the branches and trunk. Scales pierce the woody tissues with long, thread-like mouthparts, sucking out the plant juices. This reduces the vigor of the plant and often kills individual branches or the entire tree.

Immature scales overwinter, maturing by mid-June. During the next 1½ months, females give birth to as many as 600 living young. The flat, yellow, young scales crawl out from under the mother scale, wander over the host, then settle down and commence to feed. They do not move from the place where they first settle and mature in about six weeks. There are several overlapping generations each year.

Control Program 10b *or* 11c *or* 14a – Apply in the spring before plant growth begins, *or Program* 3a *or* 6 *or* 16 – Apply when the crawlers are active, which is usually in late June.

FALL WEBWORM – See Oak
TWIG PRUNER – See Oak
OYSTERSHELL SCALE – See Lilac
PIGEON TREMEX – See Maple
WOOLLY APPLE APHID – See Elm

Fig. 3 – Infestation of San José scale.

***All chemical control programs are listed by number on pages 41-43.**

ARBORVITAE

BAGWORM

Thyridopteryx ephemeraeformis

This insect infests a variety of trees and shrubs but is most destructive to evergreens, particularly arborvitae and cedar. One complete defoliation may kill a tree.

There is one generation each year; winter is passed as eggs within the mother bag. When eggs hatch in mid-June, the larvae leave the mother bag and immediately build a case of leaf or twig parts fastened together with silk. As the larvae grow, their cases increase in size, reaching 1½ to 2 inches long at maturity. The larvae remain within these protective bags and carry them wherever they go in search of food. Larvae mature during August, securely fasten their bags to the twigs of the host plant, and pupate within them. Adult moths appear during September and October. The black males are typical flying moths, actively seeking the wingless females which remain within their cases. After fertilization, each female lays 500 or more eggs within the bag, then dies.

Control – Since the bags are conspicuous, picking and burning before the eggs hatch may be practical on a limited basis. However, in large plantings a foliar spray is suggested.

Control Program 3a *or* 6 *or* 8 *or* 16 *or* 21 – Apply in mid-June.

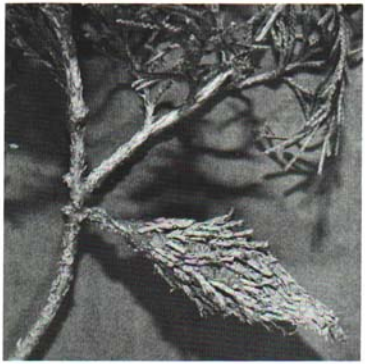


Fig. 4 – Bagworm case made of leaves from the host plant.

ARBORVITAE LEAF MINER

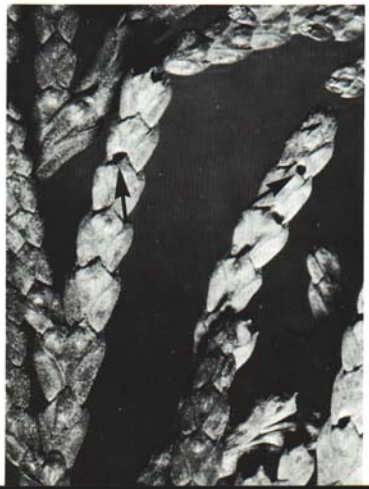
Argyresthia thuiella

Leaves of arborvitae turn yellow, brown and die back due to larvae feeding between the leaf surfaces. This pest will not kill trees but stunts their growth and ruins their appearance.

Winter is passed by partly grown larvae within mined-out leaves. Larvae resume feeding in early spring, mature during May, reach a length of ⅛ inch, and pupate within the leaves. Adults, light gray moths with a ⅜ inch wing expanse, emerge during late June and early July and lay eggs on the foliage. There is one generation each year.

Control Program 6 *or* 16 – Apply during mid-May to all foliage.

Fig. 5–Arborvitae leaf miner damage. Note adult emergence holes.



JUNIPER SCALE – See Juniper
JUNIPER WEBWORM – See Juniper
LECANIUM SCALE – See Taxus
SPRUCE MITE – See Spruce

ASH

ASH FLOWER GALL MITE

Eriophyes fraxiniflora

The male flowers of white ash are transformed into irregular masses when infested with this microscopic mite. These mites, active in early spring when the flower buds break, feed on the unfolding tissues, causing them to form clusters of galls ½ inch in diameter. During the summer the mites pass through several generations and overwinter in the gall masses and twig tissue.

Control Program 14a *or* 16 – Apply in the spring before the buds break.

Fig. 6–Galls caused by ash flower gall mite.

BOXELDER BUG – See Boxelder
COTTONY MAPLE SCALE – See Maple
FALL WEBWORM – See Oak
LILAC BORER – See Lilac
OYSTERSHELL SCALE – See Lilac
PUTNAM SCALE – See Linden
SAN JOSE' SCALE – See Apple

BIRCH

APHIDS

Calaphis spp.

These soft-bodied green pests feed by sucking juices from the foliage, twigs and small branches of birch. Trees are not killed by this feeding, but the plant's vigor is reduced and smaller twigs and branches may be killed. Aphids liberate large amounts of a clear sticky substance called honeydew which adheres to the bark and foliage. A sooty, mold fungus lives on this honeydew, turning it black and ruining the trees' appearance.

Eggs which pass the winter on twigs and branches, hatch during early May. There are several overlapping generations throughout the summer, but populations become most intense during July and August.

Control Program 11b *or* 11c – Apply during April before plant growth begins, or *Program* 6 *or* 8 *or* 15 *or* 16 *or* 17 during May or later in the summer when aphid population buildup is noted.

BRONZE BIRCH BORER

Agrilus anxius

The bronze birch borer causes die-back of the uppermost branches of birch, followed by death of the entire tree. All types of birches, willow, and poplar, especially those in a weakened condition, are susceptible.

First signs of borer activity are rusty to reddish-brown trails on the bark just below the point where the branch has wilted. This discoloration results from the feeding galleries or mines beneath the bark. These galleries run in all directions, eventually girdling the branch or stem. All woody portions above ground may be damaged.

The adult beetles emerge during early June by chewing semicircular holes through the bark. They feed sparingly on the foliage and new growth of birch, willow, and poplar, and later lay eggs singly in bark crevices. The hatched larvae penetrate the bark, feeding first on the inner bark and later in the cambium. They feed until late fall, forming cells in the

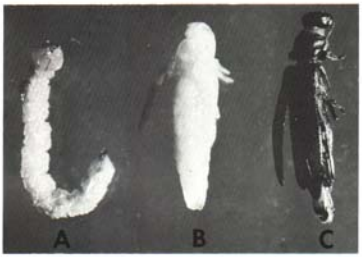


Fig. 8–Larva (A), pupa (B) and adult (C) of bronze birch borer.

Fig. 7–Larval tunnels of bronze birch borer.

galleries to overwinter. In the spring they feed for a short time, pupate in late April or early May, and the adult beetles emerge in early June. There is one generation a year.

The first step in borer prevention is to avoid injury to the trees and keep them adequately watered and fertilized. Vigorous, healthy trees are not as attractive to the borer and may overcome attack. If trees are heavily infested, prune out all dead limbs and branches before June.

Control Program 5b *or* 7a – Apply the first week in June, followed by a second spray in two weeks.

BIRCH LEAF MINER

Fenusa pusilla

Blistering and browning of the foliage of white, gray, paper, and cut-leaf birches during early June are caused by the feeding of the birch leaf miner. Black, yellow, and river birches are less susceptible. Larvae overwinter within cells in the upper layers of soil beneath the trees and pupate in late April. The black adult sawflies emerge from these cells in early to mid-May, fly to foliage, and deposit eggs within the leaf tissue. In 7 to 10 days, whitish larvae can be seen feeding in small, blistered, translucent spots in the leaves. They feed for a month, constantly enlarging their mines until a large portion or the entire leaf is damaged. When mature, the larvae drop to the ground and pupate. The second brood of adults appears in early July, but causes less damage than the first, since they lay eggs only in the newly developing leaves on the sucker growth and tops of the trees. There are two or three generations each year.

Control Program 9 *or* 20 – Apply in early May to the soil beneath the trees *or Program* 2a *or* 3a *or* 6a *or* 8 *or* 15a *or* 16 *or* 17 – Apply about May 15 or when the mines are ⅜ inch in diameter or less.

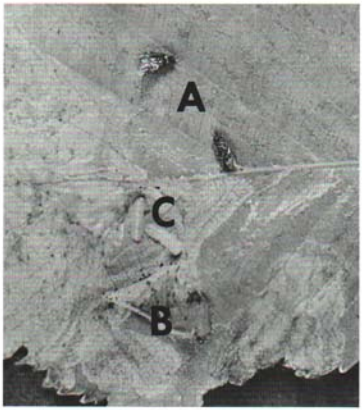


Fig. 9–Adults (A), and mines (B) opened to expose larvae (C) of birch leaf miner.

BIRCH SKELETONIZER

Bucculatrix canadensisella

The birch skeletonizer causes the foliage of paper, yellow and gray birch trees, particularly those in natural stands and woodlots or along roadsides, to turn prematurely brown in mid-August. The brown adult moths appear in late July or early August and lay eggs singly on the undersurface of the leaves. The larvae hatch in about one week, boring directly into the tissue. They feed like a leaf miner for three weeks, then form white, flat webs in which they molt. After molting, the larvae emerge from the webs and feed externally on the soft interveinal tissues of the lower leaf surfaces, skeletonizing the leaves. In the next two weeks the larvae molt once more, complete their feeding, then drop to the ground and form a cocoon in which they overwinter. There is one generation each year.

Control Program 13 *or* 18a – Apply to undersides of the leaves in late July.

FALL WEBWORM – See Oak
LECANIUM SCALE – See Elm
PIGEON TREMEX – See Maple

BOXELDER

BOXELDER BUG

Leptocoris trivittatus

The boxelder bug prefers the flowers and seeds of the female boxelder tree but does not cause serious injury. When abundant, it also feeds on ash and maple. In the fall, adults seek sheltered overwintering quarters and sometimes invade homes.

In the spring, the adults migrate to the host plant, where they lay reddish eggs on the bark, leaves, or fruit. Immature bugs, called nymphs, hatch from the eggs and feed throughout the summer. These bright red nymphs molt several times, reaching maturity by late summer.

While this insect may be extremely abundant, it causes little damage and is chiefly an annoyance pest.

Control Program 3a *or* 4a *or* 12a *or* 15a – Apply to the foliage and trunks of trees or building foundations, fences, or other outside areas where the bugs congregate. Apply sprays in May when the first activity is noted or in late summer, as the bugs are seeking sheltered places.

U.S. Forest Service Photo
Fig. 10–Adult boxelder bug.

FALL WEBWORM – See Oak

DOGWOOD

DOGWOOD BORER

Thamnosphecia scitula

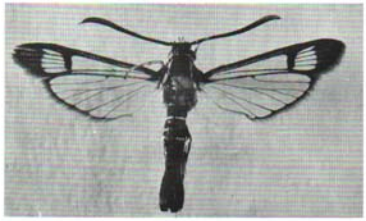
This insect causes swollen, irregular, canker-like areas on the bark of the trunk of flowering dogwood. Most frequently the damage occurs at the root collar, causing wilting or die-back of the upper parts of the tree.

Adult dogwood borers, blue-black clearwing moths with a wing expanse of about 7/8 inch, are active from late May throughout the summer. They deposit eggs on the bark, preferring rough bark or wound areas. After hatching, the larvae seek an injured area, enter it and feed beneath the bark in the cambium. These larval galleries destroy parts of the cambium and often girdle limbs or the trunk of the tree. The larvae mature by fall, overwinter in their galleries, and transform into pupae the following spring. There is one generation a year.

Control Program 5b *or* 12b – Apply the first week in June, followed by one more spray in 2 weeks. Thorough coverage of the branches and trunk (especially the base) is essential for effective control.

COTTONY MAPLE SCALE – See Maple
SAN JOSE' SCALE – See Apple

Fig. 11–Adult dogwood borer.



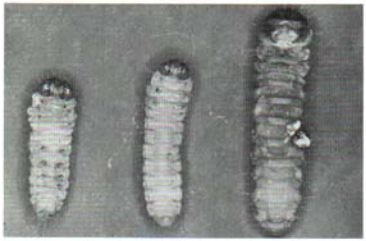


Fig. 12–Larvae of dogwood borer.

ELM

BARK BEETLES

SMALLER EUROPEAN ELM BARK BEETLE – *Scolytus multistriatus*

NATIVE ELM BARK BEETLE – *Hylurogopinus rufipes*

These two beetles, through their breeding and feeding habits, spread the Dutch elm disease fungus, *Ceratocystis ulmi*, from diseased to healthy trees. Infected trees appear to be suffering from drought since the fungus clogs the water-conducting vessels of the trees. The leaves on individual branches wilt, the branch dies, and later, as the fungus attacks other portions of the tree, the tree dies.

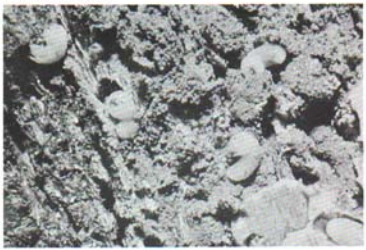
Smaller European elm bark beetles overwinter as larvae in galleries (often fungal-infested) beneath the bark of unhealthy elm trees or recently cut logs. They pupate in the spring, and during late May and early June the adult beetles emerge, fly to healthy elm trees and feed in the crotches of the two-year old twigs.

Beetles emerging from infected elm wood may carry the tiny spores of the fungus. As the beetles feed, they may introduce these spores onto the healthy tissues, and the tree is infected. After feeding, the females seek unhealthy trees or recently cut logs in which to lay their eggs. The second brood of beetles appears in early August.

Native elm bark beetles overwinter as adults in the bark of elm trees. Like the smaller European elm bark beetle, they seek unhealthy elm wood in which to lay their eggs. The native elm bark beetle differs in feeding habits, preferring to feed on the inner bark of larger branches and limbs. There appears to be one and a partial second generation each year in Michigan.

Fig. 13–Adult smaller European elm bark beetle feeding in twig crotch.

Fig. 14–Larvae of the smaller European elm bark beetle in dead elm bark.



Control – Prune all dead and dying branches out of elm trees. Remove all dead elm trees or elm wood and burn or bury it to eliminate breeding sites for the beetles. *Program* 18b – Apply in the spring before growth begins. For a more complete description of Dutch elm disease control, see Extension Bulletin 506, "Dutch Elm Disease Control."

CANKERWORMS

SPRING CANKERWORM – *Paleacrita vernata*

FALL CANKERWORM – *Alsophila pometaria*

The foliage of many deciduous trees and shrubs may be damaged or completely devoured during May and June by cankerworms, commonly called inchworms or measuring worms. Feeding begins as soon as the leaves are expanded but still tender. Elm, linden, maple, beech, and oak are favorites, but a variety of other broad-leafed plants may also be damaged.

The eggs of both cankerworm species hatch during late April or early May, and the larvae feed together. In 4 or 5 weeks they mature, drop to the ground on

silken threads and pupate. Adults of the fall canker-worm emerge during November and December (some do not emerge until the following spring), whereas adult spring cankerworms emerge the next spring. The adult males are active fliers, but the females lack wings and do not resemble moths. To deposit eggs, the females must crawl up the trunk of the tree. The fall cankerworm lays its brownish-gray egg masses in a single layer on small twigs, while the spring canker-worm deposits its egg masses under bark scales or in crevices of thick bark. Each species has one generation a year.

Control – Banding of tree trunks with a sticky material may keep the adult females from walking up the trees. However, this is dependable only when trees are isolated, and must be applied in both the fall and spring to be effective. *Program* 3a *or* 3c *or* 21 – Apply to the foliage in mid-May.

Fig. 16–Larva of elm leaf beetle. Note how feeding has removed the epidermal cells of the lower leaf surface.

EUROPEAN ELM SCALE

Gossyparia spuria

This scale rarely kills mature trees, but is a serious pest because it weakens the tree. Removal of sap by the scale kills individual branches, allowing elm bark beetles to breed in these. Heavily infested young trees, such as nursery stock, may die.

Immature scales (oval, chocolate-brown insects with a white, waxy fringe) overwinter in bark crevices. In the spring, females mature at about 3/16 inch long, mate, and lay eggs on branches during late June or early July. Soon the eggs hatch and the bright yellow, immature scales migrate to the undersides of the leaves. There they insert their thread-like mouth-parts and suck out the plant juices. Before the leaves drop in the fall, the immature scales move to the limbs or branches where they overwinter. There is one generation a year.

Control Program 11b – Apply to all woody parts in early spring before the buds swell, *or Program* 1b *or* 16 – Apply to the foliage and bark in late June or early July to control the crawler stage. Repeat in ten days if crawlers continue to emerge over an extended period of time.

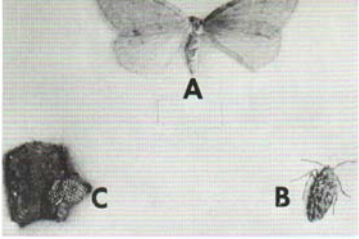


Fig 15–Adult male (A) adult female (B) and eggs (C) of spring cankerworm.

ELM LEAF BEETLE

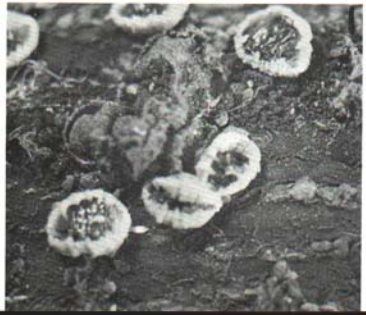
Galerucella xanthomelaena

Elm trees may be severely damaged by this beetle's feeding. The larvae cause great injury by severely skeletonizing the soft interveinal tissues on the lower surface of the leaves. Eventually these leaves dry and turn brown, disfiguring the tree, reducing its vigor. All types of elms are susceptible.

The adults (olive-green beetles ¼ inch long with a dark stripe on the outer side of each wing cover) pass the winter in sheltered places. In the spring they fly to elm trees and eat small, oval holes in the expanding leaves. Later they lay clusters of yellow eggs along the veins on the undersides of the leaves; these eggs hatch in about a week. The dull yellow, slug-like larvae with two longitudinal black stripes feed for about three weeks. They reach a length of about ½ inch when mature, moving to the base of the tree to pupate. A second brood appears about the third week in August.

Control Program 3a *or* 3c *or* 13 *or* 18a – Apply when most of the eggs have hatched, usually when the foliage is three-fourths expanded.

Fig. 17–Infestation of European elm scale.



LECANIUM SCALES

Lecanium caryae

EUROPEAN FRUIT LECANIUM – *Lecanium corni*

These two scales are common on elm but also attack a variety of other plants. *Lecanium caryae* occurs on beech, willow, and birch while *Lecanium corni* infests maple, wild cherry, willow, white oak, sycamore, linden, black-locust, and many others. Infested trees lose vigor because of the large amount of plant juices withdrawn by the scales. Individual twigs or branches are killed, making the tree susceptible to attack by other insects.

Both scales are mahogany-brown in color and oval in shape. *Lecanium caryae* may be up to ½ inch long with the anterior parts considerably thicker and wider than the posterior end. *Lecanium corni* is smaller (1/16 inch) and more smoothly rounded.

The life history and habits are essentially the same for both species. Immature scales pass the winter on the twigs or branches and mature during the spring. In May each female lays 100 or more white eggs beneath its body. By late June the eggs hatch; the immature scales migrate from beneath the mother scale to the underside of the leaves, where they settle and feed. Late in August, they move back to the twigs, completing their growth the following spring. One generation occurs each year.

Control Program 11b – Apply in the spring before the buds break *or Program* 3a *or* 6 *or* 16 – Apply in late June, followed by a second application in two weeks.

Fig. 18–Lecanium caryae on elm.

ELM LEAF MINER

Fenusa ulmi

This sawfly causes blistering of the foliage of English, Scotch, and Camperdown elms and occasionally American elm. Infested leaves, especially of small trees, become blotchy or completely blistered during early June.

Winter is passed in the topsoil as prepupae within cocoons. The black, fly-like adults emerge about the second week in May and deposit their eggs within the leaf tissues. These hatch about a week later and the larvae feed between the lower and upper leaf surfaces. By late June the larvae mature, vacate their mines, and drop to the ground to form cocoons. There is one generation each year.

Control Program 1a *or* 3a *or* 6a *or* 15a *or* 16 *or* 17 – Apply after the eggs hatch, usually in late May.

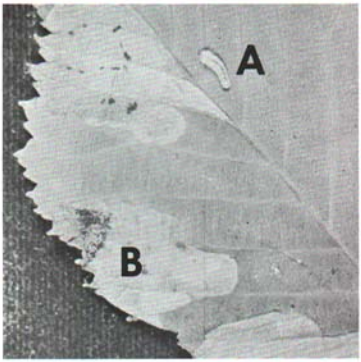


Fig. 19–Larva (A) and mines (B) of elm leaf miner.

WOOLLY APHIDS

WOOLLY ELM APHID – *Eriosoma americanum*
WOOLLY APPLE APHID – *Eriosoma lanigerum*

These aphids are similar in appearance and life habits, but cause different types of injury. Both species are purple and are often covered with white, cottony wax. The woolly elm aphid causes a curling of the edges of individual elm leaves, whereas the woolly apple aphid causes a group of leaves to curl and deform. Injury by both species appears from early spring to midsummer.

Winter is passed as eggs in protected places on the bark of twigs and branches. In the spring these eggs hatch and winged forms fly to the base of elm buds and feed on the expanding leaves, causing them to become distorted. Young are produced in this curled leaf tissue and feed for about a month. A third, winged generation is produced, flying in June to an alternate host. In the case of the woolly elm aphid, the single alternate host is serviceberry *(Amelanchier sp.)*, and for the woolly apple aphid the hosts are apple, pear, quince, or hawthorn. Three generations occur on the alternate host, with winged forms returning to elm to produce a wingless generation. These mate and each female lays one overwintering egg on the bark.

Control Program 1a *or* 3a *or* 16 *or* 17 – Apply in early May to the buds, bark, and foliage.

Fig. 20–Injury by woolly elm aphid.

FALL WEBWORM – See Oak
PUTNAM SCALE – See Linden
SAN JOSE' SCALE – See Apple
WHITE-MARKED TUSSOCK MOTH – See Horsechestnut

EUONYMUS

EUONYMUS SCALE

Eunaspis euonymi

This is the most serious pest of both evergreen and deciduous species of euonymus. It may also infest nearby bittersweet, English ivy, *Syringa* sp. and *Pachysandra sp.* Foliage turns yellow and branches or the entire plant eventually dies.

The insect passes winter as a mature female. Eggs are laid beneath the female covering during early spring. These hatch in late May, and the crawlers emerge from beneath the female scales. They settle mainly on the leaves and stems of the new growth, insert their thread-like mouthparts and suck the plant juices. A complete generation requires 50 to 65 days; there may be two or more generations each year.

Control Program 10b *or* 11b *or* 11c – Apply in the early spring before growth begins *or Program* 1a *or* 6 *or* 8 *or* 16 *or* 17 – Apply in late May or early June to control emerging crawlers.

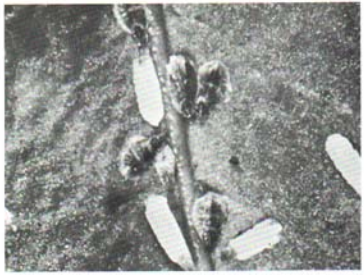


Fig. 21–White elongate males and brown oval females of euonymus scale.

FIR

COOLEY SPRUCE GALL APHID

Chermes cooleyi

This aphid alternates between spruce, where it causes galls, and Douglas-fir, where it causes needles to twist and turn yellow. Aphids produce cottony masses on the lower needle surfaces beneath which they deposit their eggs. While spruce is an alternate host, successive generations may occur solely on Douglas-fir. For a complete description of its life cycle, see SPRUCE.

Control Program 2a *or* 14a *or* 15a – Apply in early spring before the buds break.

Fig. 22–Cooley spruce gall aphid on Douglas-fir.

SPRUCE MITE – See Spruce

HONEY LOCUST

HONEY LOCUST MITE

Eotetranychus multidigituli

This mite feeds only on the underside of the leaves of honey locust. Heavy infestations build up in a short time, causing severe yellowing or browning of the leaflets and premature leafdrop.

The overwintering, reddish-orange females remain protected in bark crevices until spring, when new foliage appears. They then move to the leaves where they deposit their eggs. Summer mite forms are greenish-yellow and pass through a complete generation in less than two weeks. Many generations occur each year, and all stages—eggs, nymphs and adults—are present at the same time throughout the summer.

Control Program 17 – Apply in early summer when the mites are first seen.

HONEY LOCUST POD GALL

Dasyneura gleditschiae

Egg-shaped galls, ¼ inch in diameter are produced by this midge on the terminal leaflets. Thornless varieties of locust such as Moraine and Shademaster are particularly susceptible.

Small adult midges emerge during early summer and deposit their eggs among the newly expanded leaflets. Larvae hatching from these eggs feed on the inner leaf surface, causing the leaves to roll and pod up.

Control Program 2a *or* 3a *or* 15a – Apply the third week in May, followed by a second application the first week in July.

Fig. 23–Honey locust pod gall.

PLANT BUG

Orthotylus chlorionis

LEAFHOPPER

Macropsis fumipennis

Leaves of Moraine and honey locust drop dramatically as a result of the feeding of these insects. Both feed by piercing the leaves and petioles, sucking out juices and causing defoliation from late June to August. Their presence can be detected by shaking the tree branches to dislodge and force them into flight.

Both insects are about ¼ inch long; the plant bug is uniformly light green whereas the leafhopper has a tan colored head with a dark purple, almost black body.

Control Program 1a *or* 3a *or* 16 *or* 17 – Apply when insect buildup is first noticed – usually during early July. A repeat spray may be necessary if reinfestation occurs later in the summer.

Fig. 24–Plant bug (A) and leafhopper (B) on locust foliage.

BAGWORM – See Arborvitae
COTTONY MAPLE SCALE – See Maple
SAN JOSE' SCALE – See Apple

HORSECHESTNUT

WHITE-MARKED TUSSOCK MOTH

Hemerocampa leucostigma

This insect lives on a variety of deciduous trees and shrubs. Favored host plants include horsechestnut, elm, linden, apple, poplar, sycamore, and maple. The colorful larvae, often a serious pest of shade trees, consume all the leaf tissues, leaving only the larger veins.

Eggs overwinter on the mother cocoon, under bark scales, on the undersides of branches, or in other protected places. During late May, they hatch and the larvae (red-headed, hairy caterpillars with three long tufts of hair) feed on the foliage. Within 5 or 6 weeks they mature, reaching a length of 1½ inches, and wander about seeking protected places in which to spin their cocoons and pupate. Two weeks after pupating, the adults emerge. The gray-brown, wingless females, about ½ inch in length, lay from 300 to 700 eggs on their cocoons. Males have reddish-brown wings measuring about one inch across and are active flyers. In some seasons two broods occur, the second appearing in late September or early October.

Control Program 3a *or* 13 *or* 21 – Apply after all eggs have hatched, but before the caterpillars reach ½ inch long, which is usually during late May.

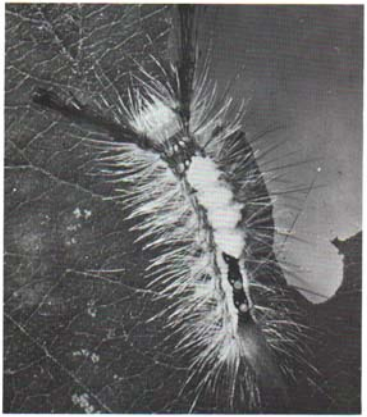


Fig. 25–White-marked tussock moth larva.

JUNIPER

JUNIPER SCALE

Diaspis carueli

While all species of juniper are damaged by this insect, red cedar, Irish, Savin, and pfitizer junipers are most commonly infested. The needles of heavily infested plants turn yellow and branches or entire trees die.

Mature females overwinter and lay 40 or more eggs starting in mid-June. Crawlers hatching from these eggs exit from beneath the mother scale, wander over the foliage for several hours, then settle on the new growth. Females molt three times and the males five times, and reach maturity by early fall. The fragile, winged adult males live a short time, mating with mature females, then die. There is one generation each year.

Fig. 26–Infestation of juniper scale.

Control Program 11b *or* 11c *or* 14a – Apply in the spring before plant growth starts, *or Program* 1a *or* 6 *or* 8 *or* 16 – Apply in mid-May followed by a second spray in early July.

JUNIPER WEBWORM

Dichomeris marginella

The larvae feed on the surface of the needles and later construct nests 2 to 3 inches long by webbing together the tips of one or more twigs. Each nest contains several larvae (reddish-brown caterpillars with light longitudinal stripes, black heads and legs). These webbed parts of the plant turn brown and die.

Immature caterpillars overwinter in the web and resume feeding in early May. During early June they mature, reaching ½ inch, then pupate. The adults, brownish-gray moths with a wingspan of ⅝ inch, emerge during the summer and deposit eggs on the foliage. They hatch in about two weeks; the young larvae first feed as leaf miners, but later build a web in which they pass the winter. One generation occurs each year.

Control Program 3a *or* 13 *or* 21 – Apply in late April, early May, or in October. It is suggested a miticide be included.

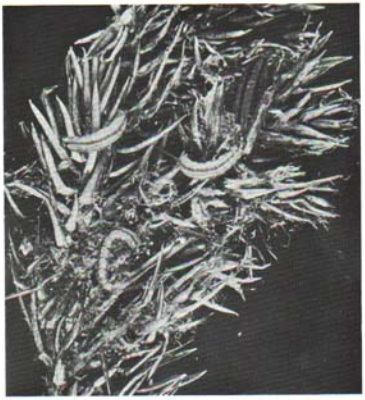


Fig. 27–Larvae and nests of juniper webworm.

FLETCHER SCALE – See Taxus
SPRUCE MITE – See Spruce

LILAC

LILAC BORER

Podosesia syringae syringae

A major pest of lilac, this borer also attacks ash, mountain ash, and privet. Larvae bore into the main stem, causing leaf wilt and weakening shoots so that they break off. Older, rough-barked stems are most susceptible to attack, particularly those with wounds or grafting scars.

Winter is passed as full-grown larvae in tunnels within the trunk. These larvae are cream-colored with a brown head and are from ¾ to 1 inch long. In early spring they pupate; the winged adults emerge from May until June, leaving their pupal cases protruding from the emergence holes. Eggs are laid on the rough bark and hatch in about a week. The larvae bore into the heartwood, feeding throughout the summer and fall. In late fall larvae plug their tunnels with borings to form cells in which they overwinter. There is one generation each year.

Control – Remove and destroy heavily infested stems before May 1. Apply *Program* 5b *or* 12b to the trunks (especially those with rough bark or wounds) of the remaining trees the first week in May and repeat twice more at three-week intervals.

Fig. 28–Adult lilac borer.

Fig. 29–Pupal case of lilac borer extruding from exit hole.

OYSTERSHELL SCALE

Lepidosaphes ulmi

As perhaps the most common and troublesome scale insect in Michigan, the oystershell scale infests many ornamental plants and shade trees. Host plants include lilac, ash, willow, apple, elm, locust, maple, viburnum, linden, and many others. The woody parts of infested plants become encrusted with this scale. Affected trees have stunted, yellow foliage and eventually individual branches or entire plants are killed.

This insect is an armored scale; the true scale body lies beneath the oystershell covering. Eggs deposited beneath this covering overwinter and hatch from late May through June beginning at the time petals are falling from apple trees. Motile crawlers emerge from under the female scale, move to the most tender twig growth, settle, and suck the plant juices. Scales mature during late August and September, and each female lays up to 100 overwintering eggs. There is one generation each year.

Control Program 10b *or* 11c – Apply before the buds break to control overwintering eggs *or Program* 1a *or* 3a *or* 6 *or* 16 – Apply in late May, followed by a second spray in 2 weeks to control emerging crawlers.

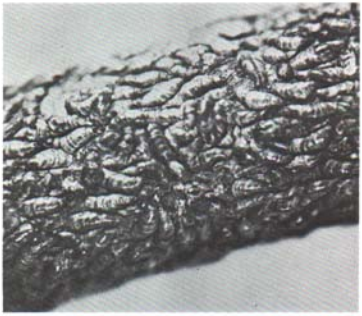


Fig. 30–Infestation of oystershell scale.

EUONYMUS SCALE – See Euonymus
SAN JOSE' SCALE – See Apple

LINDEN

LINDEN APHID

Myzocallis tiliae

This yellow and black aphid feeds on the lower leaf surface of linden leaves but causes little tree injury. It is chiefly an annoying pest, since it produces heavy amounts of honeydew, which adheres to the foliage or other objects it falls upon. This honeydew is initially a clear liquid high in sugar content. However, a sooty mold fungus feeds on the honeydew, turns it black, and gives the tree a blackened, unthrifty appearance. Aphids become active with the appearance of the new growth in the spring and pass through several generations by fall.

Control Program 2a *or* 6 *or* 8 *or* 12a *or* 16 *or* 17 – Apply in the spring when the aphids are present on the newly expanded leaves.

PUTNAM SCALE

Aspidiotus ancyclus

While very similar in appearance to the San José scale, this insect is usually a less serious pest. Infested trees rarely die, yet twigs and branches may. Linden and soft maples are most commonly infested, but ash, elm, hickory, black locust, apple, and poplar are also attacked. This scale is circular, 1/16 inch in diameter and gray-black. It has a brick-red nipple, slightly off center, which differentiates it from the San José scale with its central black nipple.

Winter is passed by immature scales on the branches and trunk. They mature in early spring and begin laying their eggs beneath the female covering in late May. Egg laying and subsequent crawler emergence continue for the next six weeks. There are two or more generations each year.

Control Program 11b *or* 14a – Apply in the spring before plant growth begins, *or Program* 1b *or* 3a *or* 15 – Apply May 20 and again in 10 to 14 days.

Fig. 31–Infestation of Putnam scale.

CANKERWORMS – See Elm
COTTONY MAPLE SCALE – See Maple
EUROPEAN FRUIT LECANIUM – See Elm
FALL WEBWORM – See Oak
FLAT-HEADED APPLE TREE BORER – See Apple
OYSTERSHELL SCALE – See Lilac
SAN JOSE' SCALE – See Apple
WHITE-MARKED TUSSOCK MOTH – See Horse-chestnut

LOCUST

LOCUST BORER

Megacyllene robiniae

This borer afflicts locust, primarily black locust, grown in open stands or windbreaks. The first sign of borer activity is a wet area on the bark in the spring and fall resulting from damaged areas in the bark. Masses of borings, pushed out through these holes by invading larvae, accumulate at the base of the tree. Eventually individual limbs or entire trees die. Larval tunnels weaken the main stem causing them to break off about a foot above ground.

Immature larvae overwinter in the bark. During the spring these larvae feed for a while in the cambium, then invade the sapwood where they construct long, winding tunnels. Larvae mature in August and make pupal cells in their tunnels. Adult beetles emerge in late August and September and feed for a short time on the pollen of goldenrod. The eggs, laid in an old wound or in bark crevices, hatch in about a week, and the young larvae bore into the bark and feed until cold weather. There is one generation each year.

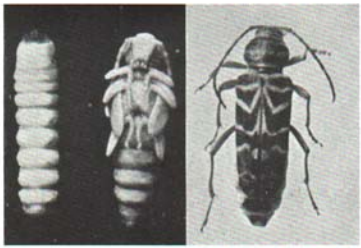


Fig. 32–Larva, pupa and adult of locust borer.

Control Program 2b *or* 7b *or* 15b – Apply in late August to the trunk and larger branches.

LOCUST LEAF MINER

Xenochaelepus dorsalis

Blister-like brown patches on leaves followed by premature leaf drop characterize the damage of this insect. These patches between the upper and lower leaf surfaces are feeding mines of the yellowish-white larvae. The adult, a black-bodied beetle with orange wing covers, is about ¼ inch long and overwinters in sheltered places. In the spring, as foliage is developing, adults lay their white, oval, flattened eggs on the underside of leaves. These hatch in about a week and the larvae feed together in common mines. Later, each larva constructs its own mine for pupation. The larval stage lasts about one month with the second brood of beetles appearing in late July.

Control Program 2a *or* 15a – Apply in the spring as soon as the leaves are fully developed.

COTTONY MAPLE SCALE – See Maple
EUROPEAN FRUIT LECANIUM – See Elm
PUTNAM SCALE – See Linden

MAGNOLIA

MAGNOLIA SCALE

Neolecanium cornuparvum

This is Michigan's largest scale insect. It is ½ inch in diameter, nearly round in shape, and varnish-brown in color. Secreted wax often covers the scales, giving them a white, dusty appearance. Infested trees often have reduced vigor and poor growth. The foliage and twigs often appear sooty due to fungus on the honeydew secreted by the scale.

Immature scales overwinter on the twigs. During August the females mature and produce eggs beneath their bodies. Crawlers hatch from these eggs, exit from under the mother scale during late August and September, and settle on the twigs. There is one generation each year.

Control Program 11b *or* 11c – Apply in April after freezing weather has passed, *or Program* 3a *or* 16 – After all eggs have hatched, usually by late September.

Fig. 33–Magnolia scale.

SAN JOSÉ SCALE – See Apple

MAPLE

APHIDS

WOOLLY ALDER APHID – *Prociphilus tesselatus*
PAINTED MAPLE APHID – *Drepanaphis acerifoliae*
NORWAY MAPLE APHID – *Periphyllus lyropictus*

Honeydew drippings and leaf curl or premature leaf drop follow the feeding of these soft-bodied insects. The woolly alder aphid, a bluish-black aphid, produces abundant white, cottony masses within curled leaves. The painted maple aphid, causes little apparent tree injury, but its yellow, wingless nymphs and gray-black winged adults produce large amounts of honeydew. The Norway maple aphid, a large, hairy green-to-brown aphid, feeds along the veins of the lower leaf surface producing copious amounts of honeydew and, under heavy infestations, summer leaf drop.

Control Program 10a *or* 11b – Apply during April before growth starts, *or Program* 2a *or* 6 *or* 12a *or* 15a *or* 16 *or* 17 – in early May when population buildup is noted.

BLADDER GALL MITE

Vasates quadripedes

This is the most common gall of red and silver maples. The bladder-shaped galls are found only on the upper surface of the leaves, and are induced by the feeding of this eriophyid mite. While these galls affect the aesthetic value of the trees, only under severe infestations do leaves fall prematurely. Injury is temporary and does not reduce tree vigor.

These mites are approximately $\frac{1}{125}$ inch long, elongate in shape and vary from creamy-white to orange. Winter is passed under bud and bark scales of the twigs. In the spring as the leaves begin to expand, the mites become active and feed on the lower leaf surface. As a result of this feeding, the leaf tissues are stimulated to form irregular growths which eventually enclose the mites. Galls are first green and later red or black. Mites remain within the gall throughout the summer and pass through several generations. In the fall before the leaves drop, the galls open and the mites migrate to the twigs where they overwinter.

Control Program 11c *or* 14a *or* 16 – Apply in the fall after the leaves have dropped or in April before the leaves expand or dikofol or morestan (program 19) in early May when the foliage is 25 to 50 percent expanded.

Fig. 34 (left)–Maple bladder galls.

COTTONY MAPLE SCALE

Pulvinaria innumerabilis

Cottony masses on the twigs of shade trees characterize this insect. While found primarily on maple, it also infests white ash, black and honey locust, dogwood, linden, oak, apple, elm, sycamore, and willow.

Cottony maple scale may be extremely numerous for 3 or 4 years, then almost disappear, apparently as a result of its numerous parasites and predators. However, this insect increases rapidly; therefore, the vigor of infested trees may be reduced in a short time. Injury shows first by yellowing of the foliage, premature leaf drop, and death of individual branches. In some cases entire trees may be killed.

Partially developed nymphs pass the winter on the twigs and mature in early spring. During May and June the female secretes the white, cottony masses

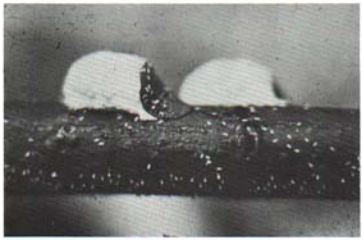


Fig. 35 (left center)–Female cottony maple scales with white cottony egg masses. Note numerous crawlers.

beneath which 500 or more eggs are laid. In late June or early July the eggs hatch, and the flattened, light yellow crawlers exit from beneath the mother scale and migrate to the leaves. They settle on the lower leaf surfaces, insert their thread-like mouthparts and feed on plant juices. In September or October before the leaves fall, these nymphs crawl back to the twigs where they overwinter. One generation occurs each year.

Control Program 11b – Apply in the fall after the leaves drop or in the spring before plant growth begins *or Program* 3a *or* 16 – Apply in late June or early July when the crawlers are active.

Fig. 36—Cottony maple scale nymphs on lower surface of a maple leaf.

CRIMSON ERINEUM MITES

Eriophyes sp.

Several eriophyid mites cause a yellow, pink, or reddish-brown pile consisting of microscopic hairs between the veins on the lower leaf surface of silver, red, and sugar maples. The microscopic mites occur in these piles. The life cycles are about the same as the bladder gall mite (see above) with the exception of the type of gall. While these mites may cause severe leaf discoloration, injury is usually not sufficient to warrant control.

Control Program 11c *or* 14a *or* 16 – Apply in the fall after the leaves drop or in April before the leaves expand.

Fig. 37—Pile produced by crimson erineum mites.

PIGEON TREMEX

Tremex columba

This pest invades only dead or dying trees. Injury is therefore secondary. The pigeon tremex will not attack healthy trees. However, it will attack dead areas in living trees. Host plants include maple, apple, birch, elm, sycamore, oak, and hickory.

During early summer adult wasps emerge from circular holes, ½ inch in diameter, in the bark. They carefully select trees with declining vigor and bore holes ½ inch into the wood for egg laying. Larvae hatching from these eggs further weaken the trees by making galleries in the wood. The life cycle of this insect is not completely known, but it appears that one generation occurs each year.

Control – Since this insect attacks only dead or dying trees, no control is needed because such plants should eventually be removed.

Fig. 38–Pigeon tremex.

BOXELDER BUG – See Boxelder
CANKERWORMS – See Elm
FLAT-HEADED APPLE TREE BORER – See Apple
TWIG PRUNER – See Oak
OYSTERSHELL SCALE – See Lilac
WHITE-MARKED TUSSOCK MOTH – See Elm

MAPLE PETIOLE BORER

Caulocampus acericaulis

The larval feeding of this insect causes the leaves of sugar and sycamore maple to drop during late May and early June. While leaf drop may be abundant, defoliation rarely injures the trees.

Pupae of this sawfly overwinter in the top 2-3 inches of soil. During early May, adults emerge and lay eggs at the base of the petioles. Larvae, hatching from the eggs, tunnel into the center of the petioles for about a month causing them to break and leaves to fall. The full grown larvae, about ½ inch long with a white body and light-brown head, continue to feed for about 10-14 days in the remainder of the petiole attached to the tree. Then, they drop to the soil, and pupate. There is one generation each year.

Control – Control is seldom justified. However, clean-tilling or cultivation of the soil beneath infested trees after late June will destroy the pupae. *Program* 5a *or* 18a applied to the soil about mid-June to destroy larvae before they pupate is the most practical control method.

Fig. 39–Damage caused by maple petiole borer. Leaves drop prematurely due to larvae feeding within the petiole.

OAK

GOLDEN OAK SCALE

Asterolecanium variolosum

This is also called the pit-making oak scale because wherever this scale settles and feeds the tissues become depressed or sunken. White, English and chestnut oaks are seriously affected, but red, swamp white, and scarlet oaks can also be attacked. Smaller twigs, branches and occasionally, entire trees are killed by this insect.

Winter is passed as adult females, round, lemon-gold, shiny scales about 1/16 inch in diameter, in the bark pits. Eggs are laid during late May and June and crawlers emerge during late June and early July. There is one generation each year.

Control Program 11b *or* 11c – Apply in early spring before plant growth begins *or Program* 6 *or* 8 *or* 15 – Apply in late June or early July when crawlers are active.

Fig. 40–Golden oak scale. Note the depressions or pits in the twig caused by scale feeding.

JUNE BEETLES

Phyllophaga spp.

During the spring, trees may be defoliated at night by these light brown-to-black, robust beetles, ½ to ¾ inch long. While the foliage of oaks is preferred by many *Phyllophaga* species, there is hardly a species of hardwood tree that is not subject to some degree of attack. The larvae, called white grubs, destroy the roots of trees, grasses and agricultural crops.

The typical life cycle lasts three years. Adult beetles appear in late May or June, feeding for a short time on the foliage of trees and shrubs. Each female lays 50 to 100 eggs in the soil. These hatch in 2 to 3 weeks and the young grubs feed on the roots of various plants until September when they move downward in the soil. They are active in the soil throughout the second year and during September move deeper into the soil to overwinter. In the spring of the third year, grubs move up into the root zone of the plants, feed for a short period, then pupate. Large numbers of adult beetles appear at the same time and disappear as abruptly as they came.

Fig. 41–Adult June beetle damage to oak.

Control Program 3a *or* 13 *or* 18a – Apply sprays to the foliage when the beetles first appear.

KERMES OAK SCALE

Kermes pubescens

Distortion, curling, and eventual death of the new growth of white, red, pin, and bur oaks result from this insect's feeding. The light brown scales, about 1/8 inch in diameter at maturity, are often overlooked. Winter is passed as immature scales on the twigs. They move to the new growth in the spring and settle on the twigs at the base of the leaf petioles or along the veins of the leaves. Each female lays 100 or more eggs beneath its body. Eggs hatch during late July, and the reddish-brown crawlers exit from beneath the mother scale. They migrate to the twigs, feeding until cold weather. There is one generation annually.

Control Program 11b – Apply in early spring before the buds break to control overwintering scales or *Program* 3a *or* 6 *or* 8 *or* 16 – Apply in late July when the crawlers emerge.

Fig. 42—Oak kermes scale.

FALL WEBWORM

Hyphantria cunea

The foliage of one limb or an entire tree or shrub may be defoliated during August and September by larvae of the fall webworm. Oak, birch, linden, ash, and apple are preferred but some 120 different trees and shrubs may also be attacked.

Winter is passed as pupae within cocoons under the bark or in surface litter. Adults, white moths with a wing expanse of about 1½ inches, emerge during July and lay up to 500 eggs in white masses on the underside of the leaves. Upon hatching from the eggs, the larvae feed on the foliage and spin a silken web over the foliage. The larvae feed together and enlarge the web as they grow. These webs may be 2 to 3 ft. long and contain excrement, molted skins and portions of leaves. The larvae have pale-yellow or greenish bodies clothed with whitish hairs and are about 1 inch long when mature.

Control – If webs are not too numerous, the most practical control is to remove and destroy them as soon as they are discovered. *Program* 1a *or* 3a *or* 6 *or* 15 *or* 18a *or* 21, applied when nests are first noticed, will protect trees before severe injury occurs.

Fig. 43—Larvae and nest of fall webworm.

LEAF GALLS

Oaks produce a variety of abnormal growths called galls when attacked by any of a number of small, fly-like insects. Winged adults deposit eggs within the leaves. Larvae hatch from these eggs and feed on the tissues, stimulating abnormal plant growth which completely envelopes them. Galls may be irregular, round, flattened, bumpy, or smooth in appearance. Each insect species produces a characteristic gall and can usually be found inside it.

Control – Damage to oak trees is seldom serious and usually does not warrant chemical control. However, *Program* 2a *or* 5a *or* 15a – applied in the spring when the leaves are three-quarters expanded will reduce the formation of new galls.

Fig. 44–Oak spangles galls caused by a small wasp.

Fig. 45–Oak apple galls.

Fig. 46–Oak apple galls with larvae within.

OAK LACE BUG

Corythuca arcuata

When present in large numbers, this insect causes a curling and bronzing of the leaves as well as premature leaf drop on various species of oaks. The adults and nymphs suck sap from the lower leaf surface. The life cycle is similar to the sycamore lacebug, except it may overwinter as eggs and adults. There are two generations each year.

Control Program 1a *or* 2a *or* 3a *or* 15a *or* 16 – Apply when the nymphs are active, usually late in May.

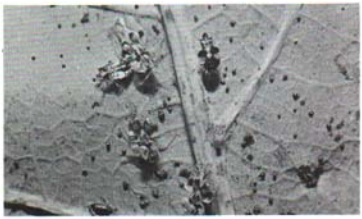


Fig. 47–Oak lacebug nymphs and adults.

LEAF MINERS

SOLITARY OAK LEAF MINER – *Cameraria hamadryadella*
GREGARIOUS OAK LEAF MINER – *Cameraria cincinnatiella*

Two species of leaf miner commonly mine below the upper leaf surfaces of oak. The solitary oak leaf miner produces blotchy mines, each containing a single larva, whereas the gregarious oak leaf miner causes similar injury but several larvae feed together in a single mine. The mines are yellowish-brown, and when several exist close together, the entire leaf may be damaged.

The life cycles of both species are similar. Winter is passed by larvae in the mines. During early spring they pupate and later the adults (small, slender moths with a wing expanse of 1/4 inch) emerge. They fly to the newly expanded leaves and lay their eggs on the upper surface. The larvae penetrate the leaves and feed below the surface. Larvae are flat, dark yellow in color, and 1/5 inch long when mature. There are two or more generations each year.

Damage by this leaf miner may be reduced by raking up and burning the fallen leaves where larvae overwinter.

Control Program 2a *or* 3a *or* 15a *or* 16 – Apply as sprays to the foliage in mid-May.

Fig. 48 (top right)–Solitary oak leaf miner.

Fig. 49 (right center)–Gregarious oak leaf miner.

OAK LEAF TIER

Croesia semipurpurana

This insect destroys the foliage of red, pin, scarlet, and black oaks in early spring. Many buds are destroyed before they open.

Winter is passed as flat, oval eggs on the bark of the twigs and branches. In the early spring the eggs hatch and the larvae bore into the unopened buds. Larvae first mine in the young tissues and later secrete a silken webbing on the surface of the buds and expanding leaves. They feed beneath this webbing, then roll and tie one or more leaves together. In early June the larvae mature, spin silken threads on which they drop to the ground to pupate. About three weeks later the adults (yellowish-tan moths with a wing expanse of 1/2 inch) emerge and lay their eggs. There is one generation annually.

Control Program 3a *or* 18a – Apply in early spring before the buds open.

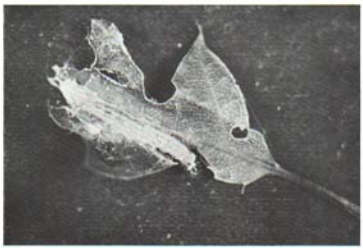


Fig. 50–Oak leaf tier.

TWIG PRUNER

Elaphidion villosum

Small, clean-cut twigs on the ground during midsummer or dead twigs clinging to the tree characterize this beetle's work. This pruning does not seriously affect mature trees. However, young trees may be deformed or their growth retarded if overpruned by the insect. Trees most commonly attacked are oak, hickory, maple, and apple.

Winter is passed by larvae in twigs on the ground. During early spring they pupate, and the adult beetles appear in June. Eggs are laid near the tip of the twigs. Larvae hatch from the eggs and bore down the center of the twig. In midsummer the larvae make several cuts from the inside outward, leaving only an area of thin bark. The wind breaks these weakened twigs and they fall to the ground with the larvae inside them. There is one generation each year.

Control – Raking and burning fallen twigs before late May will adequately control this pest. High value nursery and ornamental plants may be protected by *Program* 5a applied in early June.

CANKERWORMS – See Elm
COTTONY MAPLE SCALE – See Maple
EUROPEAN FRUIT LECANIUM – See Elm
FLAT-HEADED APPLE TREE BORER – See Apple
PIGEON TREMEX – See Maple

PINE

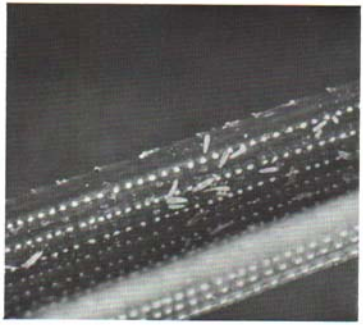


Fig. 51 (left)–Eriophyid mites.

Fig. 52 (below)–Larva of European pine shoot moth.

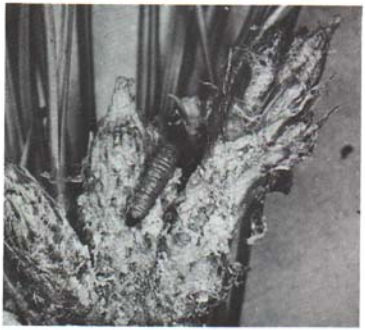


Fig. 53 (below)–European pine sawfly larvae.

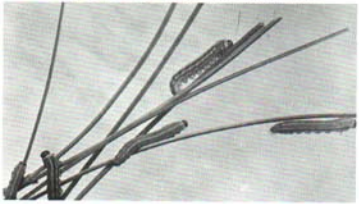


Fig. 54 (below)–Pine needle scale.

ERIOPHYID MITES

SEVERAL SPECIES

Injury by these minute creatures is often confused with damage from drought, poor soil conditions, or some other plant deficiency. Trees suffer a gradual loss of vigor with tips of the needles becoming yellowed, hooked, or twisted. Later the terminal 1/3 of the needles turn brown and drop prematurely. Several species of mites, each attacking a different type of pine, affect White, Scotch, red, Austrian, and mugho pines in Michigan.

These mites, 1/125 inch long and varying from creamy-white to orange-yellow occur most frequently in the needle sheath. They feed by piercing the needle tissues and sucking the plant juices. As a result, the surface of the needle assumes a blotchy, pale yellow, stippled appearance. However, the greatest damage occurs from mite feeding inside the sheath which affects the growth of the entire needle. Injury to the base of the needle deforms and eventually kills the terminal parts of the needles by preventing the natural movement of fluids. Mite activity begins in early spring and continues until cold weather. There are many overlapping generations each year.

Control Program 16 – Apply in early May to reduce mite populations. Repeat once or twice more at weekly intervals, if needed.

EUROPEAN PINE SHOOT MOTH

Rhyacionia buoliana

Trees are rarely killed by this insect, but two- or three-needled pines, particularly red, Scotch, and mugho, may be severely deformed. Needle, bud, and shoot damage results in the stunting of twigs and branches. Young trees in nurseries, plantations, and home plantings are more susceptible. Trees over 15 feet in height are rarely attacked.

Partially grown larvae pass the winter in mined-out buds or beneath masses of hardened pitch. In the spring these immature caterpillars leave their overwintering sites and bore into a nearby healthy shoot. By late May or early June, brown caterpillars with black heads reach about ⅝ inch long and pupate inside damaged shoots. The adults (rusty-orange colored moths with a wing expanse of ¾ inch) emerge during late June or early July. Eggs deposited on the surface of the needles or shoots hatch in 10 days. The young caterpillars bore first into the bases of the needles, and later in the summer leave the needles and bore into buds where they overwinter. There is one generation each year.

Control Program 5b *or* 8 – Apply between April 15 and April 30 to control the caterpillars moving from overwintering sites to new shoots *or Program* 1a *or* 3b *or* 8 – Apply about July 4 for control of the young larvae hatching from the eggs.

EUROPEAN PINE SAWFLY

Neodiprion sertifer

While most pines are susceptible to this insect, Scotch, red, jack, Swiss mountain, and mugho pines are most commonly infested. Larvae feed in groups on the mature needles of trees 2 to 15 feet in height and, when disturbed, move their heads up and down in a rhythmic motion. The small, immature larvae are often overlooked since they cause limited plant damage. Early larval feeding is characterized by a straw-like appearance to the old needles. However, as the larvae increase in size, so do their appetites and trees are completely defoliated in a few days. Trees are rarely killed after one defoliation, but their appearance is ruined.

During September and October the yellow-brown, winged adults lay their eggs in slits cut along the edge of the current season's needles. The eggs hatch early in May. The black-headed larvae are first pale green, then grayish-green with a light stripe along the back and dark stripes along the sides. The larvae mature, reaching a length of ⅞ inch in early June and drop to the ground for pupation. Adults emerge in September and October, mate, and lay their eggs. There is one generation each year.

Control Program 1a *or* 3a *or* 13 *or* 16 *or* 17 *or* 18a – Apply when the young larvae are active, usually the first week in May.

PINE BARK APHID

Pineus strobi

This aphid produces white, cottony masses on twigs, limbs, and trunks of white, Scotch, Austrian, and red pines. Aphids suck plant juices but cause little injury to large, vigorous trees. Small nursery stock and young, transplanted trees may be seriously stunted. Winter is passed by immature females beneath the cottony masses. In late April or early May, they mature and lay eggs beneath these masses. In 10 to 14 days, eggs hatch into both winged and wingless forms. Wingless aphids remain on the same host, whereas winged forms fly to other pines. The wingless generation lays eggs in early July and produces a brood of adults in August or September. These fall adults lay eggs which soon hatch into the overwintering nymphs.

Control Program 6 *or* 12a *or* 15a *or* 16 – Apply with pressure to the bark of branches and trunk in early May to control the young of the first brood.

PINE NEEDLE SCALE

Phenacaspis pinifoliae

The pine needle scale attacks pine, spruce, and occasionally hemlock, fir, and taxus. Most severely affected are Austrian, Scotch, white, red, and mugho pines and white and blue spruces. This sedentary insect sucks large amounts of plant juices, turning the needles yellow and causing them to drop prematurely. If left uncontrolled, infestations can stunt and gradually kill branches and entire trees.

During the fall purple-red eggs are deposited beneath the white female covering; these eggs overwinter and hatch in late May (when lilac is in full bloom) and the reddish crawlers emerge from under the mother covering. Crawlers migrate to the new growth and, once established, do not move again. In about seven weeks, this first brood matures and produces a second generation in late July. This brood matures in October and lays eggs which overwinter.

Control Program 10b *or* 11c *or* 14a – Apply in April *or Program* 3a *or* 6 *or* 8 *or* 16 *or* 17 – Apply in late May (when lilac is in full bloom) to control emerging crawlers. A second spray in late July may also be needed.

PINE TORTOISE SCALE

Toumeyella numismaticum

Infestations of this scale are usually confined to the older branches of Scotch, Austrian, red, and jack pines. Scale populations increase so rapidly that plants become covered with a black, sooty mold (see discussion on honeydew under Fletcher scale); their growth is retarded, and needles drop prematurely. Individual branches may be killed in a single season and trees die after a few years.

Partially grown females overwinter in protected places on the rough bark of the twigs. Beginning the third week in June, each reddish-brown female lays 1,000 or more eggs beneath its body. These hatch in a few hours and the small, reddish crawlers exit from beneath the mother scale. They move to the terminal branches, insert their thread-like beaks and withdraw large amounts of plant juices. Females become sexually mature by late August and mate with the extremely short-lived, gnat-like males. The females continue to feed until cold weather occurs. There is one brood each year.

Control Program 10b *or* 11a – Apply as a dormant spray *or Program* 1a *or* 3a *or* 6 *or* 15 – Apply when the crawlers are active, usually between June 20 and July 1.

Fig. 55–Pine tortoise scale and associated black sooty plant discoloration.

WHITE PINE WEEVIL

Pissodes strobi

White pine weevil larvae girdle the terminal leaders of white, red and Scotch pines, and Norway and white spruces causing them to wither, bend over, and die. This injury does not kill the tree but destroys its natural shape.

The adults (brown weevils about ¼ inch long with white flecks on their bodies) overwinter in the litter. They resume activity during late April, fly to the terminal branches, and make small punctures in which they deposit pearly-white eggs. In about 10 days white, legless grubs hatch from the eggs and feed on the inner bark. Several larvae feed together in one branch and eventually girdle it. By August they mature and pupate within their galleries. Adult weevils emerge through small holes in the bark about two weeks later. There is one brood each year.

Control Program 2b *or* 5b *or* 15b – Apply only to the terminal leader in mid-April. Spray to the point of run-off.

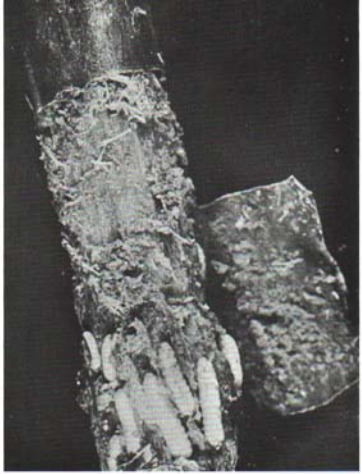


Fig. 56–White pine weevil larvae.

ZIMMERMAN PINE MOTH

Dioryctria zimmermani

The Zimmerman pine moth damages most pines but is most commonly found on Scotch, Austrian, Swiss, red, white, and jack pines. This insect produces two types of injury. On Scotch and Austrian pine, any part of the main stem or terminal shoots may be invaded by the larvae. Damage to young red pine is caused by larval tunnels in the branch tips. Abundant masses of pitch, accompanied by death of terminal branches or distortion of the main stem, characterize this insect.

Winter is passed beneath bark scales by young larvae covered by a secreted sheath-like covering. They resume activity in early spring and by April 20 bore through the bark into the sapwood. The larvae have brown heads and greenish-brown to pinkish-brown bodies adorned with small black spots. During late July and early August they mature, reaching a length of about ¾ inch, and pupate beneath the outer bark or in new shoots. The adults (moths with reddish-brown forewings, measuring about 1½ inches, and pale yellow hindwings) emerge during the last three weeks of August. The eggs, laid in bark crevices or wounds, hatch in about 10 days and the larvae build overwintering cells underneath bark scales. There is one generation each year.

Control Program 2c *or* 5b *or* 12b *or* 21 – Apply with pressure to the bark of branches and trunk between April 5 and April 20.

Fig. 57–Zimmerman pine moth larva amidst mass of pitch.

SPRUCE MITE – See Spruce

POPLAR

VAGABOND APHID

Mordwilkoja vagabunda

This aphid produces a conspicuous twisted gall on the twig tips of various poplars. These galls are particularly noticeable in the winter after the leaves have fallen. While they may be extremely numerous, they cause little tree injury.

Winter is passed by eggs inside the gall. As the leaves are unfolding in the early spring, the eggs hatch and the nymphs move to new growth, piercing the leaf tissues and sucking plant juices. This feeding transforms the leaves into hollow galls in which the aphids mature. Galls are green at first, but turn brown-black by midsummer. During June winged forms emerge from the galls and fly to an alternate host. In the fall, these same winged forms reenter the galls from which they migrated in the spring. A second generation is produced, which lays eggs inside the galls. This habit of returning to the same tree each year heavily infests certain trees with galls, while other nearby poplars remain unaffected.

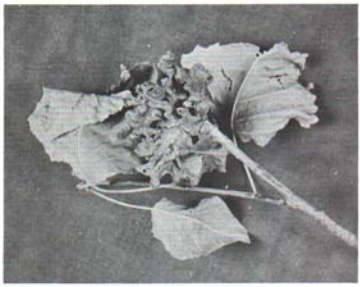


Fig. 58—Poplar vagabond gall.

BRONZE BIRCH BORER – See Birch
FALL WEBWORM – See Oak
MOTTLED WILLOW BORER – See Willow
OYSTERSHELL SCALE – See Lilac
PUTNAM SCALE – See Linden
SAN JOE' SCALE – See Apple

Control Program 10a *or* 14a – Apply to the bark of branches and twigs in the spring before the buds break, *or Program* 2a *or* 8 *or* 12a *or* 15a *or* 16 *or* 17 – As the leaves expand in the spring.

SPRUCE

COOLEY SPRUCE GALL APHID

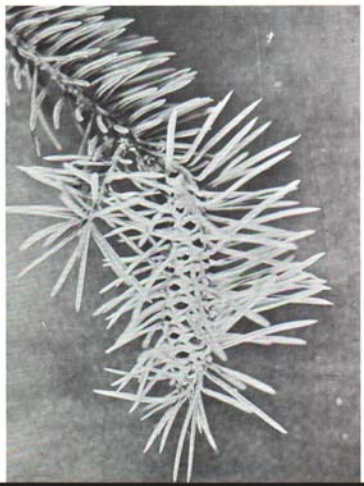
Chermes cooleyi

This insect induces abnormal galls on the tips of the twigs of Colorado blue, Englemann, and Sitka spruces. The aphid may alternate between spruce and Douglas-fir; however, complete cycles may occur on either spruce or Douglas-fir.

Immature stem mothers overwinter at the base of the buds of spruce and Douglas-fir. They mature in early spring and produce large amounts of white, waxy filaments beneath which they deposit their eggs. Eggs hatch after new growth is produced and nymphs migrate to the growing shoots. They pierce the tissues at the base of the needles and suck the plant juices. This feeding stimulates gall formation, enveloping the young aphids. In July or August the aphids mature, the galls open, and the winged aphids emerge. These winged females may fly to Douglas-fir or spruce and lay eggs on the needles; these hatch and the nymphs overwinter. The next summer these aphids remain on Douglas-fir or fly back to spruce. The summer winged forms may also continuously reinfest spruce. There is one generation each year.

Control Program 2a *or* 14b *or* 15a – Apply from mid- to late-April to control the overwintering nymphs on the twigs.

Fig. 59—Gall produced by Cooley spruce gall aphid.



EASTERN SPRUCE GALL APHID

Chermes abietis

This species causes pineapple-shaped galls at the base of the twigs of Norway, white, red, and black spruces. Unlike the Cooley spruce gall aphid, it does not live on Douglas-fir.

Winter is passed by bluish-gray nymphs at the base of spruce buds. In early spring they mature and deposit eggs under a fluffy, waxy covering. The feeding of the mature aphids affects the bud tissue, which will become the inner bark of the twig, and the stalks upon which the needles are borne. Eggs hatch in May and the nymphs move to the open bud and feed upon those tissues which have been stimulated to abnormal growth by the mature females. The feeding of these nymphs further stimulates the development of galls which eventually enclose the young aphids. During early summer, these aphids mature and lay eggs inside the galls. Eggs hatch and each cell in the gall possesses several aphids. These galls become brown and dry and crack open in late July or early August, allowing the aphids to escape. Winged adults fly to the same or another spruce and deposit eggs which hatch in the fall to establish the overwintering generation.

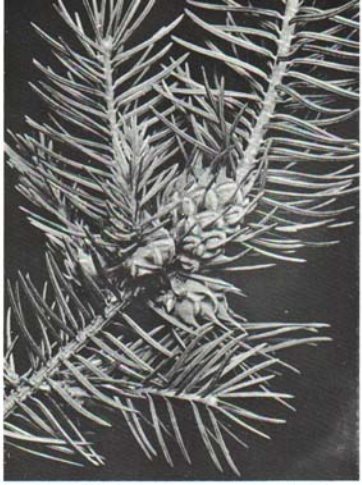


Fig. 60–Gall produced by Eastern spruce gall aphid.

Control Program 2a *or* 14b *or* 15a – Apply in mid to late April before the buds break to control the overwintering nymphs.

SPRUCE MITE

Oligonychus ununguis

This is the most common mite pest of evergreen plants in Michigan. It causes serious injury to spruce, and also damages hemlock, arborvitae, pine, juniper, cedar, fir, and larch. Mites feed by puncturing the leaf surface and sucking the plant's juices. This feeding reduces the chlorophyll (green coloring) in localized areas and gives the foliage a stippled or bronzed appearance. Under severe infestations, the entire tree turns brown, the needles drop prematurely, and the mites produce large amounts of webbing that add to the disfigurement of the plant.

The red, sphere-shaped eggs pass winter at the base of the needles. Larvae hatch from the eggs in late April, and pass through two nymphal stages to adults in 2 to 3 weeks. The development rate is accelerated under hot, dry conditions. There are many overlapping generations each year.

Fig. 61–Adults and eggs of spruce mite.

Control Program 11b *or* 11c – Apply in early spring before the buds break to control overwintering eggs *or Program* 19 – Apply from late spring to fall to control active mites or eggs.

WHITE PINE WEEVIL – See Pine
PINE NEEDLE SCALE – See Pine

SPRUCE BUD SCALE

Physokermes piceae

This insect is particularly destructive to Norway spruce, but other conifers are also affected. The tips of new growth, especially on lower branches, are most heavily infested. Scale feeding reduces plant vigor and inhibits growth but rarely kills trees. Large amounts of honeydew are produced by this scale which eventually turns black, adding to the disfigurement.

Immature females overwintering on the branch tips mature during early spring and commence egg laying. Crawlers emerge during early June, settle on the new growth and begin to feed. There is one generation annually.

Control Program 11b *or* 11c – Apply in early spring before the buds open *or Program* 1a *or* 3a *or* 6 *or* 16 – Apply during early June when the crawlers are emerging.

Fig. 62–Spruce bud scale.

SPRUCE LEAF TIER

Epinotia nanana

The needles of Colorado blue, white, Norway and red spruce are mined out and bound with spruce leaf tier larvae. Entire trees are rarely defoliated but the appearance of ornamental specimens is ruined as dried needles are webbed together.

Winter is passed in mined needles by immature larvae, which resume feeding in early April. In May, larvae (caterpillars $\frac{5}{16}$ inch long with reddish-white bodies and black heads) mature and pupate in the soil at the base of the tree or in the webbed masses of needles in the trees. Adults, dark brown moths with a wing expanse of $\frac{7}{16}$ inch, appear during early June to lay eggs on the foliage. These hatch and larvae mine as many as 10 needles and web them together by late fall. There is one generation each year.

Control Program 1a *or* 13 *or* 16 – Apply during early spring or in late July.

SYCAMORE

SYCAMORE LACE BUG

Corythucha ciliata

Sycamores, particularly the London plane variety, are commonly infested with this insect. Under heavy infestations, leaves lose their green color, becoming stippled, pale; they often drop prematurely. All stages frequent the underside of the leaves where they suck out the juices. Leaves become covered with cast nymphal skins and black excrement, which further disfigure the trees. While found principally on sycamore, it also feeds on hickory, ash, and mulberry.

Adults overwinter in protected places on the host and become active with appearance of the foliage. Eggs are laid along the ribs of the lower surface of the leaves and hatch in two to three weeks. The nymphs molt five times in 5 or 6 weeks before reaching maturity. There are two generations each year.

Control Program 1a *or* 2a *or* 3a *or* 15a *or* 16 – Apply as soon as the eggs hatch, usually in late May.

Fig. 63–Nymphs and adults of sycamore lacebug.

COTTONY MAPLE SCALE – See Maple
EUROPEAN FRUIT LECANIUM – See Elm
FALL WEBWORM – See Oak
FLAT-HEADED APPLE TREE BORER – See Apple
WHITE-MARKED TUSSOCK MOTH – See Horse-chestnut

TAXUS (YEW)

BLACK VINE WEEVIL

Brachyrhinus sulcatus

This is one of the most serious pests of taxus; hence, it is often referred to as the taxus weevil. Taxus, rhododendron, and azalea are most commonly attacked, but andromeda, hemlock, Wisteria, and many herbaceous plants, weeds, and grasses also are injured. Grubs feed on small rootlets. Damage by the adult weevils is inconsequential; they notch the needles, particularly those closest to the soil.

Winter is most commonly passed by grubs in the soil (some adults may overwinter). The grubs resume feeding on the roots in May and pupate during late May or early June. The adults crawl to the soil surface during mid- to late-June. They feed only at night and spend the daylight hours hidden in the soil or duff beneath the plants. Within two to three weeks after emergence, the adults deposit eggs in the soil. The eggs hatch during July and August, and the grubs burrow into the root zone of the plants and feed until cold weather. There is one generation each year.

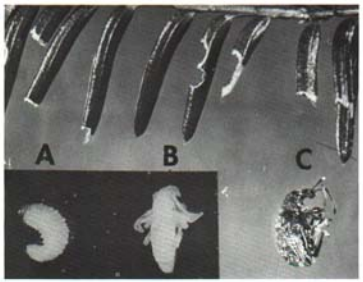


Fig. 64–Larva (A), pupa (B) and adult (C) of black vine weevil. Note adult-feeding notches in needles.

Control Program 4a *or* 7a – Apply to all plant parts and the soil beneath the plants June 30, to control adult weevils. Control of grubs in the soil has not proven effective.

FLETCHER SCALE

Lecanium fletcheri

This soft, immobile insect is the most common scale pest of taxus. It usually occurs in small numbers but can increase rapidly, causing yellowing of the foliage, excessive needle drop, and eventual death of branches or the entire plant. These scales produce honeydew—fine droplets of clear, sugary liquid which stick to the foliage. A sooty mold fungus lives on this honeydew and gives plants a sooty, unthrifty appearance.

Immature scales overwinter on the needles. In the spring they migrate to the woody plant parts, insert their thread-like mouthparts into the tissues, and suck the plant juices. By late spring they mature and each female deposits several hundred eggs underneath its scale. Crawlers hatch from these eggs in late June and July and exit from beneath the female scale. They migrate to new growth, settle, and feed until cold weather. There is one generation each year.

Control Program 11b *or* 11c – Apply with pressure before plant growth begins *or Program* 3a *or* 6 *or* 8 *or* 16 – Apply in late June and repeat about 10 days later.

Fig. 65–Fletcher scale on taxus.

TAXUS MEALYBUG

Pseudococcus cuspidatae

A slow-moving, white, "woolly" insect, the taxus mealybug occasionally is a serious pest of yews. Branches and trunks of heavily infested plants may be completely covered with these insects and their white, waxy secretion. All species of taxus are damaged but heaviest infestations occur on the more compact forms with dense foliage. Mealybugs suck the sap of twigs. This discolors the needles and causes excessive needle cast. If uncontrolled, the plant may die.

Mealybug nymphs overwinter in protected crevices or under bark scales. They mature in mid-June, reaching a length of ⅜ inch, and produce large amounts of waxy filaments beneath which they deposit their eggs. Nymphs hatch from these eggs, and move to the twigs where they settle and feed. There is one more generation by fall.

Control Program 11b *or* 11c – Apply in April before plant growth begins *or Program* 3a *or* 6 *or* 8 *or* 16 – Apply in late May before the females produce their protective, waxy masses.

VIBURNUM

APHIDS

SNOWBALL APHID

Neoceruraphis viburnicola

VIBURNUM APHID

Anuraphis viburniphila

These aphids are commonly found on viburnum, particularly the common snowball. The snowball aphid (an ash-gray to dark green, soft-bodied insect) clusters in great numbers at the tips of branches and causes the developing leaves to curl in the spring. Winter is passed on the buds as eggs. They hatch in early spring. This aphid passes through several wingless generations on viburnum before a winged generation migrates to an alternate host. In the fall, winged migrants return to viburnum to lay overwintering eggs.

The viburnum aphid feeds on the tender stems and twigs of viburnum and does not leave this host. Winter is passed by eggs on the twigs. There are several generations each year.

Control Program 10a – Apply in the spring before the buds open *or Program* 2a *or* 6 *or* 8 *or* 12a *or* 15a *or* 16 *or* 17 – Apply in early spring when the leaves are unfolding.

OYSTERSHELL SCALE – See Lilac

WILLOW

WILLOW LEAF BEETLES

SPOTTED WILLOW LEAF BEETLE

Lina interrupta

IMPORTED WILLOW LEAF BEETLE

Plagiodera versicolora

The adult, spotted willow leaf beetle is ⅜ inch long, reddish, and has black markings on the wing covers. Adults of the imported willow leaf beetle are about the same length, but are metallic-blue or greenish-blue in color. Larvae of both species are black or blue-black, ¼ inch long and slug-like, with the abdomen tapering toward the end. Most species of willow, especially the weeping variety, are susceptible to these beetles. The imported willow leaf beetle may also infest Lombardy poplar.

The life histories of both beetles are essentially the same. Adults overwinter under bark or other protected places. They resume activity in late April or early May and lay clusters of lemon-yellow eggs on the leaves, hatching in about 5 days. The adults eat holes through the leaves but do not do as much damage as the larvae that rapidly skeletonize the leaves. Damage is most evident by midsummer. There are two or more generations a year.

Control Program 3a *or* 13 *or* 18a — Apply to both upper and lower leaf surfaces when adults are active (usually in early spring).

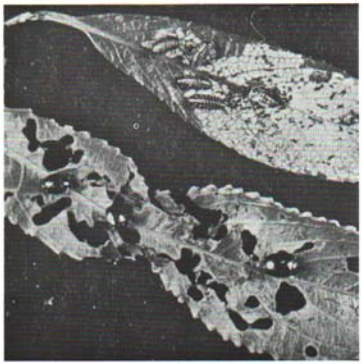


Fig. 66—Larvae and adults of imported willow leaf beetle.

MOTTLED WILLOW BORER

Cryptorhynchus lapathi

This borer causes swollen, abnormal cracking of the bark on the branches or trunks of willow and poplar. Newly transplanted stock is most seriously affected because the borer tunnels at the base deform or girdle the tree. When mature trees are infested, the borer galleries weaken the branches, and they break off or die.

Winter is passed by immature larvae beneath the bark; they resume feeding in early spring. Development is rapid, and by late June the majority of the larvae (white, legless grubs ½ inch in length) pupate.

The adults (dark brown, gray mottled, snout weevils, ½ inch in length) emerge from late July through September. They feed for about a week on the inner bark of tender shoots, then lay their eggs in the inner bark of wood at least two years old. Injuries in the bark or the edges of old scars are preferred for egg-laying. In the absence of such injured wood, the female chews holes in the bark in which to deposit eggs. While there is only one generation annually, all developmental stages occur most times during the year.

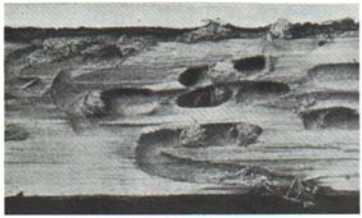


Fig. 67—Galleries of mottled willow borer.

Control Program 7b — Apply to the branches and trunk in late August.

COTTONY MAPLE SCALE — See Maple
FALL WEBWORM — See Oak
LECANIUM SCALES — See Elm
OYSTERSHELL SCALE — See Lilac
PUTNAM SCALE — See Linden

Equipment

The type of equipment selected by you to apply chemicals depends on the size of your spray operation and your preference. Obviously, the equipment required by a commercial sprayman will differ greatly from that used by the homeowner. Many types and makes of application equipment exist. The following discussion includes the common types used in ornamental and shade tree insect control.

HOSE-ON SPRAYER

This small sprayer is easy to operate and is designed to attach to a garden hose for spraying small shrubs and trees. It requires no spray tank but operates by metering a desired amount of chemical into a stream of water under household pressure. While many of these sprayers perform satisfactorily, some problems have been encountered in non-mixing of the insecticide with the water, poor spray distribution and clogging of nozzles.

TROMBONE SPRAYER

Spray mixtures can be prepared in any size container and applied by inserting the intake apparatus into it and moving the slide in a trombone-like motion. This equipment is adequate for treating small trees and shrubs. Since the insecticide is mixed with a required amount of water, a uniform spray concentration can be maintained. The insecticide mixture, particularly a wettable powder formulation, must be agitated periodically to keep it in suspension.

COMPRESSED AIR SPRAYER

Air pumped into the tank forces the spray out when the nozzle is opened. The capacity of most compressed air sprayers is 3 to 4 gallons, an amount suited to most home grounds pest control. When using wettable powder insecticides, shake the sprayer periodically to keep the insecticide in suspension.

KNAPSACK SPRAYER

This sprayer is carried on the back and the spray pressure is supplied by hand pumping a piston. Since this sprayer is relatively small, it allows the user freedom of movement in treating widely spaced plants. It has a tank capacity of 3 to 5 gallons and is not suited for spraying large acreages. For best results, a built-in tank agitator is needed to keep the insecticide thoroughly mixed in the water.

DUSTERS

Dust applications are *not practical* for controlling insects on trees and shrubs. For effective control of most insects, thorough coverage of plant parts is essential. It is difficult to get suitable deposits of insecticide dusts on the trunk and lower leaf surfaces. Furthermore, dusts do not weather as well as insecticides applied in water suspensions and emulsions, and applications must be repeated more frequently.

HYDRAULIC POWER SPRAYER

This sprayer applies a large volume of a dilute insecticide-water mixture. Hydraulic sprayers vary in tank capacities from 10 to 500 gallons. Within this size range, a sprayer can be selected which will suit the needs of commercial spray operators, growers, or homeowners. Hydraulic sprays give a uniform, complete coverage and, because of the dilute insecticide mixture, they are safer to the applicator than are concentrated sprays. Hydraulic sprayers are adequate for controlling most insects affecting ornamental plants and shade trees.

MIST-BLOWER (Air Blast)

The mist-blower applies a small amount of concentrated insecticide-water mixture by means of a high velocity, large volume air stream. Large air-blast equipment treats large trees rapidly with little runoff. The mist-blower requires but a fraction of the water used in a hydraulic spray because the insecticide is largely diluted in air. Wind conditions limit the use of air-blast equipment by disrupting the column of air in which the insecticide is applied. In addition, tank concentration, nozzle type and flow-rate, as well as the length of time a plant is sprayed are factors which must be considered. Therefore, competent operation is essential to mist application. Smaller, back-pack mist blowers are available for treating smaller trees and shrubs. Generally, mist-blowers are ineffective for mites and scales because they do not give complete uniform coverage.

AIRCRAFT

Airplanes and helicopters treat large acreages in a short time. To date, few shade tree or nursery insects can be controlled by insecticides applied by aircraft. In general, large numbers of plants, infested with exposed foliage-feeding insects, are necessary to justify aircraft treatments. Poor results have been obtained in controlling scales, mealybugs, and mites. However, cankerworms and the elm bark beetle vectors of Dutch elm disease can be controlled through helicopter application of insecticides. Obstructions such as utility lines and heavily populated areas further complicate aircraft use.

Safe Use of Pesticides

All insecticides and miticides are poisonous in varying degrees to warm-blooded mammals. They should be handled cautiously to prevent poisoning pets, livestock, children, or the user. Many insecticides recommended in this bulletin for controlling insects of shade trees and ornamental plants are persistent-type materials, whose use is restricted on edible plants or forage. Caution should be taken when treating close to such crops to avoid contaminating them by insecticidal drift or other poor application procedures.

The National Agricultural Chemical Association has published a 12-point safety code for insecticides and other agricultural chemicals. *Study these 12 rules repeatedly until each is adopted and becomes a habit with you:*

1. Always read the label before using sprays or dusts. Note warnings and cautions each time before opening the container.

2. Keep sprays and dusts out of the reach of children, pets, and irresponsible people. Pesticides should be stored outside the home and away from food and feed.

3. Always store sprays and dusts in original containers and keep them tightly closed. Never keep them in anything but the original container.

4. Never smoke while spraying or dusting.

5. Avoid inhaling sprays or dusts. When directed on the label, wear protective clothing and masks.

6. Do not spill sprays or dusts on the skin or clothing. If they are spilled, remove contaminated clothing immediately and wash yourself thoroughly.

7. Wash hands and face and change to clean clothing after spraying or dusting. Also wash clothing each day before reuse.

8. Cover food and water containers when treating around livestock or pet areas. Do not contaminate fishponds.

9. Use separate equipment for applying hormone-type herbicides in order to avoid accidental injury to susceptible plants.

10. Always dispose of empty containers so that they cannot harm humans, animals, or valuable plants.

11. Observe label directions and cautions to keep residues off edible plants.

12. If symptoms of illness occur during or shortly after spraying or dusting, call a physician or get the patient to a hospital immediately.

Dispose of excess spray mixtures correctly by dumping into a sanitary land-fill dump. If such a dump is not available, dig a hole at least 18 inches deep, pour in the excess spray and cover with soil. *Do not dump excess spray material into sewers or drains or dispose of them in soil to be used for growing edible plants.*

IN CASE OF POISONING

1. **Call your physician:** The table below lists Poison Control Centers in Michigan which can furnish specific information, including antidotes for various trade named poisons. Services of the Centers are intended mainly for Medical Doctors. However, offices remain open 24 hours a day and can give emergency poison treatment advice over the phone. If information is not available at your local Poison Control Center, call the University Hospital, Ann Arbor.

2. **For poisons spilled on the skin:** Wash thoroughly with large amounts of soap and warm water. Particles in the eyes may be removed by a thorough flushing with plain water. For phosphate materials absorbed through the skin, give atropine by injection or in tablet form.

3. **For poisons that have been inhaled:** Place the patient in the open air. Give atropine as directed above if a phosphate material was inhaled. Administer artificial respiration when necessary.

4. **For poisons that have been swallowed:** Induce vomiting as soon as possible: gently stroke the inside of the throat or give an emetic such as warm salt water (1 tablespoon in a glass of water), or both. Repeat until the vomit fluid is clear. After the stomach has been emptied, give a demulcent, such as raw egg white mixed with water.

5. Physician may inject $\frac{1}{30}$ to $\frac{1}{60}$ of a grain of atropine sulfate at hourly intervals for **phosphate materials**, or phenobarbital for **chlorinated hydrocarbon chemicals.**

Poison Control Centers

Name of Center, street address, telephone, name of director

City

ADRIAN

Poison Control Center
Emma L. Bixby Hospital
818 Riverside Avenue 49221
275-6161
Robert Greiner, M.D.

ANN ARBOR

Poison Control Center*
University Hospital
1405 E. Ann St. 48104
764-5102
George H. Lowrey, M.D.

BAD AXE

Poison Control Center
Hubbard Memorial Hospital
423 E. Irwin St. 48413
CO 9-6444
Alice J. Shoemaker, R.Ph., Director
Roy Gettel, M.D.

BATTLE CREEK

Poison Control Center
Community Hospital
200 Tomkins St. 49016
WOodward 3-5521
Sterling L. Butterfield, R.Ph.

BAY CITY

Poison Control Center
Mercy Hospital
100 15th St. 48706
TWinbrook 5-8511
Theodore Meyer, Pharmacist

Poison Treatment Center
Bay City Osteopathic Hospital
300 Mulholland Street 48706
TWinbrook 3-9554
Emergency Room under charge of Floor Supervisors
Mrs. Virginia Davis, LPN
7:00 a.m. to 3:00 p.m.

COLDWATER

Poison Control Center
Community Health Center of Branch County
274 E. Chicago St. 49036
279-9501
John C. Heffelfinger, M.D.
Office 278-2359

DETROIT

Poison Control Center
Children's Hospital
5224 St. Antoine St. 48202
833-1000
Paul V. Wooley, Jr., M.D.
Regine Arorow, M.D.

Poison Information Center
Registrar's Office
Herman Kiefer Hospital
1151 Taylor Avenue 48202
872-3334
Paul T. Chapman, M.D.
William G. Frederick, Sc.D.

Poison Treatment Center
Saratoga General Hospital
15000 Gratiot Ave. 48205
LAkeview 6-5100
Wm. B. Hennessey, Chief Pharmacist

FLINT

Poison Control Center
Hurley Hospital
6th Ave. & Begole 48502
CEdar 2-1161
Douglas L. Vivian, R.Ph.

GRAND RAPIDS

Poison Control Center
Blodgett Memorial Hospital
100 Wealthy, S.E. 49506
456-9548
John P. Foxworthy, M.D.

Poison Control Center
Butterworth Hospital
100 Michigan, N.E. 49503
451-3591
John R. Wilson, M.D.

Poison Control Center
St. Mary's Hospital
201 Lafayette, S.E. 49503
459-3131
John Rupke, M.D.

Poison Control Center
Grand Rapids Osteopathic Hospital
1919 Boston St., S.E. 49506
452-5151
Eugene M. Johnson, D.O.
Wallace Stolcenberg, R.Ph.

JACKSON

Poison Treatment Center*
Foote Memorial Hospital
205 N. East St. 49201
STate 3-2711
Ethan Stone, M.D.

KALAMAZOO

Poison Control Center
Bronson Methodist Hospital
252 E. Lovell St. 49006
342-9821
H. Sidney Heersma, M.D.
Kenneth Huckendubler, Dir. of Pharmacy and Central Services (Asst. Director)

LANSING

Poison Treatment Center
Edw. W. Sparrow Hospital
1215 E. Michigan Ave. 48912
487-6111
Sprigg S. Jacob, M.D.
Office 332-6848

Poison Control Center
St. Lawrence Hospital
1210 W. Saginaw St. 48914
372-3610
Howard Comstock, M.D., Dir.
William Mueller, Pharm., Asst.
William Adrian Phrm.

Poison Treatment Center
Lansing General Hospital
2800 Devonshire Ave. 48910
485-4311, Ext. 225
John E. Morgan, R.Ph.

Poison Treatment Center
Ingham Medical Hospital
401 W. Greenlawn 48910
484-2511
Robert C. Combs, M.D.

LINCOLN PARK

Poison Control Center
Outer Drive Hospital
26400 Outer Drive 48146
388-0606
W. S. Wheeler, Admin.
Carl A. Gagliardi, M.D.

MARQUETTE

Poison Information Center
St. Luke's Hospital
West College Ave. 49855
CAnal 6-3511
Charles King, Pharmacist
Norman Matthews, M.D.

MIDLAND

Poison Control Center
Midland Hospital
4005 Orchard Drive 48640
TE 5-6771
B. E. Lorimer, M.D.
K. W. Linsenmann, M.D.
D. N. Fields, M.D.
W. E. Thamarus, M.D.

MONROE

Poison Treatment Center
Memorial Hospital of Monroe
700 Stewart Road 48161
241-6500
Donald Wojack, Pharmacist

PETOSKEY

Poison Control Center
Little Traverse Hospital
416 Connable 49770
DIamond 7-2551
Thomas R. Kirk, M.D.

PONTIAC

Poison Control Center
St. Joseph Mercy Hospital
900 Woodward Ave. 48053
338-9111
Robert J. Mason, M.D.

PORT HURON

Poison Control Center
Mercy Hospital
2601 Electric Ave. 48060
YUkon 5-9531
Robert Lugg, M.D.

SAGINAW

Poison Control Center
Saginaw General Hospital
1447 N. Harrison Rd. 48602
753-3411
William G. Mason, M.D., Chair.

Poison Treatment Center
Saginaw Osteopathic Hospital
515 N. Michigan 48602
PL 3-7751
T. D. Webber, D.O., Chair.
C. S. Chicky, D.O.
W. C. Adams, D.O.

TRAVERSE CITY

Poison Control Center
Munson Medical Center
Traverse City 49684
947-6140
Philip K. Wiley, M.D., Dir.
A. McCrakin, Pharm.,
Deputy Dir.

WAYNE

Poison Treatment Center
Annapolis Hospital
33155 Annapolis 48184
PA 2-4400
House Physician on duty

YPSILANTI

Poison Treatment Center
Beyer Memorial Hospital
28 So. Prospect 48197
HU 2-6500
Gust Petropolous, M.D.

**Facilities available for determining cholinesterase levels in blood samples.*

Chemical Control Programs

The following are programs, listed by number, referred to in the preceding text for the control of a specific pest. These recommended controls are given in amounts of insecticide to be mixed in 100 gallons of water. Should smaller spray mixture amounts be desired, they can be obtained from the Table of Equivalents (page 43).

Plant injury may result from certain pesticides or mixtures of pesticides. When known, precautionary uses are given under the chemical. Emulsifiable concentrates give longer-lasting residues than wettable powders. However, some of the organic solvents used in these emulsions may cause plant injury. When in doubt, choose a wettable powder formulation or, before treating large areas, spray a few plants to check its effect. Environmental conditions such as temperature, direct sunlight and humidity may influence injury. Generally, the best time to apply pesticides is during the cooler part of the day.

ALL-PURPOSE SPRAYS

The most effective control of an insect is achieved by applying the appropriate chemical at the correct time. However, several different chemicals can be combined to give an all-purpose spray mixture which will protect plants from general defoliators, aphids, some scales and mites. *Such all-purpose sprays are generally more expensive and will not control all insects. Hard-to-control insects will require special treatment.* One of the following mixtures, applied on a regular schedule of May 15, June 15 and July 15, will give general plant protection through the season.

1.	2.	3.
Methoxychlor	**Carbaryl (Sevin)**	**Methoxychlor**
+	+	+
Malathion	**Meta-Systox-R**	**Lindane**
+	+	+
A Miticide	**A Miticide**	**Malathion**
		+
		A Miticide

PROGRAM 1—AZINPHOS-METHYL (Guthion):

1a. 1 lb. 50 percent wettable powder **or** 1 qt. 22 percent emulsion.

1b. 1½ lbs. 50 percent wettable powder **or** 3 pts. 22 percent emulsion.

PROGRAM 2—BENZENE HEXACHLORIDE (BHC):

2a. 2½ pts. 10 percent emulsion **or** 2 lbs. 12 percent wettable powder.

2b. 2 gals. 10 percent emulsion.

2c. 8 lbs. 12 percent wettable powder.

Note: BHC is closely related to, and may be substituted for, lindane but the dosage is different. This insecticide may cause an off-flavor on fruits and vegetables; hence, caution should be taken when applications are made close to these crops.

PROGRAM 3—CARBARYL (SEVIN):

3a. 2 lbs. 50 percent wettable powder **or** 1 qt. 4 flowable **or** 1½ lb. 80 percent wettable powder.

3b. 4 lbs. 50 percent wettable powder **or** 2 qts. 4 flowable **or** 3 lbs. 80 percent wettable powder.

3c. 2 gals. 4 flowable **or** 9.5 lbs. 80 percent wettable powder (for a 1 percent mist blower concentration).

Note: Should not be used on Boston ivy because of plant injury.

PROGRAM 4—CHLORDANE:

4a. 2½ lbs. 40 percent wettable powder **or** 2 pts. 45 percent emulsion.

4b. 5 lbs. 40 percent wettable powder **or** 2 pts. 75 percent emulsion.

PROGRAM 5—DDT:

5a. 2 lbs. 50 percent wettable powder **or** 2 qts. 25 percent emulsion.

5b. 4 lbs. 50 percent wettable powder **or** 1 gal. 25 percent emulsion.

PROGRAM 6—DIAZINON:

1 lb. 50 percent wettable powder or 1 pt. 4 E 48 percent emulsion.

PROGRAM 7—DIELDRIN:

7a. 2 lbs. 25 percent wettable power **or** ⅓ gal. 18.5 percent emulsion.

7b. 3 qts. 25 percent emlusion.

PROGRAM 8—DIMETHOATE (CYGON):

3 pts. Cygon 267 30.5 percent emulsion.

Note: Do not use on honey locust, dogwood, andromeda, elm, and maple or plant injury may result.

PROGRAM 9—DISULFOTON (DI-SYSTON):

10 percent granules applied at the rate of 4 oz. per inch of trunk diameter to soil, out to drip-line beneath the trees. Should be disked and watered into the soil for best results. Recommended only for commercial use in controlling birch leaf miner.

PROGRAM 10—DINITRO COMPOUNDS (DN's):

9a. 2 qts. slurry **or** 2 lbs. powder.

9b. 1 gal. slurry **or** 4 lbs. powder.

PROGRAM 11—DORMANT OILS:

11a. 2 to 3 gals. Petroleum oil.

11b. 2 gals. Petroleum oil.

11c. 2 gals. Oil containing 2 percent ethion.

Note: There are many types of oils available. However, narrow-cut, paraffinic oils of 60- to 70-second viscosity are preferred. Apply oil sprays according to the manufacturer's directions in the spring before plant growth begins. Choose a sunny morning when the temperature is above 45 degrees. Do not apply oils to sugar and Japanese maples, birch, beech, walnut, hickory, or butternut since plant injury may result. Oil will remove the bloom from blue spruce.

PROGRAM 12—ENDOSULFAN (THIODAN):

12a. 1 lb. 50 percent wettable powder **or** 1 qt. 24 percent emulsion.

12b. 1-2 qts. EC2 emulsion.

Note: Do not use on white birch, redbud or Andersen yew or plant injury may result.

PROGRAM 13—LEAD ARSENATE:

4 lbs. 98 percent suspension.

PROGRAM 14—LIME SULFUR:

14a. 11 gals. suspension.

14b. 2½ gals. suspension.

Note: Lime sulfur will blacken brickwork and painted surfaces and, therefore, should be used with caution around buildings.

PROGRAM 15—LINDANE:

15a. 1 lb. 25 percent wettable powder **or** 1½ pts. 20 percent emulsion.

15b. 2 qts. 20 percent emulsion.

PROGRAM 16—MALATHION:

4 lbs. 25 percent wettable powder **or** 1 qt. 57 percent emulsion.

Note: Malathion may injure Cannart Red Cedar.

PROGRAM 17—META-SYSTOX-R:

1½ pts. 25 percent emulsion.

PROGRAM 18—METHOXYCHLOR:

18a. 2 lbs. 50 percent wettable powder **or** 2 qts. 25 percent emulsion.

18b. 8 gals. 25 percent emulsion **or** for mist blower use, mix equals parts of the 25 percent emulsion and water.

Note: Methoxychlor may be used as a replacement for DDT where danger to wildlife is a major concern. The residual effectiveness is shorter than that of DDT.

PROGRAM 19—MITICIDES:

Any of the following materials will control most spider mites found on ornamental plants:

Aramite*: 2 lbs. 15 percent wettable powder **or** 1 pt. 25 percent emulsion.

Chlorobenzilate †: 1½ lbs. 25 percent wettable powder **or** 1 qt. 25 percent emulsion.

Genite*: 2 lbs. 50 percent wettable powder **or** 1½ pts. 25 percent emulsion.

Dikofol (Kelthane) †: 2 lbs. 18.5 percent wettable powder **or** 1 qt. 18.5 percent emulsion.

Morestan* †: ½ - 1 lb. 25 percent wettable powder. Do not use in combination with oil sprays, or preceding or following an oil spray.

Ovex*: 2 lbs. 50 percent wettable powder. (May cause injury to dogwood, holly, and hardy privet.)

Tedion*: 1 lb. 25 percent wettable powder or 1 qt. 10 percent emulsion.

Note: *—ovicide—effective against eggs.
†—acaricide—effective against active mites.

Where control of both active mites and eggs is desired, a combination of an acaricide and ovicide or a chemical which kills both stages is recommended. Miticides are generally not effective against insects.

PROGRAM 20—PHORATE (THIMET):

10 percent granules applied to the soil beneath the tree out to the drip-line at the rate of 3 oz. per inch of trunk diameter. Should be disked and watered into the soil for best results. Recommended only for commercial use in controlling birch leaf miner.

PROGRAM 21—TRICHLORFON (DYLOX):

1¼ - 1½ lbs. 80 percent wettable powder.

Note: May cause injury to carnations and zinnias.

TABLE OF EQUIVALENT AMOUNTS OF INSECTICIDE*

Gallons of Spray To Be Applied	Wettable Powder			Liquid Concentrate			
100 gal.	1 lb.	2 lbs.	3 lbs.	1 pt.	1½ pts.	1 qt.	1 gal.
50 gal.	½ lb.	1 lb.	1-½ lbs.	1 C.	1-½ C.	1 pt.	2 qts.
25 gal.	¼ lb.	½ lb.	¾ lb.	½ C.	¾ C.	1 C.	1 qt.
10 gal.	10 T.	¼ lb.	6 oz.	3-½ T.	5 T.	7 T.	1-⅔ C.
5 gal.	5 T.	10 T.	15 T.	2 T.	2-¾ T.	3-½ T.	6 oz.
3 gal.	3 T.	6 T.	9 T.	1 T.	1-½ T.	2 T.	½ C.
1 gal.	1 T.	2 T.	3 T.	1 t.	1-½ t.	2 t.	2-⅔ T.

*C = cup
T = Tablespoon
t = teaspoon

NOTE: The insect control programs (pp. 35-36) give the amount of insecticide to be mixed in 100 gallons of water. Should you desire to mix smaller amounts of spray, you may determine the amount of insecticide to use from this table. For example, control program 16a indicates that 2 pounds of 50 percent wettable powder of methoxychlor should be mixed with 100 gallons of water. If you desire to apply only 10 gallons of spray, run down the "gallons" column until you find "10." Then, proceed horizontally on the same line until you find the correct figure under "2 lbs." (in this case, ¼ lb.). You should therefore mix ¼ pound of 50 percent wettable powder of methoxychlor with 10 gallons of water. Similarly, mix ½ pound for 25 gallons, 2 tablespoons for 1 gallon, etc.

INDEX

SPRAY RECORD SHEET

GROWER	YEAR
CROP	

DATE APPLIED	MATERIAL	RATE/ APPLIED	VARIETY	COMMENTS (Weather Conditions, Etc.)

Tear out along this line

SPRAY RECORD SHEET

GROWER	YEAR
CROP	

DATE APPLIED	MATERIAL	RATE/ APPLIED	VARIETY	COMMENTS (Weather Conditions, Etc.)

Tear out along this line

SPRAY RECORD SHEET

GROWER	YEAR
CROP	

DATE APPLIED	MATERIAL	RATE/ APPLIED	VARIETY	COMMENTS (Weather Conditions, Etc.)

Tear out along this line