

A black and white photograph of a large, mature tree with dense foliage, occupying the left and center of the frame. In the foreground, a wooden fence runs across the bottom. The background shows a flat, open field under a light sky.

Protecting Shade Trees from Insect Damage

By
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CONTENTS

	PAGE		PAGE
AILANTHUS	4	MAPLE	32
Ailanthus Worm	4	Cottony Maple Scale	32
ASH	5	Other Insects on Maple	35
Lilac Borer	5	MOUNTAIN ASH	35
Red-Headed Ash Borer	5	OAK	35
BEECH	7	Borers	35
BIRCH	7	Flatheaded Apple Tree Borer	36
Bronzed Birch Borer	7	Periodical Cicada	37
BOX ELDER	8	May Beetles	39
Boxelder Bug	8	Twig Pruner	40
Fall Webworm and Bagworm	8	Oak Scales	41
BUCKEYE AND HORSE CHESTNUT	9	Leaf Miners	44
CATALPA	9	Other Insects on Oak	45
Catalpa Sphinx	9	POPLAR	45
CRABS AND HAWTHORNS	10	Oystershell Scale	45
Yellow-Necked Caterpillar	10	Poplar and Willow Borer	47
Other Insects on Crabs and Hawthorns	11	Other Borers	48
ELM	12	Leaf-Feeding Insects	49
Spring Cankerworm	12	Other Insects on Poplar	49
White-Marked Tussock Moth	15	SYCAMORE	49
European Elm Scale	17	Sycamore Lacebug	49
Scurfy Scale	18	Other Insects on Sycamore	50
Woolly Elm Aphid	19	WILLOW	50
Fall Webworm	19	EVERGREENS	50
Other Insects on Elm	23	Bagworm	51
GINKGO	23	Pine Needle Scale	53
HACKBERRY	23	Common Red Spider and Other Spider Mites	53
Leafhoppers	26	LARCH	54
HICKORY AND WALNUT	26	POTENTIAL INSECT ENEMIES	55
Hickory Bark Beetle	26	Brown-Tail Moth	55
Other Bark Beetles	28	Elm Leaf Beetle	55
Walnut Caterpillar	29	Gypsy Moth	56
Galls	29	Japanese Beetle	56
LINDEN	31	Satin Moth	57
Elm Spanworm	31	SPECIAL EQUIPMENT NEEDED FOR SHADE-TREE SPRAYING	58
Other Insects on Linden	32	INDEX OF INSECTS	59

Protecting Shade Trees From Insect Damage

By W. P. FLINT and M. D. FARRAR¹

SHADE TREES in full foliage and vigorously growing are one of the most beautiful of all natural objects. Yet the beauty of these trees can be quickly destroyed by the attacks of many tiny insects that leave the trees defoliated and their trunks and branches scarred.

Most important of all in resisting insect attack is to recognize the insect and meet it with the proper control measures, tho good care also plays an important part in protecting trees from these enemies. Watering, spraying, fertilizing, pruning, and repairing, by aiding a tree to maintain its vigor help it to resist attack.

Since most insects prefer some definite part of a tree on which to feed, it is convenient to group them according to the injury they cause.

Borers. There are a number of insects which feed in the bark, in the layers between the bark and the wood, in the sapwood, and even in the heartwood. Most of these invaders spend the greater part of their lives in the bark layers, boring into the hardest parts of the trees for the later stages of their life cycle. These inner bark layers are essential to the tree's existence and a very few borers may work great havoc by destroying these tissues. A single borer may kill a small tree by girdling the trunk.

Sap-sucking insects. Scales, aphids, treehoppers, leafhoppers, and true bugs that obtain their food by sucking the sap are found on the surface of the bark of the trunk and limbs and on leaves.

Leaf-feeders. More insects feed in or on the leaves than on any other part of the tree. Some consume the entire leaf, while others suck out the leaf juices. Some mine within the leaves and destroy a greater part of the leaf tissues without disturbing the leaf surfaces.

Root-feeders. Roots of trees also are subject to insect attack. Some insects burrow into the soil and suck the sap from the roots or cut into the roots and eat them.

Gall-makers. The many curious galls on the leaves of shade trees are plant growths that have been stimulated by insects. The

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developing insects appear to consume very little plant tissue, but their presence in the leaf or twig causes the plant galls to develop around their bodies.

With all these possibilities of insect attack, it is evident that those who wish to protect their shade trees must be constantly on the alert. They must be able to recognize the dangerous insects and then use control methods specifically adjusted to them. This circular tells how to recognize the more common insects that attack the shade trees of Illinois and describes the necessary control methods.

The insects are described under the trees that they infest. An insect that is a general feeder is discussed under the tree that it attacks most seriously, or occasionally under the tree most common in Illinois.

• AILANTHUS •

The Ailanthus, also known as the tree-of-Heaven, and the box elder are perhaps the least desirable of Illinois shade trees. The Ailanthus is exceptionally hardy and spreads naturally in many cities. It is objectionable because it is difficult to eliminate when once established; it seeds abundantly; the seedlings are continually springing up where they are not wanted; the staminate flowers have a strong disagreeable odor; and the annual leaf fall creates an objectionable litter. The tree should be used only in locations where conditions are so unfavorable that a more desirable shade tree will not thrive. The Ailanthus worm is the only insect to cause much damage to the tree.

Ailanthus Worm

Atteva punctella Fitch

Importance and injury. Ailanthus worms apparently do not seriously injure a tree. They feed on the bark of tender stems and leaf stalks. They are gregarious, as many as 15 often feeding within a single web.

Control. Infested trees should be sprayed when the first feeding is noticed in May or June and again later if heavy feeding occurs. A spray composed of 3 pounds of lead arsenate and 4 ounces of soybean flour¹ to 100 gallons of water will give good control.

Life history. Ailanthus worms are thought to overwinter as golden-spotted moths about 1/2 inch long. The first larvae appear in May, feed about three weeks, and pupate within the web. No definite

¹When not obtainable substitute 1/2 pound of wheat flour.

brood cycles are followed, and larvae and pupae of all ages will be found in the same web. Two or more generations a year are common in Illinois.

• ASH •

The ashes, especially such species as green ash, white ash, and blue ash, are popular shade trees of the Middle West. Oystershell scale (*page 45*) sometimes causes great damage to ash trees.

Weakened trees are severely attacked by the painted ash borer. The larvae of this borer are legless roundheaded grubs of a cream-yellow color. There is no known control.

The caterpillars of certain moths attack ash trees by boring into injured limbs. The injury they cause nearly always occurs in split forks of the trees or around pruning wounds. Careful pruning, careful application of a good tree paint, fertilizing the trees, and in some cases the use of the P.D.B. mixture described below are the best methods of controlling these borers.

Lilac Borer

Podosesia syringae (Harr.)

The lilac borer is one of the most common borers attacking ash trees. The injury it causes is shown by numerous holes thru the bark, usually with dark-colored pellets around the outside of the hole, and often by a dark sappy fluid oozing from these wounds. A very effective way to control this borer is to paint the infested areas with a mixture made by dissolving 2 pounds of paradichlorobenzene (popularly known as P.D.B.) in 1 gallon of miscible oil and diluting with water to make 2 gallons of the mixture. This should be applied with a brush over the injured part of the trunks or branches.

Red-Headed Ash Borer

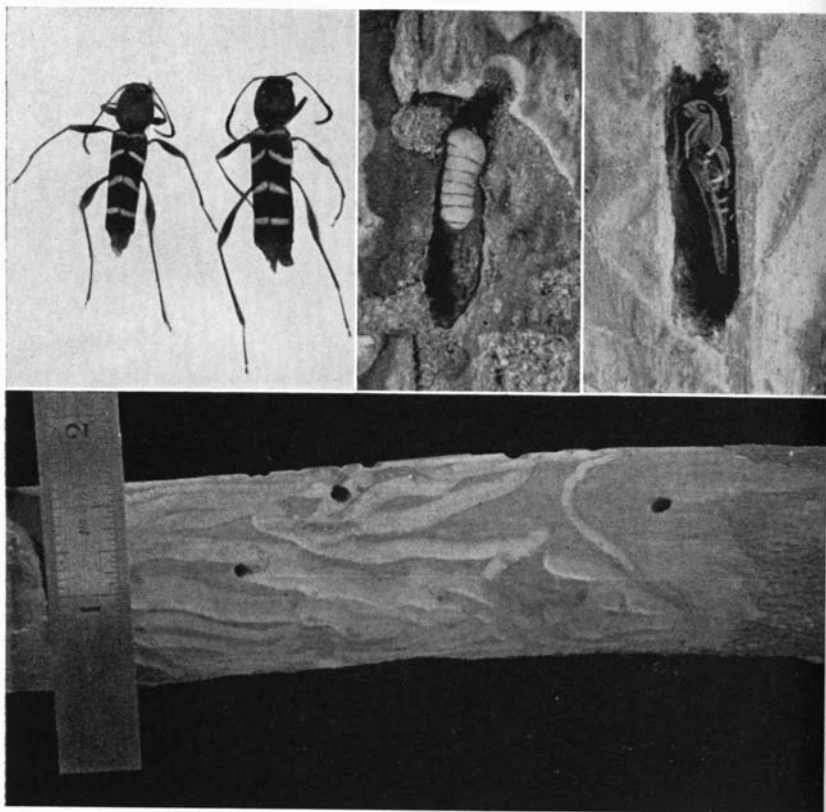
Neoclytus acuminatus (F.)

Importance and injury. The red-headed ash borer attacks ash, elm, hickory, hackberry, oak, and linden trees. The young larvae enter weakened or newly set trees. They work thru the outer bark layers into the inner layers to feed, and in doing so they cut off the normal flow of sap. These rather short, stocky, roundheaded grubs burrow in all directions in the sapwood, often cutting deep into it. They may

eventually girdle a tree. The burrows may extend both horizontally and vertically thru the trunk and cause trees less than 2 inches in diameter to break and fall over.

Control. The only control known for this insect is to keep the trees that are subject to its attack in a healthy growing condition. Such trees are practically free from attack.

Life history. These borers overwinter as larvae in the interior of the trunk of the ash. The larvae pupate during the late winter, the adults emerging in April and May. The adult is a slender round-bodied beetle about $\frac{1}{2}$ inch long. The head and thorax are reddish, and the



Red-headed ash borer. In the top row are adult borers (*left*), burrow and grub (*center*), and an adult borer ready to emerge (*right*). All are about twice natural size. In the lower picture are narrow deep furrows in the sapwood caused by the borers and the round holes thru which the adults have emerged.

body and wings are light brown. Three V-shaped yellow bands cross the wing covers. The female lays her eggs in crevices in the bark, and the young larva bores into the inner layers of the bark to feed. Adults of a second generation appear in August. Ordinarily one generation and a partial second generation appear annually in Illinois.

• BEECH •

The beech is a somewhat difficult tree to transplant and establish as a shade tree. It is native to southeastern and southern Illinois.

A wide variety of destructive insects may attack beech trees. These include the flatheaded apple tree borer, the brown wood-borer, the beech-limb borer, the beech barkbeetle, and leaf-feeders, aphids, and scales. Controls for all of these insects are the same as for similar insects found on the other deciduous shade trees (*see index, page 59*).

The obscure scale, *Chrysomphalus obscurus* (Comst.), is common on beech in Illinois and can be controlled by spraying with a mixture of 1 gallon of liquid lime sulfur to 7 gallons of water. It is somewhat similar in appearance to the San Jose scale, page 10.

• BIRCH •

The birch tree is a rather short-lived tree, both by nature and because of insect attack. Its foliage is eaten by several leaf-feeders, all of which can be controlled by spraying with lead arsenate. Vigorous birch trees are relatively free from attack by borers, particularly while the trees are small. Trees lacking vigor are more likely to be attacked by borers.

Bronzed Birch Borer

Agrilus anxius Gory

Importance and injury. The bronzed birch borer is the most destructive insect of birch. The injury it causes is due to the grubs which burrow in the bark. The injury is first noticeable as a dying-back of the top or top branches of the less vigorous trees. Heavily infested trees will die.

Control. Trees that are kept in a vigorous condition are seldom injured by the bronzed birch borer. Careful watering and fertilizing of birch trees is the best preventive for insect injury. Heavily infested

trees should be cut and burned during the dormant season to destroy the overwintering grubs in the dead or dying trees.

Life history. The bronzed birch borer passes the winter as a grub within the infested tree. It pupates in April or May, and the adult emerges in June as a slender bronze beetle about $\frac{1}{3}$ inch long. Eggs are laid in the bark crevices; then the grubs hatch and burrow into the trunk, where they feed until cold weather. A single generation occurs each year.

• BOX ELDER •

This tree is one of the least desirable of the Illinois shade trees. Its soft wood is a favorite of borers and the foliage is relished by practically all the leaf-feeders. It should not be planted as a shade tree.

Boxelder Bug

Leptocoris trivittatus (Say)

Importance and injury. Altho boxelder bugs are harmless they are greatly disliked because of their abundance and the unpleasant odor they give off when disturbed. They make nuisances of themselves wherever they are found. The adult bugs, searching for a place to hibernate, enter dwellings during the fall months or may be found in immense numbers on the sunny sides of buildings.

Control. Eliminating box elder trees from a neighborhood is the only satisfactory control of the boxelder bug. Spraying masses of bugs in the fall with a mixture of 1 tablespoonful of nicotine sulfate in 1 gallon of water in which 1 cubic inch of laundry soap has been dissolved will kill all bugs actually wet with the spray.

Life history. Adult insects are about $\frac{1}{2}$ inch long, reddish in color, with black wings banded with orange. They hibernate in warm dry places around buildings or in trash. In warm spring weather they lay their eggs on the box elder trees. These hatch into small reddish nymphs which suck the tree juices until they are full-grown in August or September. There is one generation each year.

Fall Webworm and Bagworm

The fall webworm and the bagworm also attack box elder trees (*see index, page 59*).

• BUCKEYE AND HORSE CHESTNUT •

The buckeye is native to Illinois but is not a common shade tree. The horse chestnut has been planted widely as a landscape tree. Altho relatively free from insects, these trees may be attacked by bagworms, white-marked tussock moths, flatheaded apple tree borers, lace bugs, and Japanese beetles (*see index, page 59*).

• CATALPA •

Catalpa has been widely planted for shade, for ornamental effect, and for posts. The catalpa sphinx is the most destructive insect enemy of this tree.

Catalpa Sphinx

Ceratonia catalpae (Bdv.)

Importance and injury. The catalpa is defoliated almost annually by the catalpa sphinx. In early feeding the larvae skeletonize the leaf, but later the colony scatters and each worm feeds alone on the leaf edges. This feeding may occur in late June in central Illinois from first-brood worms, or in early September from second-brood worms.

Control. Foliage should be sprayed with a mixture of 3 pounds of lead arsenate in 100 gallons of water, as for leaf-feeders (*page 49*), when the worms appear. The newly hatched larvae are light yellow, but when nearly full-grown are black with several narrow yellow stripes along the back and with greenish-yellow sides. There is a rather soft black horn on the top of the last body segment. The trees must be carefully watched during late June and again about mid-August for the appearance of the worms.

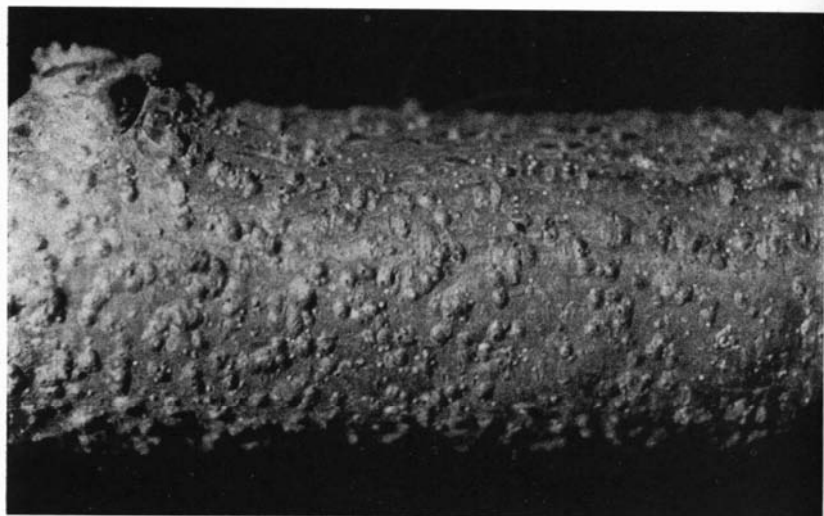
Life history. This insect overwinters in the soil in the pupal stage. The adult is one of the large hawk moths with a wingspread of about $2\frac{1}{2}$ inches. Eggs are laid in early June in large clusters on the underside of catalpa leaves and hatch in 7 to 10 days. The larvae then feed on the leaves. In most places the insect has two generations a year, the first during late June or July and a second in late August or September.

• CRABS AND HAWTHORNS •

Various species of crabs and hawthorn are now being used extensively for ornamental plantings.

San Jose scale frequently causes damage on these trees. Spraying during late winter or early spring before the foliage appears, with dormant oils at 2½-percent strength gives satisfactory control.

The foliage is relished by a number of leaf-feeders, including the yellow-necked caterpillar.



San Jose scale. This very common scale, which is particularly harmful to fruit trees, sometimes kills crabs, hawthorns, and mountain ashes.

Yellow-Necked Caterpillar

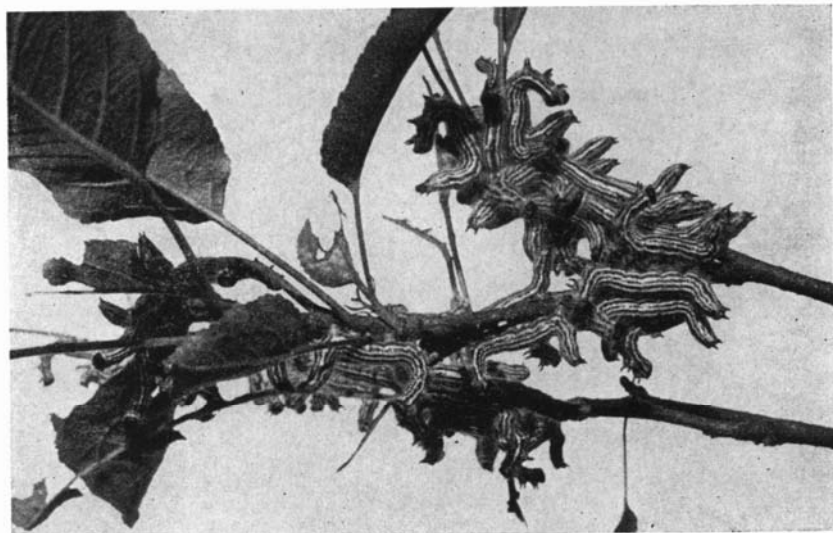
Datana ministra (Drury)

Importance and injury. This insect appears each year on both wild and planted crabs and hawthorns, as well as on hickory. When small, the caterpillars skeletonize the leaves, but later they eat the entire leaves. These gregarious larvae strip the foliage on a limb before moving to a new location.

Control. A small colony may be destroyed by cutting out the infested branch. A spray made by dissolving 3 pounds of lead arsenate

in 100 gallons of water and adding 4 ounces of soybean flour as a sticker or spreader (or 8 ounces of wheat flour) gives very effective control. Spraying should be started when the worms are first seen feeding.

Life history. This insect overwinters in the soil in the pupal stage. The adults, which are medium-sized brown moths, appear in



Yellow-necked caterpillars. These large caterpillars feed as colonies on crab, hawthorn, and hickory trees. When disturbed they assume the angular position shown above.

May and lay large masses of whitish eggs on the underside of leaves. When the worms are full-grown, they burrow a few inches into the soil and change to brown pupae. There are two generations each year, the first in June and the second in late July or August.

Other Insects on Crabs and Hawthorns

The trunks of crabs and hawthorns are frequently attacked by the flatheaded apple tree borer. Other insects attacking these trees are the twig pruner, the fall webworm, the walnut caterpillar, the cankerworm, the tussock moth, woolly aphids, oystershell scale, and scurfy scale. All these insects are discussed under other trees (*see index, page 59*).

• E L M •

The elm is by far the most popular shade tree of the Middle West. Elms of several varieties, but mainly the American elm, are to be found along almost every street of our villages and towns. It is also the most common tree along our highways. Elms in the Middle West have thus far escaped infestation by several insect pests, such as the elm leaf beetle, gypsy moth, brown-tail moth, and leopard moth, now distributed generally thru the East. The Dutch elm disease, which has killed over 50,000 elms in the eastern states, including Indiana, is known to be carried by several different insects that attack the elm, particularly the European bark beetle.

Spring Cankerworm

Paleacrita vernata (Peck.)

Importance and injury. Probably the most serious pest of elm foliage in the Middle West is the spring cankerworm. It prefers elm, hackberry, apple, honey locust, some oaks, and cherry, but will feed upon other trees if they occur in mixed plantings. These small gray-to-dark-brown measuring worms start feeding on the trees when the leaves are about half open in the spring. Defoliation for several years may so weaken the trees that they can be killed by bark beetles and other borers.

Control. The most effective control is spraying with a mixture of 3 pounds of lead arsenate and 4 ounces of soybean flour in 100 gallons of water. For large trees it is necessary to use spray machines (*page 58*) that will develop enough pressure to reach the tops of the trees. A community interest in both banding and spraying is necessary to combat this serious shade-tree pest.

Banding has proved fairly effective as a control when the proper methods are used and when the bands are applied by February 1. In outbreaks of the fall cankerworm banding must be done by September 15.

An effective band consists of a strip of sticky material such as tree tanglefoot placed around the trunk of the tree to prevent the wingless female moths from crawling up the trunk of the tree to lay their eggs. These bands should be at least 3 inches wide and should be placed 4 to 5 feet from the ground. Or the material may be applied directly to a smoothed area made by scraping off the rough bark completely around the tree. As hundreds of moths may try to climb the trunk of one tree

during a warm night in early spring, it is very important that the bands be examined and combed free of moths several times on such evenings. In the fall the bands should be examined once a day to make sure that they are not bridged by the bodies of moths caught in them.

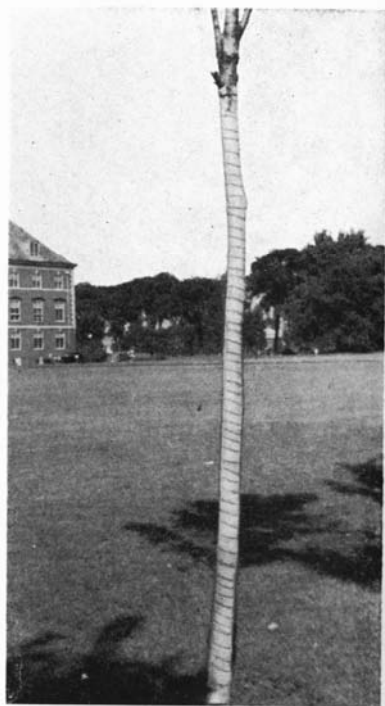
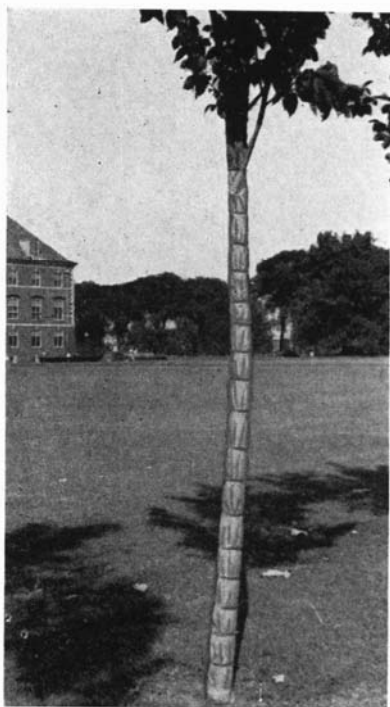
In order to give the best protection it is necessary that *all* trees within at least 200 feet be banded.



Spring cankerworm on elm. The elms shown above were almost completely defoliated by spring cankerworms on May 16. By August 20 these trees had developed a growth of small leaves (*below*).



Life history. The spring cankerworm overwinters as a brown pupa which may be found from 1 to 6 inches below the surface of the soil. The wingless females and winged males appear in the brief warm periods that come during February, March, and April. The female crawls up the trunk of the elm and lays her eggs high in the tree. The brown males are strong fliers. They are attracted to lights, and often are seen in large numbers at night on lighted store fronts. The eggs hatch during April and May. The grayish-black young measuring worms feed on the leaves, spinning down on a silk thread when disturbed. When mature the inch-long worms drop to the ground and burrow several inches into the soil to pupate. A single generation occurs each year. Outbreaks of this insect occur at irregular intervals, usually ten or twelve years apart.



Wrappings on newly set elms. Elms can be protected against borers and against injury for the first two years after setting by various types of wrappings on the trunks. Large sheets of wrapping paper held with binder twine (*left*) or waterproof paper cut in strips and wrapped spirally (*right*) are two good methods of wrapping. See pages 36-37 for more detailed directions.

The fall cankerworm is also distributed thruout Illinois. Its habits are the same as those of the spring species except that its eggs are laid in the fall. The worms of these two species can be distinguished by noting that the fall species has three pairs of legs on the rear third of the body and the spring species has only two pairs.

White-Marked Tussock Moth

Hemerocampa leucostigma (S. & A.)

Importance and injury. The tussock moth ranks next to the cankerworm as the most destructive leaf-feeder on elm. This feeding is done by the larvae, which are about $1\frac{1}{4}$ inches long when full grown,

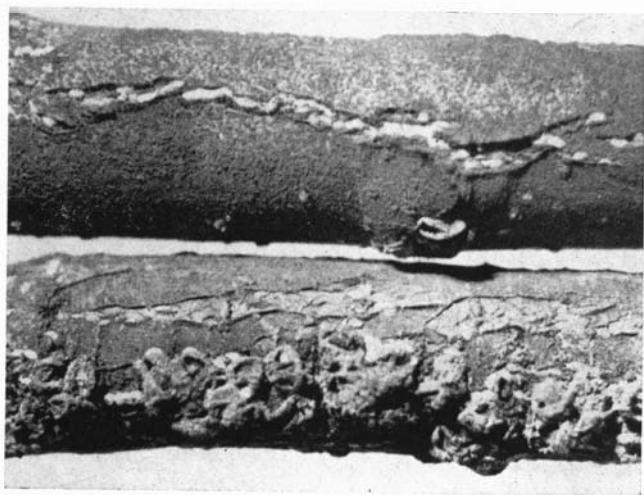


Lateral growth on young elms. The paper wrappings on the three-year-old elm (*left*) have burst, and the trunk has started to send out laterals. These laterals should be allowed to grow for a few years because they shade the trunk and prevent sun scald. The four-year-old elm (*right*) has a healthy growth of laterals.

very hairy, with tufts of white and yellow hairs on their backs. Winterkilling and parasites prevent the moth from becoming abundant for periods of more than one to three years. Altho this moth prefers elm trees, it is a general feeder and will attack most shade and ornamental trees in Illinois.

Control. Spraying or, where it can be done more cheaply, treating the winter egg masses with creosote, is the most effective method for the control of this species. An excellent spray for the control of both tussock moth and cankerworms is made up of 3 pounds of lead arsenate and 4 ounces of soybean flour (or 8 ounces of wheat flour) in 100 gallons of water. The eggs can be killed by touching the white egg masses with a brush wet with creosote at any time during the winter.

Life history. This moth overwinters in the egg stage. Frothy masses of white eggs can be observed attached to the trunks or branches of trees. The caterpillars hatch in May and migrate at once to the foliage to feed. These caterpillars spin flimsy cocoons in which they change from the caterpillar to the adult stage. The full-grown adult male is a dark moth, about 1 inch across the wings; the female is a grayish, wingless, sluglike insect. Two generations occur each year in Illinois.



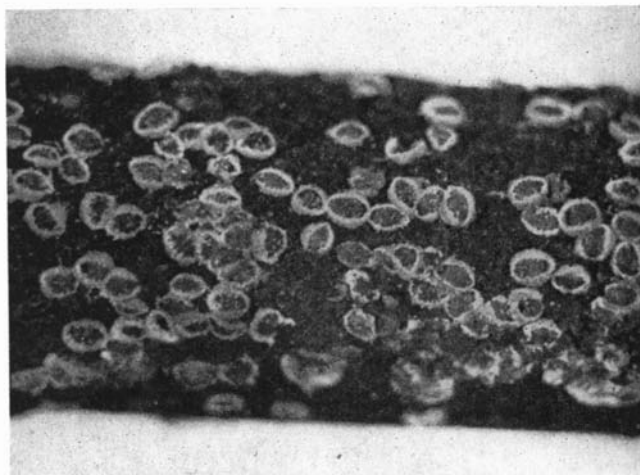
European elm scale in fall. The young scales (*upper branch*) are imbedding themselves in crevices of the bark to pass the winter, while the large adults are disintegrating (*lower branch*).

European Elm Scale

Gossyparia spuria (Mod.)

Importance and injury. The European elm scale, the most serious scale pest of elm, is now very generally distributed thruout the Middle West. Immense numbers may often be found in the crotches and on the underside of the limbs and around pruning wounds. It has been found in many areas over the northern half of Illinois, but is causing only moderate damage on American elm, even in areas infested for some time. On the Camperdown elm infestation is more serious. The young scale excretes a sticky fluid that drips onto objects under infested trees. A black fungus resembling soot grows on the dried fluid excreted by the scale. Automobiles, lawn furniture, and porches may become badly soiled by the discharge from this scale.

Control. Complete eradication of the scale on large trees is not possible after it becomes established. A very effective control is to spray during the early spring before growth starts, with any of the better type of miscible-oil sprays, used as recommended by the manufacturers, usually about 5 gallons of the oil to 100 gallons of water. Fairly good control can be obtained by spraying during May or June with the following mixture: summer oil, 1 gallon; 40-percent nicotine sulfate, 1 pint; soybean flour, 4 ounces; and 100 gallons of water.



European elm scale in spring. The scales are reddish brown with a conspicuous edging of white and if crushed become a red pulp.

Life history. The partially mature scales overwinter on the larger limbs in the crevices of rough bark. The male scale is much smaller than the female, light gray in color, and when fully developed resembles a minute yellow fly. It is wingless and matures several weeks before the female.

The female scale is wingless and matures in central Illinois by March or April. It is about $\frac{1}{8}$ inch in diameter, with a conspicuous white band around the body. After mating, the mature female dies, leaving within her shell a mass of reddish eggs. These hatch in May and June, and the young scales migrate to the leaves to feed until late summer. Then they migrate back to the bark crevices on large limbs to pass the winter. A single generation occurs each year.

Scurfy Scale

Chionaspis furfura (Fitch)

Importance and injury. Scurfy scale is present wherever elms are grown in the Middle West. It rarely causes any serious damage to mature trees. Young trees weakened by transplanting or other causes may have their vitality still further reduced by the scurfy scale. This scale, or a closely related species, also attacks willow, poplar, wild cherry, crabs, hawthorns, and many other trees.



Scurfy scale. Mature scales are shown as they appear in winter on the bark. Under these scales are the purplish eggs that will hatch in the spring.

Control. Tar-oil distillate sprays are among the best methods for control of this scale. Sprays should be applied during late winter or early spring before the leaves appear. Any of the better-grade dormant miscible oils, at 3 to 4 percent strength, are also effective. All commercial oils should be used as directed by the manufacturers, as they vary somewhat in their oil content, in their breaking action, and in the emulsifier used in making them miscible.

Life history. The scurfy scale overwinters as a mass of purplish eggs under the body of the dead mother scale. The eggs hatch during May or June, and the young migrate to favorable places on the bark to feed. When mature they are flattened gray scales about $\frac{1}{12}$ inch in diameter. There is normally a single generation each year in central and northern Illinois.

Woolly Elm Aphid

Eriosoma americanum Riley

Importance and injury. The woolly elm aphid attracts attention because it is white and is sometimes seen in such enormous numbers feeding on elms, crabs, and hawthorns. The aphids are most noticeable around injured areas such as pruning scars on the trunk, and they are to be seen on the roots also. The feeding that takes place on the roots produces numerous gall-like swellings.

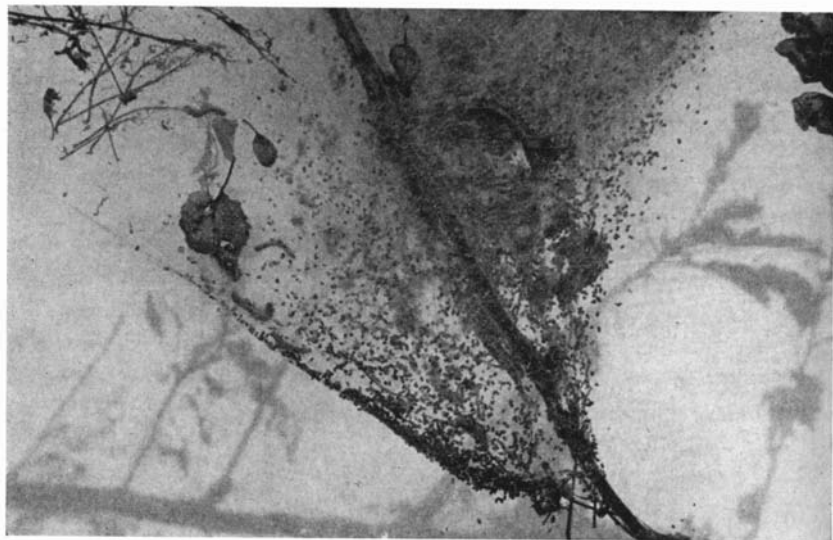
Control. Spraying the masses of these aphids that are found on the trunk and branches of an infested elm with a mixture of 1 pint of nicotine sulfate and 4 pounds of soap dissolved in 100 gallons of water will kill all the insects that are wet with the spray. The spray must be applied with force in order to penetrate the waxy coating of the aphids. There is no practicable method of killing the aphids on the roots.

Life history. Adults and nymphs of the woolly elm aphid are found on elm trees from May to November. They hibernate as nymphs and eggs on the tree trunks, and in all stages on the roots. Several generations occur each year.

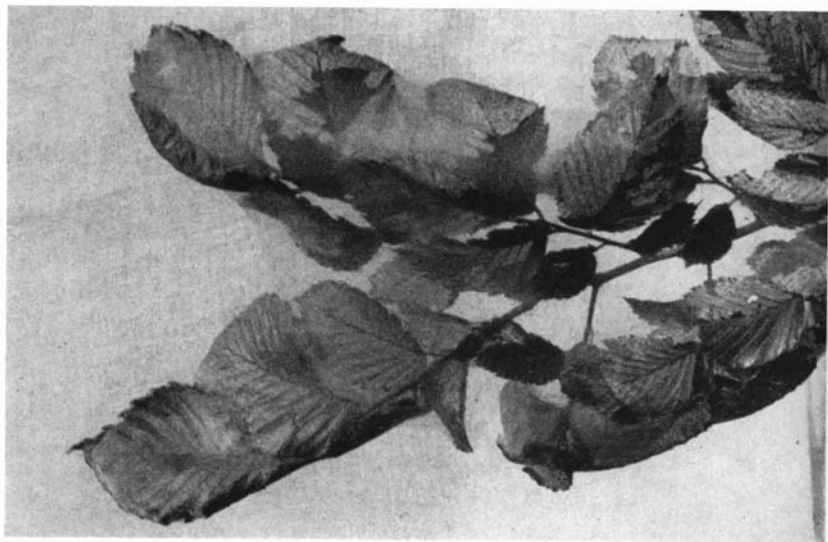
Fall Webworm

Hyphantria cunea (Drury)

Importance and injury. The fall webworm is prevalent everywhere thruout the Middle West and is found on most of our deciduous trees and shrubs. The dirty, scrawly webs which the caterpillars make



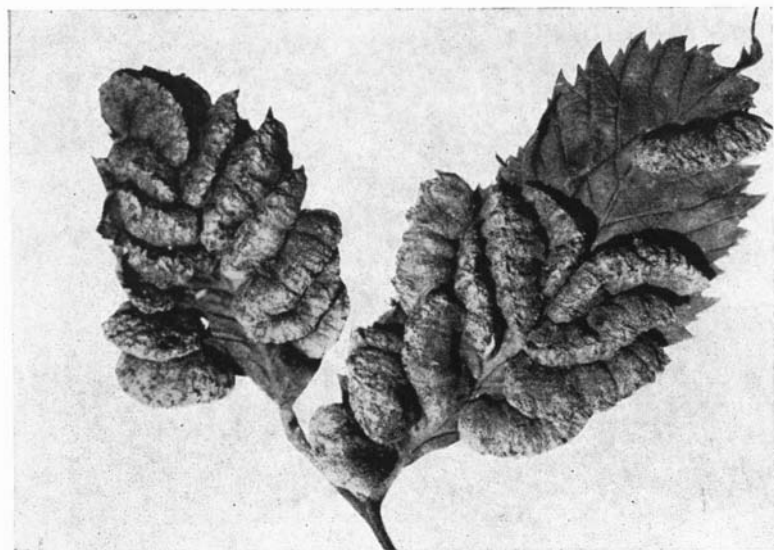
Fall webworm. The very unsightly nest of this insect often begins on a limb tip and becomes larger as the feeding area is extended. The hairy caterpillars feed within or near the protection of the web. Below is another typically affected twig. Webs of this insect are found on many other shade trees besides elms.



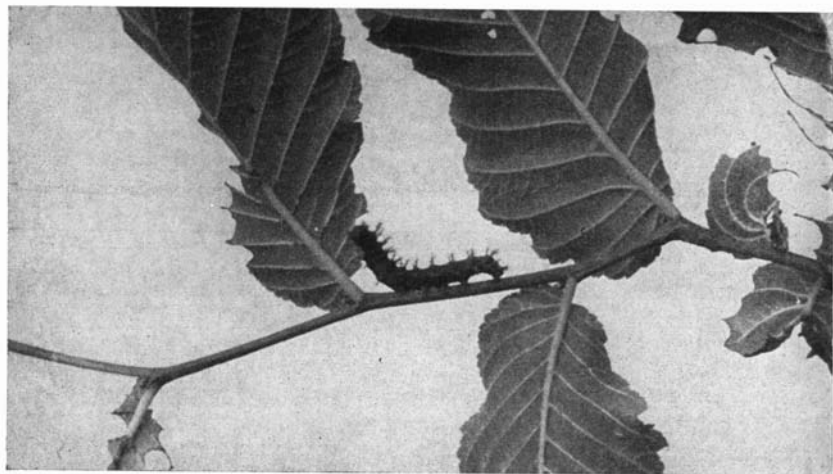
deface even the most attractive shade trees. The web nests, containing 100 or more grayish, hairy caterpillars spotted with brown and black, are often located on the tips of limbs. The nests are enlarged as feeding progresses to include more foliage. Several colonies feeding on the same tree may entirely enclose a tree within their webs, resulting in complete defoliation.

Control. A careful watch should be kept for this insect during July, August, and early September. The most effective control is to spray the trees when the worms are first seen, using 4 pounds of lead arsenate with 4 ounces of soybean flour (or 8 ounces of wheat flour) to 100 gallons of water. For most small trees, cutting off the webbed nests with a pole pruner and destroying the nests is quite effective as a method of control.

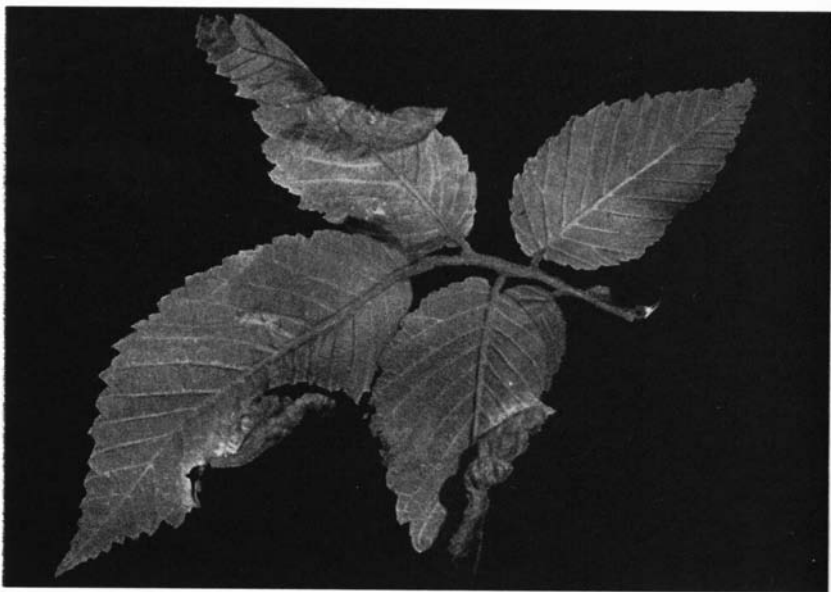
Life history. The webworms overwinter as pupae in the ground or trash, under trees, along hedges, and in protected situations. The white adult moths (about $\frac{1}{2}$ inch long) appear in May and June. The female deposits on the foliage a mass of several hundred greenish eggs. The caterpillars hatch and feed as a colony, spinning a web over the feeding area. When mature they drop to the ground and pupate. The



Cockscomb gall on elm. The irritation caused by the feeding of a bluish aphid causes the formation of these galls. The galls do no serious injury to the trees.



Mourning-cloak butterfly. The larvae feed on the tips of elm limbs and often completely strip the foliage from one or more small branches.



Elm-leaf aphid. Immense numbers of these aphids of all ages feed in the curled leaves. They are often so abundant that the winged forms almost cover the bark of an elm tree.

second generation appears in August and September. There are usually two generations each year.

Other Insects on Elm

The larvae of the mourning-cloak butterfly feed on elms and may completely strip the foliage from one or more of the smaller branches; the only control is to spray the foliage when the larvae are feeding as for the walnut caterpillar (*page 29*). The elm-leaf aphid is often very abundant; there is no satisfactory control for this insect. Cockscomb galls, for which there is no control, are sometimes formed by the feeding of a bluish aphid. These insects are pictured on the preceding pages.

Other insects that attack elm are the red-headed ash borer, the flatheaded apple tree borer, the bagworm, and leafhoppers. Control measures are described elsewhere in this circular (*see index, page 59*).

• GINKGO •

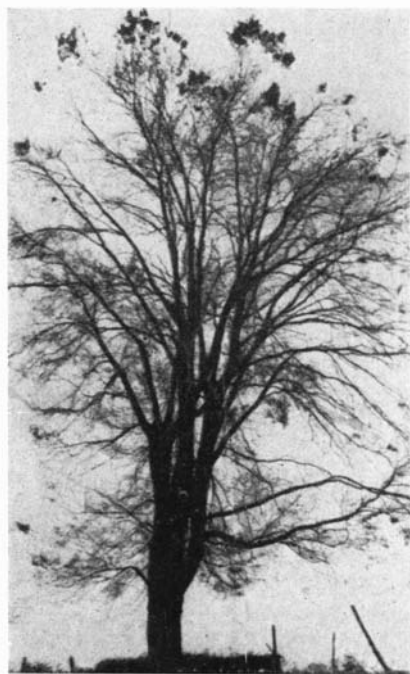
The ginkgo tree is finding a place in Illinois as a shade and ornamental tree. It is relatively free from insect attack. In Illinois its only important insect enemies are the bagworm and the fall webworm (*see index, page 59*). Unless controlled, these insects may entirely defoliate a ginkgo tree. A spray made of 4 pounds of lead arsenate and 4 ounces of soybean flour (or 8 ounces of wheat flour) to 100 gallons of water will control them if applied before the insects are half mature.

• HACKBERRY •

This splendid shade tree is seldom seriously injured by insects, the newly set trees are sometimes killed by tiny bark beetles (*page 28*) unless the trunks are wrapped. Hackberry foliage is often covered by small nipple-like galls which do no apparent harm to the tree.

Some hackberry trees are subject to injury by mites that feed in the bud scales. Bunchy growths of small twigs called witches' brooms develop from these injured buds. Affected trees retain most of their normal vigor and appear to live as long as those not affected.

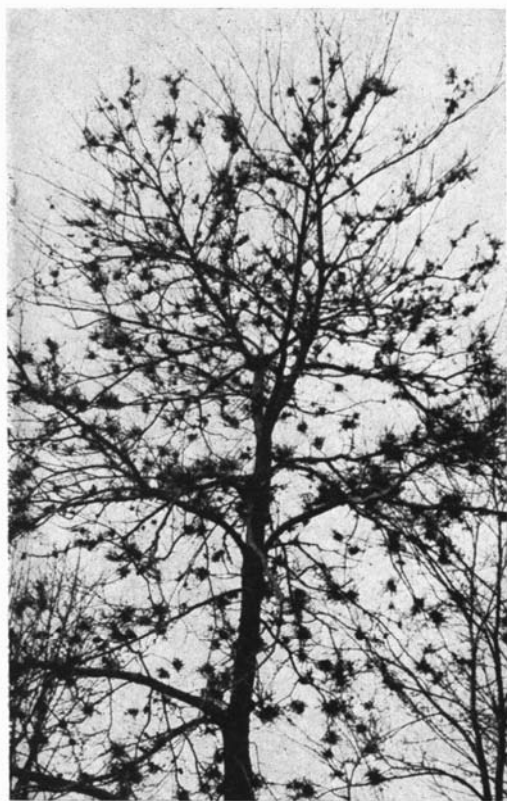
The hackberry is one of the cankerworms' favorite trees and may be completely defoliated by this insect (*page 12*).



Spring cankerworm on hackberry. A hackberry completely defoliated on May 16 replaced its foliage by August 20 with a growth of leaves of smaller than normal size. Attacks such as this are fairly common.

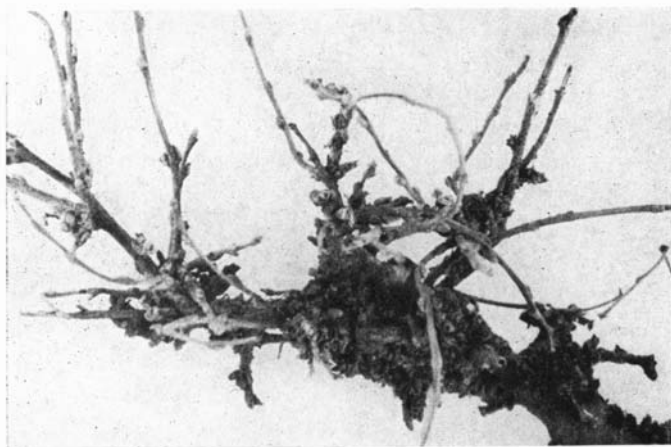


Nipple galls on hackberry. Altho these galls are often abundant, they do no apparent harm to the trees.



Witches brooms on hackberry. The masses of malformed twigs which produce this fantastic effect are caused by the feeding of mites within the bud scales. The vitality of the tree seems not to be affected by this feeding.

Close-up of
witches
brooms on
hackberry



Leafhoppers

Importance and injury. Leafhoppers feed in large numbers on hackberry, elm, sycamore, poplar, willow, linden, hawthorn, crab, and other shade trees. The nymphs and adults suck the juices from the leaf cells, and these empty cells make the leaves appear thin and lifeless. Extensive feeding may cause a premature dropping of the foliage.

Control. A blanket recommendation for control is unsatisfactory because of the differences in the life histories of the different leafhoppers. They are all easily killed in the nymphal, wingless stages, and all sprays for leafhoppers should be timed to strike the maximum number of nymphs. These nymphs are very active, wingless forms that run rapidly over the underside of the leaves. The foliage should be thoroly sprayed with a mixture containing 1 pint of nicotine sulfate, 3 pounds of fish-oil soap, and 100 gallons of water. Control measures are seldom necessary except on valuable shade trees.

Life history. Leafhoppers overwinter in either the egg or the adult stage. The eggs are laid in the stems of leaves or in the leaf tissues or twigs. The adults hide in protected places, especially under leaves. The first generation of nymphs appears in May or June. Within 4 to 6 weeks the nymphs mature, get their wings, and fly to the same or new host plants. In most species a second generation appears in August and September.

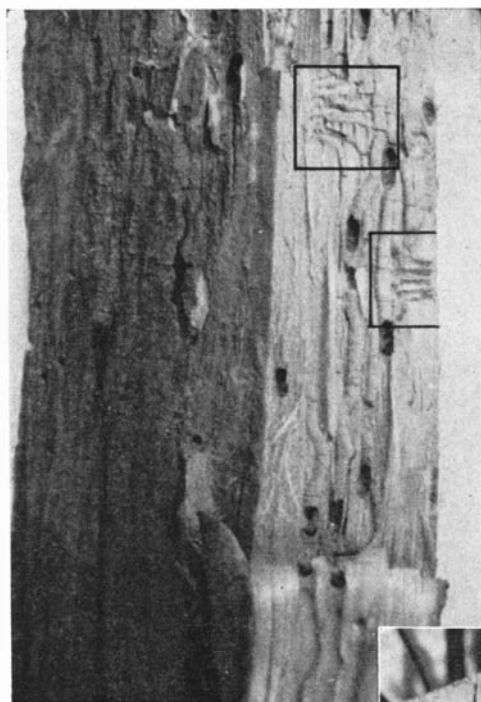
• HICKORY AND WALNUT •

Hickory and walnut trees are used considerably as shade trees. They are subject to some damage by the flatheaded apple tree borer (*page 36*) and by the painted hickory borer for which there is no control other than keeping the trees in a vigorous growing condition. The trunk and larger branches of hickory are particularly subject to attack by the hickory bark beetle.

Hickory Bark Beetle

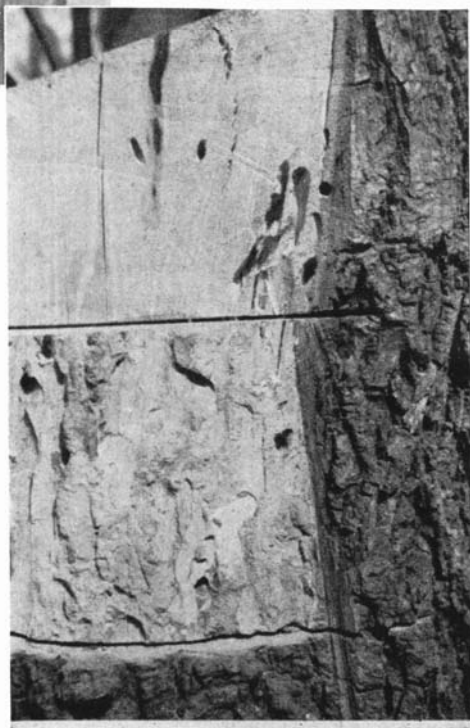
Scolytus quadrispinosus Say

Importance and injury. The feeding of these beetles often destroys the cambium and loosens the bark layers of the trees. The only indication of the presence of this insect on a hickory tree is the



Burrows of hickory bark beetles. These beetles have attacked the inner bark layers of a hickory tree. The lateral burrows that cut across the trunk and so girdle a tree are shown in the rectangles. Vertical burrows can also be seen.

Work of painted hickory borer. The borers attacked this pignut hickory after the tree had been killed by hickory bark beetles. The work in the sapwood (*top*) and inner bark layers (*middle*) can be seen.



accumulation of fine sawdust thrown out from tiny holes along the trunk of the tree. Trees attacked usually show a slight yellowing of the foliage.

Control. No method of controlling this insect by spraying or dusting has been worked out. If a tree is seriously injured, it should be cut down and the branches and trunk burned by the first of May. If the attack is noticed in midsummer it is well to wait and cut the tree in the fall after the adult beetles have laid their eggs and died. The insects are then all concentrated in the trunk and branches of the tree. Fertilizing and watering to keep the tree in a vigorous condition are very effective in combating injury by these bark beetles.

Life history. The adult beetle is a tiny black hard-shelled insect about $\frac{1}{8}$ inch long. It is rarely seen, but the round exit holes thru the bark of weakened hickory trees show its presence. Stripping the bark from an injured limb will show the many branched feeding tunnels.

Other Bark Beetles

Importance and injury. All shade trees are attacked by bark beetles. The injury appears externally as small round holes about $\frac{1}{16}$ inch in diameter in the bark of dead or dying limbs or trunks. In the sapwood are shallow indented lines branching from a central furrow. The rather definite patterns of these burrows characterize the different species of bark beetles.

Control. Because bark beetles normally attack only weak trees or limbs, infested wood should be removed and burned during the dormant season. Fertilization, the pruning out of weak or dead wood, and the removal of surplus trees will help to reduce bark beetle damage. Neither sprays nor paints have aided in controlling these insects.

Life history. Most species of bark beetles pass the winter as larvae under the bark of the tree. They pupate in the spring, and the adult beetles cut their way thru the bark to the outside of the branch or trunk, and emerge during the early summer. The female locates a weak limb and bores into the cambium. She excavates a burrow and lays her eggs along the side. After these eggs hatch, the small grubs burrow at right angles to the main gallery. As the grubs grow they increase the size of the lateral burrow. A single generation each year is common for most species, but some have two. All life stages may be found in a tree at the same time.

Walnut Caterpillar

Datana integerrima (G. & R.)

Importance and injury. Many walnut and hickory trees in the Middle West are subject to frequent defoliation by the walnut caterpillar. These almost black caterpillars are covered with long gray hairs. They feed together, usually stripping all the leaves from a small branch. They come down the main trunk to molt their skins. The empty skins hanging on the trunk are very unsightly.

Control. Much time and money has been wasted by property owners who have banded trees in an attempt to prevent damage by these large leaf-feeding caterpillars. The only effective method of control is spraying, using a mixture of 3 pounds of lead arsenate and 4 ounces of soybean flour (or 8 ounces of wheat flour) in 100 gallons of water. The spray should be applied when several colonies of the insects are first noticed feeding on the tips of small branches; this will be about July 1 in central Illinois.

Observations made in wildlife conservation areas in Illinois during the last several years indicate that these insects are held in check in areas where certain species of birds, particularly cuckoos, are protected and where conditions are favorable for their nesting.

Life history. The walnut caterpillar overwinters as a brown pupa in the soil. The adult is a chestnut-brown strong-flying moth that flies to the trees instead of crawling up the trunk. The female lays her eggs in July and August in masses of 50 to 100 on the underside of walnut or hickory leaves. When full-grown the caterpillars go into the ground and make a shallow burrow in which they change to naked brown pupae. It is in this stage that the insects pass the winter.

As there are two generations of this insect in most of the Middle West, trees will have to be watched from about July 1 to September 1 for the appearance of the caterpillars.

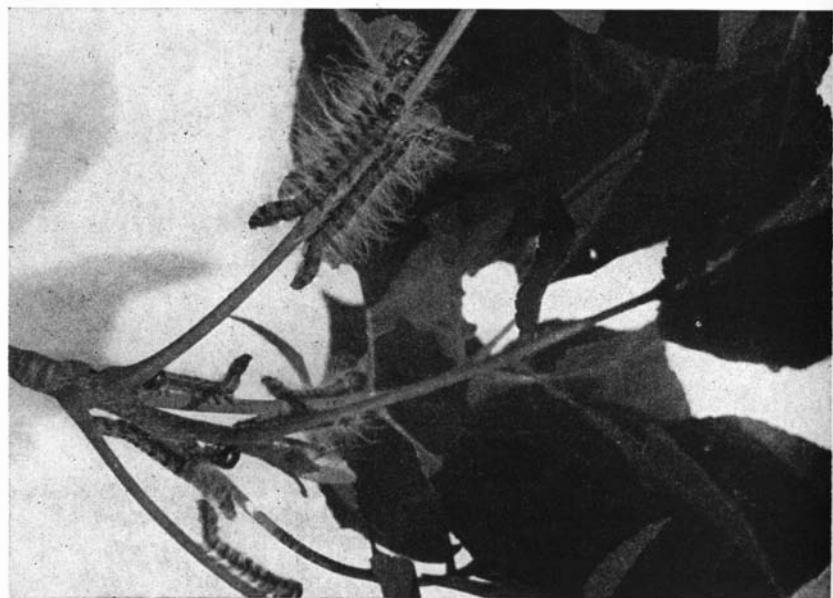
Galls

Hickory foliage is attacked by many species of insects whose stings cause galls to form; but rarely, if ever, do these galls cause serious injury to the trees.

All varieties of shade trees, but particularly oak, hickory, elm, hackberry, and poplar have galls on the foliage, twigs, or roots. The insects which cause the galls lay their eggs on some part of the tree or in its tissues. The reaction set up, either by the egg puncture or by

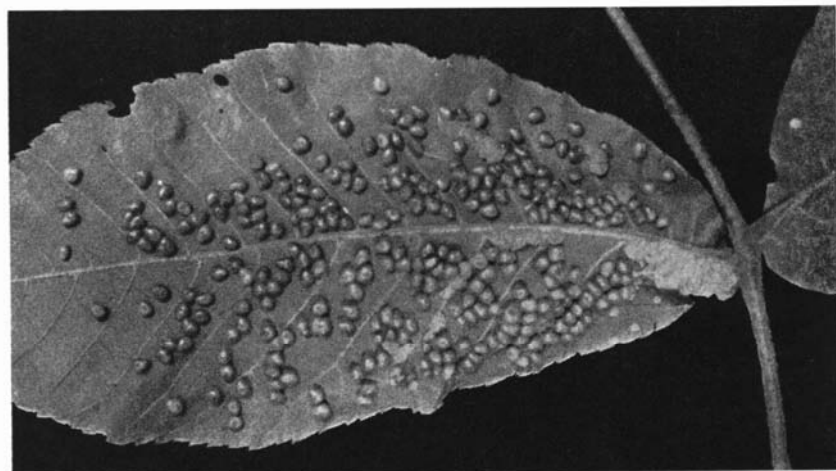


Damage by walnut caterpillar. The caterpillars (*below*) are nearly full grown. The trees without leaves (*above*) are walnuts stripped of their foliage by these caterpillars. Note that the oak at the left is untouched.



the feeding of the young insect, causes the gall to form and in the gall the insect grows. The type of gall formed is characteristic of the insect and will sometimes be the same for that insect on different species of plants.

Control. No satisfactory method of controlling gall insects is known. Picking off infested foliage will aid, but this is not practicable except on small isolated trees. Parasites are of great help in keeping down gall damage.



Typical galls on hickory. These galls are not harmful to the trees. (Note two types of galls.)

• L I N D E N •

The linden, or basswood, is native thruout Illinois and is used quite generally as a shade tree.

Elm Spanworm

Ennomos subsignarius Hbn.

The elm spanworm, also known as the snow-white linden moth, has very marked periods of abundance that come after a number of years when it has been hard to find. In the caterpillar stage this moth may defoliate lindens, maples, elms, and some other trees. The snow-white

moths, which are on the wing in mid-July, may cover tree trunks and buildings like a snowstorm.

Control. Spraying linden trees about May 10 in central Illinois with a mixture of .3 pounds of lead arsenate and 4 ounces of soybean flour (or 8 ounces of wheat flour) in 100 gallons of water is the only control known. Insect parasites help greatly in keeping down this moth.

Life history. The snow-white linden moth overwinters in the egg stage. Masses of eggs are attached to the bark of small branches and twigs. The eggs hatch in late April into grayish measuring worms. These worms complete their growth in about a month, spin a flimsy cocoon in which they change to the moth stage, and then lay the eggs for the next year. There is one brood of the moth each year.

Other Insects on Linden

The soft wood is attacked by the flatheaded apple tree borer and a number of roundheaded borers, as well as by several other types of borers. The foliage of the linden tree is eaten by a number of the common leaf-feeders such as the cankerworm, tussock moth, and several others. These insects are discussed under other trees (*see index, page 59*).

• MAPLE •

Probably the second most popular shade tree of the Middle West is the maple. Hard maples set in a suitable environment and properly fertilized are quite free from insect injury once they are established.

Cottony Maple Scale

Pulvinaria vitis (L.)

Importance and injury. The cottony maple scale is a long-established and well-known insect. Soft maples, and to some extent hard maples, are very generally infested with it. It is also quite common on box elder, peach, and several other trees and on grape.

The scale feeds by sucking the sap mostly from the underside of the leaves. Heavily infested trees may lose many limbs because of this scale, and in their weakened condition are likely to become prey to borers also. The heaviest infestations occur on streets and in parks in large cities, where the trees are weakened by smoke and other adverse conditions. At periodic intervals this scale becomes so abund-



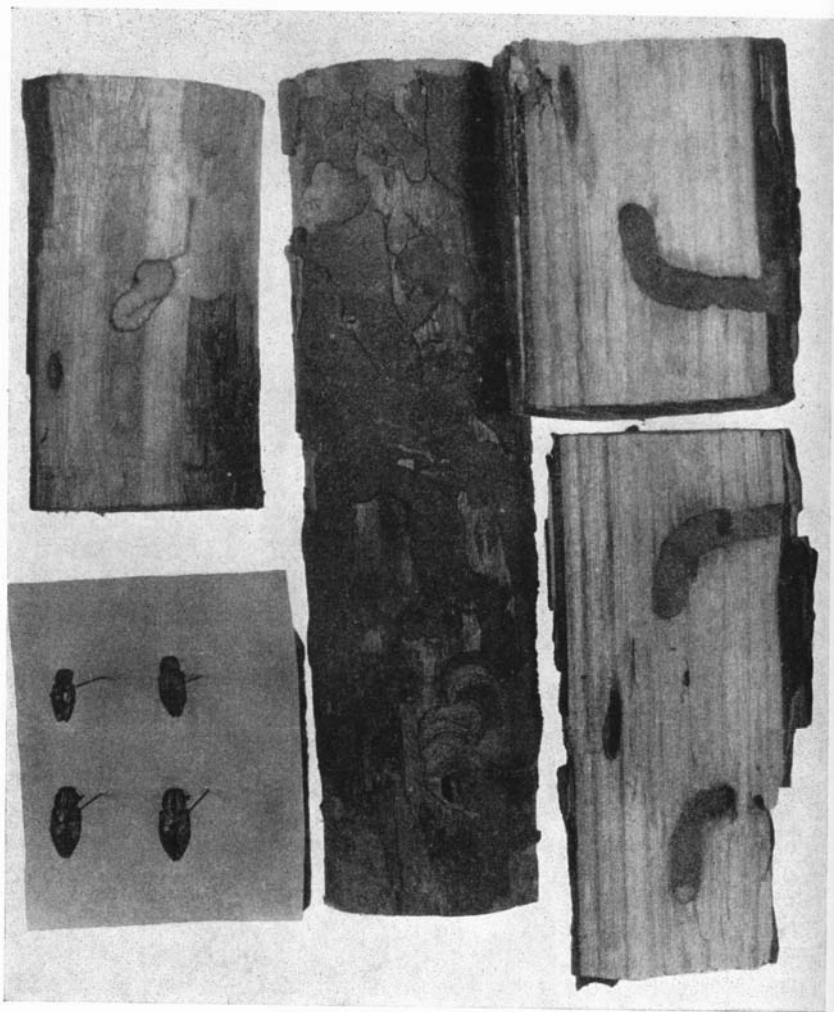
Cottony maple scale on soft maple. This scale can be identified easily by these masses of white wax in which the eggs are laid.

ant as to cover the smaller twigs and limbs of infested trees, and the smaller branches will appear to be coated with masses of cotton.

Control. Thoro spraying with a dormant oil emulsion or miscible oil at a dilution of 2 gallons of oil per 100 gallons of water will give satisfactory control of the cottony maple scale. The spray should be applied in late winter or early spring before the buds begin to open, when the trees are *completely dormant* because hard maples in particular are very sensitive to oil. Spraying at this time will kill the partly grown, fertilized female scales on the small branches; these scales are flat, reddish-brown, and about $\frac{1}{6}$ inch across. No effective summer spray has been found for this insect.

The insect is, however, subject to attack by several very active insect enemies, the most important of which are the larvae of a small moth and the two-spotted lady beetle. In Illinois the lady beetle is by far the most abundant. The cottony maple scale is usually kept down by these predators after one or two years of abundance.

Life history. The cottony maple scale overwinters as partly grown, fertilized female scales attached to the small branches. When tree growth starts in the spring, these scales grow rapidly and secrete



Flatheaded apple tree borer in hard maple. This destructive borer is very prevalent. Above can be seen the larva in its burrow (*upper left*); the adult borers (*lower left*); the work of the larvae (*center*); the exit holes made by the adults (*upper right*); and the burrow in which the grub changes to an adult (*lower right*).

large cottonlike masses of wax, in which several hundred creamy-white eggs are deposited. The females die in late May. The young scales hatch in late June and crawl to the leaves to start sucking the sap. In early August the winged males develop, mate with the females, and die. The females crawl back to the branches for the winter.

Other Insects on Maple

The tussock moth (*page 15*) feeds on maples to some extent. Maples are occasionally attacked by the green-striped maple worm, especially in the northern part of Illinois; spraying the foliage with a stomach poison such as lead arsenate is the only control for this insect. The sugar-maple borer rarely does serious damage; carbon bisulfid injected carefully into the burrows of this borer is fairly effective in killing it if control measures should become necessary.

The periodical cicadas (*page 37*) attack maples. Newly set maple trees are very subject to attack by the flatheaded apple tree borer, pictured on opposite page. Control is the same as on oak trees (*page 36*). The red-headed ash borer also attacks maple trees and is controlled in the same way as on ash (*page 5*).

• MOUNTAIN ASH •

The mountain ash is not generally planted for shade but for landscape effects. It is short-lived thruout most of Illinois. Most of the insects that feed on apple trees and on crab trees and hawthorns (*pages 10 and 11*) will attack the mountain ash. It is very subject to injury by the roundheaded apple tree borer and the flatheaded apple tree borer. This tree often dies as a result of insect injury.

• OAK •

In Illinois, oak trees are used extensively in parks and along streets and highways. There are many kinds of oaks, all differing somewhat in the insects that attack them.

Borers

The roundheaded or longhorned borers and the oak carpenter worm frequently attack the trunks of oak trees, especially those of the black and red oaks. Sawdust-like bits of wood thrown out from the borer burrows is usually evidence of borer activity.

Very effective control of these borers can be obtained by carefully injecting carbon bisulfid into their burrows. The chemical is injected into the burrow with an oil can. Closing the exterior of the burrow with soft clay will confine the fumes and will kill the feeding larvae as far as 6 inches from the place of injection. Use of this method

during the warm summer months is very effective, but the work may be done at any time. The greatest drawback to the method is the labor needed to carefully open the larva burrows and handle the necessary chemicals.

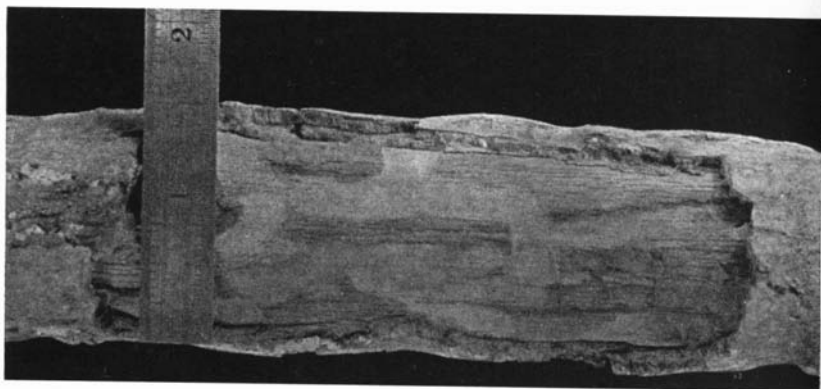
Flatheaded Apple Tree Borer

Chrysobothris femorata (Oliv.)

Importance and injury. To many species of newly transplanted shade trees thruout Illinois, the flatheaded borer causes more damage than any other insect. It attacks elm, hard and soft maple, sycamore, oak, hickory, linden, poplar, willow, and many other trees. Newly set trees or those that have been so pruned as to expose the trunk to the direct light of the sun are very likely to become infested with this borer.

The injury inflicted by this insect is caused by the white elongated grubs or borers feeding on the inner bark layers of the trunks and exposed limbs. These grubs are sluggish worms about 1 inch long when grown. Their bodies are greatly flattened and enlarged just back of their heads. A single larva may girdle a small tree and cause its death. The attack begins on the side exposed to the sun but may extend to all parts of the tree. Early feeding is evidenced by sap exudations that attract other insects. Extended feeding may entirely loosen the bark from the trunk.

Control. A highly effective yet simple method of protection from these borers is to wrap the trunks of newly set or newly pruned trees with a good grade of wrapping paper or newspaper. This should



Work of flatheaded apple tree borer in oak. For a picture showing various life stages of this borer see page 34.

be done when the trees are planted or pruned, in order to prevent the establishment of borer-larvae in the trunks. The paper should be so applied as to give a continuous protection from the ground to the first branches, or for any other part of the trunk or large branches that is exposed to sunlight. Spiral wrappings made from 4-inch widths of paper are fairly effective against borers, but should be applied to cover the entire trunk.

Wrappings can be held in place with binder twine or any similar twine. They should be put on in such a way as not to hinder or retard the swell of the tree due to growth, and should remain on the tree for two years. Extensive experiments made over a period of four years on hundreds of trees in Illinois have shown about 90 percent protection by this method.

After the wrappings are removed, the trunks should be allowed to develop side branches for several years as further protection against borers. These side branches aid the growth of the tree and can be easily removed after the tree is well established.

Once the tree is well established and growing vigorously, practically no damage from this borer occurs unless branches are removed so as to expose to the sunlight parts of the trunk which have been shaded previously. Where such pruning is done, protection is needed. Tests which have been carried on with the most generally recommended repellent washes and tree paints have been unsuccessful.

Life history. These borers overwinter as partially grown or mature larvae in their feeding burrows or cells in trunks and large branches. They pupate in the spring, and the adults emerge in May, June, and July. The adults are flattened beetles, about $\frac{1}{2}$ inch long, of a general gray color with a metallic coppery-green appearance in the light. They are strong fliers and easily disturbed. Eggs are deposited in crevices of the bark, usually during June and July in central Illinois. Hatching extends over several months so that all stages of larval development may be observed on a single tree. There is one generation each year.

Periodical Cicada

Magicicada septendecim (L.), *Magicicada tredecim* Walsh-Riley¹

Importance and injury. The adults of the periodical cicada feed very little, but the female injures the trees by depositing her eggs in

¹Entomologists do not agree on the species identity of the 13- and 17-year broods of this insect. They are probably biological phases of the same species.

a series of deep punctures which she makes in twigs and small branches; these punctures cause the twigs or branches to die or break off. Old trees are only temporarily disfigured, but young trees are often greatly dwarfed by this attack. There are broods of the 13- and 17-year cicada in many sections of Illinois. The areas where each of these broods occurs have been well mapped. Their characteristic song



Twigs injured by periodical cicada. The cicadas puncture the twigs to lay their eggs. The punctures shown here have partly healed, two years having elapsed since the eggs were deposited.

in the woods denotes the emergence of one of these broods. Information as to when a brood of this insect will appear at any point in Illinois will be furnished to anyone requesting it, by the CHIEF ENTOMOLOGIST, ILLINOIS STATE NATURAL HISTORY SURVEY, and ILLINOIS AGRICULTURAL EXPERIMENT STATION, URBANA.

Control. No effective control on large trees is known for the periodical cicada. Spraying small trees when the adults are on the wing early in June with a mixture of 1 gallon of summer oil and 1 pint of nicotine sulfate in 100 gallons of water will kill the adults wet with the spray. Young trees of special value may be protected by cheesecloth nets to prevent these large insects from flying into the trees to lay their eggs.

Life history. The eggs of the cicada are laid in the twigs of trees and hatch in 6 to 8 weeks. The young, resembling minute crayfish, drop to the ground and burrow to a tree root. For either 13 or 17 years the nymphs burrow thru the soil, sucking the sap from the roots of trees and plants. Their rate of growth is very slow and their feeding apparently does no harm. When mature they open a gallery to the surface and climb any convenient object. They anchor their feet firmly to the object, the outer skin splits down the back, and the adult emerges, dries its wings, and flies away, leaving the brown empty shell. Emergence of a brood occurs over about a two-week period. The adults mate, lay their eggs, and die within about a month—in central Illinois from the last half of May to mid-June.

May Beetles

Phyllophaga sp.

Importance and injury. The most serious defoliation of oaks in the Middle West is caused by the feeding of "May beetles," or "June bugs." Besides attacking oaks, some species attack elm, hickory, willow, poplar, and other trees.

Brood A occurred in 1938 and will occur again in 1941, 1944, and each three years thereafter; *Brood B* occurred in 1939, and will occur again in 1942, 1945, and each three years thereafter. *Brood C* will occur in 1940, 1943, 1946, and each three years thereafter. *Brood A* is the most important in northern Illinois; beetles of that brood may completely strip all the oaks over large areas. Defoliation by May beetles sometimes lowers the vitality of a tree so much that bark beetles will kill it.

Control. Thoro spraying of infested oak trees with 5 pounds of lead arsenate and 4 ounces of soybean flour in 100 gallons of water about the time the leaves are three-fourths grown will prevent defoliation and reduce the number of grubs in nearby lawns or pastures.

Life history. This insect spends its third winter as an adult in the soil. Flights from the soil occur in May and June. On warm evenings the insects feed on their favorite host trees, returning to the ground to deposit their eggs and to rest during the day. For the first and second years the grubs feed on roots of grasses and other plants. Late in the second summer they pupate. The adults remain in the soil until the following spring, when they emerge.

More than fifteen different species of May beetles are prevalent in

Illinois. Most of them have a three-year life cycle, altho some species mature in one year.

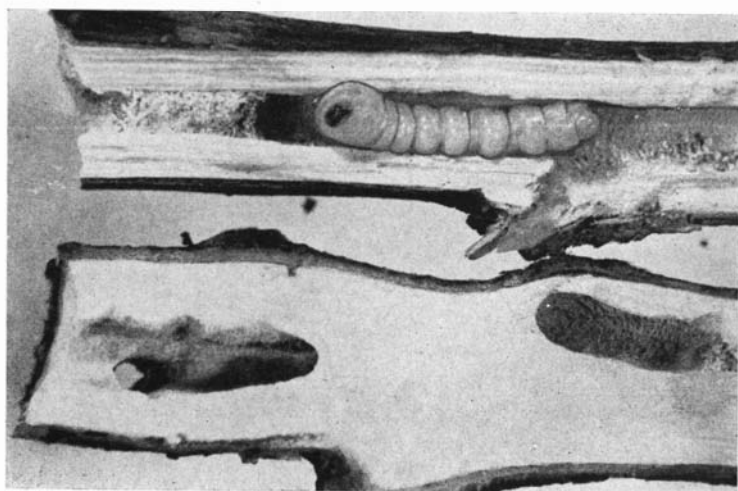
Twig Pruner

Hypermallus villosus (F.)

Importance and injury. Many complaints are received each year of damage by the twig pruner. This small grayish-brown beetle is very generally distributed thruout the Middle West. It attacks oak, maple, elm, hickory, pecan, apple, and many other trees. Infested branches are cut off squarely by the feeding larvae, leaving only the bark, which is easily broken by the wind. Limbs $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter drop to the ground when infested.

Control. The best control measure known is to pick up and burn the fallen branches in the infested areas in order to destroy the larvae. This should be done in mid-September and again about the first of November. There is no spray or wash which is at all effective in controlling this beetle.

Life history. The twig pruner overwinters in fallen branches either in the larval or pupal stage. Pupation occurs in the late fall or spring, and the adults appear in May and June to lay their eggs in



Larva of twig pruner. The larva is in a twig which has been cut off by its feeding. The grub will complete its growth and change to an adult in the cut twig lying on the ground. Empty burrows are shown in lower twig.

healthy twigs. The larvae remain feeding within the twig until they pupate and emerge as full-grown beetles the following spring. Some of the insects may require two years to complete their transformation. The adult of this insect is a slender brown beetle about $\frac{1}{2}$ inch long.

Oak Scales

A number of scales, particularly the bur oak Kermes, the European fruit lecanium, and the golden oak scale, attack oak trees. The scales increase rapidly and cause dwarfing of twigs and loss of foliage.

The bur oak Kermes (*Kermes pubescens*), one of the most common of these scales, attacks not only the bur oak, but also white and red



Bur oak Kermes. This scale causes a knotty growth of twigs and leaves on red and bur oaks. Bunches of dead leaves in the summer may be evidence of infestation by this scale.

oaks. On infested trees the terminal twigs grow very slowly, and have short terminal growth, with groups of dead, distorted leaves scattered thru the foliage.

The European fruit lecanium (*Lecanium corni* (Bouché)) is most noticed in the spring when the white masses of eggs are conspicuous about the scale. It weakens the branches by sucking the sap but does not cause noticeable damage to strong, growing trees.

The golden oak scale (*Asterolecanium variolosum*), sometimes called the pit-making scale, is common on various species of oak thruout the state. Its feeding causes small depressions in the bark. The scale covering is nearly circular, greenish-golden in color, and about $\frac{1}{16}$ inch in diameter.

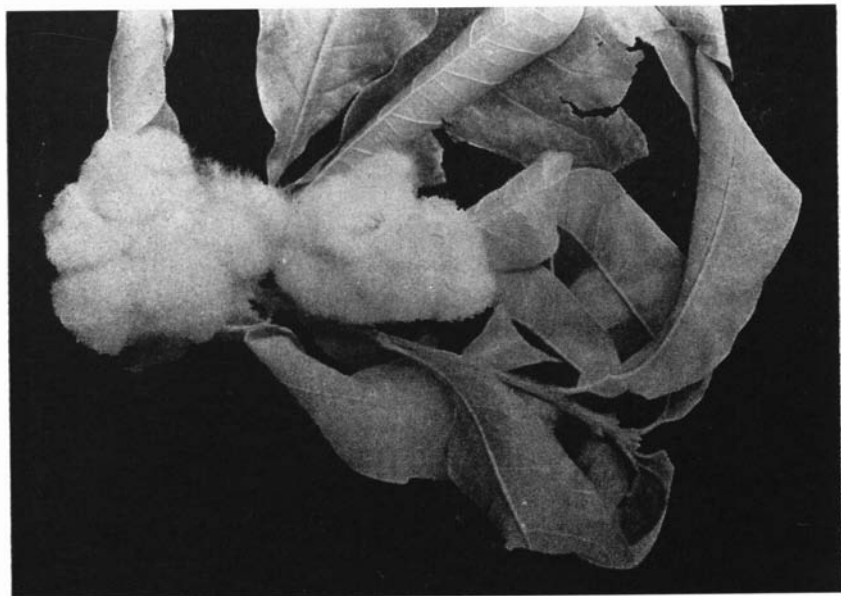
Control. The large size of these scales makes them the prey of other insects and mites, which serve as important controls.

Dormant sprays of tested oil emulsions or miscible oils at strengths recommended by the manufacturers will destroy the overwintering stages of these scales. These oil sprays should usually be diluted to 5 percent of oil in water. They will give good control if thoroly applied in March or April before the leaves appear. The quick-breaking type of oil emulsion is likely to injure oak trees.

Life history. Most soft scales overwinter in the egg stage within the body of the dead female scale. A few live over as partly grown scales. The eggs hatch in late spring or early summer, and the young scales migrate to the new twigs or leaves. Those feeding in the leaves later go to the twigs to complete their growth and pass the winter.



Galls on white oaks. These typical galls on white oak were caused by stings of tiny wasps.



Other galls on oak trees. The large wool sower galls (*above*) are found on shingle oak, and the oak apple galls (*below*) are common on black oak. Both types of galls are caused by wasps, but they differ in size, shape, and structure.



Leaf Miners

Importance and injury. The leaves of all deciduous shade trees and many evergreens are subject to attack by insects whose larvae mine in the leaf tissues between the upper and lower leaf surfaces. Some of these larvae are the young of flies, some of moths, and some of beetles. The mined-out areas on the leaf become brown, and the leaf often curls or breaks out along these areas.

Control. If these insects are feeding inside the leaf, the only way to kill them without injuring the trees is to spray them with some compound that will penetrate thru the leaf tissue. One quart of nicotine sulfate in 100 gallons of water in which 4 pounds of soap has been dissolved, makes a very effective spray. Spraying should be done very thoroly. There are some leaf miners that cannot be killed by this treatment; but as some of these pass the winter in fallen leaves, the composting or burning of the leaves will aid in controlling them.

Life history. Some leaf miners pass the winter in the soil, others within the fallen leaves. The adults emerge during the spring and fly to their favorite host tree to lay their eggs. After hatching, the larvae feed and mine within the leaves. Some species pupate within the mine in the leaf, others drop to the ground and pupate in the soil. Several generations may occur during the warm summer months.



Bark beetle scars on white oak. The bark on weak trees is soon loosened by the feeding of several kinds of bark beetles. Most of these beetles, however, will not injure healthy trees.

Other Insects on Oak

Bark beetles (*pages 28 and 44*) may feed on oak trees and loosen the bark but seldom injure healthy trees. Galls caused by various species of minute wasps are often found on these trees (*pictured on pages 42 and 43*).

Other insects that attack oak trees are the red-headed ash borer, the fall webworm, and the yellow-necked caterpillar (*see index, page 59*).

• POPLAR •

The poplar is another common shade tree in the Middle West that is very subject to insect injury.

Oystershell Scale

Lepidosaphes ulmi (L.)

Importance and injury. Poplar and all varieties of ash, with the exception of the blue ash, may be seriously infested or killed by some form of oystershell scale. During some years this scale has been held in check by parasites and predators, particularly by predaceous mites that attack the eggs.

Control. Spraying trees with tar-oil emulsion, dinitro oils, and similar sprays some time in the late winter or early spring before any growth has started on the trees will give satisfactory control of these scale insects. These tar distillates can be purchased from most of the large oil companies or from dealers in insecticides. They must be used according to the manufacturer's directions.

If dormant spraying is not done, a very satisfactory way to control oystershell scale is to spray shortly after the eggs have hatched. In the latitude of St. Louis the eggs hatch about May 20-25; in the more northern parts of the state, hatching occurs a little later. One and one-half gallons of summer oil in 100 gallons of water, applied thoroly at hatching time, will kill most of the newly set and unprotected young scales. This method has been used very successfully in a number of Illinois cities.

Life history. Oystershell scale overwinters as pearly-white eggs. These eggs are protected under the waxy scale of the dead female, 80 to 100 being found under each scale. One form of this scale has two generations in a year, the first hatching in May and the second in July or August; the more common form on ash has one generation a



Oystershell scale. The lower branches of this lombardy poplar have been killed by oystershell scale. This destruction could have been prevented by spraying the trees in late winter or early spring.

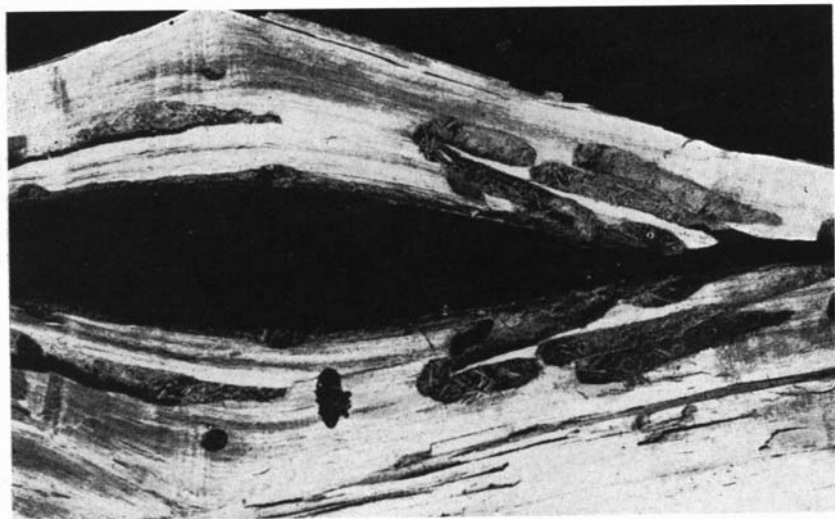
year which hatches in June. The scales resemble half of a very tiny oyster shell and are about $\frac{1}{8}$ inch long. The young scales migrate to first- or second-year twig growth and begin feeding. They soon molt their skins, lose the use of their legs, and begin to exude wax from their bodies. This wax forms the protective scale over the insects' bodies. When mature, the winged male and the wingless female mate; the female deposits her eggs under the waxy scale, her shriveled body remaining in the small end of the scale.

Poplar and Willow Borer

Cryptorhynchus lapathi (L.)

Importance and injury. Both poplars and willows are seriously damaged by the poplar and willow borer, a very common insect found wherever these trees are growing. These medium-sized snout beetles riddle twigs with their burrows, causing them to break easily.

Control. Pruning off infested twigs, which can be recognized by the swollen areas on them, and burning them immediately has proved a fairly effective method of controlling this borer. Some work has been done with applications of carbolineum emulsion. An emulsion of P.D.B. (paradichlorobenzene) in soluble pine oil has also been



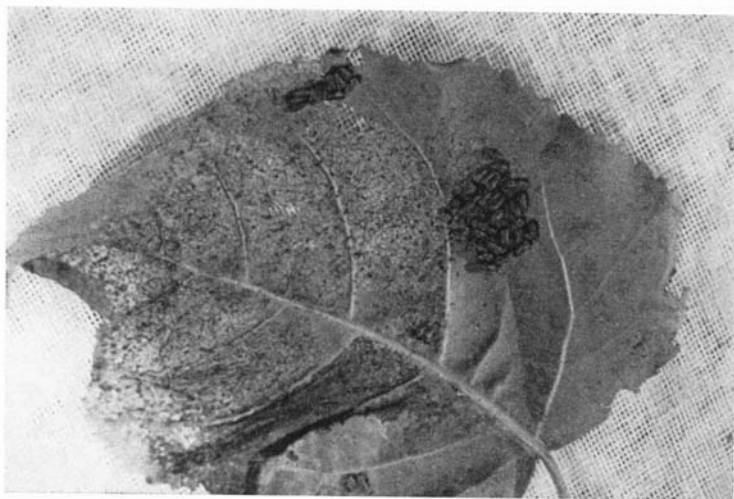
Poplar and willow borer. The borer tunnels thru the trunks and limbs of these trees, killing or so weakening the limbs that they break off.

found effective. This is made by dissolving 2 pounds of P.D.B. crystals in 2 quarts of soluble pine-tar oil and diluting with 2 quarts of water. It should be applied in the early fall. As both the carbolineum emulsion and the P.D.B.-emulsion mixture have to be applied with a brush, they are practical only for small or especially valuable trees.

Life history. This borer overwinters in infested trees as a partly grown white legless grub about $\frac{1}{2}$ inch long, with a brown head. The following spring the grubs feed ravenously, burrowing in all directions thru the cambium and outer sapwood. Pupation occurs within the burrow during July, and the adults emerge in August and September. The adults are black-and-white-mottled snout beetles about $\frac{3}{8}$ inch long. Eggs are laid in the bark of wood at least two years old; the eggs hatch, and the young grubs burrow into the inner bark to overwinter.

Other Borers

The trunks and larger branches are almost certain to be infested with either the large poplar borer or the poplar Saperda. In addition, the large black-and-white cottonwood borer is a pest of these trees in the southwestern part of Illinois. Eventually these insects so riddle the trunks with their burrows that the trees break or die. The injury



Cottonwood leaf beetle on poplar. The clustering dark-brown-to-black larvae of this beetle skeletonize the leaves. The larvae on the above poplar leaf are about one-third grown.

can be identified by the dark-colored sappy ooze and the excelsior-like bits of wood around the openings of the burrows and around the base of the trunk.

Control. Control measures for these borers will prolong the life of infested trees a few years. Valuable trees can be protected by injecting carbon bisulfid into the burrows in the tree trunks. This is a laborious process and must be repeated frequently. It will control the borers, however, if done carefully. The borers cannot be controlled by spraying.

Leaf-Feeding Insects

Bagworms, the cottonwood leaf beetle, the poplar tentmaker, the tussock moth, sawfly larvae, and several other leaf-chewing insects all attack the poplar foliage.

Control. Spraying with a mixture of 3 pounds of lead arsenate and 4 ounces of soybean flour (or 8 ounces of wheat flour) to 100 gallons of water when the insects are seen feeding will control any of these leaf-feeders if the sprays are properly timed and applied.

Other Insects on Poplar

The poplar foliage is defaced by numerous gall-making insects, and the satin moth is a serious pest. The fall webworm also attacks this tree. Control of these insects is described elsewhere in this circular (*see index, page 59*).

• SYCAMORE •

The sycamore is common in both city and country. It is a hardy tree, being able to withstand adverse conditions along city streets which would prevent the growing of most trees. It is sometimes damaged by a fungus infection in the spring.

Sycamore Lacebug

Corythucha ciliata Say

Importance and injury. Sycamores are frequently damaged by a species of the so-called "lacebug." This bug is not abundant every year, but occurs frequently enough so that sycamores should be watched each season for its presence. It is a small brown-and-green

mottled bug about $\frac{1}{8}$ inch long and half as wide with very transparent wing covers. It may become so abundant on the underside of sycamore leaves, sucking out the leaf juices, as to whiten the foliage and render the tree very unsightly. A heavily infested tree may lose a number of its leaves following an attack by this insect.

Control. Thoro spraying on the underside of the leaves with a mixture of 1 gallon of summer-oil emulsion and 1 pint of nicotine sulfate in 100 gallons of water is an effective method of controlling the sycamore lacebug. This spray should be applied about the first of August.

Other Insects on Sycamore

As with most shade trees, newly set sycamores are subject to infestation by the flatheaded apple tree borer and must be protected from it. They are not particularly subject to attack by any of the scale insects. The foliage is fed upon and greatly relished by the tussock moth, bagworm, and a few other leaf-feeders. Control measures for these insects are described elsewhere in this circular (*see index, page 59*).

Leafhoppers often become abundant. They cause the same injury as discussed under hackberry and can be controlled in the same way (*page 26*).

• WILLOW •

The willow tree is hardly to be considered a shade tree, altho it is often planted in parks, along roadsides, and in group plantings. Its foliage is attacked by many leaf-feeders, including nearly all those that attack poplar. Sprays recommended for the control of the leaf-feeding insects on poplar (*page 49*) usually give effective control.

• EVERGREENS •

Besides the many shade trees of Illinois that need to be protected against insect attack, there are a number of landscape trees that require protection. Some of these, such as the junipers, arbor-vitae, and pines, are native to many parts of Illinois. Plantings have also been made of pines, spruces, firs, yews, and a host of less well-known evergreens as landscape trees. Each species is fed upon by several insects, of which a few will be discussed here.

The trunks of these trees are subject to attack by various species

of flatheaded borers, for which no control is known. Some species of woolly aphids also attack the trunks. The aphids can be controlled by spraying with a mixture of 2 quarts of summer oil, 1 pint of nicotine sulfate, and 100 gallons of water.



Cedar apples on red cedar. These galls are caused by a fungus, and are not related in any way to galls formed by insects.

There are a number of species of leaf-feeders that strip the foliage from evergreens. One complete defoliation of a tree is usually fatal, largely because bark beetles and borers always concentrate their attacks on weakened trees. For the most part these can be controlled as for the bagworm (*see below*).

Because evergreens are easily injured by oil sprays, care must be taken in using them.

Bagworm

Thyridopteryx ephemeraeformis (Haw.)

Importance and injury. The most destructive of the leaf-feeding insects on evergreens in Illinois is the bagworm. It also attacks many deciduous trees, but its most serious damage is to the evergreens.

Control. Spraying is the best method of control, as it can be done thoroly and will result in a great reduction in infestation. To be most effective, sprays must be applied within three weeks after the

eggs hatch (which is in May or June) while the worms are small. Four pounds of lead arsenate and 4 ounces of soybean flour in 100 gallons of water is a strong enough spray to use at this time. Later in the summer, when the damage becomes more noticeable and the bagworms have increased in size, it will be necessary to increase the dosage of lead arsenate to 6 pounds per 100 gallons of water. On small trees



Bagworm. The feeding larva of the bagworm constructs its bag from silk and bits of foliage. When the larva is full-grown, the bag is firmly attached to a twig of the host tree by silken threads.

picking and burning the overwintering bags containing the eggs is a fairly effective method of control.

Life history. The overwintering bags contain 400 to 500 eggs each. These eggs hatch in late May in central Illinois. Each worm, immediately after hatching, constructs its own bag out of bits of the host plant webbed together with silk. When the worm is not feeding, the bag is attached to a twig with a thread of silk. The worm lives in this bag, carrying it with it wherever it goes. Pupation occurs within these bags. The winged male emerges, flies to the bags containing the wingless females, mates, and dies. The female lays a mass of about 500 eggs in the upper part of her bag and then drops to the ground and dies. There is one brood each year.

Pine Needle Scale

Chionaspis pinifoliae (Fitch)

Importance and injury. Sporadic outbreaks of the pine needle scale occur on pines and spruces. The scale is heavily attacked by parasites, but its numbers may still be great enough to cause reduced tree vigor and severe losses of foliage.

Control. Sprays of dormant miscible oils containing not more than 2 percent actual oil are effective if applied before growth starts in the spring. A spray containing 1 gallon of summer oil (*not* of the quick-breaking type), 1 pint of 40-percent nicotine sulfate, and a wetting agent such as soybean flour (4 ounces) or soap (2 pounds) to 100 gallons of water, is fairly safe and effective if applied in late May or June when the young scales are hatching.

If the evergreens are in a weak condition, an oil spray may cause injury. In Connecticut two sprays two weeks apart, consisting of nicotine sulfate 1 part, water 500 parts, and 8 pounds of soap flakes to 100 gallons of water, has given good control.

Life history. The scale overwinters as whitish eggs under the dead female scale. The eggs hatch in late May or June, and the larvae migrate to new foliage to feed. They appear as small white spots along the needles of pine and other evergreens. In the southern part of Illinois the scales produce a second generation that hatches in late July or August. In the northern part of the state there is but one generation during the year.

Common Red Spider and Other Spider Mites

Tetranychus telarius (L.) and others

Importance and injury. Several species of mites, including the common red spider, attack all species of conifers as well as many deciduous trees. These mites are very destructive to newly transplanted evergreens and will injure established trees during periods of drouth. The injured needles become gray or brown and many drop off, weakening or killing the tree. If the infestation is severe, the trunk of the tree and the needles are covered with silk strands or webs.

Control. Keeping evergreens growing vigorously by providing abundant moisture and fertilizing the ground will greatly lessen mite damage. Spraying the trees with clear water under strong pressure will wash many of the mites off the foliage. Where water under pressure is not available, spraying with a mixture of 1½ pounds of

glue in 10 gallons of water is effective. Dusting the foliage with dusting sulfur will destroy most of the mites, but may cause injury to the foliage during hot weather. Spraying with a mixture of 1 gallon of summer oil, 1 pint of nicotine sulfate, and 3 pounds of soap in 100 gallons of water is also quite effective, but during hot weather may injure tender evergreen species.

Any spraying of evergreens, even with clear water, should be done at a time to avoid a bright hot sun on the wet foliage, preferably during late afternoon or evening, or in the early morning.

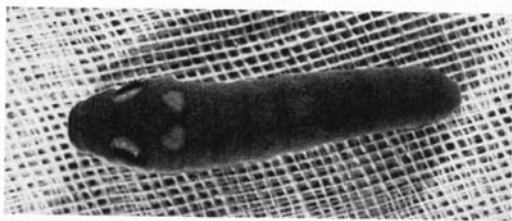
Life history. These mites overwinter either as adults in trash on the ground, or as eggs on the trees. Eggs are deposited and hatch in late spring. The life cycle is completed in 12 to 14 days, permitting a rapid increase in numbers. The mites are most abundant during dry, hot weather.

• LARCH •

The larch, or tamarack, is planted in Illinois for windbreaks and for landscaping. The American larch occurs naturally in northern Illinois, where it is associated with the swampy lands of that area.

Insects such as bark beetles (*page 28*) that attack the evergreens may also be found on larch. Similar control methods should be followed.

In the late summer black-spotted smooth caterpillars (the young of sawflies) may strip a larch of its leaves. Spraying with a mixture of 3 pounds of lead arsenate and 100 gallons of water is a very effective control.



Dog-head caterpillar. Altho this caterpillar feeds on a number of trees, it is rarely of importance as a pest. However, its striking appearance is the cause of many questions. No control measures are necessary. (This specimen is about $1\frac{1}{2}$ times natural size.)

• POTENTIAL INSECT ENEMIES •

There are many insects not known at present to occur in Illinois that are potential enemies of Illinois shade trees. Five of these are described in the following section. Anyone discovering insects in Illinois that appear to be similar to those described are urged to send specimens to the CHIEF ENTOMOLOGIST, ILLINOIS NATURAL HISTORY SURVEY and ILLINOIS AGRICULTURAL EXPERIMENT STATION, URBANA, for identification. Early knowledge of the establishing of new insect pests may make it possible to hold down the infestation for a number of years or to wipe it out completely.

The following insects are to be watched for in particular.

Brown-Tail Moth

Euproctis phaeorrhoea (Hüb.)

Appearance and injury. The brown-tail moth feeds on the foliage of trees; the long barbed hairs from its body will sometimes cause a very irritating rash on human beings. This insect attacks oak, elm, maple, willow, and many other deciduous shade trees; it also feeds on apple, plum, and pear trees. The adult moths are white, except for the tips of their abdomens, which are covered with brown hairs. The caterpillars are reddish brown with a broken yellow stripe along each side. The body is covered with stiff barbed hairs, and on the upper part of the last segment are two red tubercles.

Life history. The partially grown caterpillars overwinter in a mass of leaves webbed together. They continue to feed during the following spring and pupate in late May or June. The adults appear in July and lay masses of brown eggs on the underside of leaves. The young are gregarious and feed over the ends of the branches.

Elm Leaf Beetle

Galerucella xanthomelaena (Schr.)

Appearance and injury. This insect feeds on elms. The adult beetles are about $\frac{1}{4}$ inch long, yellow to light brown in color. The larvae are about $\frac{1}{2}$ inch long and dull yellow in color. The adults feed by cutting holes thru the elm leaves. The yellow sluglike larvae skeletonize the underside of the leaves.

Life history. Elm leaf beetles overwinter as adults. During

May and June they lay masses of eggs on the underside of leaves. The larvae pupate on the leaves and emerge as adults to start a second generation, which also feeds on the leaves. This second emergence takes place in July or August.

Gypsy Moth

Porthetria dispar (L.)

Appearance and injury. Of all the leaf-feeding insects that attack shade and woodland trees, the gypsy moth is the most destructive. It feeds on nearly all deciduous trees and, except in the early stages of its development, on many evergreens. Millions of dollars are spent each year in fighting it. The only areas known to be infested lie east of the Hudson river except for a small area in Pennsylvania.

Adult moths have a wing spread of $1\frac{1}{2}$ to 2 inches. The male is the smaller of the two and is light brown, while the female is heavy-bodied and light buff in color. The full-grown larvae are 2 to $2\frac{1}{2}$ inches long, dark gray, and covered with rather stiff hairs. A series of colored tubercles extend along the back.

Life history. Gypsy moths overwinter as hair-covered masses of eggs attached to trunks of trees, stones, or buildings. The eggs hatch as the leaves unfold, and the larvae feed on the developing foliage. The feeding period extends over about two months, during which time trees may be stripped of their foliage. The adults appear in July or August and deposit the eggs that remain dormant during the winter and hatch in the spring.

Japanese Beetle

Popillia japonica Newm.

Appearance and injury. The Japanese beetle feeds as an adult on many trees—on the elm, linden, birch, willow, horse chestnut, Lombardy poplar, Norway maple, sassafras, oak, sycamore, larch, buckeye, cypress, hawthorn, and others—as well as on shrubs, vines, and herbaceous plants. A native of the Orient, this beetle was first found in the United States in 1916 and has now been reported in most northern states east of the Mississippi river, including Illinois, and in Missouri and Iowa. The adult is a green beetle somewhat smaller than the May beetle, with four white markings on the tip of the abdomen just back of the wing covers. It is a strong flier and is very fond of ripening

early apples, corn silk, and soybeans. The larvae, or grubs, resemble May beetle grubs; they feed in the soil on the roots of plants but do not harm the trees.

Life history. The larvae of the Japanese beetle overwinter in the soil as partially grown grubs. They resume feeding in the spring, complete their growth, and pupate. The adults appear in late June or July, feed for several months, and lay eggs in the soil. The eggs hatch about 2 weeks later. There is one generation each year.

Satin Moth

Stilpnotia salicis (L.)

Appearance and injury. The satin moth feeds in the larval stage on poplar, willow, and oak. It was first found in North America in Massachusetts in 1920 and is now established on both coasts. It is particularly fond of poplars and may completely defoliate them. The adults are white and have a wing expanse of 1½ to 2 inches. The caterpillars are 1½ inches long and black, with distinct white blotches down the back. The body is studded with tubercles bearing whorls of hairs.

Life history. The partially grown larvae of the satin moth overwinter in small webs on the trunks of trees. They resume feeding in the spring and complete their growth by June. The mature larvae seek crevices or trash in which to pupate. The adults appear in July and lay clusters of white eggs on tree trunks, limbs, leaves, or other objects. The eggs hatch in about 2 weeks, the young feed for a while and then hibernate. There is a single generation each year.

SPECIAL EQUIPMENT NEEDED FOR SHADE-TREE SPRAYING

Tho most of the measures discussed in the foregoing sections on the control of insects can be taken by farmers for the protection of their shade-tree plantings, one of the most important measures unfortunately will prove impractical for most Illinois farmers. That is the matter of spraying the mature large-growing trees. The spraying of trees more than 30 feet high requires special and expensive equipment (costing from \$1,000 to \$1,800), which individual farmers could not, of course, be expected to own. Moreover, the spraying of the larger trees requires special skill which only those who make such work their business would be likely to have. The use of sprays as a method of controlling insects on the larger shade trees of Illinois must therefore be limited to towns or cities that own the large spray outfits or to communities where such outfits are available for custom work. Few Illinois towns or cities own these spray outfits, but in most of the larger ones there are dependable companies that do custom spraying.

Because of the skill and equipment and number of workers required to do a thoro job of spraying a large tree the cost of custom spraying may seem rather too high to those unfamiliar with the work. But property owners must consider the cost of failure to control the insects as well as the cost of controlling them, when deciding whether to spray or not. Where insect infestation threatens to defoliate a tree, or threatens the life of the tree in some other manner that can be controlled by spraying, the expenditure of several dollars for the proper kind of spray is likely to be well worth while, inasmuch as a good shade tree usually adds \$200 to \$300 to the value of residence property. With the better type of shade-tree sprayers, trees up to 125 feet high can be given a thoro coating of insecticide from the ground.

The spraying of smaller shade trees, those under 30 feet, is a more practical operation for farmers themselves to do, especially those who have access to power orchard sprayers. Trees no more than 10 or 12 feet high may be sprayed with a barrel pump. Small hand sprayers have no place in the spraying of shade trees, except perhaps in protecting seedlings during the first year or two of their growth.

Dusting for the control of shade-tree insects has been developed rapidly during the past few years, and equipment is now available for dusting 60- to 70-foot trees. Dusting has some advantages for the control of leaf-feeding insects, but it is not practical for the control of scale insects. Insects on small trees can be well controlled with a hand duster for the first two or three years after the trees are set.

INDEX OF INSECTS

The insect is described on the page or pages indicated below in **bold-face** type.

On the pages listed in *italics* are shown pictures of either the work of the insect or the damage it does. On the other pages listed the insect is merely mentioned.

For index arranged by trees, see contents, page 2.

- Ailanthus worm—4
 Aphids—7
- Bagworm—8, 9, 23, 23, 49, 50, **51**, 52
 Bark beetles—23, **28**, 44, 45, 54
 Beech barkbeetle—7
 Beech-limb borer—7
 Boxelder bug—8
 Bronzed birch borer—7
 Brown wood-borer—7
 Brown-tail moth—**55**
 Bur oak Kermes—**41**, 41
- Cankerworm—11, **12**, 13, 23, 24, 32
 Catalpa sphinx—9
 Cockscomb gall—21, **23**
 Cottonwood borer—48, 48
 Cottonwood leaf beetle—49
 Cottony maple scale—**32**, 33
- Dog-head caterpillar—54
- Elm leaf beetle—**55**
 Elm spanworm—31
 Elm-leaf aphid—22, **23**
 European elm scale—16, 17, 17
 European fruit lecanium—41
- Fall webworm—8, 11, **19**, 20, 23, 45, 49
 Flatheaded apple tree borer—7, 9, 11, 23, 26, 32, 34, 35, **36**, 36, 50
- Golden oak scale—**42**
 Green-striped maple worm—35
 Gypsy moth—56
- Hickory bark beetle—**26**, 27
 Hickory galls—**29**, 31
- Japanese beetle—9, 56
- Lace bugs—9, **49**
 Leaf miners—**44**
 Leaf-feeders—7, 32, **49**, 50, 51
- Leafhoppers—23, **26**, 50
 Lilac borer—5
 Longhorned borers—35
- May beetles—39
 Mourning-cloak butterfly—22, **23**
 Nipple galls—23, 24
- Oak carpenter worm—35
 Oak gall—42, 43, **45**
 Obscure scale—7
 Oystershell scale—5, 11, **45**, 46
- Painted ash borer—5
 Painted hickory borer—**26**, 27
 Periodical cicada—35, **37**, 38
 Pine needle scale—53
 Poplar and Willow borer—**47**, 47
 Poplar borer—48
 Poplar Saperda—48
 Poplar tentmaker—49
- Red spider—53
 Red-headed ash borer—5, 6, 23, 35, 45
 Roundheaded borers—32, 35
- San Jose scale—10, 10
 Satin moth—49, 57
 Sawfly—49, **54**
 Scales—7
 Scurfy scale—11, 18, 18
 Snow-white linden moth—31
 Sugar-maple borer—35
 Sycamore lacebug—49
- Tussock moth—9, 11, **15**, 32, 35, 49, 50
 Twig pruner—11, 40, 40
- Walnut caterpillar—11, **29**, 30
 Witches' brooms—**23**, 25
 Woolly aphids—11, **51**
 Woolly elm aphid—19
- Yellow-necked caterpillar—10, 11, 45

INSECT ATTACKS on shade trees are for the most part avoidable. Proper control measures against the invading insects and proper care of the trees to keep them in a vigorous condition will help to keep shade trees free from serious insect damage.

In this circular the more important insect enemies of the various shade trees of Illinois—the borers, the sapsuckers, the leaf-feeders, the root-feeders, and the gall-makers—are described, and the most effective control measures against each are discussed.