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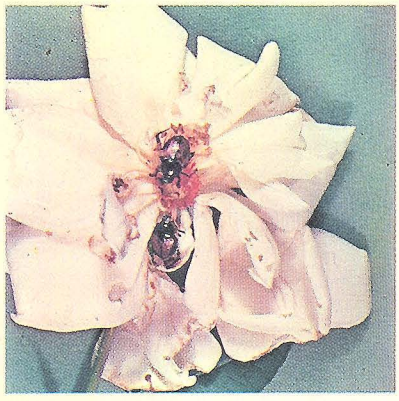
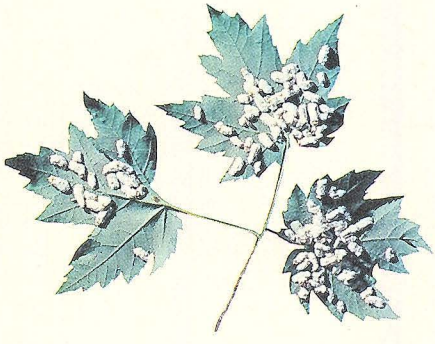
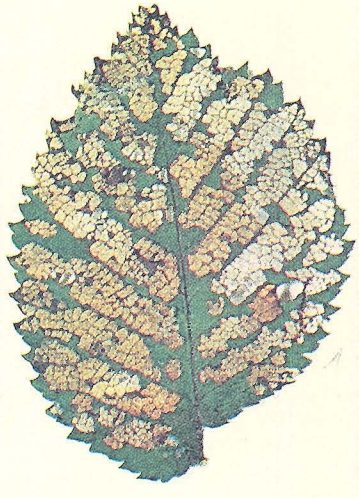


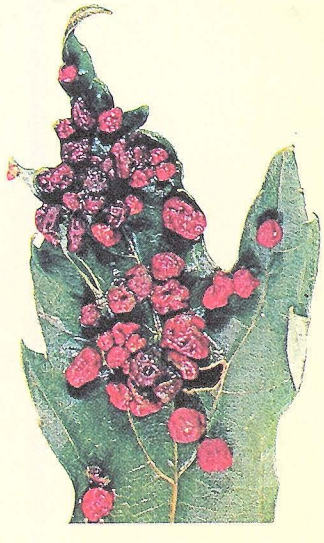


Insect and Mite

Pests of Trees and Shrubs

R. B. NEISWANDER





OHIO AGRICULTURAL RESEARCH AND
DEVELOPMENT CENTER — WOOSTER, OHIO

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Over a period of years, many graduate students helped to obtain information which has been summarized in this bulletin. Five who should be mentioned are Dr. J. G. Rodriguez, Dr. W. E. Miller, Dr. Carl H. Shanks, Jr., Dr. Robert E. Williams, and Dr. James E. Appleby.

Cooperation by the Section of Insect and Plant Disease Control, Division of Plant Industry, Ohio Department of Agriculture, has been most helpful. James T. Walker of that division provided one of the photographs, as well as much other useful information.

ON THE COVER: From upper left to lower right are: Japanese beetle (page 36) feeding on a rose, adult females of cottony maple leaf scale (page 5), elm leaf skeletonized by elm leaf beetle (page 36), and maple bladder gall (page 21) on silver maple leaf; lower left: damage by juniper midge (page 19).

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INSECT AND MITE PESTS OF TREES AND SHRUBS

RALPH B. NEISWANDER[1]

INTRODUCTION

This bulletin is issued primarily to aid home gardeners, nurserymen, and commercial arborists in identifying specific insect pests of trees and shrubs so control measures can be employed more intelligently. Photographs and short descriptions are included, as well as important features of the habits and life histories.

Because of the vast amount of information becoming available on methods of insect control, recommended control measures are constantly being changed and improved. For this reason, control measures are not included in this publication. Such recommendations can be found in a mimeograph, Ohio Insecticide Recommendations for Trees and Shrubs (10), and a bulletin, The Control of Insects and Plant Diseases in the Nursery (33).

Many species of insects and mites occur only occasionally on trees and shrubs. Others may occur often but never cause significant damage. These are not included in this publication, which is limited to pests destructive in Ohio.

SUCKING PESTS OF FOLIAGE AND TWIGS

Insects and mites which suck juices from the foliage and twigs of trees and shrubs are usually small and inconspicuous. Nevertheless, some of these are among the most troublesome pests. Plants may become infested and severely injured before the pest is known to be present. Because the foliage is not torn or broken, the injury may not be detected until discoloration, wilting, or stunting occurs.

SCALE INSECTS ON DECIDUOUS PLANTS

Most scale insects remain fixed on the host plant for a relatively large portion of their life cycles. Consequently, they can be transported for long distances in a living condition on nursery stock. The young appear and crawl for short distances but usually lose their legs at the time of the first molt. Females of most species remain stationary after the first molt but males emerge as winged insects when mature.

On deciduous plants, most scale insects occur on the bark of twigs and branches. Only an occasional species occurs on the leaves. These either retain legs and crawl to the twigs in late summer or a brood appears in late summer and lives during the winter on the twigs and buds.

European Elm Scale, *Gossyparia spuria* (Modeer)

The European elm scale has been destructive at times in Ohio. Although it attacks only elm trees, all species of elms grown in Ohio are subject to attack. Houser (12) stated that this insect causes positive injury to the host, and its copious discharge of honeydew promotes the profuse growth of an unsightly sooty mold over the foliage, sidewalks, and other objects. At the same time, the honeydew attracts myriads of flies and other insects.

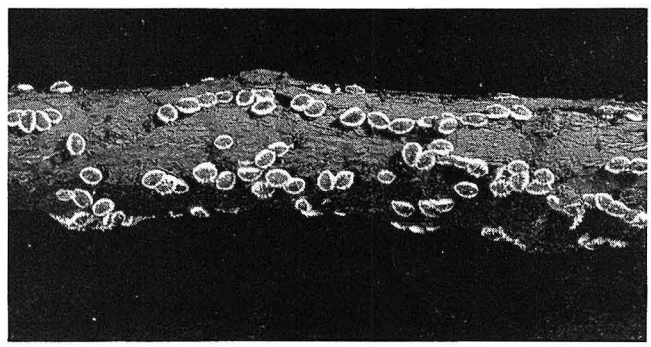

Fig. 1.—An infestation of European elm scale on an elm twig.

The adult female is oval, reddish brown, and has a waxy fringe along the body margin (Figure 1). Eggs are deposited in late spring and young begin to appear in June. Most of the young establish themselves on the lower surface of the leaves. Later they migrate to the trunk and branches, where they live during the winter in an immature condition. Only one generation occurs each year.

Magnolia Scale,
***Neolecanium cornuparvum* (Thro)**

The magnolia scale is the largest and most conspicuous scale insect known to occur in Ohio. Adult females may be almost a 1/2 inch in diameter and may occur in sufficient numbers to cover the bark of many branches of magnolia. The fleshy individuals

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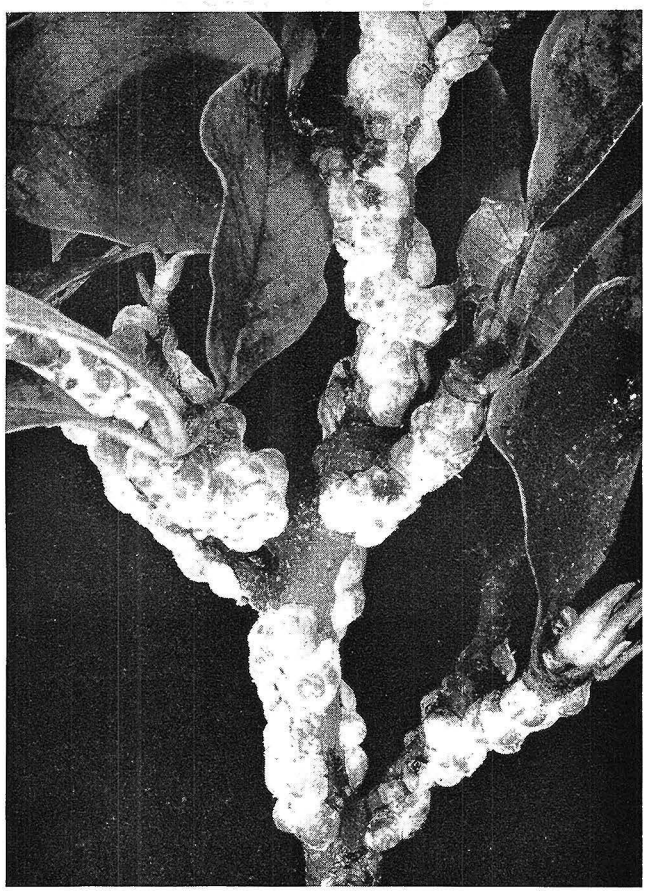

Fig. 2.—Mature females of the magnolia scale. Note the sooty fungus.

are brown but are covered with a white, mealy wax (Figure 2).

As the name indicates, the insect is primarily a pest of the various species of *Magnolia*. Infested plants are weakened and occasionally may be killed. During June and July, the insects produce large quantities of honeydew. This drips on the foliage and a black, sooty fungus grows on the secretion. As a result, the leaves turn black and the plant loses its ornamental value.

The magnolia scale lives during the winter on twigs as tiny, dark colored individuals, much like those of the tuliptree scale (Figure 4). They begin to feed and grow in early spring and become full grown in late July and August. The adult females then give birth to young. Although most of the young crawlers appear during August, an occasional female may continue to produce young through September. Only one generation occurs each year.

Tuliptree Scale, *Toumeyella liriodendri* (Gmelin)

The tuliptree scale is one of the largest scale insects known to occur in Ohio. Only the magnolia scale may exceed it in size. When permitted to develop without crowding, the adult female is hemispherical, about 1/3 inch in diameter, and dark brown (12). However, the scales usually occur in crowded masses where they become distorted (Figure 3).

The insect occurs primarily on tulip poplar in Ohio. Small and immature individuals live during the winter on the twigs of the host (Figure 4). The crawlers of a new brood appear in August. Only one generation occurs each year.

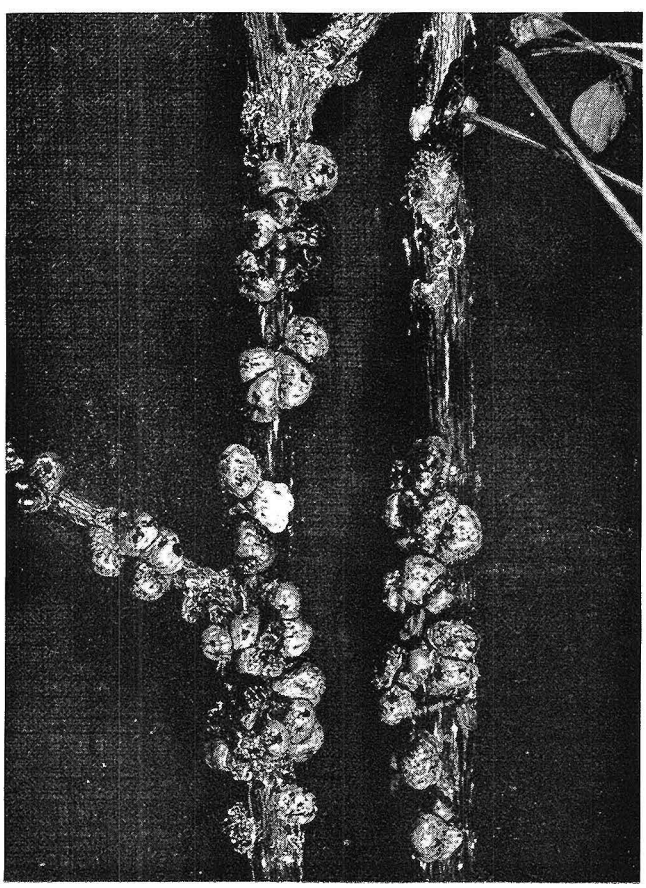

Fig. 3.—Mature females of tuliptree scale on tulip poplar.

Fig. 4.—The hibernating form of tuliptree scale (enlarged).

Cottony Maple Scale, *Pulvinaria innumerabilis* (Rathvon)

The cottony maple scale is primarily a pest of silver maple but occasionally occurs on basswood or linden. The insects live during the winter as very small, flat, brown objects on the twigs of the tree. They grow rapidly in the spring and become conspicuous in early June. A mass of white fibers is produced in which many eggs are deposited (Figure 5). The eggs hatch in late June or early July. Only one brood occurs each year.

Sometimes the scale insects appear in great numbers, particularly where many silver maples occur as shade trees. The insects produce quantities of honeydew which may drip from the trees. A black, sooty fungus may grow on the secretion where it falls on the leaves, giving the foliage a black appearance.

When outbreaks of this pest occur, the insect is attacked by natural enemies and thus the pest usually disappears after 2 or 3 years. However, branches of trees may be killed and an occasional tree may die if no control measures are used.

Fig. 5.—Adult females of the cottony maple scale with eggs in masses of white fibers.

Cottony Maple Leaf Scale, *Pulvinaria acericola* Walsh & Riley

The cottony maple leaf scale closely resembles the cottony maple scale but is somewhat smaller. The adult females occur primarily on the leaves of the host (Figure 6). The young nymphs feed for a time on the leaves but migrate to the twigs and branches in the fall before the leaves fall from the trees. In

Fig. 6.—Adult females of the cottony maple leaf scale with eggs in masses of white fibers.

late April or early May, most of the females return to the leaves. Only one generation occurs each year.

This species causes less damage in Ohio than *P. innumerabilis*. However, it may cause early dropping of the leaves and perhaps death of twigs and branches.

Euonymus Scale, *Unaspis euonymi* (Comstock)

The euonymus scale is one of the more troublesome pests of ornamental plants because it multiplies rapidly and is difficult to control. It attacks most species of *Euonymus* and may occur on bittersweet and *Pachysandra*. The tiny insects may cover the stems and leaves (Figure 7). It is not unusual for a plant to be killed if no control measures are employed.

The mature female is about 1/16 inch long. It is roughly pear-shaped and grayish-brown. The males are snow white, somewhat narrower than the females, and have three longitudinal ridges. They sometimes become so abundant on a plant that the stems and lower surface of the leaves appear gray.

The insect lives during the winter as a mature female. Crawlers of the first brood begin to appear in early May in northern Ohio and may continue to appear throughout June. The young crawl for a short distance and then insert their thread-like mouth parts into the plant and begin feeding. They lose their legs at the first molt, after which the females are stationary. The males are stationary until they become full grown; then they change to winged insects.

At least two generations of this species occur each year. Crawlers of the second generation begin to appear during the last half of July. After that, all stages of the insect are present on a plant until cold weather appears.

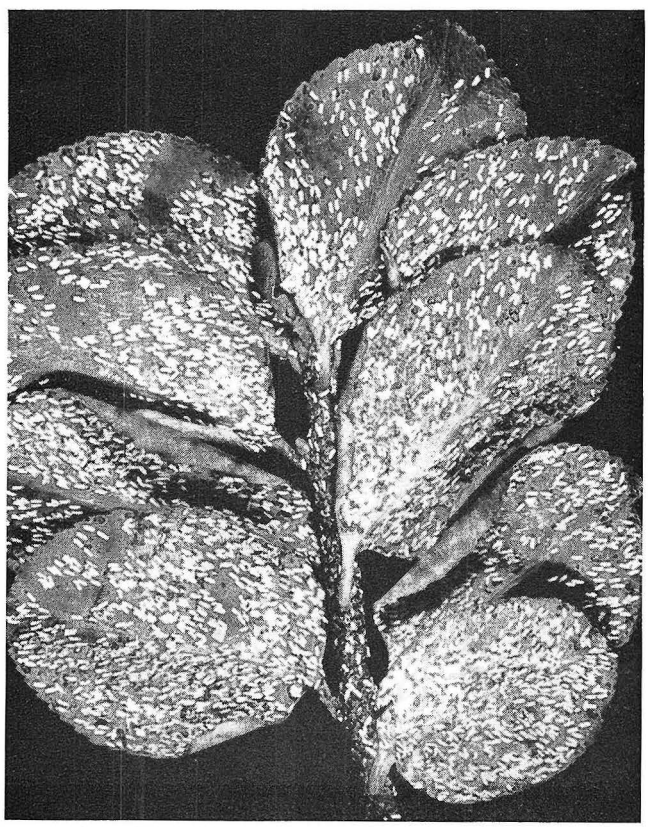

Fig. 7.—The euonymus scale on *Euonymus vegetus*. The conspicuous white individuals are males. Brownish females can be seen on the stem.

San Jose Scale, *Aspidiotus perniciosus* Comstock

Houser (12) reported the San Jose scale to be the most destructive scale insect of fruit trees in Ohio and that it causes severe injury to ornamentals. The insect has been less troublesome in recent years.

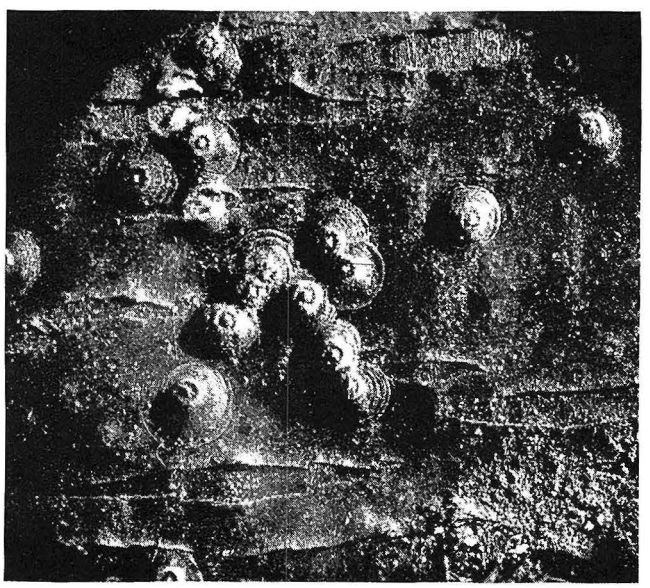

Fig. 8.—Mature San Jose scales (highly magnified).

However, it sometimes occurs on a rather large group of trees and shrubs, including *Pyracantha, Cotoneaster,* Japanese quince, redbud, and most fruit trees.

The insect lives during the winter in a very immature condition. Mature females are flat, circular, and about 1/12 inch in diameter, with a slightly raised central area or nipple which is dark or yellow (Figure 8). Females become mature during the latter part of June and begin giving birth to living young. One female may produce 200 or more young over a period of several weeks. Three or four generations may occur during a year and all stages of development are present during the summer.

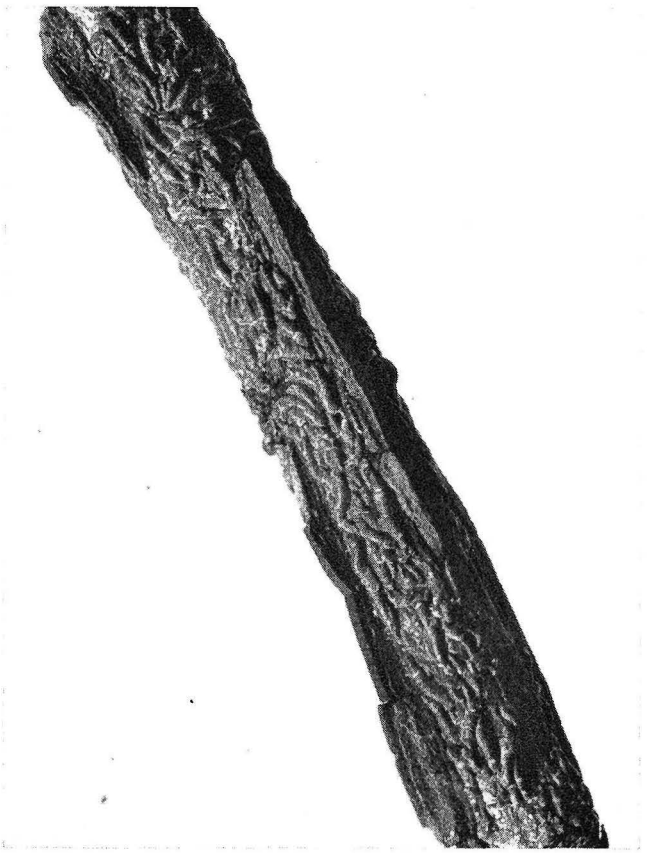

Fig. 9.—Winged euonymus scale on a twig of *Euonymus alatus compacta.*

Putnam Scale, Aspidiotus ancylus (Putnam)

The Putnam scale closely resembles the San Jose scale. It differs by being dark gray to nearly black in color and by having a brick-red nipple, which is off center. It lives during the winter in a partly-grown condition but somewhat more developed than overwintering San Jose scales.

Egg laying and hatching occur over a period of several weeks in early summer. Only one generation occurs each year.

Silver maple and linden seem to be the favored hosts of the Putnam scale but it may occur on ash, elm, hackberry, and other trees and shrubs.

Winged Euonymus Scale, *Lepidosaphes yanagicola* Kuwana

Lepidosaphes yanagicola Kuwana, a scale insect which resembles the oystershell scale, was first found and identified in Ohio in 1950. By the fall of 1951, it was already widely distributed. Infestations were found in nurseries in Lake County, as well as at Springfield, Mansfield, and Avon Lake. It has no approved common name. In Ohio it has been observed only on *Euonymus alatus* and *E. alatus compacta* (Figure 9).

This scale lives during the winter primarily as an immature female but occasionally eggs may survive. First-generation egg laying begins in early June and a second generation begins to appear about the end of July. As many as 45 eggs were counted under one female. By fall, the insects are present in all stages of growth.

Oystershell Scale, *Lepidosaphes ulmi* (Linnaeus)

Houser (12) described the oystershell scale as the most destructive shade tree and forest scale insect in Ohio. It has been recorded on many host plants but has caused most damage to lilac in Ohio. It also occurs commonly on poplar, grape, *Pachysandra,* and peony.

As the name indicates, the scale insect resembles a miniature oyster shell. The mature female is about 1/8 inch in length (Figure 10). The insect lives during the winter in the egg stage, well protected by the scale of the parent female. The eggs are oval and pearly white in color. As many as 100 may occur under the scale of one female. The eggs hatch in late May or very early in June in northern Ohio. Only one generation occurs each year.

As shown in Figure 10, it is not unusual for the insect to occur in sufficient numbers to form a crust on branches of a host plant. Such branches lose vigor and may be killed.

Fig. 10.—Oystershell scale on lilac (enlarged).

Fig. 11.—A pit-making oak scale infestation collected at Painesville, Ohio.

Pit-Making Oak Scales

Three species of pit-making scale insects are known to attack oak trees in Ohio. These are *Asterolecanium variolosum* (Ratzeburg), *A. minus* Russell, and *A. quercicola* Bouche. The common name of the first species is the golden oak scale. The others have no approved common names. The three species are so similar that special training and study are required to distinguish them.

Wherever an immature individual of either species settles on the bark of a host plant, a small pit or depression results and the insect appears to be embedded in the bark (Figure 11). The depression remains after the scale insect is dead. Consequently, the twigs and small branches of a heavily infested tree become quite rough. Infestations are usually most severe on the lower branches of a tree and it is not unusual for such branches to be killed.

Only one brood of each of the three species occurs annually. All live primarily as adult females during the winter. They are circular, somewhat convex, purplish-brown, and approximately 1 mm in diameter.

Houser (12) reported infestations of *A. variolosum* in Cincinnati, as well as in northeastern Ohio. English oak and white oak were found infested. Newly hatched crawlers were found as early as May 11 at Cincinnati and as late as July 19 at Cleveland.

Griswold (9) recorded the collection of specimens of both *A. minus* and *A. quercicola* in Ohio which were identified by Louise M. Russell. *A. minus* was obtained from five locations in northeastern Ohio and was recorded on white, red, pin, chestnut, swamp white, scarlet, and bur oak. He reported newly hatched crawlers beginning to appear in late May or early June and continuing to appear for 11 weeks.

A. quercicola was found at Shaker Heights on English oak. Collections were brought to Wooster and grown on both English and chestnut oak. However, attempts to rear the insect on pin oak and bur oak were not successful.

Griswold recorded mature females of this species to be slightly larger and to contain more eggs than those of *A. minus,* averaging 60 eggs per female compared with 40 for *A. minus.* Houser (12) recorded an average of 50 eggs per female for *A. variolosum.*

Fig. 12.—The lower surface of a sweetgum leaf infested with sweetgum scale.

Young crawlers of *A. quercicola* began to appear on June 8 and continued to appear for 4 weeks.

Sweetgum Scale,
***Diaspidiotus liquidambaris* (Kotinsky)**

This scale insect has been observed only on sweetgum. During the summer, it occurs primarily in pockets on the lower surface of the leaves (Figure 12) and small galls, somewhat discolored, occur on the upper surface. In the fall, another brood congregates primarily on the twigs and on or near the buds (Figure 13). As many as 20 individuals were counted on one bud.

The scale of the mature female is circular, convex, light in color, and slightly more than 1 mm in diameter.

Kosztarab (14) reported that the insects overwintered as mature, unmated females and as males in the pupal stage, and that all eggs were hatched by June 19 at Columbus. Apparently two broods occur during a season.

This insect causes damage primarily to the foliage but damage is seldom sufficient to warrant control measures.

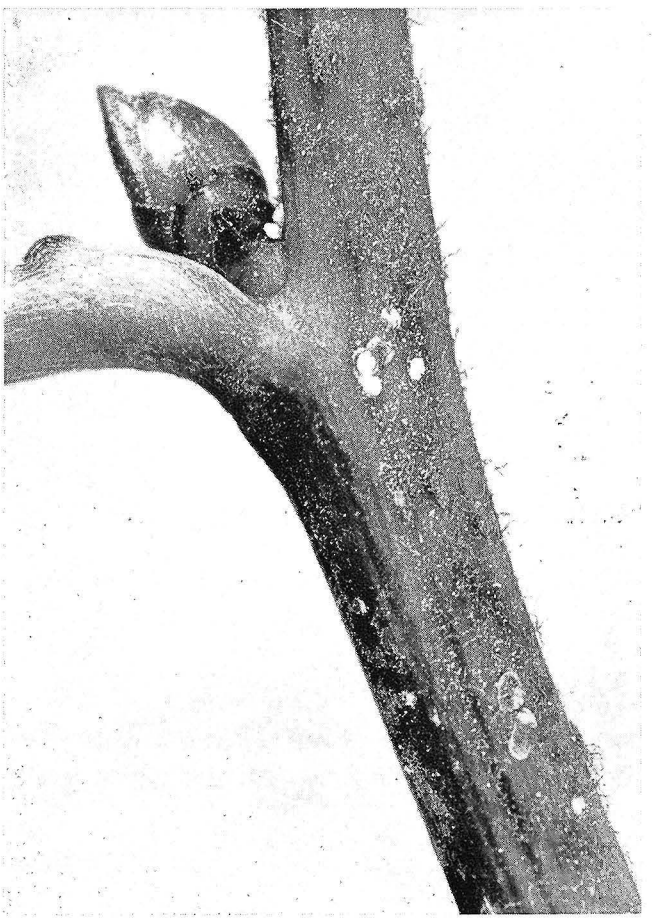

Fig. 13.—An infestation of sweetgum scale on a sweetgum twig in October.

Fig. 14.—Well-grown pine tortoise scale on Scotch pine.

SCALE INSECTS ON CONIFERS

The life histories and habits of scale insects on evergreens are similar to those of scale insects on deciduous trees and shrubs. However, it is not unusual for some species, such as the pine needle scale, to live almost exclusively on the foliage.

Pine Tortoise Scale,
***Toumeyella numismaticum* (Pettit & McDaniel)**

The pine tortoise scale is occasionally a pest of Scotch pine in Christmas tree plantations in Ohio. It also has been reported on red, Austrian, mugho, and jack pine. Infested trees are weakened and usually appear black because sooty fungus grows on the honeydew secreted in quantity by the scale insects (Figure 14).

Females are reddish brown, oval, and very convex. They may be as much as 1/4 inch in length when full grown. Egg laying usually begins during the first half of June and may continue for 3 weeks

but the eggs hatch within a few hours. The stage surviving the winter is primarily that of immature females. Only one generation occurs annually.

Pine Needle Scale, *Phenacaspis pinifoliae* (Fitch)

The pine needle scale is particularly troublesome on ornamental plantings located in or near towns and cities. It is a conspicuous white scale insect known to occur throughout the United States and southern Canada, although it causes most damage in states east of the Mississippi River. It attacks most species of pine and spruce trees and may attack hemlock and Douglas fir.

As its name implies, the insect feeds on the needles. The mature female is about 1/8 inch long and is white with a yellow pellicle attached at the anterior end (Figure 15). The scale usually widens toward the posterior end but the shape varies somewhat with the shape and width of the needles on which it occurs. On the needles of white pine, the female scales are very slender. They are usually broader on evergreens with broader needles. The male is also white and quite slender but is not more than half as long as the female.

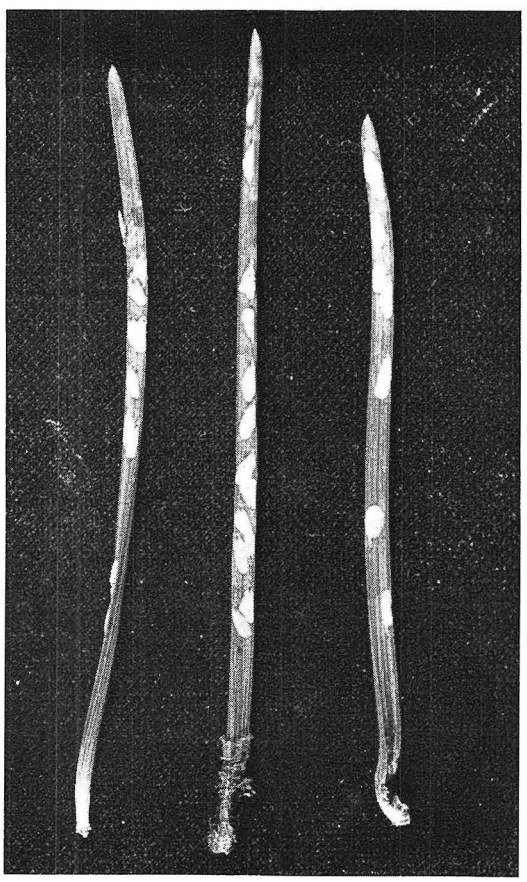

Fig. 15.—Needles of Scotch pine infested with pine needle scale.

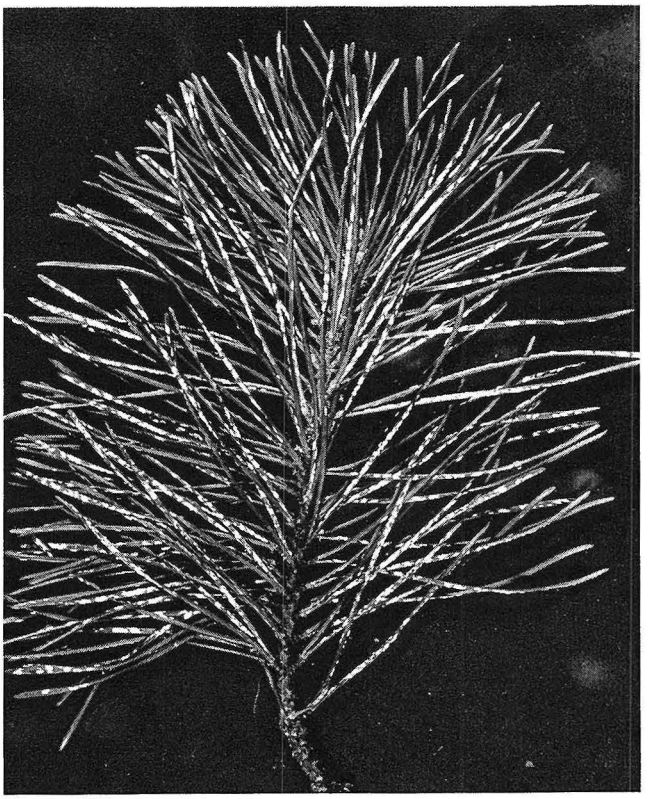

Fig. 16.—A pine twig heavily infested with pine needle scale.

Sometimes the scale insects become so abundant that the infested plants present a gray, unhealthy appearance (Figure 16). When the attack is severe, the needles become yellow and parts of branches or the entire tree may die.

The life history of the pine needle scale varies with climatic conditions. Two generations occur annually in Ohio. The insect lives during the winter in the egg stage. As many as 30 oblong, reddish eggs may occur under the dead scale covering of the parent female. In northern Ohio, these overwintering eggs usually hatch in early May.

The newly hatched crawlers move from beneath the dead remains of the parent female and soon begin feeding on the green needles. At the first molt, the tiny insects lose their legs and remain stationary until they become full grown. The males then change to tiny, winged creatures which emerge from the scale covering and mate with the females.

The females of the spring generation reach maturity during July in northern Ohio and produce the eggs of the first generation. This generation reaches maturity in the fall, when the reddish-purple eggs are produced which survive the winter.

Sometimes a relatively high percentage of pine needle scales are destroyed by natural enemies. Predators such as larvae and adults of lady bird beetles and larvae of lacewings may attack them.

Fletcher Scale, *Lecanium fletcheri* Cockerell

Fletcher scale is widely distributed throughout the eastern and midwestern United States and Canada (33). In Ohio it causes most trouble on various species of yew and is sometimes called the *Taxus* lecanium. However, it also occurs on arborvitae and juniper. The foliage on the inner portions of a heavily infested plant is often black because of the sooty fungus growth on the secretion produced by the scale insects.

The mature female scale insect is yellowish-brown, hemispherical in shape, and about 1/6 inch in diameter. One individual may produce 600 to 800 eggs during the latter part of June. The crawlers of the new brood usually appear during the first half of July. Only one generation occurs each year. The insect lives during the winter as a small, flat-bodied form which is light brown.

Juniper Scale, *Diaspis carueli* Targioni-Tozzetti

The juniper scale is one of the more troublesome pests of ornamental evergreens. It is primarily injurious to juniper but has been reported on arborvitae, incense cedar, and cypress (24). Badly infested plants make poor growth and assume a grayish-brown appearance.

Scales pass the winter in an immature condition and reach the adult stage during May in northern Ohio. The scale covering of the mature female is white with a yellow center. It is round, slightly convex, and about 1/20 inch in diameter (Figure 17).

The scale covering of the male is also white. It is smaller than that of the female and is long and narrow. The males pupate under the scale covering and later emerge as winged insects. Males are active during July and August but disappear in early fall and only the fertilized females survive the winter.

Egg laying begins during the last half of May and newly hatched crawlers appear throughout the month of June. The number of eggs found under individual females in early June, when eggs began hatching, varied from 15 to 28. After the crawler stage, the female attaches herself to the host and remains in the same position during the remainder of her life. Only one generation occurs each year.

Winter mortality varies greatly with weather conditions. Observations made after each of four winter seasons showed it to vary from 13 to more than 95 percent. For that reason, control measures may be more effective in the fall than at other seasons of the year. Sprays which do not kill all of the scale insects during the summer months may, if applied in the fall, weaken the young scale insects so they do not survive the winter.

APHIDS

Many species of aphids or plant lice occur on trees and shrubs in Ohio. These are soft-bodied, winged or wingless, insects which for the most part are gregarious. Their mouth parts are fitted for piercing the food plant and sucking its juices. Several generations usually occur annually and in some cases complicated life history patterns occur.

Aphids commonly produce a secretion known as honeydew. When the insects occur in large numbers on a shade tree, this secretion may drip from the tree and become a nuisance. Where the secretion falls on foliage, a sooty fungus may grow and cause a black discoloration. Occasionally aphids on a tree in a picnic area become a nuisance in the fall by dropping or crawling from an infested tree.

Aphids sometimes occur in large numbers on woody ornamentals. However, they are commonly attacked by natural enemies which often control the population before severe injury results. Because most

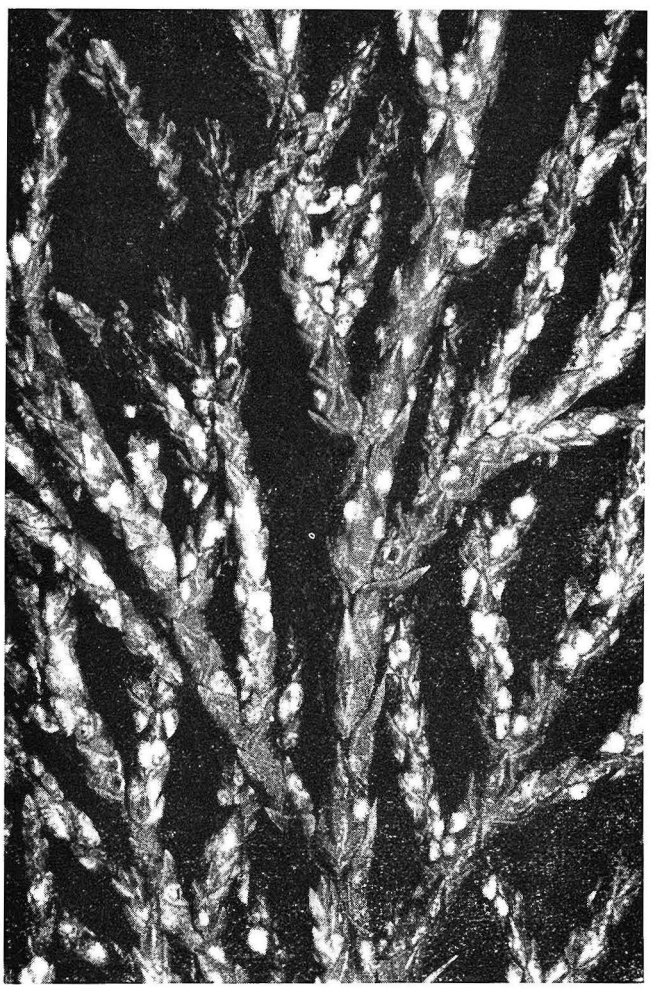

Fig. 17.—An infestation of juniper scale on Pfitzer juniper.

Fig. 18.—A colony of woolly apple aphids on scar tissue at the base of a nursery apple tree.

species can be controlled readily by spraying trees whenever an infestation develops, only a few species are discussed. These have peculiar life histories and habits which help to govern the control measures employed.

Woolly Apple Aphid, *Eriosoma lanigerum* (Hausmann)

The woolly apple aphid is primarily a pest in nursery plantings of apple trees. As many as 40 percent of the trees dug in one year may be infested and it is not unusual for 10 percent to be discarded because of nodules on the roots if control measures are not employed.

This insect demonstrates two separate life histories. In one case, the insect lives during the winter in the egg stage on the twigs of elm trees. The eggs hatch in the spring and the aphids feed on the elm leaves, which they cause to curl into a rosette (5). Winged aphids develop in this rosette and fly to apple. In northern Ohio, this usually occurs during the first half of June.

On nursery apple trees, colonies form which are brownish to purple, covered by an abundant, bluish-white, woolly excretion. These usually occur on trunk wounds or pruning scars near the ground (Figure 18).

During the summer, some aphids move to the roots, probably with the aid of ants which like the honeydew. In the fall, winged forms occur in both the aerial and root colonies. These return to elm where the sexual forms are produced and the eggs are laid which live through the winter.

Aphids remaining in the aerial colonies on apple are killed by winter weather but those on the roots survive and continue reproduction year after year. The colonies on the roots cause the damage to nursery apple trees. Their feeding results in gall-like formations (Figure 19) which increase in size from year to year if the infestation persists.

Pine Bark Aphid, *Pineus strobi* (Hartig)

The pine bark aphid is rarely seen because it is hidden beneath a mass of white, cottony secretion. These cottony masses occur in great abundance on the

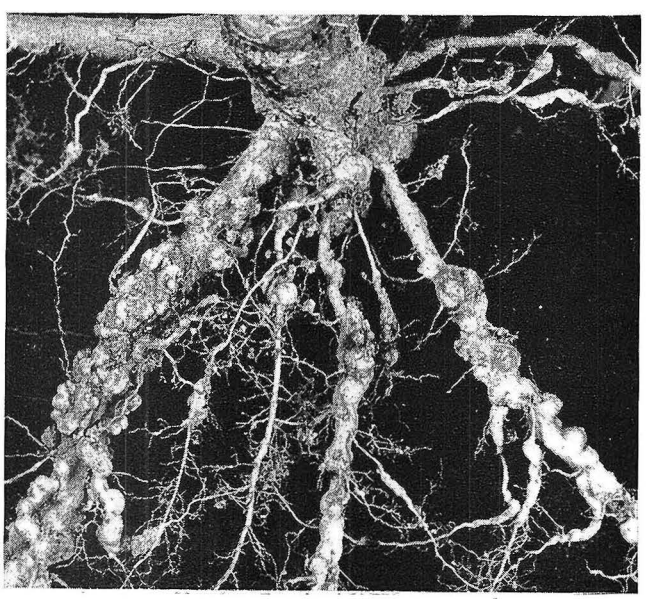

Fig. 19.—Nodules caused by the woolly apple aphid on the roots of an apple tree growing in a nursery.

trunk and large branches of white pine (Figure 20). Small trees may be killed.

The pine bark aphid overwinters as a mature female within the protection of the cottony secretion. Reproduction begins early in the spring and may continue throughout the summer.

MITES FEEDING ON FOLIAGE

Several species of mites attack trees and shrubs, particularly in nurseries. During each of the past 9 years, mite species have been recorded by Ohio nursery inspectors more often than any other pest. Mites are related to spiders and are not insects. However, the injury to plants caused by mites is often similar to that caused by small sucking insects.

Although it is important that nurserymen and those doing tree and landscape service know how and when mites can be controlled, it is not essential that they learn to identify the species. The five species discussed in the following paragraphs cause similar types of injury. All can be controlled effectively during the summer months with modern miticides.

Two-Spotted Spider Mite,
***Tetranychus urticae* (Koch)**

The best known mite species is the two-spotted spider mite (Figure 21), which is often designated as the common red spider. It feeds on the lower surface of the leaves of many species of deciduous trees and shrubs by sucking the plant juices. Infested leaves become stippled with gray and may be covered with webs in severe cases.

Two-spotted spider mite females hibernate in the adult stage wherever they find protection. The adult is too small to be seen clearly without the aid of a lens,

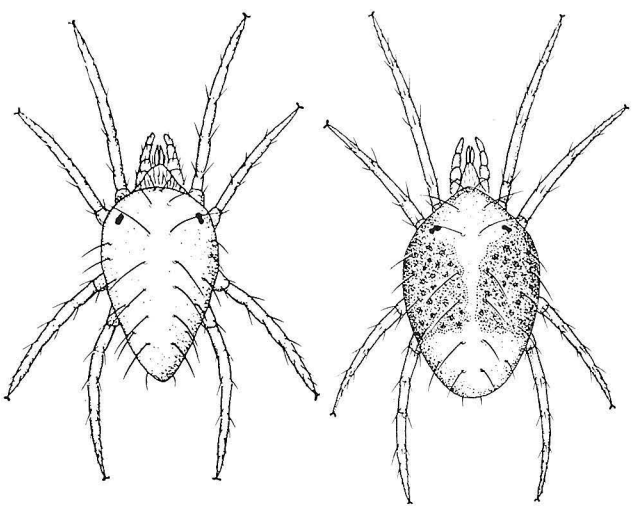

Fig. 21.—The two-spotted spider mite (from drawings by Dr. R. W. Rings). Male is at left and female at right.

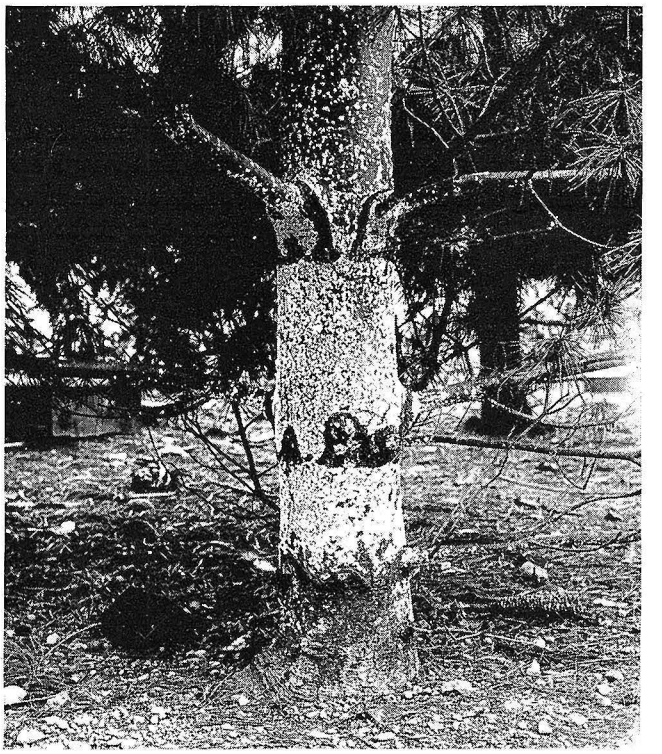

Fig. 20.—An infestation of the pine bark aphid on white pine.

being about 1/50 inch in length. It is usually green with a dark blotch on each side but those in hibernation have a bright orange color. Adult females deposit globular eggs on the lower surface of the leaves where they feed.

The length of the life cycle varies greatly but in warm weather may be completed in 9 days. Consequently, a mite population may build up rapidly.

Spruce Spider Mite,
***Oligonychus ununguis* (Jacobi)**

The mite species occurring most commonly in Ohio nurseries is the spruce spider mite. As the name indicates, this is a pest of all species of spruce. It also occurs commonly on arborvitae and juniper and sometimes attacks larch. It has been observed on pine in significant numbers only after the trees were sprayed with an insecticide which killed natural enemies of the mites.

Infested evergreen foliage loses its bright green color and becomes gray or brown. The spruce spider mite is similar to the two-spotted spider mite in size and feeding habits. Its color varies from dark green to dark brown. Only orange-colored eggs on the needles and twigs of the host plant survive the winter. The eggs hatch early in the spring and reproduction continues throughout the summer. A new generation may occur in about 17 days.

European Red Mite, *Panonychus ulmi* (Koch)

The European red mite is primarily a pest of fruit trees in Ohio nurseries but may occur on flowering crab and hawthorn in ornamental plantings. It is similar in size and feeding habits to the two-spotted spider mite but the adults may be brick red in color and do not have the dark blotches commonly occurring on that species. Like the spruce spider mite, the European red mite overwinters in the egg stage.

Southern Red Mite, *Oligonychus ilicis* (McGregor)

The southern red mite seldom causes trouble in home gardens but sometimes attacks holly and azalea in Ohio nurseries. It causes foliage injury similar to that caused by the two-spotted spider mite and the European red mite. Like the spruce spider mite and the European red mite, it overwinters in the egg stage on the host plant. A dormant spray can sometimes be used for control of these three species.

Honey Locust Mite, *Eotetranychus multidigituli* (Ewing)

The honey locust mite is known to occur only on honey locust. It feeds primarily on the lower surface of the leaves and frequently causes leaflets to turn yellow and fall prematurely. It is slightly smaller than the two-spotted spider mite and, like that species, overwinters as orange-colored females. These occur in rough bark at the base of twigs and under bud scales. Sometimes they congregate in large numbers on a specific area of the bark, where they form a conspicuous orange-colored area. Others may crawl from the tree to hibernate in debris on the ground.

OTHER SUCKING INSECTS

Grape Mealybug, *Pseudococcus maritimus* (Ehrhorn)

Investigations on the biology and control of *Pseudococcus maritimus* (Ehrh.) on *Taxus* in Ohio were reported by Neiswander (28). Although the grape mealybug is widely distributed and is known to attack many host plants, its damage in Ohio has been limited primarily to grapes and *Taxus*.

On *Taxus*, the insect overwinters in the first instar within the shelter of a mass of white waxy threads produced by the parent female. It is further protected by bits of dead foliage, scales of bark, and other debris webbed together. Most of the mealybugs occur in the interior of the plant near the main stem (Figure 22). During April and May, the tiny mealybugs leave their winter quarters and establish themselves on the twigs where they feed.

The adult stage is reached during the latter half of June, when eggs are deposited in masses of white

Fig. 22.—A grape mealybug infestation on *Taxus*. White fibers were produced during the process of oviposition.

fibrous material. Newly hatched crawlers of the summer brood appear during the last few days of June and the first half of July. They soon leave the cottony masses and begin feeding on the foliage. Some reach the adult stage during August and eggs which produce the overwintering brood were found as early as August 30. However, egg laying may continue until late fall and hatching continues from mid-September until cold weather appears. Eggs which failed to hatch before cold weather were shriveled and discolored in the spring.

Mealybug eggs on *Taxus* are frequently attacked by natural enemies. A predator, *Sympherobius amiculus* (Fitch), and a parasite, *Pseudleptomastix* sp., were reared in significant numbers from egg masses collected in nurseries in northern Ohio. Mealybugs do not often cause damage to *Taxus* in ornamental plantings in Ohio, apparently because of the work of

natural enemies. However, the use of insecticides is sometimes advisable in extensive nursery plantings, particularly on varieties with dense foliage. Sprays have been most effective during the latter part of May, in early June, and again in August when no eggs are present and all of the mealybugs are feeding on the foliage.

Lace Bugs

Several species of lace bugs occur on trees and shrubs in Ohio. They take their name from the characteristic lacy wing covers and hood. The adults vary in length from 1/8 to 1/4 inch. In Ohio, information has been requested most frequently on two species, the hawthorn lace bug, *Corythuca cydoniae* (Fitch), and the rhododendron lace bug, *Stephanitis rhododendri* Horvath.

Infestations of the hawthorn lace bug (Figure 23) were studied briefly at Wooster (20). The insect is known to attack *Cotoneaster,* juneberry, buttonbush, grape, and quince, as well as hawthorn. In this study, the insect occurred in large numbers on *Cotoneaster* and quince.

Infested leaves become spotted with brown as the chlorophyll is destroyed. The lower surface is covered with excrement, remains of eggs, and cast skins (Figure 24). The upper surface has the usual stippling caused by sucking insects. Quince foliage in a small quince orchard was completely brown by October 20 as a result of the injury. Early in the next spring, many adults were found in hibernation in the debris under *Cotoneaster* plants but none could be found in the quince orchard.

The insects emerged from hibernation and began laying eggs during the last half of May, with egg laying continuing until about June 15. The eggs were laid on the lower surface of the leaves, usually near the midrib. They were well embedded in the leaf and covered with a prominent black substance. The average incubation period was 18 days. By July 15, only adults could be found and no young were found later in the year, indicating only one generation annually.

Fig. 23.—The hawthorn lace bug on a *Cotoneaster* leaf (enlarged).

Fig. 24.—*Cotoneaster* leaves (lower surface) injured by the hawthorn lace bug.

The rhododendron lace bug attacks mountain laurel and azalea, as well as rhododendron. Foliage injury is similar to that described for the hawthorn lace bug. However, two generations occur annually (4) and the insect lives during the winter in the egg stage.

GALL MAKERS

A plant gall has been described as a swelling, or excresence, of the plant tissues resulting from the attack of certain parasites. Galls have been known for more than 2000 years. They may be caused by various types of organisms (27) but the greatest number are caused by insects. More than 1000 species of gall makers of the hymenopterous family Cynipidae have been described but relatively few cynipid gall makers cause economic damage.

Galls are also produced by moths, beetles, aphids, midges, jumping plant lice, and mites. A relatively large proportion of the gall makers requiring control measures are members of the last four groups.

Fig. 25.—Twig galls on hickory caused by the hickory gall aphid. Photo taken after the galls opened and insects were no longer present.

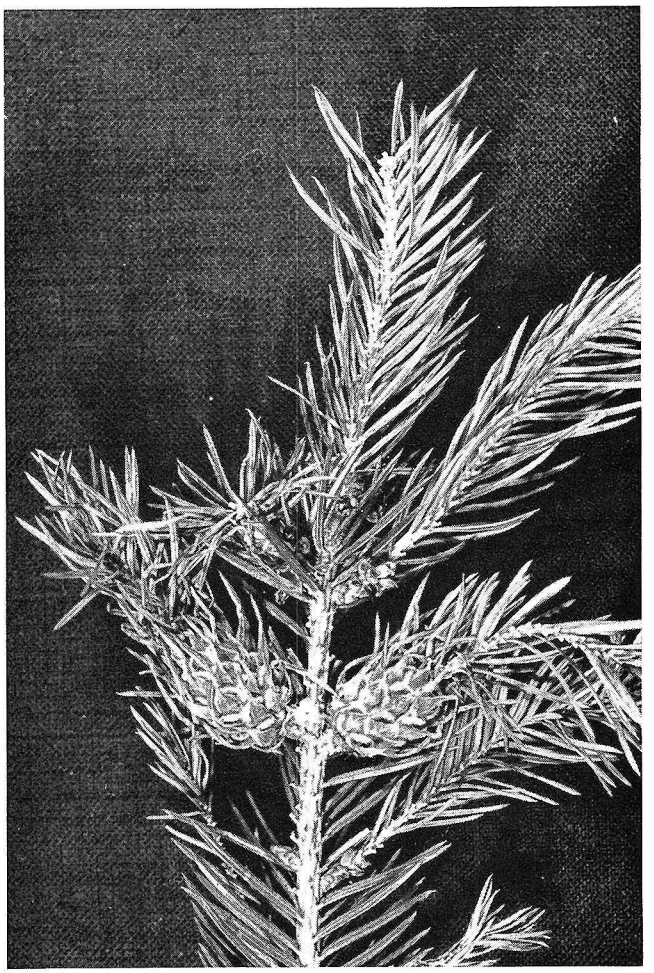

Fig. 26.—Galls caused by the eastern spruce gall aphid.

APHID GALL MAKERS

Hickory Gall Aphid,
***Phylloxera caryaecaulis* Fitch**

Galls caused by the hickory gall aphid sometimes occur in large numbers on the twigs and petioles of prized hickory trees (Figure 25). The swellings vary from 1/4 to 1 inch in diameter and frequently girdle twigs, causing them to die and break at the point where a gall ocurs. Large trees have been observed which were noticeably weakened because of the loss of foliage.

The gall makers live during the winter as tiny black eggs in crevices of the bark of twigs. The eggs hatch in the spring when the buds begin to swell and the newly hatched aphids congregate on the swelling buds. As many as 12 were counted on one bud.

At this time of the year, after overwintering eggs have hatched but before galls are formed, the gall makers are exposed to the action of contact sprays.

The insects begin feeding as soon as green tissue is available and galls completely enclosing the insects

soon form in the rapidly growing twigs and leaf stems. The galls are almost spherical in shape. At first the galls are green but they turn brown or black in early summer when they break open and the insects escape.

Eastern Spruce Gall Aphid, *Chermes abietis* Linnaeus

The eastern spruce gall aphid lives during the winter as an immature female, usually located in a crevice at the base of a spruce bud. It begins feeding in early spring and in May deposits a mass of eggs which is covered with waxy threads.

The eggs hatch about the time the shucks break away from the bud and expose the new needles. The newly hatched aphids crawl into the mass of new needles to feed. The swelling needle bases develop into a compact mass and form the pineapple-shaped gall with many individual cells, each inhabited by aphids (Figure 26).

In late July or in August, the cells open and the aphids escape. These deposit the eggs producing the individuals which live during the winter.

Galls caused by this insect occur most commonly on Norway spruce but may occur on white, black and red spruce. An infestation does not spread rapidly from one tree to another. It is not unusual to find specific trees in a planting rather heavily infested year after year while other trees of the same species may escape injury.

Cooley Spruce Gall Aphid, *Chermes cooleyi* Gillette

Galls caused by the Cooley spruce gall aphid occur on Colorado blue spruce, Sitka spruce, and Engelmann spruce. The galls are somewhat larger than those caused by the eastern spruce gall aphid and occur on the tips of twigs. The growing gall varies from light green to dark purple. It may be 1 to 2 inches in length and 1/2 to 3/4 inch in diameter (Figure 27).

The life history of this aphid, when it remains on spruce, is similar to that of the eastern spruce gall aphid. However, some of the mature aphids emerging from a gall in July or August fly to Douglas fir to lay eggs. The eggs hatch into young aphids which live during the winter on fir and produce a new brood in the spring when growth appears. These feed on the new growth and may cause some distortion but do not form galls.

Some aphids develop wings and when mature fly back to spruce to deposit the eggs which produce the overwintering generation. Others are wingless and remain on Douglas fir, where they deposit eggs which again produce the overwintering aphids on fir.

Fig. 27.—Galls caused by the Cooley spruce gall aphid.

GALL GNATS OR MIDGES

Vein Pocket and Marginal Fold Gall Makers

Two species of gall gnats or midges which are similar in appearance and have similar life histories sometimes distort the foliage of pin oaks in Ohio. These are *Itonida foliora* Rssl. and Hkr., the marginal fold gall maker, and *Itonida* sp., the vein pocket gall maker. It is not unusual for both species to occur on the same tree.

The adults and full grown larvae measure between 1 and 2 mm in length (Figures 28 and 29).

Pin oaks have been observed on which vein pocket galls were present on nearly all leaves (Figure 30). When this occurs, the efficiency of the leaves is reduced but leaves are not killed.

The midge larvae live during the winter in the soil, usually near the surface. Adults emerge between April 15 and May 15 in northern Ohio, usually during a period of about 1 week. Oval, reddish-orange eggs are deposited primarily on the lower surface of the new leaves, with one end glued to the leaf. The incubation period is 4 to 5 days and the newly hatched larvae crawl to the upper surface of the leaf.

Larvae of *I. foliora* congregate along the leaf margins to feed and the leaf tissues there soon begin to thicken and fold upward. In approximately 2 days, the larvae are enclosed in marginal fold galls (Figure 29).

Larvae of *Itonida* sp. congregate along both sides of the main veins. There the leaf tissues form a pocket which encloses the insects.

The gall makers live inside the galls until September or October but drop to the ground a few days before the leaves fall.

Larvae in the galls are commonly attacked by predacious mites and thrips. A period of cold weather soon after egg deposition also may prevent the formation of galls. Because the leaves are not killed and an infestation usually disappears after 1 to 3 years, the need for control measures is questionable (29).

Honey Locust Pod Gall, *Dasyneura gleditschae* Osten Sacken

With the development of popular varieties of thornless honey locust trees and the increasing demand for these as shade trees, the work of the honey locust pod gall maker has attracted more attention (29).

The adult female gall maker is a small gall gnat which lays eggs on the growing tips of honey locust trees. The eggs hatch into larvae which feed on the partially developed leaflets. The leaflets fail to open but grow into oblong, rounded galls, each of which encloses a larva (Figure 31). When a larva is full grown, it changes to a pupa and eventually to an adult which emerges from the gall. The leaflet forming the gall usually continues to grow and becomes a functioning leaflet which is somewhat deformed. Three or more generations of this gall maker occur during a year.

Because the gall makers are attacked by natural enemies, the number of galls varies greatly. They may occur in great numbers one year and disappear a year or two later. They have been most troublesome in nurseries where rapidly growing thornless honey locust trees occur in large numbers. Control measures may be warranted in such nurseries but are seldom needed in ornamental plantings.

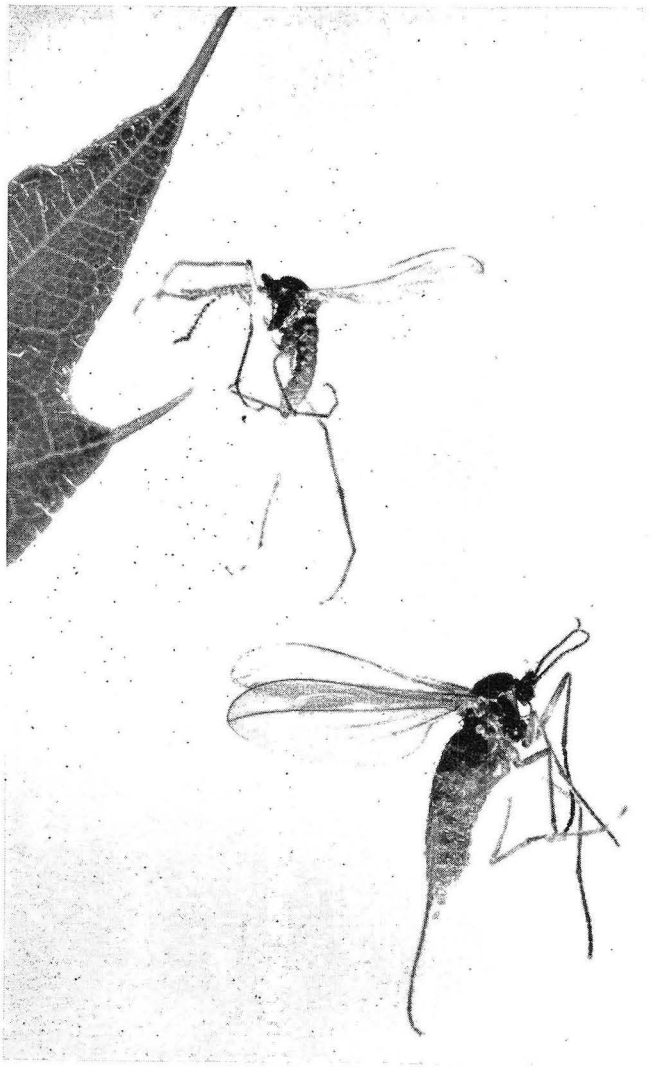

Fig. 28.—The marginal fold gall maker. Male above and female below.

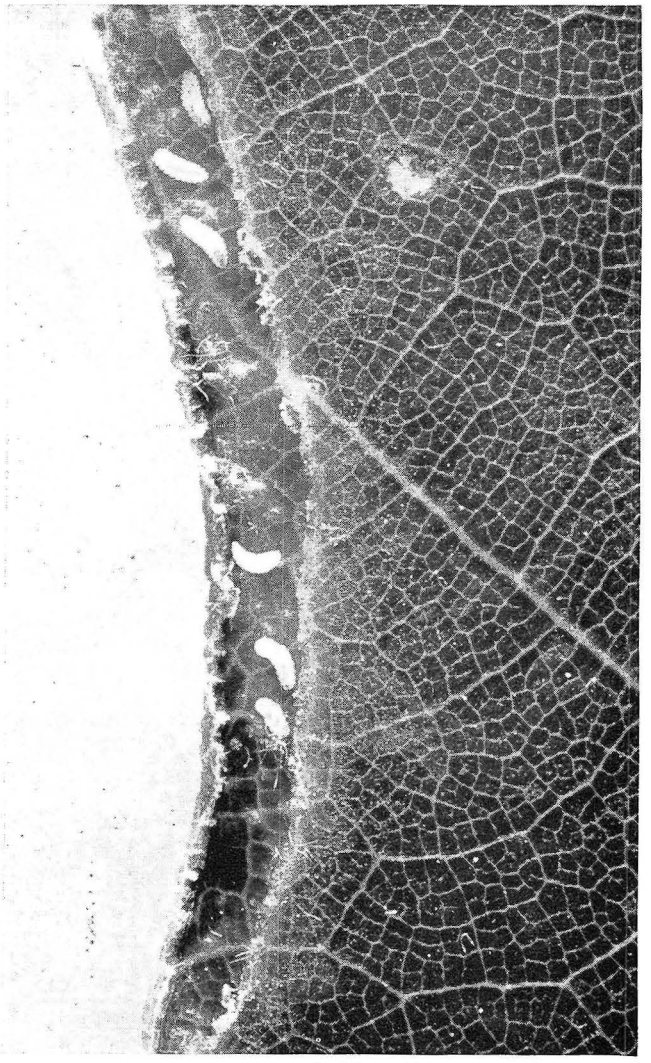

Fig. 29.—Marginal fold gall opened to show the midge larvae.

Juniper Midge, *Contarinia juniperina* Felt

This midge caused rather severe injury in two nurseries in Hamilton County in 1950. It occurred primarily on *Juniperus virginiana canaertii* and *J. v. glauca* and caused most damage on trees which were 3 to 4 feet in height. A small larva, by boring into a twig 1/2 to 3 inches below the tip, causes the death of the twig beyond that point. The brown discoloration was conspicuous by fall (29).

Only one generation of the juniper midge occurs each year. The larvae become full grown in late fall. At that time, they are bright orange and are approximately 1/8 inch long. They drop to the ground and enter the soil where they remain during the winter.

Hibernating larvae were collected in Hamilton County in early April 1951 by taking surface soil to a depth of approximately 1 inch under trees which had been heavily infested the previous season. The soil was taken to Wooster and placed in cages in the insectary. A total of 712 adult midges emerged from this material. Emergence began on May 8 and continued until May 22, with the peak of emergence occurring on May 17. The emergence of 176 parasites also was recorded. These were identified as *Platygaster* spp.

The most heavily infested planting was sprayed when the adult midges were emerging. No injury was evident in that planting and the trees soon regained their normal green color. The other planting was not sprayed and midge larvae could be found readily. However, the infestation was rather light. The next year the infestations were low in both plantings. Although the insect has been reported at times by nursery inspectors, no appreciable damage has been observed in Ohio since that time.

Juniper Tip Midge, *Oligotrophus apicis* Appleby & Neiswander

Injury caused by the juniper tip midge was first observed in Ohio in 1952 when an infestation was recorded in Canaert redcedar in Lake County (29). The insect, which had no name at that time, was studied in detail by James E. Appleby and was described by Appleby and Neiswander (3).

The injury caused by this insect occurs only in the growing tips and only the terminal bud is killed. However, in some cases, a relatively large percentage of the tips are infested, resulting in a more dense and bushy growth (Figure 32). A small larva can be found in each infested tip.

During the 10-year period following the discovery of this insect in 1952, the number of infested juniper plantings in Ohio increased significantly. In 1962,

Fig. 30.—Pin oak leaves distorted by vein pocket galls.

Fig. 31.—Honey locust pod galls caused by the honey locust pod gall maker.

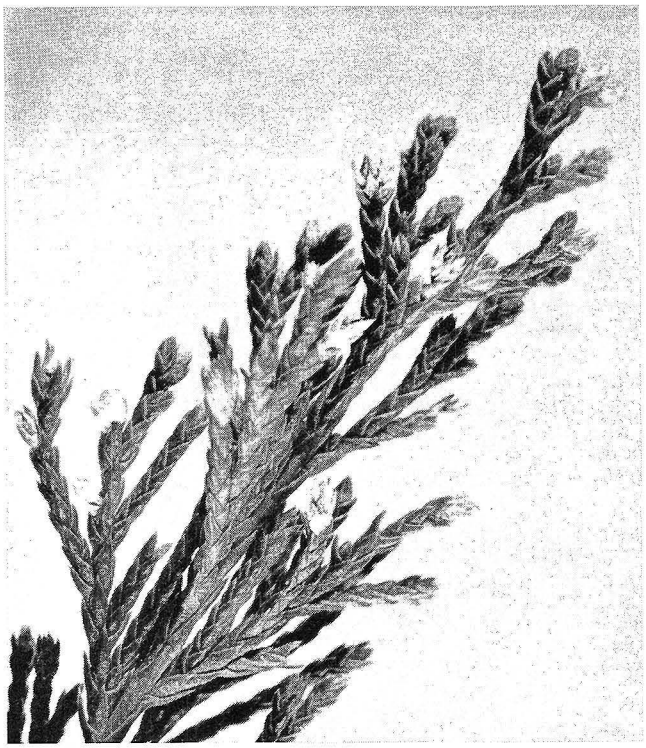

Fig. 32.—A juniper twig severely injured by the juniper tip midge.

infestations were reported in 88 nursery plantings in Ohio. The injury occurred most commonly in *J. v. canaertii, J. v. hilli,* and *J. horizontalis.* Infestations were reported in Illinois, Indiana, Michigan, and Pennsylvania.

The juniper tip midge lives during the winter as a well-grown, light yellow larva in its burrow. The larvae change to pupae in April and adults emerge in early May in northern Ohio. First generation larvae appear in the tips during the last half of May. Four generations occur during a season, with the adult midges occurring again in significant numbers in late June, early August, and mid-September. All stages of the insect are present in an infested planting from August until October.

Larval parasites have been a contributing factor in control of the juniper tip midge (2) but have not prevented the development of damaging populations in areas of Ohio.

PSYLLID GALL MAKERS

Hackberry Nipple Gall Maker, *Pachypsylla celtidismamma* (Riley), and Blister Gall Maker, *P. celtidisvesicula* Riley

Hackberry trees throughout Ohio are commonly attacked by these two gall makers (1). Both are members of the family Psyllidae, which includes the insects known as jumping plant lice.

Hackberry nipple gall maker (Figure 33) causes conspicuous, mammiform galls on the lower surface of hackberry leaves (Figure 34). The blister gall maker causes blister-like leaf galls which are smaller and less conspicuous but usually more abundant.

The two gall makers have similar life histories and are similar in appearance. However, *P. celtidismamma* is somewhat larger than *P. celtidisvesicula.* The adults appear in the fall, often in large numbers. They become troublesome by invading homes or accumulating in fresh paint.

The adults live during the winter in crevices of the bark of hackberry or other trees, as well as in cracks and crevices of buildings. They become active during April, when new growth begins to appear on hackberry trees. Egg laying may continue throughout most of May. Only one generation occurs each year.

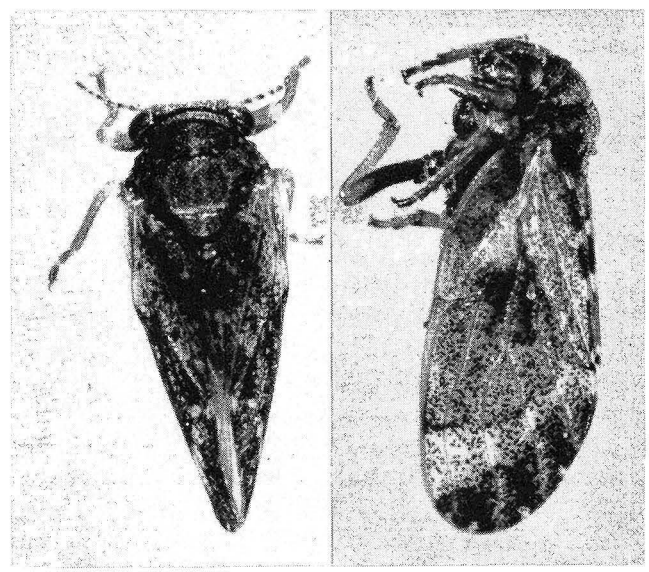

Fig. 33.—An adult of the hackberry nipple gall maker.

GALL OR BLISTER MITES

Many members of the mite family Eriophyidae cause galls or blisters. The members of this family may be called gall mites by some authors and blister mites by others but not all species cause galls or blisters.

Some species occur on trees and shrubs and cause conspicuous abnormalities which attract attention. However, most species cause no appreciable damage. Some may cause a rusty brown or hairy area on leaves and others a brightly colored patch known as erinium.

The eriophyid mites are too small to be seen clearly without a lens. Their bodies are elongated, as shown in Figure 36. Full-grown mites have two pairs of legs near the anterior end of the body.

Fig. 34.—Galls on the lower surface of hackberry leaves. Blister galls, left; nipple galls, right.

The following species frequently come to the attention of the Department of Zoology and Entomology, Ohio Agricultural Research and Development Center.

Maple Bladder Gall Mite, *Vasates quadripedes* (Shimer)

Maple bladder galls occur commonly on silver maple trees in Ohio. The galls are globular and are located on the upper surface of the leaves (Figure 35). They vary in size but the larger ones are approximately 1/8 inch in diameter. When first formed, the galls may be pink or green but they often become bright red and later almost black.

The gall maker is an eriophyid mite that is approximately 1/125 inch in length. The mites live during the winter in crevices of the bark of maple trees and crawl to the leaves when the new growth appears in the spring. They feed on the lower surface of the leaves by means of sucking beaks and, as a result, galls develop on the upper surface. As a gall enlarges, a cavity forms with an opening on the lower surface of the leaf. Then the mites feed and reproduce inside the galls.

In late summer, before the leaves begin to fall from the trees, the mites leave the galls and crawl to the twigs. They congregate there in folds or rough areas of the bark.

Maple bladder galls often become conspicuous, particularly on young trees. However, they cause no appreciable damage to a tree except to reduce its ornamental value.

Fig. 35.—Maple bladder galls on a silver maple leaf.

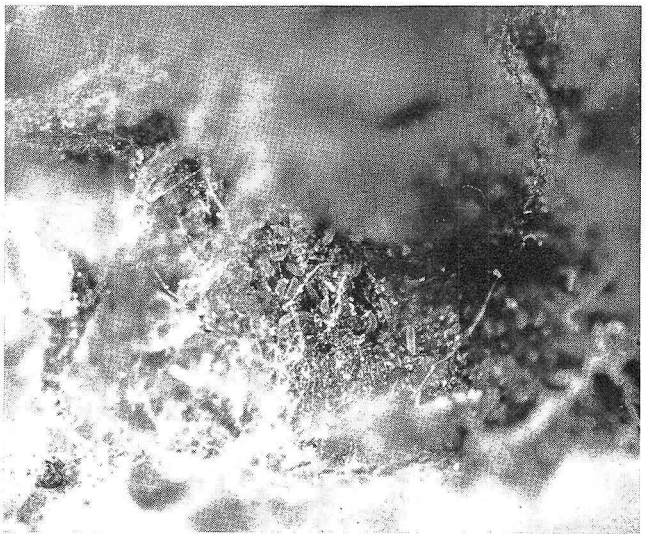

Fig. 36.—Ash flower gall mites hibernating in a fold of the bark (highly magnified).

Ash Flower Gall Maker, *Eriophyes fraxiniflora* Felt

The habits of the ash flower gall maker are similar to those of the mites which cause maple bladder galls. The mites live during winter on the twigs in rough areas of the bark (Figure 36). When the blossoms begin to form in the spring, the mites leave their hibernating quarters and feed on the male blooms. Their feeding results in the large abnormal growth shown in Figure 37. These structures are conspicuous and remain on the trees throughout the summer.

Although the galls are unsightly, they cause no appreciable damage other than destruction of the staminate blooms. Consequently, control measures are seldom warranted. However, both ash flower gall mites and maple bladder gall mites are subject to the action of dormant sprays because of the location of their hibernating quarters.

Tip-Dwarf Mite, *Eriophyes thujae* Garman

The tip-dwarf mite is primarily a pest of oriental arborvitae but often occurs on occidental arborvitae and sometimes attacks juniper. The mites occur in the growing tips which become constricted, crooked, and sometimes yellow. Because of the dwarfing of new growth, infested plants develop unevenly and the foliage appears rough.

Azalea Mite, *Vasates atlantazaleae* (Kiefer)

This eriophyid mite sometimes injures azaleas in Ohio nurseries. The tiny mites occur in the rapidly growing tips and as many as 1000 individuals were counted on the small leaves of a single tip (22). Such tips become stunted and rusty brown.

LEAF MINERS

Small insect larvae that feed between the layers of a leaf are commonly called leaf miners. In the adult stage, they may be sawflies, moths, beetles, or flies. Each species causes a characteristic type of tunnel or mine.

Seven species are discussed as rather severe pests of trees or shrubs. Another species, the oak skeletonizer, feeds for a time as a leaf miner but causes more damage and attracts more attention after it leaves its mine. For that reason it is listed among the defoliators (page 37).

Birch Leaf Miner, *Fenusa pusilla* (Lepeletier)

Frequently the foliage of white, gray, or paper birches becomes brown and unsightly early in the summer. Half or more of each leaf may be killed by small larvae which feed between the upper and lower surfaces of the leaf and devour the green tissues. The insect is known as the birch leaf miner. In the adult stage, it is a small bee-like insect known as a sawfly.

The larvae spend the winter in the soil. Adults appear during the first half of May and lay eggs in the

Fig. 37.—Ash flower galls on white ash.

new leaves. When the larvae become full grown, they emerge from the leaves and drop to the ground where they change to the adult stage. Three or four generations may occur each year, with larvae of the first generation appearing in late June. However, most damage usually results from the spring generation.

Holly Leaf Miner, *Phytomyza ilicis* (Curtis)

The holly leaf miner is the most troublesome insect pest of American holly in Ohio. Many leaves become disfigured and drop prematurely as a result of its damage. A severe infestation can retard the growth of a tree and may destroy its ornamental value.

The adult insect is a grayish-black fly about 1/10 inch long. In northern Ohio, the flies normally emerge during the last half of May. The peak of emergence usually occurs between May 15 and 20.

Eggs are deposited in punctures made in the lower surface of a leaf, usually near the midrib. The larvae mine just under the upper surface (Figure 38). At first the mines are thread-like and inconspicuous but in late fall they begin to widen into light blotches or blisters (Figure 39).

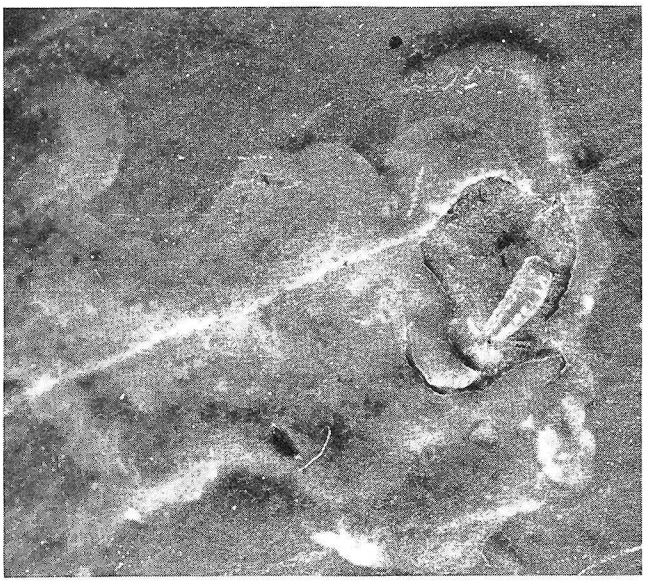

Fig. 38.—A mine in a holly leaf opened and enlarged to show leaf miner larva.

The larvae live in their burrows during the winter and change to pupae during April. At that time, the blotch-like mines may be nearly 1/2 inch in diameter. Only one generation occurs each year.

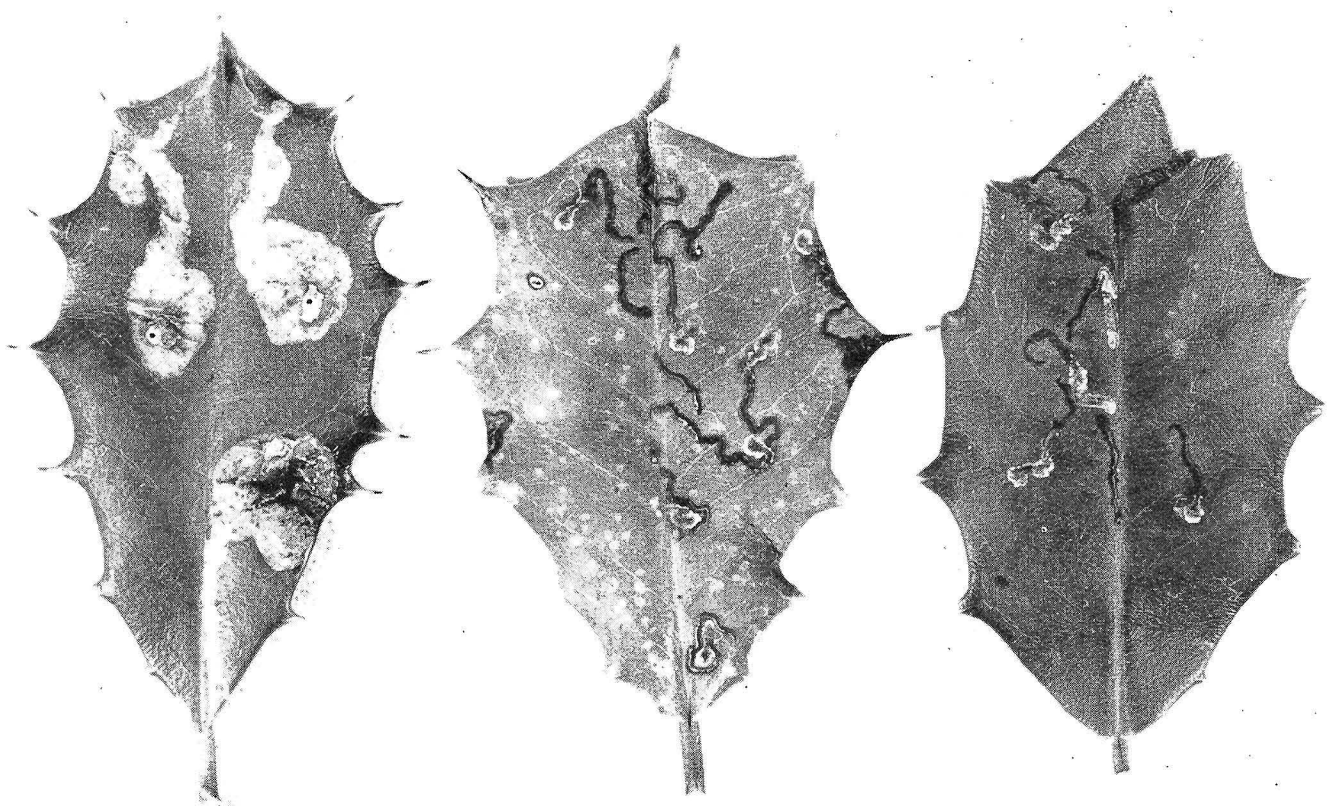

Fig. 39.—Holly leaf miner damage. Leaf at left contains blotch-like mines found in the spring. Those at right contain new mines which appear in late summer.

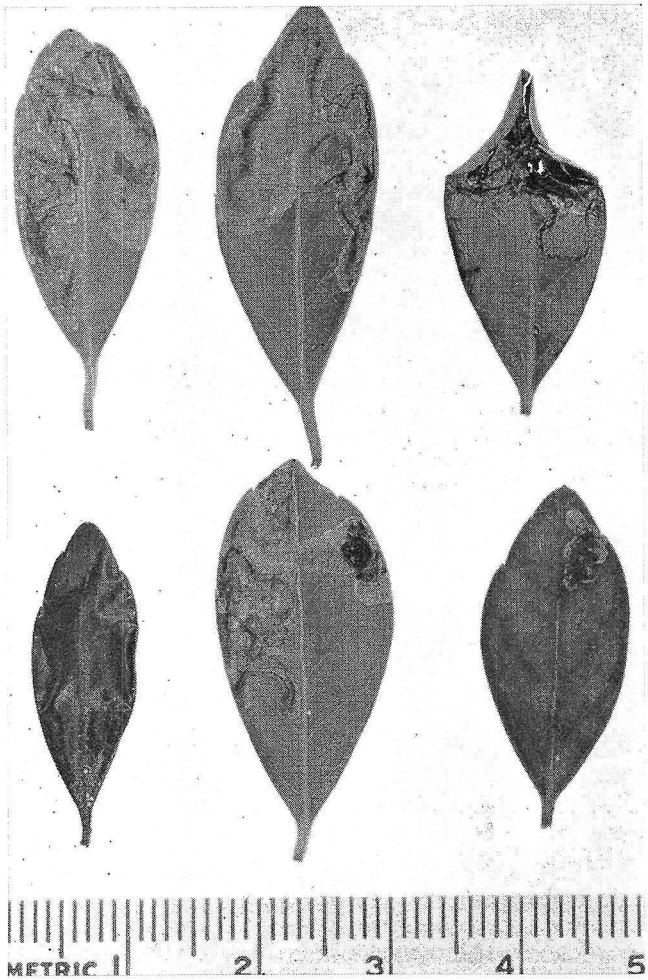

Fig. 40.—*Ilex glabra* leaves infested with leaf miner larvae.

Inkberry Leaf Miner, *Phytomyza weidhausii* Crafts

This leaf miner is similar to the holly leaf miner and sometimes causes damage on inkberry or *Ilex glabra* in Ohio (Figure 40). It has no approved common name.

Although it resembles *P. ilicis,* it has a much different life history. Two or more broods occur each year and in late fall larvae are present in various stages of growth. The insect lives in the larval stage during the winter and pupation occurs in the spring. Emergence of adults from wintering generations may occur throughout May. For this reason, sprays applied to kill the adults before oviposition need to be repeated for best results.

Azalea Leaf Miner, *Gracillaria azaleella* Brants

The azalea leaf miner is a pest of both outdoor and greenhouse azaleas in Ohio. Outdoors it has appeared in nurseries more commonly than in ornamental plantings. *Azalea mollis* has been attacked most commonly.

The adult insect is a small moth with yellow markings on the wings. The wing expanse is slightly less than 1/2 inch. Spring brood moths appear primarily during the last half of May and lay eggs on the lower surface of azalea leaves. The eggs hatch in 4 to 6 days. The larvae feed first between the layers of the leaf, removing the green tissue and forming blister-like areas. When nearly half-grown, a larva crawls from the mine to the leaf margin, where it folds a portion of the leaf and feeds inside the enclosure. Pupation occurs inside the folded leaves.

The larvae live inside the fallen leaves during the winter. Three generations may occur annually. In a greenhouse, reproduction may be continuous and all stages may be present at one time.

Arborvitae Leaf Miner, *Argyresthia thuiella* (Packard)

Arborvitae foliage is sometimes invaded by the arborvitae leaf miner. The tips of twigs are killed and the brown discoloration becomes conspicuous and

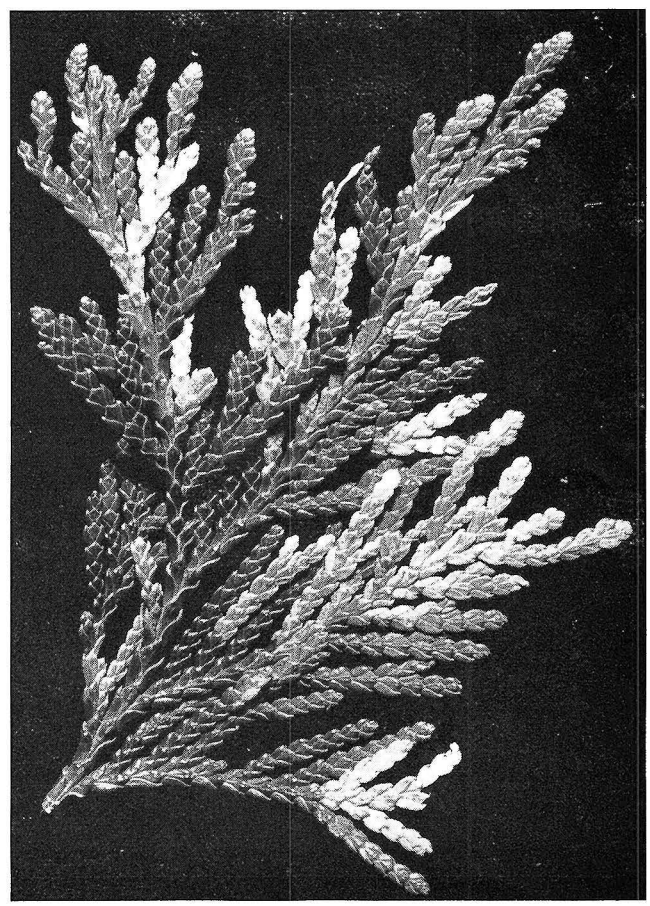

Fig. 41.—Injury caused by the arborvitae leaf miner.

unsightly (Figure 41). The adults appear primarily during June. They are white or light gray moths, with a wing expanse of about 3/8 inch. The fore wings are marked with brown bands.

Eggs are deposited on the new growth. The larvae burrow into the leaves and feed between the leaf surfaces. They hibernate inside their burrows as well-grown larvae and become full grown during May. At that time, they are about 1/8 inch in length. They pupate in their burrows. Only one generation occurs each year in northern Ohio.

Solitary Oak Leaf Miner,
***Cameraria hamadryadella* (Clemens)**

The solitary oak leaf miner occurs commonly in Ohio. It attacks many species of oaks and the blotch mines may become conspicuous (Figure 42). Although the injury is seldom severe and control measures are not often necessary, the insect sometimes temporarily reduces the ornamental value of prized oak trees.

The mines are located just under the upper surface of the leaves. A number of mines may occur in one leaf. Each individual mine contains only one larva but the mines may run together on a leaf that is heavily infested.

The adult insect is a small, light-colored moth. The larvae are flattened and about 4 mm in length when well-grown. Several generations may occur during a year. The larvae live during the winter in cocoons in the fallen leaves. Consequently, the raking and burning of fallen leaves under infested shade trees in the fall is commonly recommended.

This insect may sometimes be confused with the gregarious oak leaf miner, *C. cincinnatiella* (Chambers), which occurs primarily on white oak. The larvae of the latter species are somewhat gregarious and a number may occur in one mine. However, they have been observed less frequently in Ohio than the solitary oak leaf miner.

Locust Leaf Miner,
***Xenochalepus dorsalis* (Thunberg)**

Houser (12) described the locust leaf miner as "The most destructive single species of the hilly woodlands of southern Ohio. The browning of the foliage of the black locust in summer and fall is due to the feeding of the adult beetles and to the mining of the leaf tissues by the larval form."

The adult beetles, which are about 1/4 inch long, hibernate in the litter of the forest floor, in crevices of the bark of trees, and other sheltered areas. They emerge and begin feeding as soon as foliage develops on the black locust trees. After a short time, eggs are

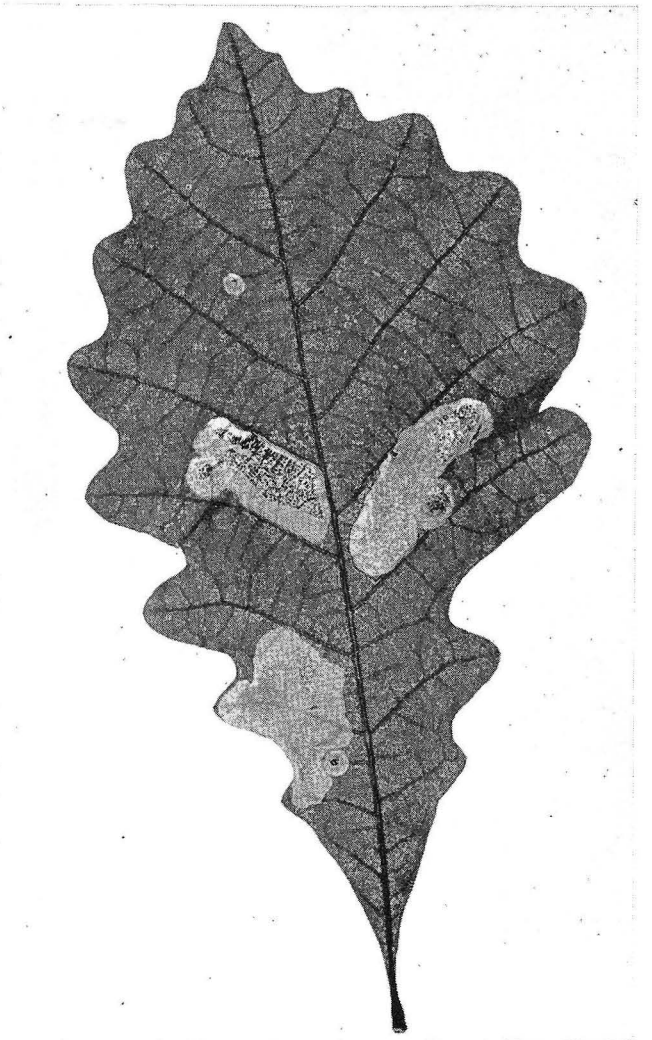

Fig. 42.—Blotch mines of the solitary oak leaf miner.

deposited on the foliage and newly hatched larvae bore into the leaves and form mines (Figure 43). The larva is somewhat flattened and about 1/4 inch long when full grown. It is yellowish white with black legs, head, and thoracic and anal shields.

Pupation occurs in the mines, with the first generation adults appearing during July. After a period of wandering in which the beetles scatter far and wide, eggs are deposited which produce a second generation of leaf miners. These produce the beetles which live during the winter.

Injury caused by this insect has been recorded on a number of hosts but it is primarily a pest of black locust. Other hosts may be injured when located adjacent to heavily infested locust trees. In a severe infestation, the combined feeding of larvae and adults may kill the foliage of a tree in July and again in September. In areas of southern Ohio, hillsides covered with black locust may turn completely brown. If

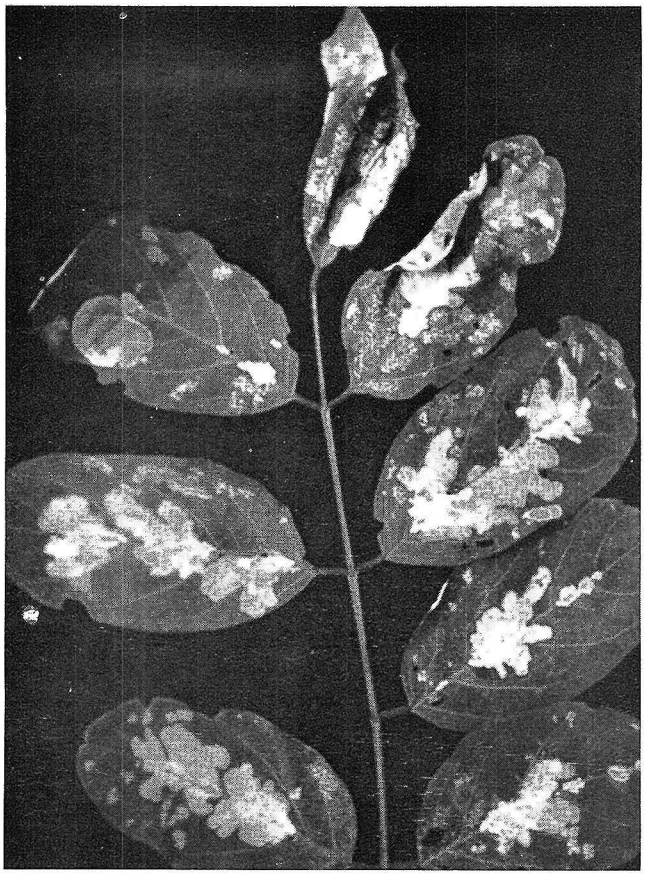

Fig. 43.—A leaf of black locust showing injury caused by the locust leaf miner.

such an infestation is accompanied by a season of unfavorable tree development, many locust trees may die. This injury can be minimized to some degree if dead or dying trees are cut promptly.

DEFOLIATORS

The most conspicuous type of insect injury on trees and shrubs is caused by insects which eat the foliage. If pests such as the elm leaf beetle or the catalpa sphinx devour 20 percent of the leaves on a tree, the injury is observed quickly, even though it may be much less severe than that caused by a borer feeding in the trunk.

In the following pages, seven insect species are described as defoliators of conifers and ten as pests of deciduous trees. However, bagworms attack deciduous trees and shrubs, as well as evergreens. They are listed under conifers because they cause most damage to arborvitae and juniper in Ohio.

INSECTS DEFOLIATING CONIFERS

Hemlock Looper, *Lambdina athasaria* (Walker)

In 1925, an outbreak of geometrid larvae appeared on hemlock in eastern Ohio (13). Hundreds of hemlock trees, some large enough for sawlogs, were defoliated and killed. The scourge disappeared in 1926, apparently as a result of the work of a fungus on the hibernating larvae.

In 1949 and 1950, a similar outbreak appeared in the Mohican Forest area near Loudonville. Again many trees were completely defoliated and killed. The insect was identified by Dr. Franclemont as *Lambdina athasaria.*

In the larval stage, the insect is a typical looper or measuring worm, about 30 mm long and 3 mm wide when full grown. It closely resembles the color of a hemlock twig (Figure 44).

Larvae become full grown in late September and either crawl down the tree or drop to the ground by a silken thread. As many as 28 were counted on 1 square foot of the trunk of a large hemlock. The

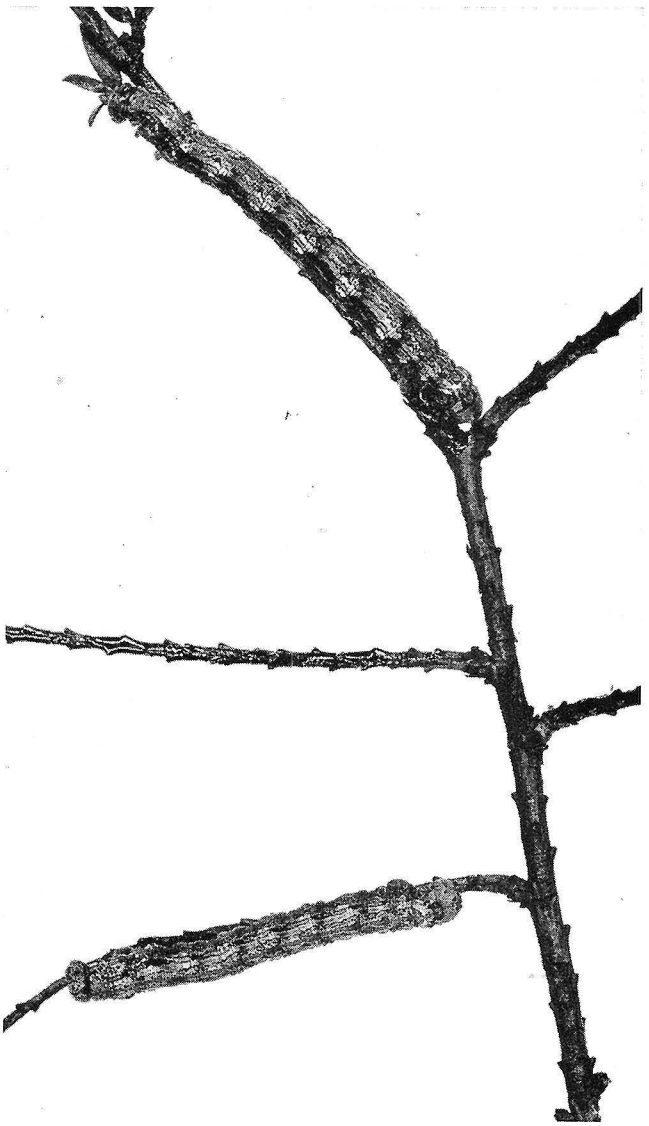

Fig. 44.—Two larvae of the looper *Lambdina athasaria* on a defoliated hemlock twig.

larvae change to pupae on the forest floor during October.

Moths emerge primarily during June. Many were observed on the trunks of trees in a characteristic position, with wings spread and flat against the bark. Eggs are deposited on both the upper and lower surfaces of hemlock foliage. Approximately 1 month is required for the incubation period of eggs.

Newly hatched larvae are difficult to find in the forest because their color is similar to that of the foliage. By jarring a branch lightly, larvae may drop down on a thread where they can be seen readily. In August, when larvae are larger and feeding injury becomes evident, larvae can be observed more readily. Only one brood occurs each year.

The life history of this insect is somewhat unusual. A period of 6 to 8 weeks elapses between the time of egg deposition and the time when larvae can be observed readily. The insect is in the pupal stage

Fig. 45.—A Scotch pine tree being defoliated by larvae of the European pine sawfly.

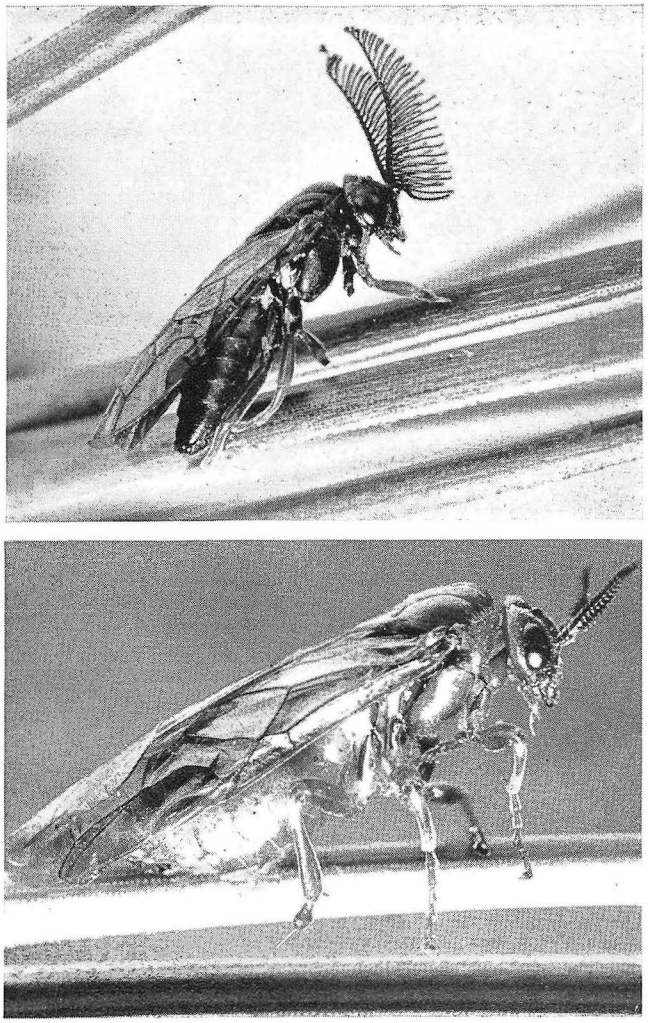

Fig. 46.—European pine sawfly adults. Male above and female below.

on the forest floor from October until June. In this stage, the insect is subject to attack by fungi during wet weather.

Pine Sawflies

A number of species of sawflies are known to attack pine trees but only three species have been observed causing damage in northern Ohio. The larvae feed in dense colonies and in severe cases may defoliate trees.

The European pine sawfly, *Neodiprion sertifer* (Geoffroy), has been the most destructive species in Ohio. Although it attacks a variety of pines, it causes most trouble on red and Scotch pines and occurs primarily in the northern half of the state.

The larvae are greenish-brown and are about 1 inch long when full grown. They appear in large colonies on the tips of branches during the latter part of April or in early May. The larvae feed only on the old needles but may defoliate trees by June 1 (Figure 45).

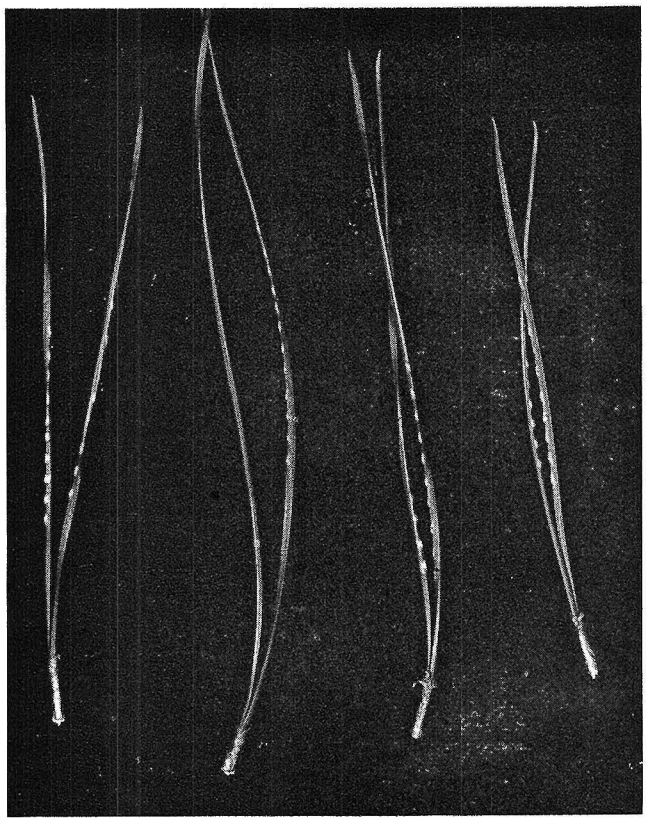

Fig. 47.—Eggs of the European pine sawfly in red pine needles.

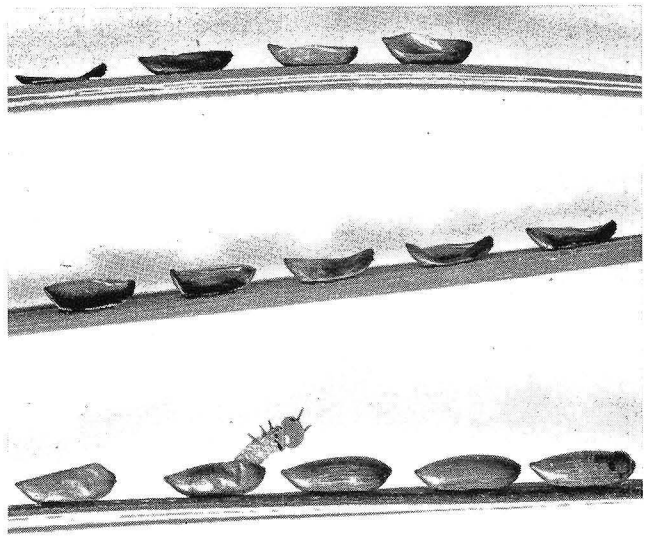

Fig. 49.—Eggs of the nesting pine sawfly on white pine needles. Note one egg hatching.

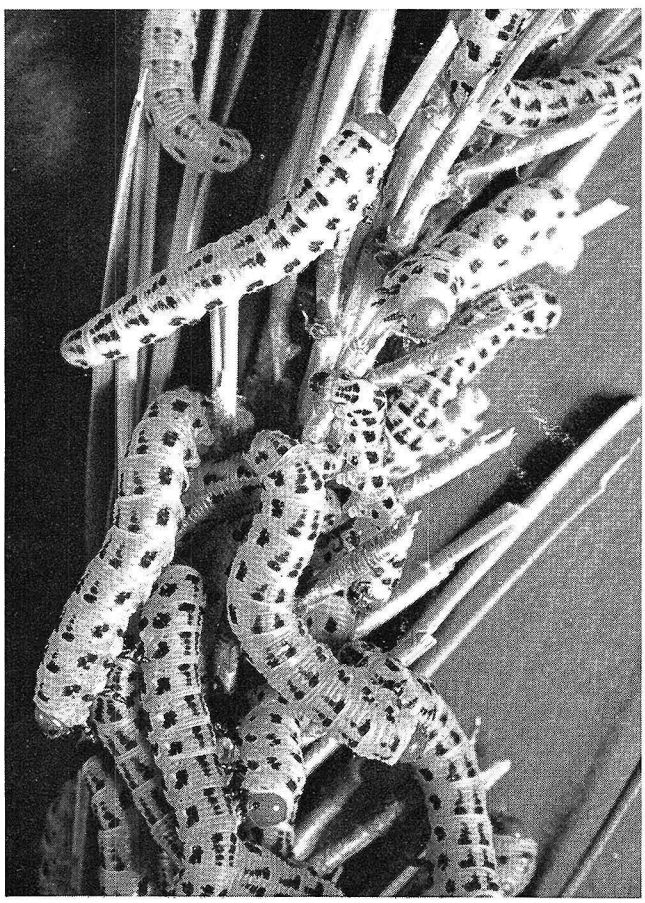

Fig. 48.—Red-headed pine sawfly larvae on Scotch pine.

Injured trees are seldom killed during the first year they are attacked because new needles which develop during May and June are not injured. However, heavily infested trees are weakened and complete destruction of the old needles for two or three consecutive seasons may kill the trees.

European pine sawfly larvae become full grown during the first half of June. Then they drop to the ground, where they change to pupae. During September and October, the small bee-like adults emerge (Figure 46) and deposit eggs partly in the needles on the tips of the branches (Figure 47). The insect lives in the egg stage during the winter.

The white-pine sawfly, *Neodiprion pinetum* (Norton), has been observed most often on white pine in Ohio but has occurred on pitch and short-leaf pine. The larva is yellowish white, with four rows of rectangular black spots extending in lines lengthwise of the body. The head is black.

This insect overwinters in cocoons in the debris under the trees. The period of adult emergence extends over several weeks and a partial second generation occurs. Consequently, larvae may appear at almost any time during the summer.

The larva of the red-headed pine sawfly, *Neodiprion lecontei* (Fitch), is whitish in color, with six rows of conspicuous, irregular, black spots and a reddish-brown head (Figure 48). This sawfly feeds on a variety of pines, including those grown individually as ornamentals. The old pine needles are preferred but new needles may be attacked in late summer. The life history of the insect is similar to that of the white-pine sawfly and colonies of larvae may appear at almost any time in summer and fall.

Nesting Pine Sawfly,
***Acantholyda luteomaculata* (Cresson)**

An infestation of nesting pine sawfly was found in a forest planting of white pine in central Ohio in 1960. The insect has spread to neighboring plantings since that time but has not been a severe pest.

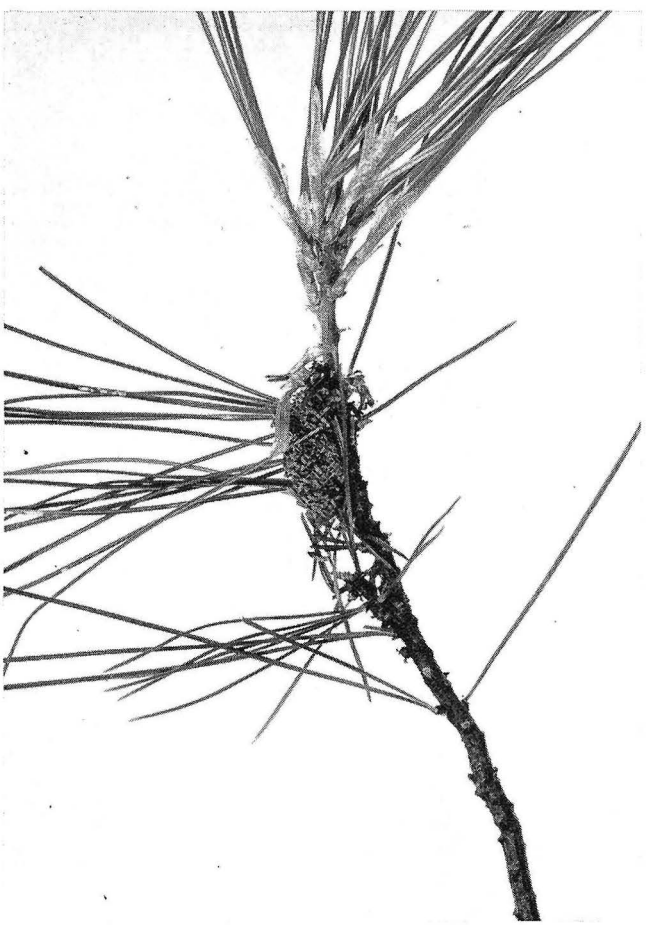

Fig. 50.—A newly formed nest of the nesting pine sawfly. This nest was about 1 inch long and contained three small larvae when found.

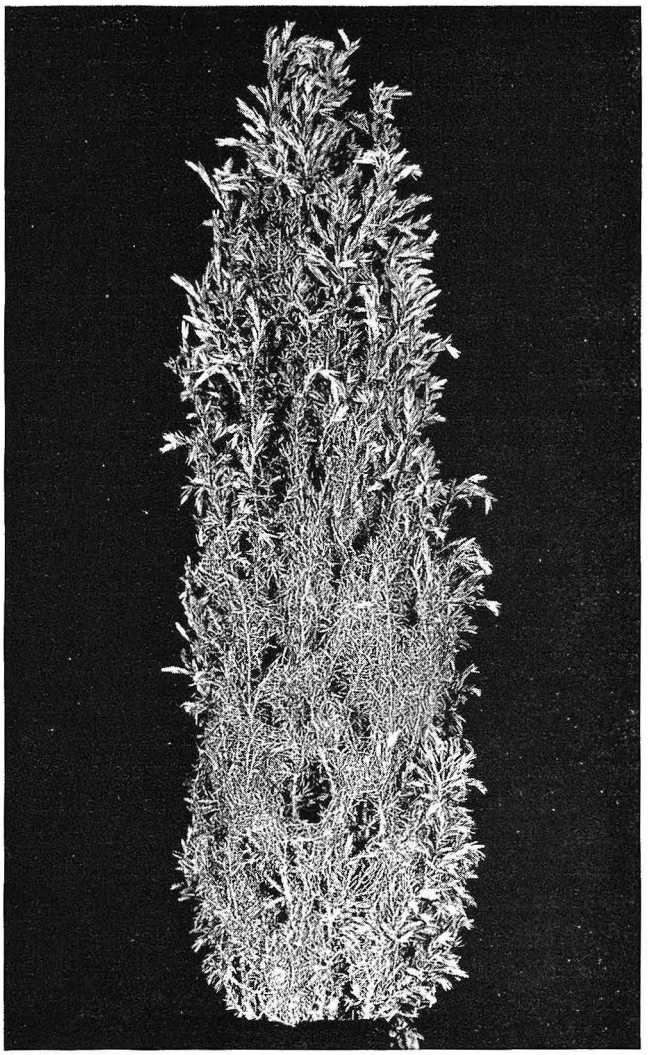

Fig. 51.—Juniper webworm injury on Irish juniper.

The larvae live in cells in the soil during the winter and transform to pupae and adults in the spring. Boat-shaped eggs (Figure 49) are attached to pine needles in June or July. The larvae cut off the needles and tie them together with webs, forming a nest in which they feed (Figure 50). As the larvae grow, the nests are enlarged and may become 4 to 5 inches in length. Several larvae may occur in one nest.

When full grown, the larvae drop to the ground. Both red and green phases of larvae and prepupae occur. Only one generation occurs each year.

Juniper Webworm,
***Dichomeris marginellus* (Fabricius)**

The juniper webworm attacks various species of juniper but causes most damage to varieties of Irish juniper. The larvae feed on the foliage and web it

together in dense masses (Figure 51). On a small tree, the entire top of the plant may be tied together.

The adult moths have a wing expanse of slightly more than 1/2 inch. They appear primarily during June and deposit eggs on the foliage. The larvae grow slowly and are only partly grown when cold weather appears. They are light brown, with darker brown longitudinal stripes.

The larvae hibernate in the webs among the dead foliage and become active again during May. By the middle of the month, pupation begins within the webs. Only one generation occurs each year.

Another insect known as the pale juniper webworm, *Phalonia rutilana* (Hubner), is sometimes confused with the juniper webworm. It causes the same type of injury but occurs less commonly in Ohio. The larvae are light yellow and not striped. They complete their growth in the fall and pupate in April.

Bagworm,
***Thyridopteryx ephemeraeformis* (Haworth)**

The bagworm is one of the most curious and interesting of the insect pests of trees and shrubs. Each newly hatched larva immediately constructs a bag in which it lives. The bag is enlarged as the insect grows. The larva drags the bag wherever it goes by extending the fore part of its body, permitting the free use of its fore legs.

When a larva becomes full grown, it stops feeding and firmly attaches the bag to a twig (Figure 52). The time of attachment usually occurs during August but varies from year to year, depending somewhat on the weather as well as the species of plant attacked.

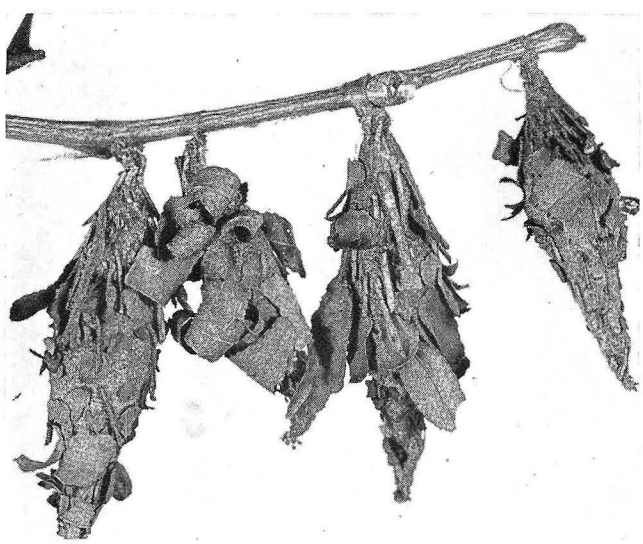

Fig. 52.—Bags which have been firmly attached to a twig by the full grown bagworms now inside the bags.

Pupation takes place inside the bag. The adult stage appears about 4 weeks after a larva has stopped feeding. Adult females have neither legs nor wings. After mating with a winged male through an opening in the bottom of the bag, the female deposits a mass of eggs inside the bag. She then wiggles out of the bag and falls to the ground. The eggs live inside the bag during the winter and only one generation occurs each year.

In southern Ohio, the eggs may hatch during the latter part of May. Hatching usually occurs during the first half of June in the northern part of the state.

During the early part of the century, the insect was found only in southern Ohio (12). However, in recent years it has occurred in all parts of the state and injury has been reported in northern Ohio more often than elsewhere.

Bagworms attack a wide variety of plants but most damage in Ohio occurs on ornamental arborvitae and juniper. Relatively few plants are killed but the ornamental value of many plants may be destroyed by defoliating and killing the top portion of each plant.

Populations of bagworms fluctuate from year to year, apparently because of natural enemies. Egg and larval parasites increase in abundance as the bagworm population grows.

A knowledge of the life history of the insect is helpful in attempting control measures. On deciduous trees, a degree of control can be maintained by picking off and destroying the bags during the fall and winter months. However, this procedure is less effective on arborvitae and juniper plants because too many bags, and thus too many egg masses, escape detection.

Newly hatched larvae can be killed with insecticides much more readily than larvae which are well grown. Unfortunately, because portions of the plant on which the insect feeds are used in constructing the bag, an infestation may not be observed until defoliation becomes prominent. By that time, larvae may be nearly full grown and stomach poisons will be less effective.

INSECTS DEFOLIATING DECIDUOUS TREES

Eastern Tent Caterpillar,
***Malacosoma americanum* (Fabricius)**

During spring months in Ohio, it is not unusual for conspicuous silken tents to develop in wild cherry trees along roadsides. They are built by colonies of insect larvae known as eastern tent caterpillars. Although wild cherry appears to be the favored host, various other deciduous shade and forest trees may be attacked.

The moth has a wing expanse of 1-1/4 to 2 inches. It is reddish-brown, with two white stripes

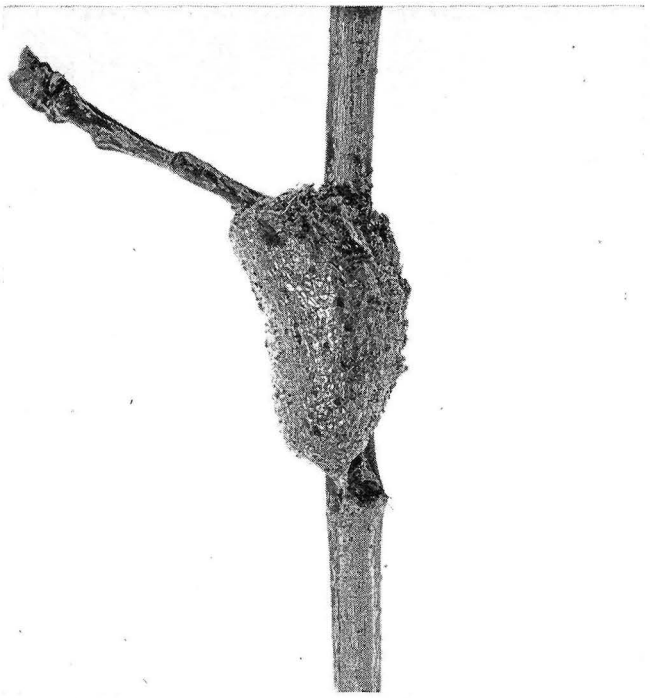

Fig. 53.—An egg mass of the eastern tent caterpillar on a twig.

extending obliquely across the fore wings. The moths appear in July and early August and deposit the eggs which overwinter. The eggs are placed in masses of 150 to 300 which encircle twigs (Figure 53). These are cemented together and coated with a dark substance which hardens into a brown mass.

The eggs usually begin to hatch in the spring when the wild cherry leaves begin to appear. The larvae are gregarious and cooperate in constructing their tent in a fork of a branch and in enlarging it as they grow. During rainy weather, larvae remain in the tent but in favorable weather they move out to the foliage to feed. They become full grown in about 6 weeks and at that time are about 2 inches long. The head and body are black, with a white stripe along the back (Figure 54).

The larvae change to pupae in silken cocoons which may be found on the tree or adjacent objects. Only one brood occurs each year.

This insect appears most commonly on roadside trees and shrubs. The numbers which develop vary greatly from year to year, primarily because of the work of natural enemies. However, insecticides may be needed occasionally to prevent damage to prized shade trees. The removal and destruction of the conspicuous egg masses during the fall and winter months may be worthwhile.

Fall Webworm, *Hyphantria cunea* (Drury)

Fall webworms are most often recognized by the unsightly, light gray, silken webs on the trees in late summer and early fall (Figure 55) and by the blackened web remnants which remain on the branches during the winter (12).

Adult moths first appear in early June but may continue to appear in small numbers during most of the summer. Moths vary considerably in color from pure white to white with black spots. Light yellow eggs are deposited in clusters of 1 to 300 on the lower surface of the leaves.

Newly hatched larvae begin at once to form the web which encloses the leaves on which they feed. The web increases in size as the caterpillars extend their feeding area and may eventually encompass an area 2 to 3 feet in length. Young larvae are pale yellow, with two rows of black marks along the body. When full grown, they are covered with whitish hairs

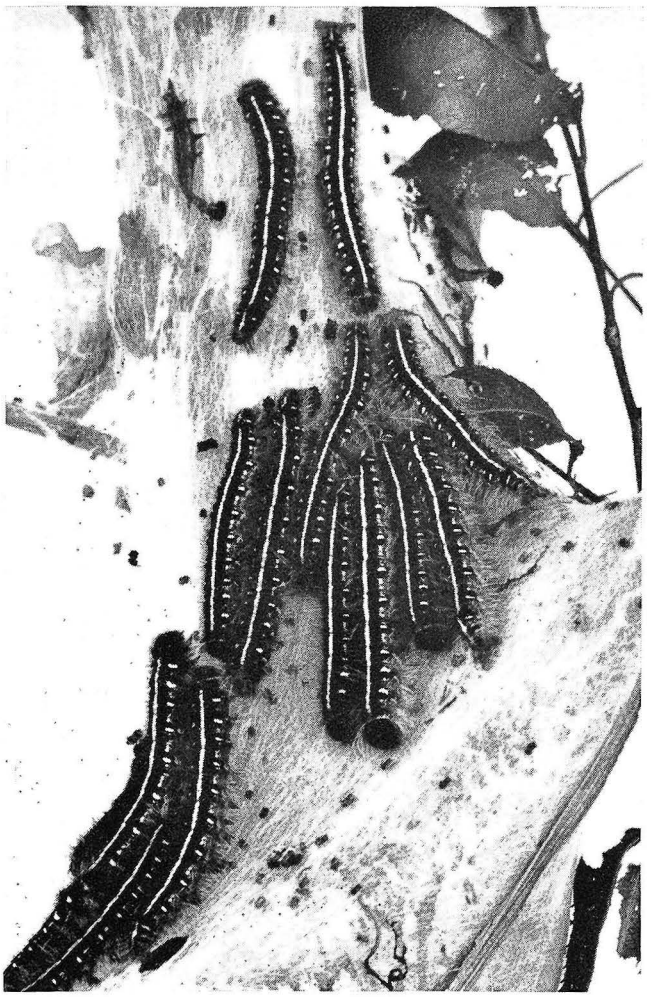

Fig. 54.—Full-grown larvae of the eastern tent caterpillar on silken tent.

Fig. 55.—A web formed by a colony of fall webworm larvae, photographed in October when full grown larvae were leaving the web.

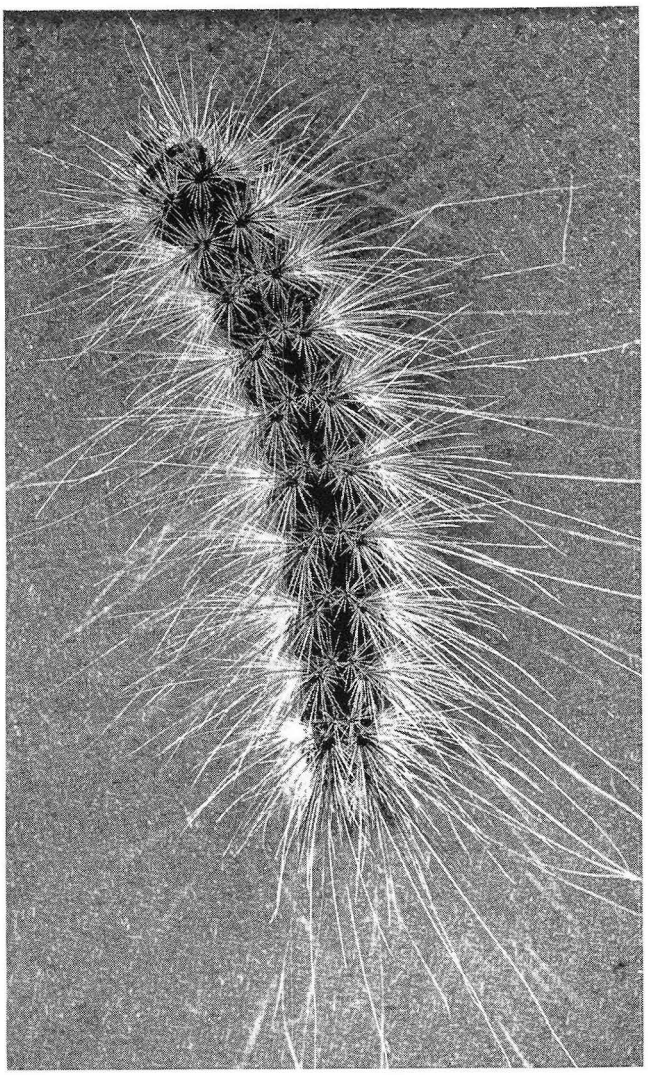

Fig. 56.—Full grown fall webworm larva, photographed October 1.

(Figure 56) which spring from black and orange-yellow warts. The larvae vary as to the depth of coloring and markings but are usually greenish with a broad, dusky stripe along the back and a yellow stripe along the sides.

Full grown larvae leave the web and pupate on or in the soil or in crevices around a building or fence. After a few days, another generation of moths appears to produce a second generation of larvae.

The fall webworm has been recorded on a wide variety of trees and shrubs but wild cherry seems to be the preferred host. On shade trees, the webs usually occur on an occasional branch. This may not injure the tree appreciably but reduces its ornamental value. However, occasionally the tree may be almost defoliated if control measures are not employed.

Natural enemies of various kinds help to control this insect. Birds, insect predators, and internal parasites attack the larvae. Clusters of eggs may be destroyed by predators and internal parasites.

Cankerworms

Two species of cankerworms occur commonly in Ohio. These are the spring cankerworm, *Paleacrita vernata* (Peck), and the fall cankerworm, *Alsophila pometaria* (Harris). The two species are similar in appearance and habits but have somewhat different life histories.

Cankerworm larvae are slender, looping caterpillars, belonging to the group commonly known as measuring worms. When full grown, they are about 1 inch in length (Figure 57). They vary from light brown to black, with faint yellow stripes usually running lengthwise of the body. The male moths have a wing expanse of slightly more than 1 inch. The hind wings are light gray and the fore wings somewhat darker. Female moths are wingless and about 1/2 inch long.

Moths of the fall cankerworm emerge primarily in November and December and the winter is passed in the egg stage. The spring cankerworms live in the pupal stage in the soil during the winter and the moths emerge early in the spring. The eggs of both species usually hatch in early May. Only one generation of each species occurs each year.

The eggs of the spring species are oval and are deposited in irregular clusters in protected places on a tree (Figure 58). Eggs of the fall species (Figure 59) are deposited on end in a definite formation.

Both species attack a wide range of hosts but elm and apple trees seem to be preferred. The young larvae feed first on the newly formed leaves on the tips of branches. Later they attack the older leaves and devour all but the larger veins.

Because the female moths are wingless, they crawl up the trunks of trees to deposit eggs. For that reason, the banding of tree trunks with tanglefoot has been commonly recommended as a control measure. However, it has not been completely effective because of the long period of time in which one of the two species may appear.

Fig. 57.—Larvae of the spring cankerworm feeding on apple blossoms and leaves.

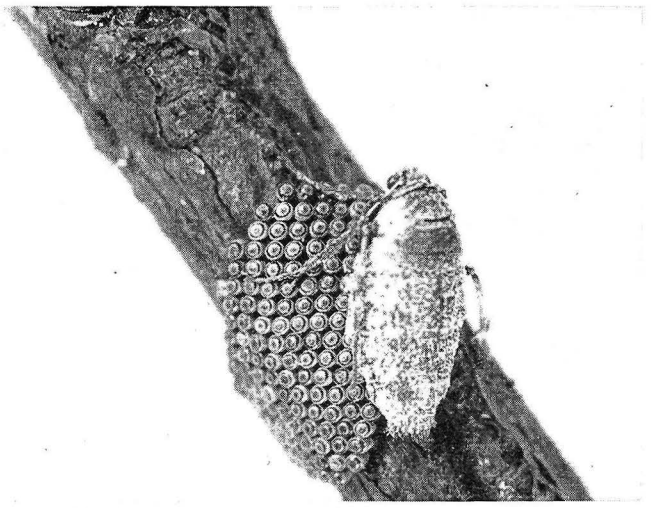

Fig. 59.—Adult female and egg mass of the fall cankerworm.

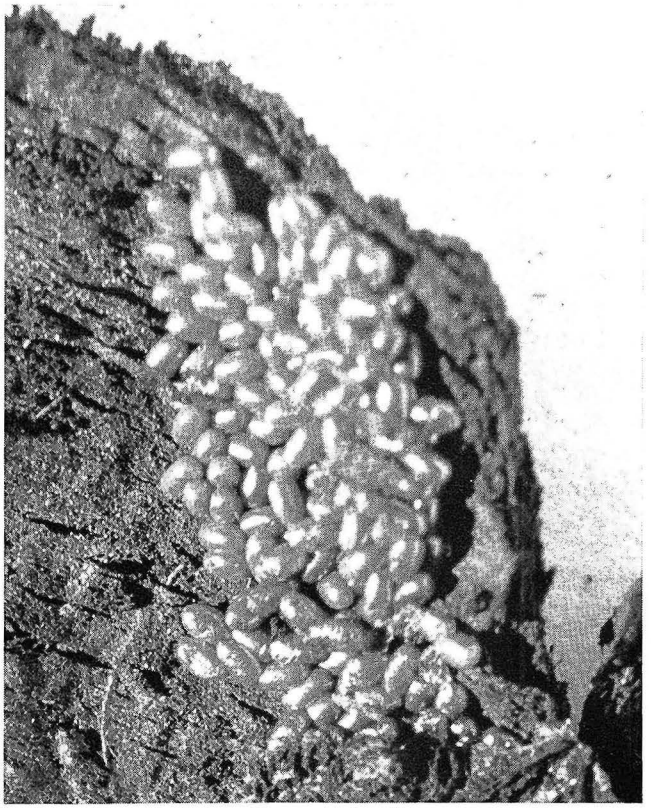

Fig. 58.—Egg mass of the spring cankerworm.

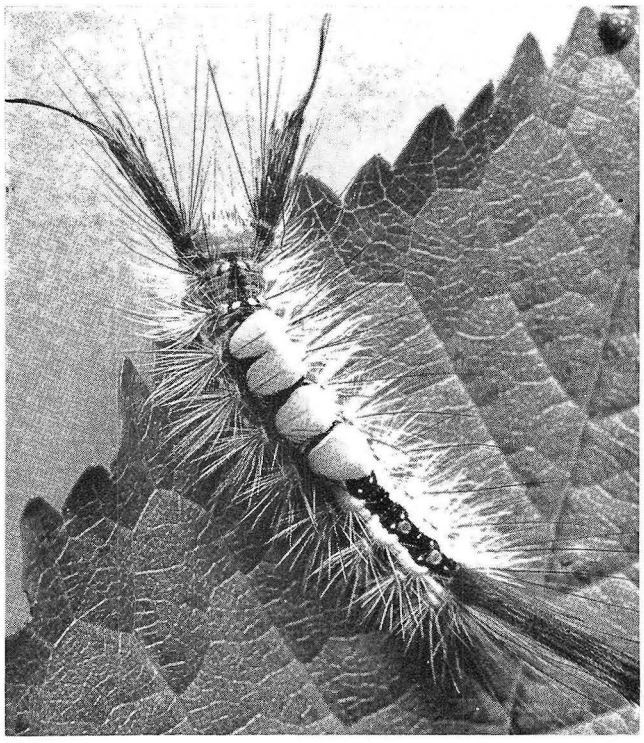

Fig. 60.—A well-grown larva of the white-marked tussock moth.

White-marked Tussock Moth, *Hemerocampa leucostigma* (J. E. Smith)

The white-marked tussock moth is a pest primarily of shade trees, particularly along the streets in cities and towns. It attacks a wide variety of trees, including most species commonly grown as street trees.

The full-grown larva is an attractive creature about 1-1/2 inches long, with four dense white tussocks or brushes of hairs on its back (Figure 60). Long tufts of black hairs grow on each side of and directly in back of the head. A single similar tuft grows at the rear end of the body.

The insect lives in the egg stage during the winter and the eggs usually hatch during the latter part of May. The larvae become full-grown in late June or early July and form silken cocoons in which the pupal stage occurs. The cocoons may be located on the trunk or branches of the tree or on nearby buildings or fences.

The larvae may weave hairs from their bodies into the cocoons. Because the cocoons may occur in large numbers in specific locations, the silken webs may be very unsightly.

The moths emerge 10 to 14 days after the cocoons are formed. The male moth is grayish-brown, with a wing expanse of about 1-1/4 inches. The female is light gray and is wingless. Eggs are laid during the last half of July in masses of 100 to 500, usually on the empty cocoon. A frothy substance which becomes brittle covers and protects the eggs. These eggs produce a second brood of larvae which may be somewhat larger than the first. Two full generations occur annually in northern Ohio and a partial third generation may occur in the southern part of the state.

In severe infestations, trees may be completely defoliated and weakened. In most cases, however, the chief concern is the loss of ornamental value because of partial defoliation and the presence of unsightly remains of egg masses and old cocoons.

Because the females cannot fly, the banding of tree trunks with tanglefoot is practiced in some cities. This is effective only if the tree is not already infested and if the branches do not contact other infested trees. Spraying with an insecticide is the most reliable control measure at the present time.

Catalpa Sphinx, *Ceratomia catalpae* (Boisduval)

The catalpa sphinx is of particular interest because it was the first insect controlled by airplane dusting in the United States. A 6-acre field of infested catalpa trees in Ohio was dusted in August 1921, under the direction of Professor J. S. Houser. A lead arsenate powder was used with satisfactory results. The following information concerning the insect is

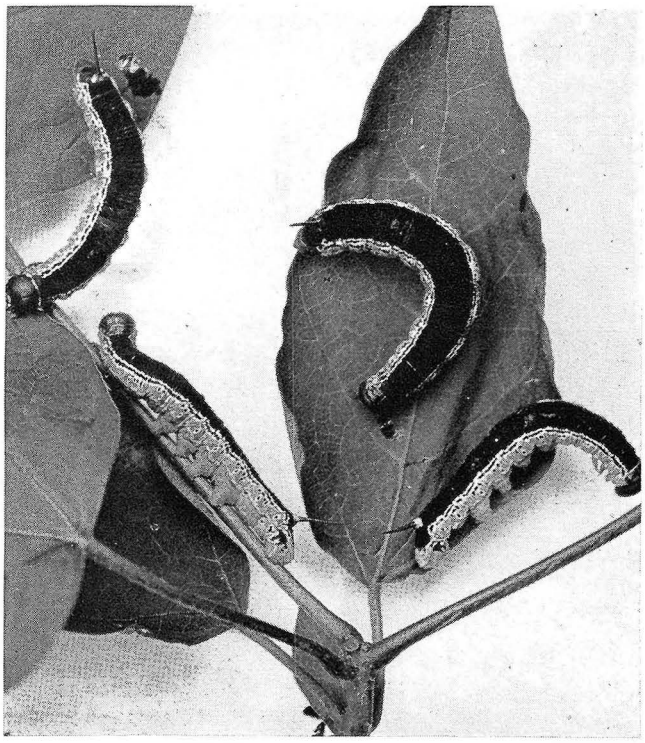

Fig. 61.—Well-grown catalpa sphinx larvae on catalpa leaves.

taken primarily from Ohio Agricultural Experiment Station Bulletin 332 (12).

The mutilation and sometimes complete defoliation of catalpa trees and groves are traceable to the catalpa sphinx. In its best known stage, it is a fleshy caterpillar of the hornworm group, resembling in size and shape the well-known tomato or tobacco hornworms. When mature, it is about 3 inches long (Figure 61). The rear of the body has a formidable appearing spine which is quite harmless. The worms are dark green with black markings but the proportions of the two colors vary greatly.

The adult insect is a typical sphinx moth. It is grayish brown and is about 3 inches across its expanded wings.

The insect lives during the winter in the pupal stage beneath the surface of the soil. After appearance of the catalpa leaves, the moths emerge and lay eggs in large convex masses on the lower surface of the leaves. The newly hatched larvae feed gregariously for some time. Later they separate but never lose their ravenous appetites.

When full grown, the larvae pass to the soil where they pupate and produce a first generation of moths. These produce the second generation of larvae, which usually appear in early August. Two generations occur commonly in Ohio.

The various species of catalpa trees constitute the only known host plants attacked by this insect. In 1918, the insect was reported primarily in the southern half of Ohio but in recent years it has occurred rather commonly in northern Ohio.

Mimosa Webworm,
***Homadaula albizziae* Clarke**

The mimosa webworm was first recorded in Ohio nurseries by inspectors in 1956. It appeared first in Hamilton and Montgomery counties in southwestern Ohio but spread rather rapidly. By 1962, the infested area had extended northward into Wood County and eastward to the Pennsylvania line. It was recorded that year in 95 nursery plantings of thornless honey locust.

The mimosa webworm is primarily a pest of honey locust in Ohio. The new varieties of thornless honey locust have been popular in recent years and large numbers have been planted as shade trees and in landscape plantings. In most areas of Ohio, the mimosa webworm attacks these trees and frequently defoliates them if control measures are not employed The need for two protective spray applications annually has significantly reduced the sale of nursery trees.

The mimosa webworm lives during the winter in the pupal stage in cocoons located in the debris under the host trees or under scales of bark. The adult moths emerge in mid-June and deposit eggs on the foliage of honey locust trees. Larvae of the first brood appear in late June and early July. A second brood, which is often larger than the first, occurs in August.

The moths are silvery gray and have a wing expanse of about 1/2 inch. The larvae vary in color from pale gray to dark brown and have five white stripes running lengthwise of the body. They are slightly more than 1/2 inch long when full grown and move very actively when disturbed.

Fig. 62.—Moth, larva, and web or nest of the mimosa webworm.

A single larva may web two or more leaflets together and feed inside the enclosure. More often, however, when larvae are abundant, a number cooperate in building nests 8 to 12 inches in diameter (Figure 62). It is not uncommon for such nests to occupy most of the foliage of a tree.

When a nest is disturbed, one or more larvae may quickly drop down on a silken thread. When larvae are full grown, many of them drop to the ground on silken threads. These white fibers hanging from a tree sometimes become abundant and conspicuous.

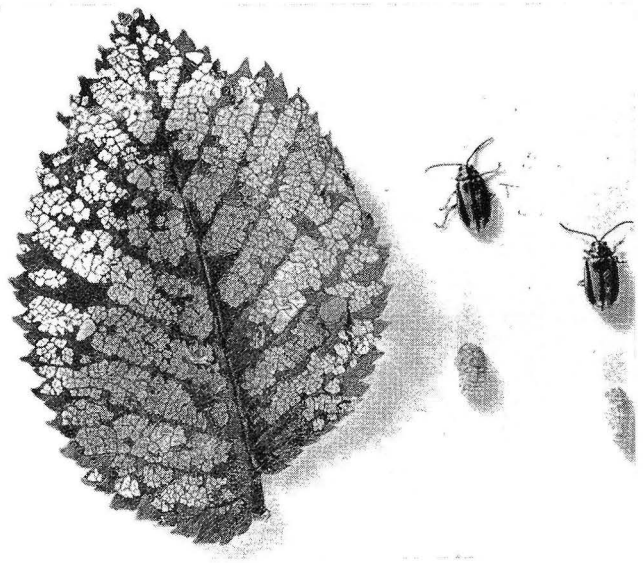

Fig. 63.—Two elm leaf beetles, two pupae, and an elm leaf skeletonized by larvae.

Elm Leaf Beetle, *Galerucella xanthomelaena* (Schrank)

The depredations of the elm leaf beetle are limited to the various species of elm trees, with European species attacked most severely. Houser (12) reported severe infestations in southwestern Ohio and T. H. Parks (30) stated that English elms were defoliated in Columbus in 1934 and 1935.

Severe injury has seldom been observed in recent years, although the insect is found often and sometimes is reported by nursery inspectors. This may be due in part to the destruction of elms by phloem necrosis and the Dutch elm disease, as well as the reduction in the number of elms planted as shade trees because of the ravages of these diseases. However, both Houser and Parks stressed the work of the natural enemies of the insect, particularly a fungus disease.

The adult elm leaf beetle is about 1/4 inch long and resembles the striped cucumber beetle, although the color is variable. Newly emerged beetles are reddish yellow, with black spots on the head and thorax and black lines down the side. As the beetles become older, the reddish yellow areas become dark yellowish-green.

The beetles live during the winter in buildings, piles of rubbish, or wherever they can find protection. They fly to elm trees when new leaves appear on the trees in the spring. They feed on the foliage for a short time and soon begin laying eggs.

The larvae feed on the lower surface of the leaves, skeletonizing them (Figure 63) and leaving primarily the veins and upper membrane. Severely injured leaves may turn brown and fall from the tree. The most severe injury occurs in late June. Full grown larvae, which are about 1/2 inch in length, are yellow with a pair of black stripes down the back. They make their way to the ground and transform to pupae at the base of the tree. Two generations occur annually in Ohio.

The most effective control measure known at the present time consists of a spray applied to the entire tree when the larvae are feeding. However, injury may not be observed until the first brood is in the pupal stage, which usually occurs during the latter part of June. Consequently, attention should be given to the destruction of the orange-colored pupae under the tree.

Japanese Beetle, *Popillia japonica* Newman

The Japanese beetle was found in Ohio for the first time in 1931 (31). Since that time, the insect has spread throughout most of the state, damaging turf and foliage in many localities.

The adult insect is about 1/2 inch long. The head, thorax, and abdomen are metallic green and the hard outer wings are coppery brown. Tufts of

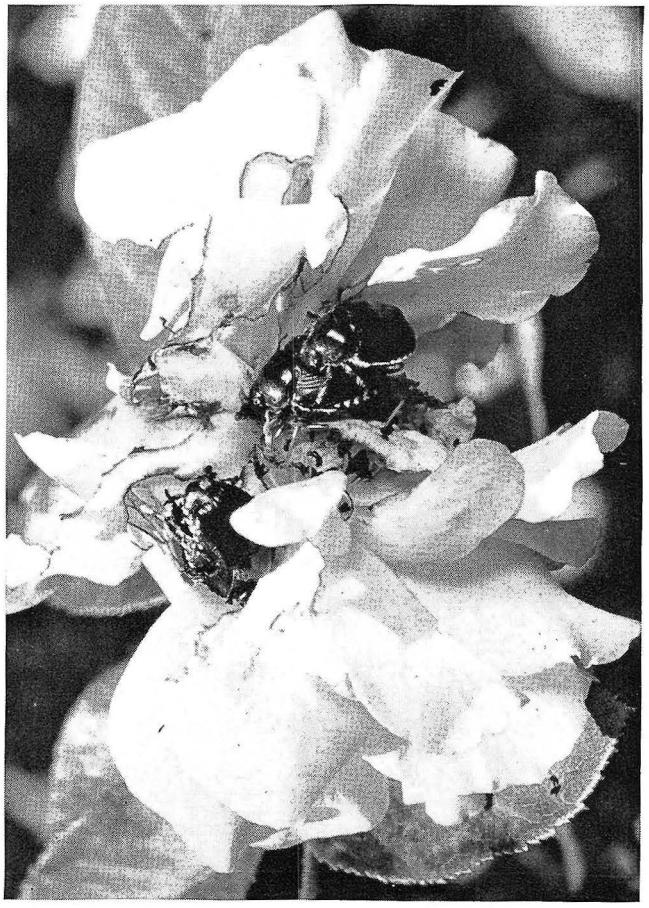

Fig. 64.—Japanese beetles and feeding damage on a rose.

white hairs along the sides of the body and behind the tips of the wing covers are helpful in identifying the insect.

The beetles begin to appear during the latter part of June in northern Ohio. Eggs are laid in turf, primarily during July. They hatch in about 10 days and the larvae feed on the grass roots. The beetles feed on the leaves, flowers (Figure 64), and fruit of a large number of plants. Large trees may be defoliated. Some of the most favored hosts are grape, sassafras, linden, and rose. One brood occurs each year.

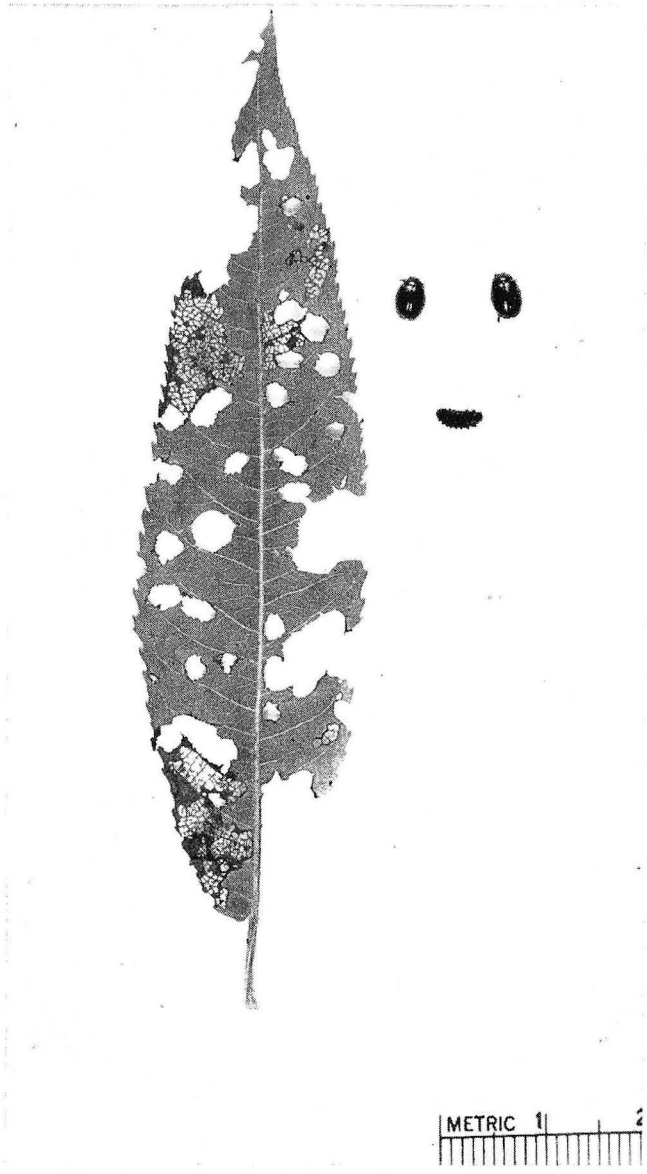

Fig. 65.—Two adults and a larva of the imported willow leaf beetle, with an injured willow leaf.

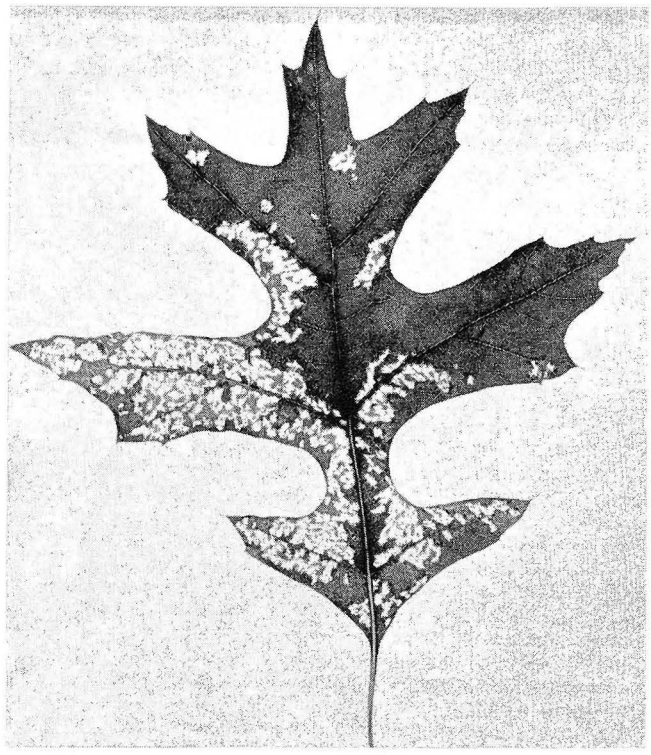

Fig. 66.—Injury caused by the oak skeletonizer.

Imported Willow Leaf Beetle, *Plagiodera versicolora* (Laicharteg)

The imported willow leaf beetle was first recorded as a pest of willows in this country in 1915, when it was found on Staten Island. It now is a rather common pest in Ohio. Several species of willow and poplar are attacked and sometimes trees are almost completely defoliated.

The adult is a metallic-blue or bluish-green beetle approximately 1/8 inch long. The beetles hibernate under bark and in other protected places. They appear on the foliage about the middle of May or soon after the foliage develops. Yellow eggs are deposited on the leaves and the dark-colored larvae appear in 5 to 7 days. Both the larvae and adults feed on the foliage. The beetles eat holes in the leaves but the larvae feed primarily on the lower surface (Figure 65).

The larvae become full grown in 3 or 4 weeks and are approximately 1/4 inch long. They attach themselves to the leaves and change to pupae and finally to adult beetles. At least two broods occur each year.

Oak Skeletonizer, *Bucculatrix ainsliella* Murtfeldt

Larvae of the oak skeletonizer are about 1/4 inch long when full grown. They feed first as leaf miners but when partly grown they leave the mines and feed

Fig. 67.—Cocoons of the oak skeletonizer.

on the lower surface of oak leaves, completely skeletonizing them (Figure 66).

Two generations occur each year. Larvae of the spring generation feed during June and early July and larvae of the first generation feed from late August until cold weather appears. They are yellowish green in color. The insects live during the winter in white, ribbed cocoons (Figure 67) which can often be found on the bark of the trunk and larger branches of infested trees. Outbreaks sometimes occur on large estates and control measures are necessary to prevent severe defoliation.

WOOD BORING INSECTS

Some of the most destructive pests of trees and shrubs are those which bore into the wood. Their presence may not be detected because they feed in tunnels in the twigs or shoots, in larger branches, or in the trunk. In this publication, they are divided into two groups: (1) those which attack the growing tips or shoots, and (2) those which bore into the trunk or large branches.

BORERS IN GROWING TIPS

European Pine Shoot Moth,
***Rhyacionia buoliana* (Schiffermuller)**

The European pine shoot moth was first found in Ohio in 1915 but it was not known to cause appreciable damage until 25 years later. During the 15-year period following 1940, damage to red pine in forest plantings of northern Ohio was so severe that the number of such trees planted was reduced significantly.

Although the insect is primarily a pest of red pine in Ohio, it also attacks Austrian, Scotch, and Swiss

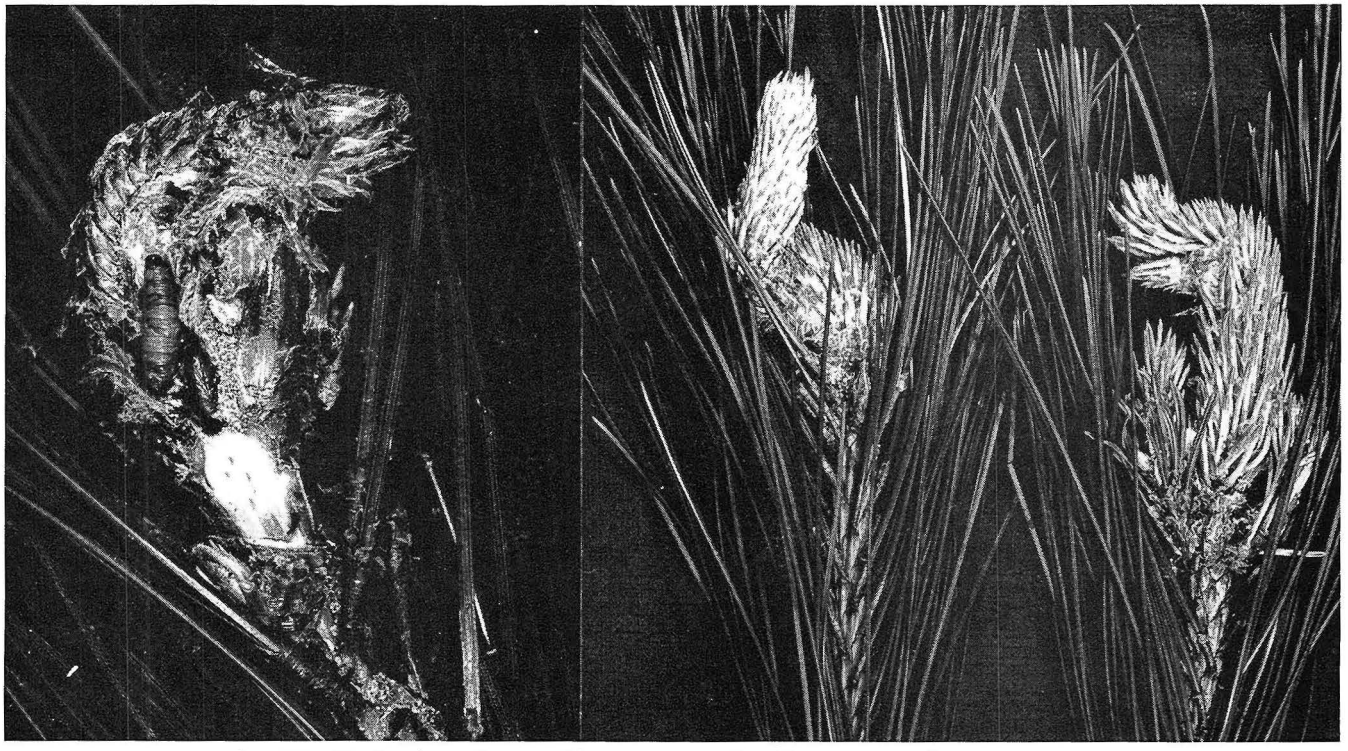

Fig. 68—Red pine shoots distorted by the European pine shoot moth, with a shoot cut open (left) to show larva and pupa within.

mountain pine. The larvae, which are brown and approximately 1/2 inch long when full grown, burrow into the new shoots and either kill or distort them (Figure 68). The repeated killing of terminal leaders results in stunted and bushy trees. The injury is most severe in young forest plantings. After a period of 6 to 8 years, the injury becomes less severe and the trees grow more normally.

The moths emerge primarily during June and deposit eggs on the pine needles. The eggs hatch during a period of about 3 weeks beginning the last few days of June. The newly hatched larvae feed at the base of the needles for a short time, killing many needles. Later the larvae crawl to buds and bore into them.

The injury to a bud causes the exudation of resin which, together with frass and other debris, is removed by the larvae. The material accumulates on the side of a bud where it hardens and becomes a yellow-white pitch mass. A larva may attack more than one bud but eventually it hibernates under a pitch mass, either inside a bud or attached to it.

In mid-April of the following spring, the larvae again become active. They move to other buds, bore into them, and continue to feed in the growing shoots. Pupation takes place in the larval burrow (Figure 68).

Fig. 69.—Tubes of white pine needles formed by the pine tube moth.

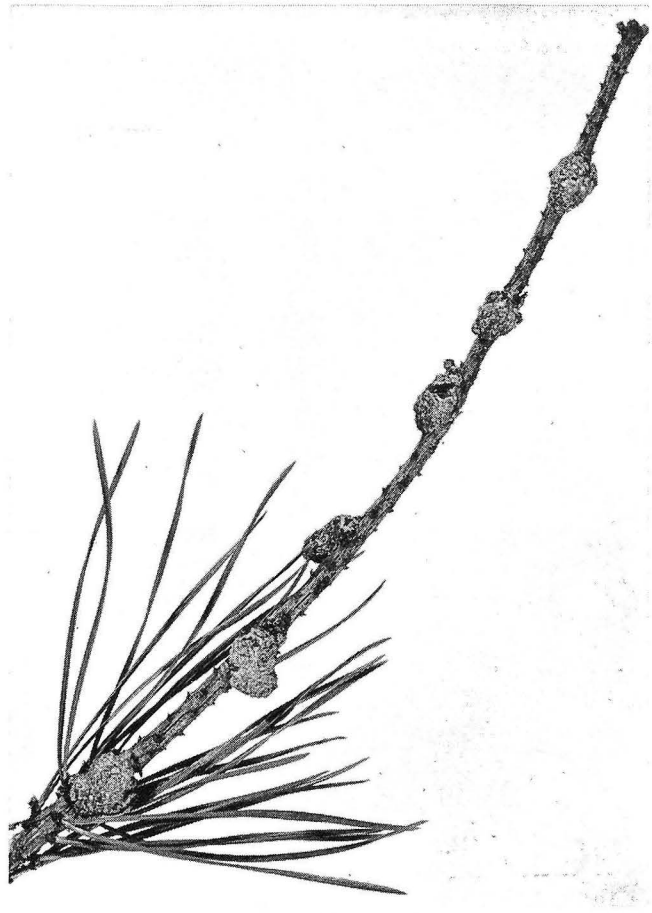

Fig. 70.—A twig of Scotch pine killed by pitch twig moth larvae.

Although a larva feeds primarily inside the shoots where it is protected from the action of insecticides, it is exposed during two periods of its life cycle. A newly-hatched larva crawls over the foliage for several hours in search of a suitable feeding site at the base of a needle bundle. In the spring, a larva leaves its hibernating quarters and crawls over the foliage in search of a suitable growing bud in which to feed (17).

Pine Tube Moth,
***Argyrotaenia pinatubana* (Kearfott)**

The pine tube moth occasionally attacks white pine (23) but it is not a severe pest. The larvae are greenish yellow and about 1/2 inch long when full grown.

By tying from 5 to 20 needles together with silk, each larva forms a tube in which it lives (Figure 69). It feeds primarily on the tips of the needles that form the tube.

Two generations occur each year. The moths emerge and lay eggs in late April or May and in July. The insect lives during the winter in the pupal stage inside the tube.

Fig. 71.—Red pine needles infested by *Exoteleia* sp. The needle at right has been opened to show larva inside.

Fig. 72.—A Scotch pine tip infested by *Exoteleia* sp.

Other Pine Tip Moths

Polivka and Houser (32) listed three pine tip moths which occurred commonly in southern Ohio. These were the pitch twig moth, *Petrova comstockiana* (Fernald); the Nantucket pine moth, *Rhyacionia frustrana* (Comstock); and the Zimmerman pine moth, *Dioryctria zimmermani* (Grote).

Miller and Neiswander (19) described the life history and habits of the pitch twig moth (Figure 70) and listed two other species of the same genus, *P. virginiana* (Busck) and *Petrova* sp. (undescribed), found throughout southern Ohio. The undescribed species was later described by Miller (16) as *P. houseri* Miller. Miller and Neiswander (18) described the life history of the pitch pine tip moth, *Rhyaciona rigidana* (Fernald), which also occurs rather widely in southern Ohio.

The Zimmerman pine moth increased to damaging proportions in Christmas tree plantings in Indiana, Illinois, and Michigan in recent years and has continued to cause damage in those states (34, 35). It occurred rather commonly in both southern and northern Ohio in 1936 and for several years after that. In more recent years, only an occasional one has been found which could be identified.

None of the insects listed above have appeared in sufficient numbers in Ohio to warrant special control measures. For that reason, the reader is referred to the publications mentioned for information concerning them.

Recently an insect known as the white-pine shoot borer, *Eucosma gloriola* Heinrich, appeared on Scotch pine in a few Christmas tree plantings in northern Ohio. The moths appear in late April or early May and deposit eggs on the new foliage. The larvae tunnel in the pith of the new shoots, primarily during May and early June. Tunnels may extend from the base to near the tip. Infested shoots droop and often break.

During the latter half of June, the larvae leave their tunnels and drop to the ground. Cocoons in which the pupal stage occurs are formed in the debris under a tree. The insect remains in the pupal stage until late April or early May of the following year (6).

***Exoteleia* sp.**

Exoteleia sp., an insect which has not been described or named, was first found in Ohio in a Christmas tree planting in Lake County in 1960 (15). Since that time, it has been observed in other Christmas tree plantings in northeastern Ohio (21). The complete host range of the insect is not known but it has occurred in relatively large numbers on both red

and Scotch pine. White pine and spruce were not injured when growing in the same plantation with infested Scotch and red pine.

The adult insect is an inconspicuous moth with a wing expanse of less than 1/2 inch. Full-grown larvae are pink and about 1/4 inch in length. Moths emerged in cages in the insectary at Wooster from June 1 to July 8 in 1962 and from June 20 to July 19 in 1963.

Female moths deposit eggs on the pine needles and the newly hatched larvae bore into the tips of the needles. They feed during the remainder of the summer and fall as needle miners (Figure 71) and live in their burrows during the winter.

When the trees start to grow in the spring, the larvae crawl from the needles to the swelling buds. This period occurred during the last half of April in 1963. The larvae feed inside the growing shoots until full grown (Figure 72) and then change to pupae inside their burrows. Only one generation occurs each year.

Approximately 43 percent of the larvae collected in Lake and Trumbull counties in 1963 were destroyed by parasites. The parasite species primarily responsible was determined by B. D. Burks as *Copidosomo deceptor* Miller.

White-Pine Weevil, *Pissodes strobi* (Peck)

As the name implies, the white-pine weevil is primarily a pest of white pine. The adult is a snout beetle about 1/4 inch long. It is reddish brown, irregularly marked with brown and white scales.

The adults live in the duff under the trees during the winter and appear on the trees very early in the spring. They feed primarily on the bark of the leader and soon begin laying eggs in holes in the bark.

The larvae feed in the inner bark and usually girdle and kill the leader (Figure 73). It is not unusual for the top of a tree to die as far down as the third whorl of branches. As the larvae become full grown, they change to pupae inside their burrows and the adults emerge during August and early September.

Craighead (4) described this insect as the most serious pest of white pine in the East. However, it has not caused appreciable damage in Ohio in recent years.

Northern Pine Weevil, *Pissodes approximatus* Hopkins, and Pales Weevil, *Hylobius pales* (Herbst)

The increase in the number of Christmas tree plantations in northern Ohio in recent years and the practice of harvesting relatively large numbers of trees in localities where young trees are growing have resulted in a marked increase in specific insect pests. This has been particularly noticeable for the northern pine weevil and the pales weevil. Both insects breed in freshly cut logs and stumps and abundant breeding wood becomes available in Christmas tree plantations when trees are harvested.

Beetles emerging in late summer feed in the inner bark of vigorous trees until cold weather appears.

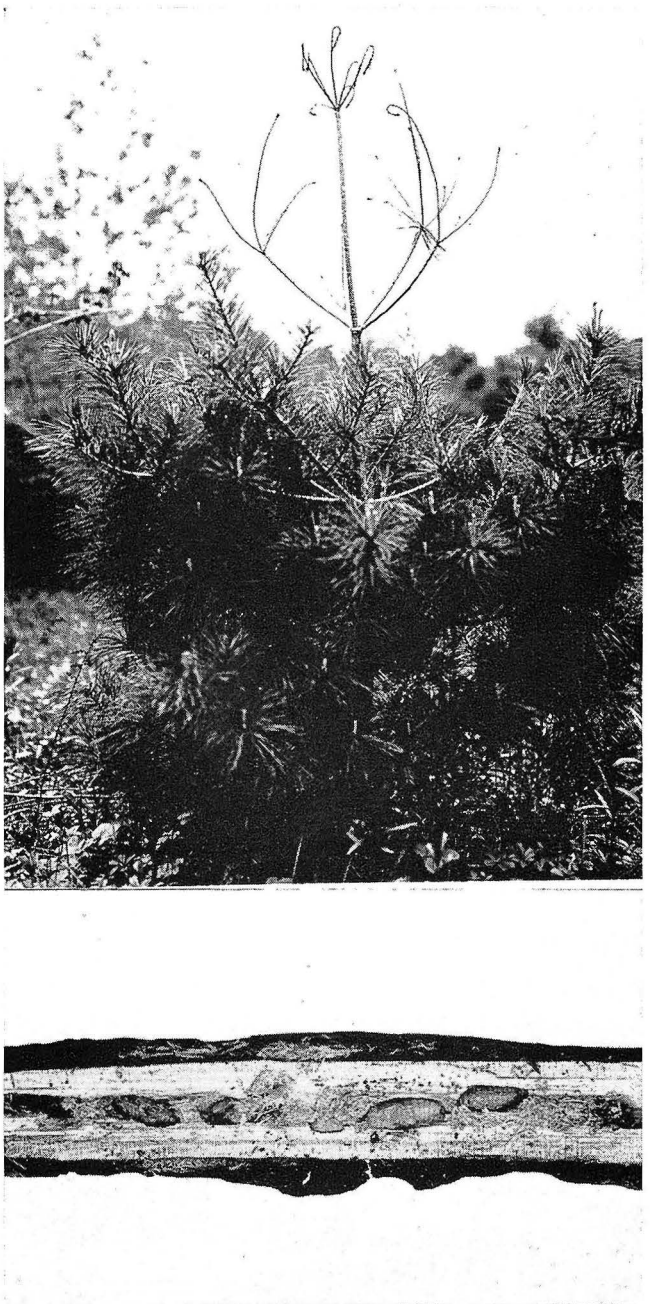

Fig. 73.—White-pine weevil injury. Above, typical injury on young white pine; below, a leader cut open to show insects inside.

Young trees may be killed and leaders may be destroyed on larger trees (Figure 74). The beetles are somewhat gregarious. Trees in a portion of a planting may be damaged severely and others may not be injured.

Because the northern pine weevil has been studied more extensively in Ohio, its life history and habits are reported in more detail. The adult insect resembles the white-pine weevil and is slightly more than 1/4 inch in length (Figure 75). The weevils appear primarily during July and August in Ohio and feed as indicated above until cold weather appears. They hibernate in the debris under the trees and resume activity in the spring.

Early in May, they begin laying eggs in the stumps of trees as well as in cull trees cut the previous fall. Eggs were found in Scotch pine stumps on May 10, 1961. Early development of the insects in 1963 indicated that eggs were deposited by May 1.

The larvae feed just under the bark and when full grown form cocoons from chips of wood bound together with silken fibers (Figure 76). The rate of development of the insects varies with the season. During 1960 and 1961, adults continued to emerge through August. During 1959, 1962, and 1963, nearly all were in the adult stage by the end of July.

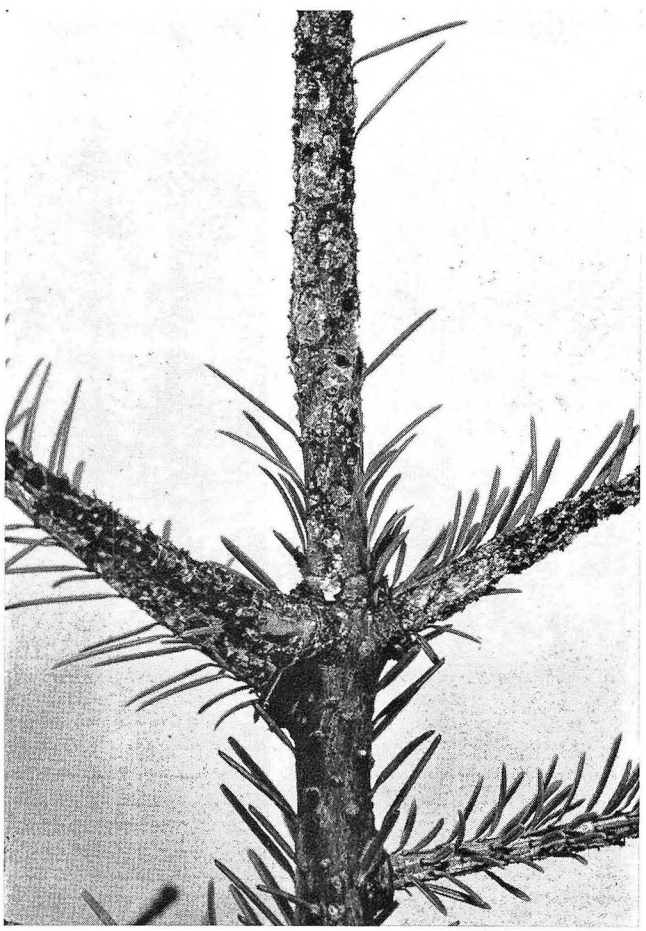

Fig. 74.—Top branches of a Douglas fir tree injured by the feeding of northern pine weevil adults.

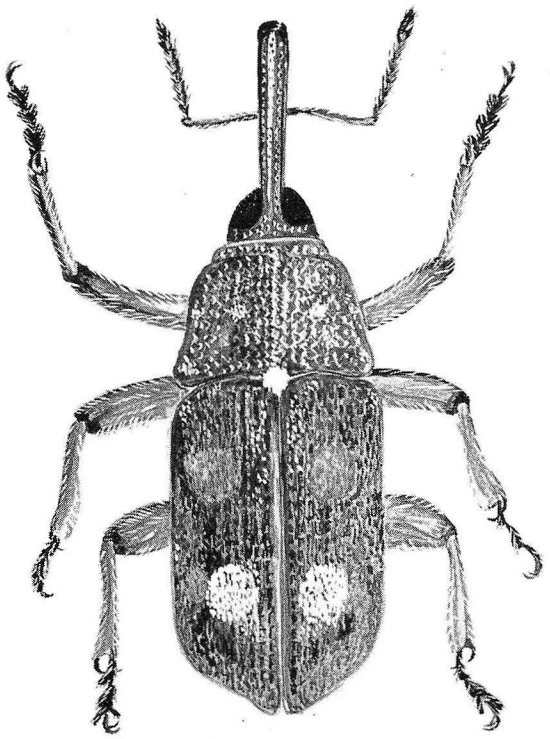

Fig. 75.—Adult of the northern pine weevil. (From painting by J. T. Walker)

If trees are cut during the spring and summer months and fresh breeding wood becomes available to the weevils at that time, the life history of the insect is changed somewhat. In 1960, freshly cut trees and stumps were available at 2-week intervals during the spring and summer months. Eggs were deposited in this wood much later in the spring and summer and when cold weather appeared in the fall, only 54 percent of the insects which developed had reached the adult stage. Thirteen percent were in the larval stage and 33 percent were pupae. Apparently the insect can hibernate as a larva, pupa, or an adult.

The pales weevil has habits and life history similar to the northern pine weevil. It is not unusual to find larvae of both species in the same stump. Weevils were found in relatively large numbers in two Christmas tree plantations in Wayne County, Ohio in 1963. In one planting, more than 95 percent were *P. approximatus* and in the other *H. pales* predominated.

Fig. 76.—An infested Scotch pine stump with a portion of the bark removed to show cocoons of the northern pine weevil.

H. pales is somewhat larger than *P. approximatus* and emergence occurs somewhat later in the fall. However, pales larvae and pupae have not been found in hibernation. Both insects breed in freshly cut wood of a variety of conifers and both thrive in Christmas tree plantations where Scotch pine predominates. It is interesting to note, however, that no living larvae were found in Scotch pine stumps containing one or more branches which continued to grow.

Because the weevils breed only in freshly cut wood, control consists of the removal or elimination of such wood or treating it chemically to prevent weevil reproduction.

BORERS IN TRUNKS AND LARGE BRANCHES

A relatively large number of wood-boring insect larvae attack trees and shrubs in Ohio. Two of the more common pests become bronze-colored beetles when they reach the adult stage and represent the family of metallic wood borers, Buprestidae. These are the bronze birch borer and the flatheaded apple tree borer.

Both borers occur primarily in trees which are in a weakened condition. This lack of vigor may be due to the shock of transplanting, drought, defoliation, improper soil condition, or other causes.

The locust borer is the most severe pest of black locust in Ohio. It is a member of the family of long-horned beetles, Cerambycidae, which is so named because of the unusually long antennae of the adults. In the larval stage, the members of this family are known as roundheaded borers.

Five of the common wood boring insects are progeny of clear-winged moths of the family Aegeriidae. In the adult stage, they resemble bees and wasps. These are the lilac borer, ash borer, dogwood borer, rhododendron borer, and peach tree borer.

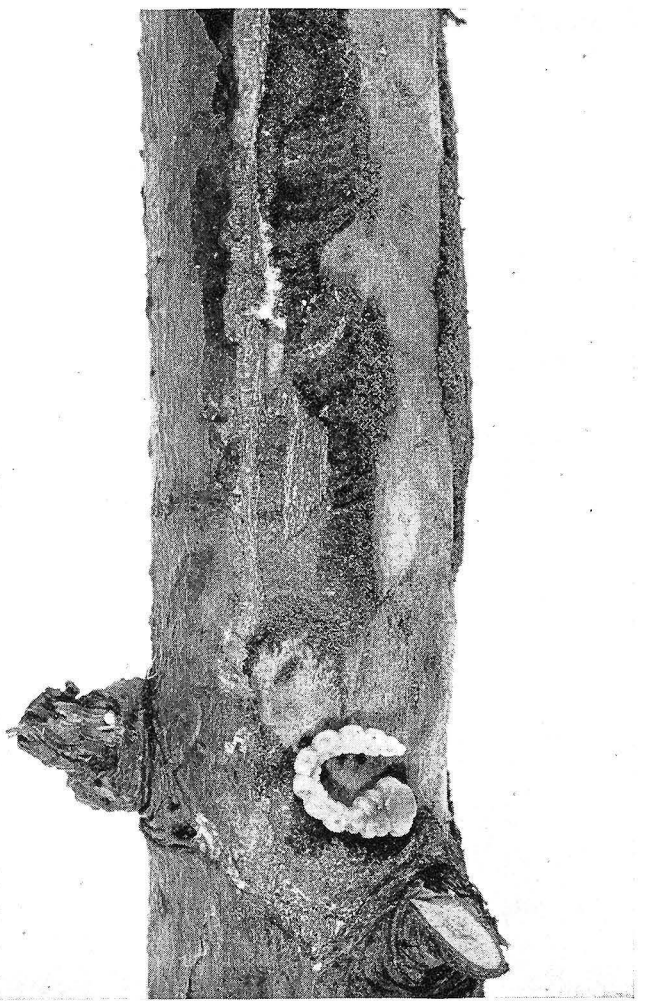

Fig. 77.—Bark removed to show a flatheaded apple tree borer and its work.

Flatheaded Apple Tree Borer, *Chrysobothris femorata* (Olivier)

The borer which causes most trouble in ornamental plantings and nurseries of Ohio, primarily because it attacks such a wide variety of trees, is the flatheaded apple tree borer (Figure 77). Although it was first named as a pest of apple trees, it attacks nearly all fruit and shade trees. It is widely distributed throughout the United States. A full-grown larva is about 1 inch long and is white, with the fore part of the body broad and flattened.

The beetles appear primarily during June and July. Eggs are deposited in crevices of the bark in areas of the trunk and larger branches exposed to the sun. The eggs hatch into larvae which burrow through the bark. They feed just under the bark during most of the summer. Relatively large areas of the bark may be killed and a small tree may be girdled and killed by one borer.

In the fall when the larvae are nearly full grown, they penetrate deeply into the wood where they live during winter. Only one generation occurs each year.

Because the flatheaded apple tree borer occurs primarily in weak trees, much damage can be avoided by maintaining trees and shrubs in a vigorous condition. Arborists wrap the trunks of newly transplanted trees with burlap from the ground to the first branch and this practice aids materially in control of this pest.

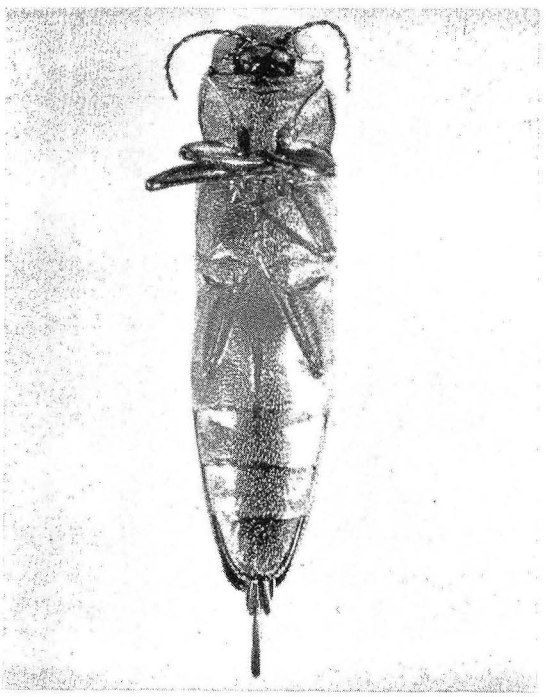

Fig. 78.—Adult of the bronze birch borer.

Bronze Birch Borer, *Agrilus anxius* Gory

The bronze birch borer attacks various species of birch and is said to attack beech and aspen. In Ohio, it is primarily a pest of white birch (*Betula pendula*) and paper birch (*B. papyrifera*) grown as shade trees and ornamental plants. Trees which have been injured and those in a weakened condition are most subject to attack. If the insect is not controlled, trees may be killed during a period of a few years. No adequate control measures were known until the modern organic insecticides became available. The borer occurs throughout the north central and northeastern states, as well as in Quebec and Ontario, Canada.

The adult insect is a greenish-bronze colored beetle, slightly less than 1/2 inch in length (Figure 78). Beetles usually appear during the first half of June in northern Ohio and are active primarily during June and July. They feed to some extent on the foliage but this causes no apparent damage. Eggs are deposited in crevices of the bark. These hatch into larvae which bore into wood and make long, winding tunnels just under the bark (Figure 79). Ridges in the bark sometimes show the path of the tunnels.

Fig. 79.—Boles of white birch showing exposed tunnel, larva, adult, and characteristic D-shaped exit hole of the bronze birch borer.

When full grown, a larva is about 3/4 inch long. It is slender, flattened and creamy white. It lives

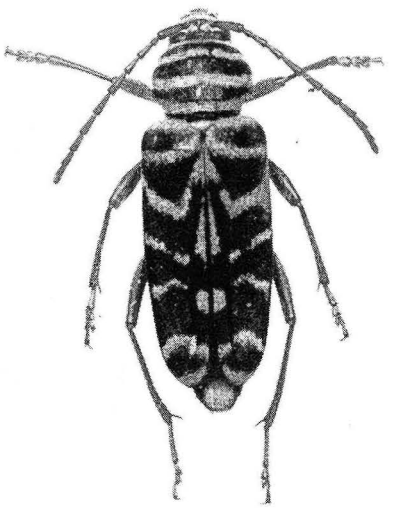

Fig. 80.—Locust borer adult (enlarged).

during the winter in a boat-shaped depression just under the bark. In late April or early May, it changes to the pupal stage. The adult (Figure 79) emerges through a characteristic D-shaped hole in the bark.

The injury first appears in the top of a tree and a dead branch may represent the first evidence of attack. If the infestation is not checked, the infestation gradually moves downward and in a few years the tree is killed.

A parasite, *Phasgonophora sulcata* Westwood (Family Chalcididae), frequently attacks the bronze birch borer. However, it has not been observed to control an infestation effectively in Ohio.

Locust Borer, *Megacyllene robiniae* (Forster)

The locust borer occurs throughout the United States wherever black locust is grown, except perhaps in the far western states. In Ohio, the adult beetles appear in September and may be seen feeding on the flowers of goldenrod. The beetles vary from 1/2 to 3/4 inch in length. The body color is velvety black, marked crosswise with bright yellow lines (Figure 80).

Eggs are laid in rough areas of the bark of black locust, usually under scales of bark. The eggs hatch in the fall and the small larvae burrow into the outer corky bark and remain there during the winter.

They resume feeding in the spring and work their way into the heartwood. During this period, a sawdust-like material is exuded through the entrance hole. The larva is about 3/4 inch long when full grown. The pupal stage occurs in the burrow during July and August.

Infested trees are mutilated and weakened (Figure 81). Some trees are killed and others may be broken over or limbs blown off.

Lilac Borer,
***Podosesia syringiae syringiae* (Harris), and**
Ash Borer, *P. syringiae fraxini* (Lugger)

The lilac borer and the ash borer are very similar and apparently have been confused at times. The moths of both species are black with a brownish cast and have a wing expanse of slightly more than 1 inch. The fore wings are dark and the hind wings transparent with a black border.

A severe ash borer infestation was observed on white ash trees grown as shade trees at Wooster. Four infested trees were on a lawn near a house. All had trunk diameters of about 4 inches and one was dying from the top down when first observed. As many as 20 exit holes were counted on this tree, distributed at random on the trunk and central leader, with a few out of reach from the ground. Small piles of sawdust-like castings occurred on the ground at the base of the tree.

The moths emerged from these ash trees during the last half of August and first half of September. The eggs hatched in the fall and small larvae lived during the winter just under the bark.

Fig. 81.—Black locust tree severely injured by locust borer.

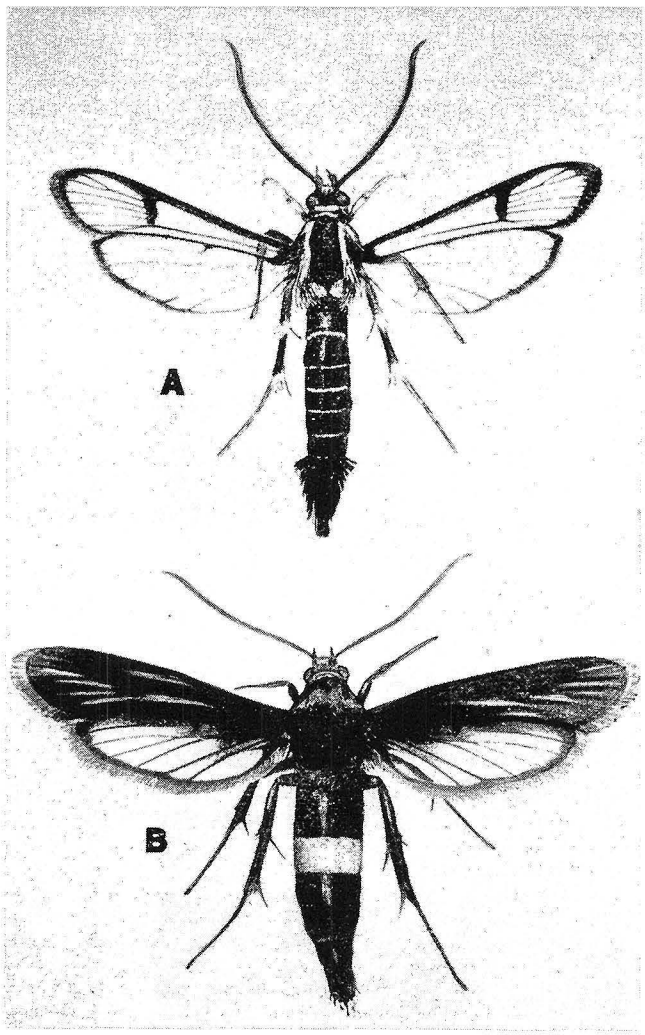

Fig. 82. —Peach tree borer moths. Male (a) and female (b).

Borer infestations in lilac have produced moths only in the spring, usually in May. Eggs are deposited in rough areas of the bark near the base of the larger stems. The larvae tunnel under the bark and later penetrate deeply into the wood. Scars and exit holes occur on the older stems, which are weakened and sometimes killed if the infestation is not controlled. Larvae are white and approximately 1 inch long when full grown. They live during the winter primarily as full grown larvae deeply embedded in the wood.

Peach Tree Borer, *Sanninoidea exitosa* (Say)

The peach tree borer is one of the most destructive insect pests in commercial peach orchards. It is not a common pest in ornamental plantings but in a nursery may attack flowering almond, plum, cherry, and apricot, as well as peach. Infested nursery trees may be killed or injured so severely they are valueless.

Peach tree borer adults are clear-winged moths (Figure 82). The female can be recognized by a broad orange band on the abdomen. The moths appear primarily during July and August in northern Ohio.

Eggs are deposited near the base of a tree, either on the bark or on weeds or debris. A newly hatched larva burrows through the bark and then works downward. Most injury occurs below the soil surface but masses of gum and frass usually occur at the base of an infested tree.

Partially grown larvae hibernate in their burrows and feeding is resumed in the spring. Full-grown larvae (Figure 83) are 1 to 1-1/4 inches in length. The pupal stage occurs in the burrow. Only one brood occurs each year.

Dogwood Borer, *Thamnosphecia scitula* (Harris)

The dogwood borer is primarily a pest of dogwood in Ohio. In the southern states, it attacks pecan trees and is sometimes called the pecan borer (36). The clear-winged moths are somewhat smaller than peach tree borer moths and appear somewhat earlier in the season. Emergence begins in late May

Fig. 83.—Two peach tree borers exposed in their burrows.

and moths are usually most abundant about the end of June.

On young trees, eggs are deposited primarily at the base of a tree. On older trees, eggs are deposited in scars and rough areas of the bark on the trunk and larger branches. The larvae feed in the bark and the cambium. The conspicuous sawdust-like castings produced by the ash borer are not observed under infested dogwood trees. Only one brood occurs each year but larvae of various sizes hibernate in their burrows.

Young trees may be killed in 1 or 2 years. Older trees which have been infested for a few years develop rough and knotty areas on the trunk and larger branches. Areas of the bark may be killed and branches may break off. Infestations occur more commonly in ornamental plantings and nurseries than in wooded areas.

Rhododendron Borer,
***Ramosia rhododendri* (Beutenmuller)**

The rhododendron borer is smaller than the borers listed previously. Craighead (4) describes it as the smallest of the clear-winged moths. The wing expanse of the adult is about 1/2 inch.

The moths appear in late May and June and deposit eggs on the bark of the larger branches of *Rhododendron*. The larvae feed for a time just under the bark but later bore into the sapwood. A full grown larva is about 1/2 inch long. It hibernates in its burrow and in the spring transforms to the pupal stage. Only one brood occurs each year.

Borer injury in an ornamental planting of *Rhododendron* tends to increase from year to year if the infestation is not controlled. Branches may be girdled, causing the leaves to turn brown and die. Areas of the bark are killed and holes may exude sawdust-like castings. Growth is restricted and fewer blooms are produced.

ROOT FEEDERS

Two insect pests are listed as root feeders because their damage results primarily from attacks on the roots. In the adult stage, both species feed to some extent on plant foliage but seldom cause appreciable damage there.

Black Vine Weevil,
***Brachyrhinus sulcatus* (Fabricius)**

The black vine weevil has been recorded as a pest of a large number of plants. Its common name was derived from its activities in a number of European countries where it was a severe pest of grapes. It is sometimes listed among the pests of strawberries

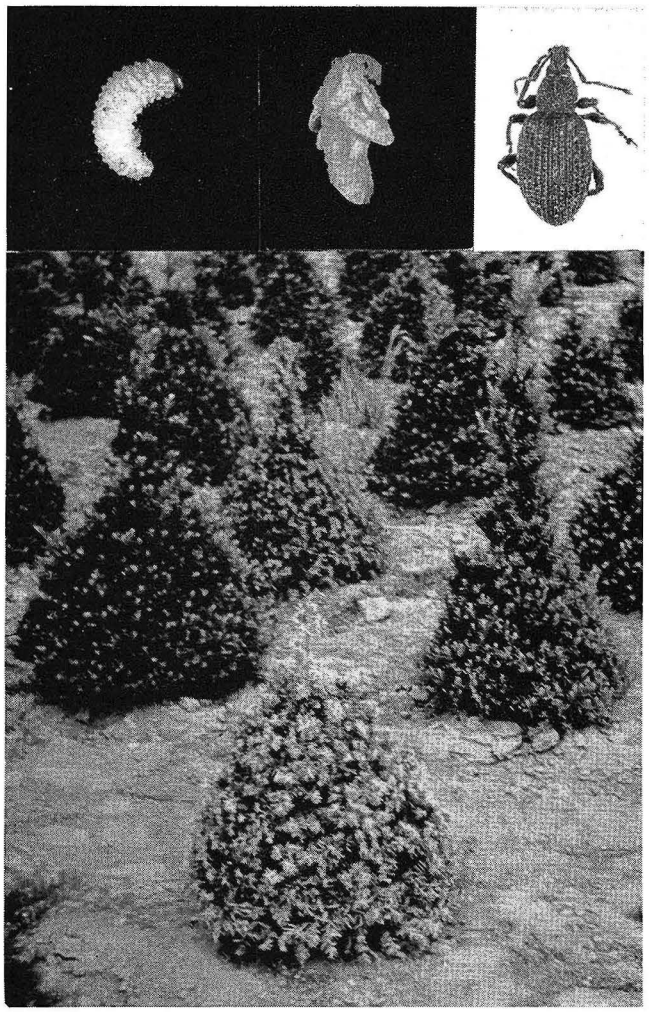

Fig. 84.—The light-colored *Taxus* in the foreground was damaged by black vine weevil larvae feeding on the roots. Larva, pupa, and adult shown above.

but is one of the less destructive of the strawberry root weevils. It has attracted most attention as a pest of woody ornamentals in commercial nurseries.

In Ohio, the injury has been most severe on *Taxus* where the roots are destroyed by the feeding of the larvae. Heavily infested plants turn yellow (Figure 84) and eventually die if the injury continues. Injury also has been observed on rhododendrons and azaleas but this consisted primarily of foliage injury resulting from the feeding of the adults.

Injury to *Taxus* has appeared throughout northern Ohio, particularly in northeastern Ohio where many nurseries are located. The importance of this pest as an economic insect increased with the increased popularity of various species of *Taxus* for ornamental purposes and the corresponding increase in the size and number of *Taxus* plantings in Ohio nurseries.

Occasionally hundreds of plants have been killed after growing to the stage where they were salable for landscaping purposes.

Only one generation of black vine weevils occurs outdoors annually in Ohio. The adults appear during June and early July. They feed on the foliage at night but hide during the day, primarily in debris and loose soil under the plants. Eggs are laid during July and August on the soil under the plants on which the adults feed. As the eggs hatch, the larvae burrow into the soil and feed on the roots. They live during the winter as well-grown larvae in the soil and change to pupae in late May or early June.

If infested *Taxus* plants are located near a greenhouse where ornamental plants are grown, beetles may wander into the greenhouse and deposit eggs on plants growing there. Various greenhouse plants are subject to attack but most injury is likely to occur on woody ornamentals. Rather severe injury was observed in a small greenhouse where *Taxus* plants were being propagated. The adults were feeding on the foliage of rooted cuttings and the larvae were feeding on the roots.

Under greenhouse conditions, the life history of the insect is changed and adults may appear in January.

The beetles of this genus are unusual as no male has been observed. Eggs are deposited without fertilization and produce only females. The beetles cannot fly, so infestations spread slowly from one area to another but may spread rather rapidly in a specific area.

Strawberry Root Weevil, *Brachyrhinus ovatus* (L.)

As its name indicates, the strawberry root weevil is an important pest of strawberries in parts of the United States, particularly in the Pacific Northwest. It may occur occasionally on strawberries in Ohio but is not a common pest of that crop in this state.

Like *B. sulcatus,* the strawberry root weevil occurs more commonly in nurseries. There the larvae may feed on the roots of hemlock, spruce, *Taxus,* and arborvitae. The most severe injury has been observed on nursery hemlock trees 18 to 30 inches in height.

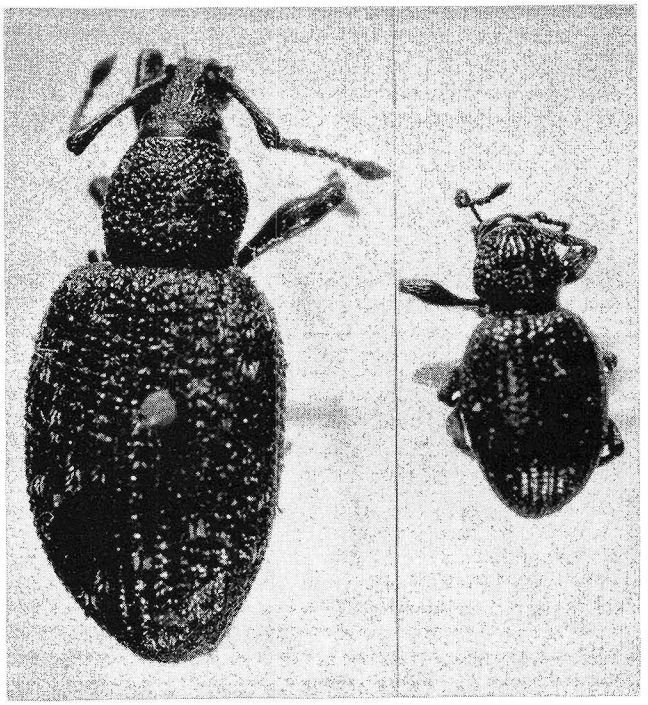

Fig. 85.—Strawberry root weevil (right) is about 1/4 inch in length compared with 1/2 inch for black vine weevil (left).

The foliage of an occasional tree was pale yellow and showed evidence of a lack of vigor. As many as 92 dead beetles were collected under one plant about 2 feet in height in late June, 1 week after spraying with benzene hexachloride.

As shown in Figure 85, the strawberry weevil is smaller than the black vine weevil. The adult beetles appear about 2 weeks earlier in the spring than the black vine weevil. However, the two insects are similar in many respects. Both occur only as females and both are unable to fly. In the adult stage, both feed only at night and hide during daylight hours.

B. ovatus is frequently a household pest. In late July and August or after the egg-laying period, beetles may congregate in relatively large numbers and wander into houses and other buildings, apparently in search of hibernating quarters. Similar invasions have been reported in the spring but relatively few beetles are known to survive a winter outdoors in Ohio.

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