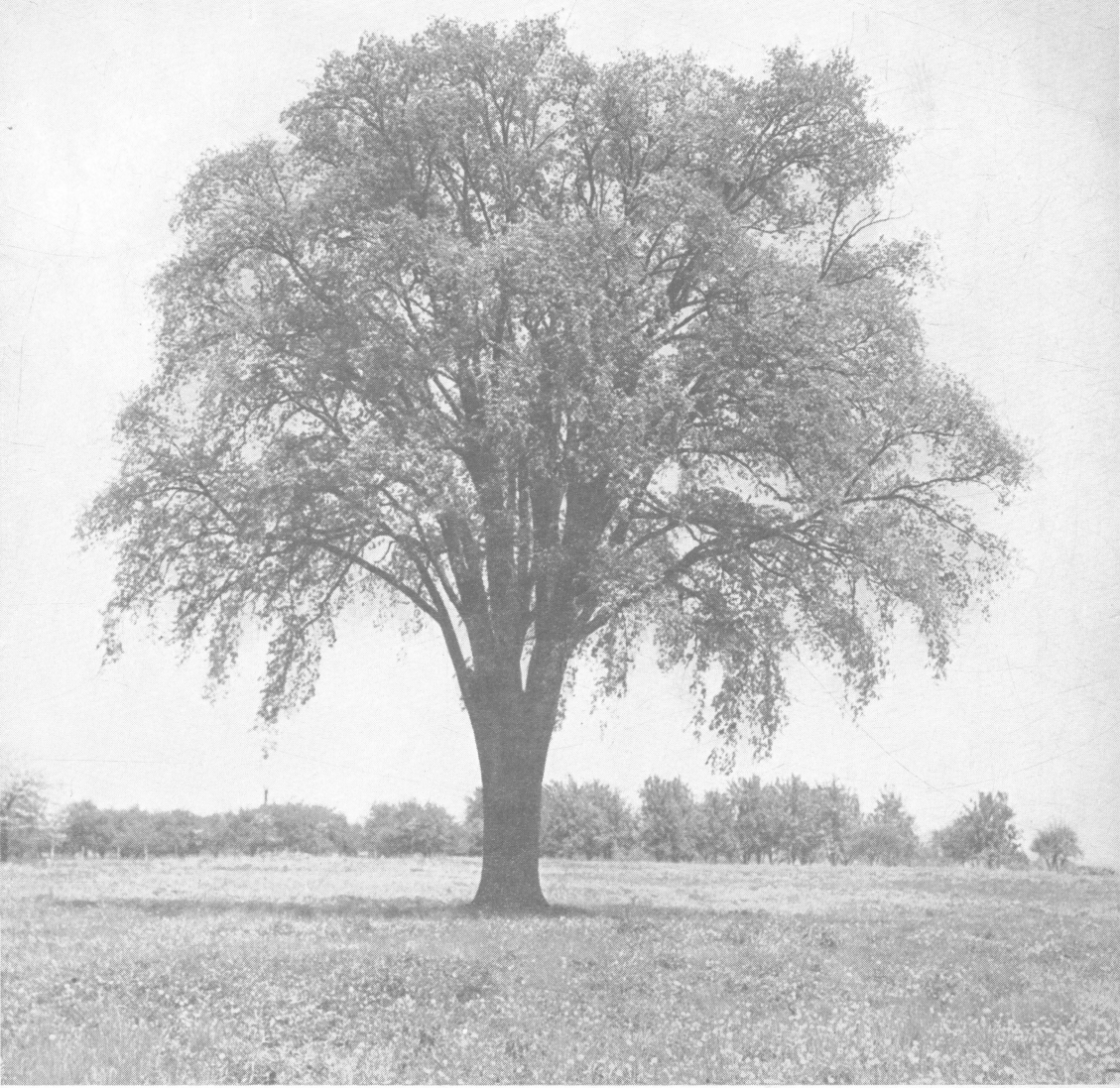
Insects on Elms



Bulletin 172
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Agricultural Extension Service, The Ohio State University

Identifying Your Trouble

Insects on Elms

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Introduction

The American elm[1] and its European cousins, the English[2] and Scotch[3] elms, occupy front rank among our valued shade trees. Probably no tree surpasses the American elm for its ability to grow and thrive under all sorts of conditions. Its majestic stature, graceful spread of branches, rapid growth, and vigor has endeared it to the hearts of all. The American elm spread its lofty branches over the forests when the white m..n first came to Ohio, and has since stood watch as a sentinel in open fields and highways. The gigantic Logan Elm, now standing near Chillicothe, cast its shade over the signers of the peace treaty with the Indians in 1774.

The beauty and gracefulness of the American elm, together with its ability to thrive under conditions found in cities, has been responsible for its predominance among the shade trees of city plantings. Some of our Ohio cities, for example Marietta, are noted for their beautiful elms. Their presence adds not only to the economic value of property, but to the aesthetic value of a community far beyond our ability to measure. For this reason, symptoms which point to the unhealthy condition of valuable trees are sure to demand the attention of the property owner.

Many inquiries and requests for information about ailments of elm trees come to the Ohio State University each week during the summer. This is due to the increasing injury to elms in America caused chiefly by European species of insects and diseases. At least two of these insects have become alarmingly abundant in Ohio during the last decade.

Causes of Elms Dying

The chief causes that may independently or collectively be responsible for the death of valuable elm trees are:

Insects	Leaky gas line
Diseases	Lightning
Lack of plant food	Mutilation of trunk or branches
Lack of water	Burying tree roots beneath filled in soil

The almost complete extermination of the chestnut trees in Ohio, due to the chestnut blight disease, is still fresh in our memories. What will happen to our elm trees should the newly introduced Dutch elm disease remain unchecked is a matter of conjecture. This disease has destroyed many beautiful elms around New York City, and its principal agency of spread is known to be a species of bark beetle[4] which carries the fungus organism that causes the diesase.

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[1] *Ulmus americana*
[2] *Ulmus campestris*
[3] *Ulmus scabra*
[4] *Scolytus multistriatus* Marsh

During 1935 an outbreak of cankerworms defoliated elms in northwestern Ohio, while in some of our cities the European elm scale has injured the lower limbs of many of our American elms and destroyed their beauty. Recently the elm leaf beetle has defoliated many of the English elms and some American elms in several Ohio cities. This has necessitated the spraying of these trees to save them from dying or to prevent serious injury.

The purpose of this bulletin is to aid the property owner and those responsible for public parks in following the proper procedure to preserve the elms; also to select the proper insecticide and direct its application, should spraying become necessary. Trees that have been weakened through drouth, or other causes, are readily exposed to attacks of some insects, and the result of their feeding may prove serious where otherwise it would not greatly affect the life of the tree.

The more important insect pests that attack elms are here treated under the headings of:

1. Leaf feeders, which devour the leaves
2. Plant lice, which make galls and cause distortions of the leaves
3. Scale insects, which suck sap from the limbs
4. Borers and bark beetles that work in the wood
5. Insects that scar the twigs in laying eggs.

Insecticides

The insecticides likely to be needed in combating elm insects are: lead arsenate for insects that devour the leaves, and nicotine sulfate solution for certain plant lice and newly hatched scale insects, that suck the sap. A suitable spreader, such as powdered skim milk, or calcium caseinate, is desirable to be used with these materials. The spreader will add to the effectiveness of nicotine and reduce the chances of foliage injury from lead arsenate. One-half pound of casein spreader to 50 gallons of spray is sufficient. Dormant spraying with a miscible oil, or oil emulsion, is advised in early spring only where scale insects threaten the life of the tree.

Care should be used to select and apply the proper insecticide at the proper time. Spraying should be resorted to only as an emergency on elm trees, but should not be neglected when necessary.

Spray Equipment

Should it become necessary to spray valuable elm trees, complete coverage is absolutely essential. This requires a good gasoline power sprayer if mature trees are to be protected. For young trees not over 25 feet high, a hand spray pump mounted on a barrel will suffice. Since a city property, or estate owner usually does not own a suitable sprayer for use on tall trees, it is usually necessary to engage a commercial spray operator to do the work. City park commissions and often city boards of education will find it advantageous to own a good power sprayer.

In selecting a commercial spray operator, one should be chosen who has an established standing in the community and one who has had training and experi-

ence in the care of shade trees. It is unsafe to let a stranger treat your valuable shade trees just because he happens along and insists that some strange malady will kill your trees if they are not sprayed, or otherwise treated at once. Inserting chemicals in the trunk of a tree is absolutely worthless for controlling insects or diseases. In such cases it is wise to call your county agricultural agent for advice.

Fig. 1.—Modern equipment enables the effective spraying of shade trees.

Wrapping Trunks

Wrapping of tree trunks with paper or burlap is now practiced by landscape architects and city park superintendents to prevent borer attack the first year or two after transplanting. This is *very* necessary, especially for the larger transplanted trees, and results in preventing borers from entering the trunks during the time the trees are developing feeder roots and becoming established. If this practice had been followed more generally during the dry seasons of 1933 and 1934, when much tree planting was done along the state highways, it would have saved many of the young trees that died during those years. Most wood boring insects thrive in trees that are in a weakened condition. Drouth affected, or newly transplanted trees, are very susceptible to borer attack. For this reason, it is very desirable to wrap the trunks of all shade trees immediately after transplanting and leave the wrapping in place until the end of the second year. By the end of that time the tree is sufficiently vigorous to prevent the entrance of borers.

Tree Banding

For certain insects, strips of cotton or sticky tanglefoot bands may be applied to the trunks of trees to prevent insects climbing them. Frequently, however, tree bands are applied without any knowledge of why they are being used, and possess little if any value after they are applied.

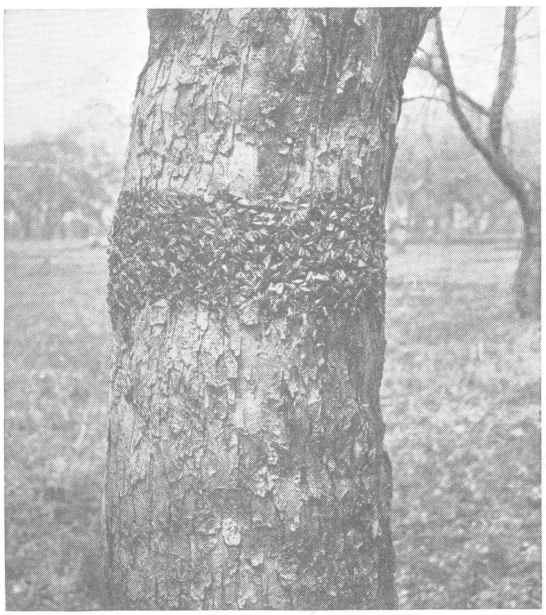

Fig. 2.—Male and female cankerworm moths caught on a band of sticky tanglefoot.

The chief elm insects for which banding is at times valuable are: cankerworms and the white-marked tussock moth. Banding is valuable only where certain larva, or wingless adults, use the tree trunk as a highway to reach the foliage. Even then one must know that the tree is not already infested with the insect, that it will quite likely be exposed to insect attack, and that the branches do not interlock with other unbanded trees.

Shade tree banding has a very small place in protecting trees against insects and it is safe to say that 75 per cent of the banding of trees, as now practiced, is useless.

Fertilizing and Watering

While elms thrive better than most trees in poor soil, they respond to applications of commercial fertilizer high in nitrogen which keeps them vigorous and resistant to borer attack. This should consist of about 2½ pounds of sulfate of ammonia, or 5 pounds of 10-6-4 analysis for each inch of trunk diameter. The usual method is to scatter the chemical broadcast on the ground on the area covered by the spread of branches, during late April or early May. Some advantage is claimed for applying the complete fertilizer in holes punched in the soil to a depth of 12 to 18 inches and spaced about 1½ feet apart, under the spread of the tree. There is no advantage in applying the sulfate of ammonia in this manner.

It is a mistake to assume that shade trees do not exhaust the fertility of the soil, the same as other crops. Likewise water should be added in such a way as to thoroughly soak the soil under a valuable tree at intervals during a prolonged period of drouth. This may save the tree.

The conditions under which shade trees are grown in cities, namely, paving requirements, quick run off of surface water, lack of leaf mulch, and the filling in of lawns with subsoil excavated from basements, make it necessary to apply fertilizer and water to the soil if trees are to thrive under such conditions.

Insects Devouring Leaves

Elm Leaf Beetles[1]

The elm leaf beetle, a native of Europe, was first found in America near Baltimore, Md., in 1833 and appeared in Dayton, Ohio, in 1904. It is now generally distributed over the southwestern quarter of Ohio, where it has seriously damaged elm in cities.

This insect feeds only upon the leaves of elm, but the English elm and the weeping Camperdown elm are the varieties most seriously injured. The native American elm is also attacked and frequently injured, though to a much less extent than the English elm. Other species of elms are seldom injured.

Some English elms in the city of Columbus, Ohio, were defoliated by the insect in 1934 and 1935. During the past three seasons complaints have reached us of injury occurring in most of the counties in the southwestern quarter of the state.

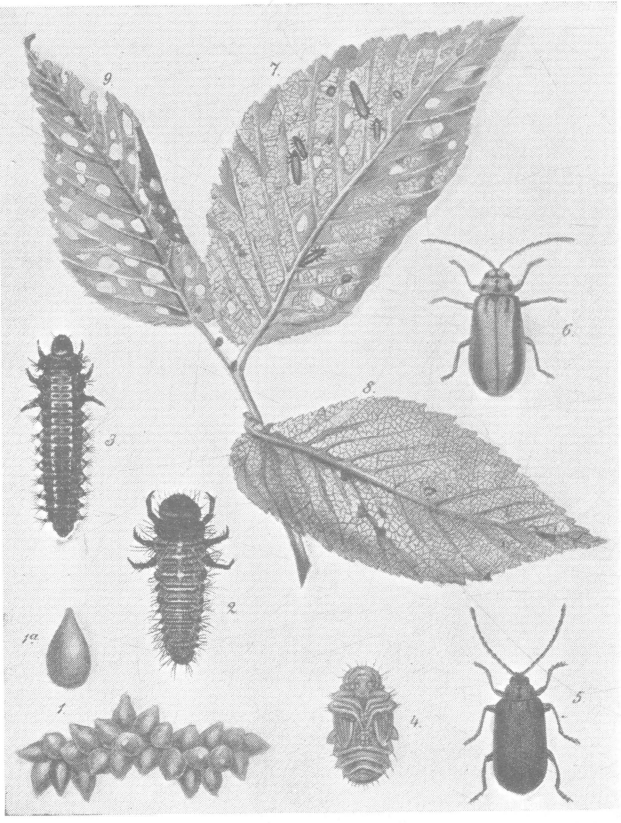

Fig. 3.—Elm leaf beetle: (1) Cluster of eggs; (1a) side view of single egg; (2) dorsal view of recently hatched larva or grub; (3) dorsal view of full grown larva; (4) pupa; (5) overwintered beetle; (6) fresh, brightly colored beetle. (All much enlarged.)

(7) Under surface of leaf showing damage from larva; (8) leaf nearly skeletonized by larvae; (9) leaf showing holes eaten by beetles.

[1] *Galerucella luteola* Muller

Life Stages and Habits:

The adult elm leaf beetle closely resembles the striped cucumber beetle in size, shape, and markings. The color is quite variable; the newly emerged beetles being reddish yellow, marked with black spots on head and thorax, and black stripes down the side. As the beetles become older, they change to yellowish-green with dark markings.

The beetles live over winter in attics of buildings, in piles of rubbish, under loose bark, and other similar places. They fly to the tops of elm trees as soon as the new leaves have appeared in the spring. There they eat elliptical holes through the leaves and place their yellow eggs on end in double parallel rows on the under surfaces of the leaves. The eggs hatch in about one week and the larvae feed upon the under surface, skeletonizing the leaf and leaving only the veins and upper membrane. Badly injured leaves soon turn brown and drop. The most serious foliage injury occurs during the month of June, when the larvae are approaching maturity.

The full-grown larvae are about ½ inch long, yellow, with a pair of black stripes down the side of the back and with two rows of tubercles on the back and sides. The larvae crawl down the tree trunk and transform to bright orange colored pupae at the base of the tree. In about 10 days these transform to adults which fly into tops of elm trees to lay eggs for another brood of larvae. There are two generations annually in Ohio.

Control:

Fortunately a fungous disease known to botanists as *Beauveria globulifera* Speg. is an important natural check to this insect, and kills a high percentage of the pupae and beetles on the ground during wet weather. This is the same fungous disease that kills the chinch bugs under similar weather conditions. It leaves the dead body of the insect covered with a white mold as shown in Fig. 4.

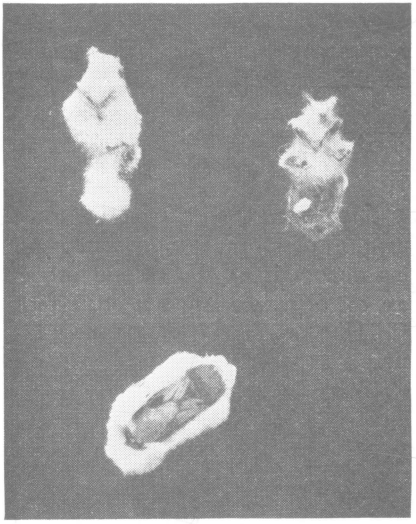

Fig. 4.—Insects killed by a disease. Dead bugs are covered with a white fungus.

The larvae and beetles can be killed with a poisoned spray carrying 3 pounds of lead arsenate to each 50 gallons of water. One-half pound of calcium caseinate or powdered skim milk should be added as a spreader. It is quite necessary to spray the under sides of the leaves to make the application before serious injury has occurred.

English elms should be inspected regularly during May and the spray applied as soon as its need is evident. If defoliation occurs before the owner

is aware of the presence of the insect, a new set of leaves will put out after the larvae stop feeding. Should these leaves be devoured by the second brood of larvae, the life of the tree would be threatened. Therefore, careful watch should again be kept for injury in August, and a spray should be applied against the second brood of larvae if necessary.

Cankerworms

Cankerworms are known as measuring worms, or loopers, that travel by a looping movement of the body, and when disturbed, let themselves down by a

Fig. 5.—Injury to elm foliage by cankerworms.

silken thread which they spin. These insects are native to America and are well known to apple growers, for they frequently defoliate apple trees in May, unless orchards are sprayed regularly. The same insect feeds upon elm leaves, appearing almost as soon as the elm leaves have put forth.

Injury from this insect is confined to the months of April and May, and outbreaks are always local and of varying intensity. Sometimes the leaves are only slightly injured, bearing only a few feeding holes, or presenting a ragged appearance (see Fig. 5). At other times almost complete defoliation takes place before the larvae become full grown. The writer distinctly remembers a period of years between 1898 and 1904 when both elm and apple trees were almost

defoliated each spring in central Ohio. Recently serious defoliation has occurred two years in succession to unsprayed apple and elm trees over a great part of northwestern Ohio. From this we see that cankerworm outbreaks occur intermittently and are regional.

From the standpoint of injury the cankerworm stands high among elm insects. While a new crop of leaves is put forth to replace the ones destroyed in early season, this effects a heavy drain upon the vitality of the tree and repeated defoliation may lead to its death.

Life Stages and Habits of the Insect:

There are two species of cankerworms which destroy elm foliage. One of these is called the fall cankerworm[1], because the adult moths emerge from the ground in the fall. The female moth has no wings, and crawls up the trunks of elm trees to lay eggs on the twigs and branches. The eggs are placed in masses around the twigs (see Fig. 6), and these hatch during the following April or early May.

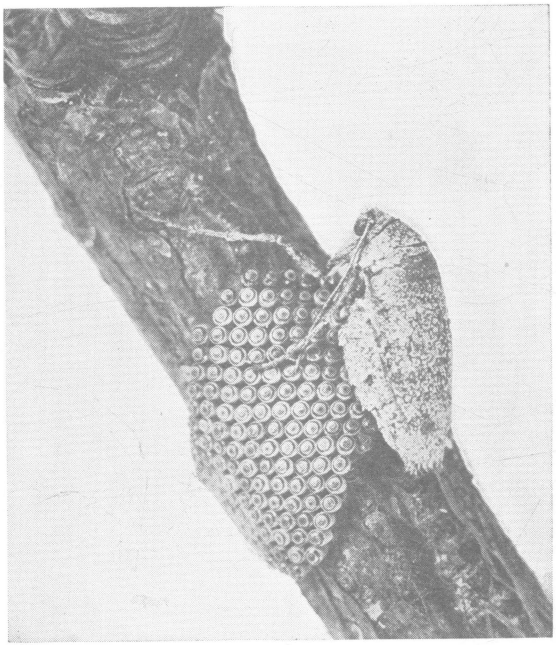

Fig. 6.—Fall cankerworm moth laying eggs.

The second species is known as the spring cankerworm[2], because the parent moths emerge early in the spring from ground beneath trees, where the larvae fed the previous summer. The male moths have wings, but the females are wingless, crawling up the trunks very early in the spring and laying their eggs in loose irregular clusters in the crevices of the rough bark. The eggs of both species hatch at about the same time in the spring.

Both species of larvae are loopers and vary in color from pale green to nearly black, but those of the fall cankerworm have three pairs of pro-legs, while the spring cankerworm has only two pairs. The two species frequently occur together and were both present in 1935, when many elm trees were injured by them in northwestern Ohio. The caterpillars feed for a period of 3 to 4 weeks during late April and May. When full grown they are about ¾ to ⅞ inch long (see Fig. 7), and quite dark in color. They let themselves down by threads when the tree is disturbed, or when they are ready to pupate.

[1] *Alsophila pometaria* Harris

[2] *Paleacrita vernata* Peck

They construct cells in the soil under the trees, where they transform to pupae, from which the adult moths emerge, either in the fall or the following spring, depending upon the species. There is only one generation annually.

Control:

Fortunately, this insect does not call for control measures during many seasons. Careful watch will indicate when its presence calls for action and a spray of lead arsenate at the rate of 2 to 4 pounds in 50 gallons of water will give excellent control. The spray must reach the topmost leaves and should be applied when the larvae are very young. In case the application is delayed until the larvae are nearly grown, the heavier amount of lead arsenate is required.

The use of sticky bands on tree trunks is of some value against both species of cankerworms, if applied on elm trees some distance away from unbanded elms. The bands should be applied in October, and kept in good condition during the time the wingless female moths are attempting to ascend the trunk, both in the fall and spring. Tree tanglefoot is the best material to use (see Fig. 2). It is preferable to apply this over a 5-inch band of heavy paper held tightly against a little cotton batting tied around the trunk. This enables the band to be removed in early May, leaving the tree free from the objectionable sticky mixture.

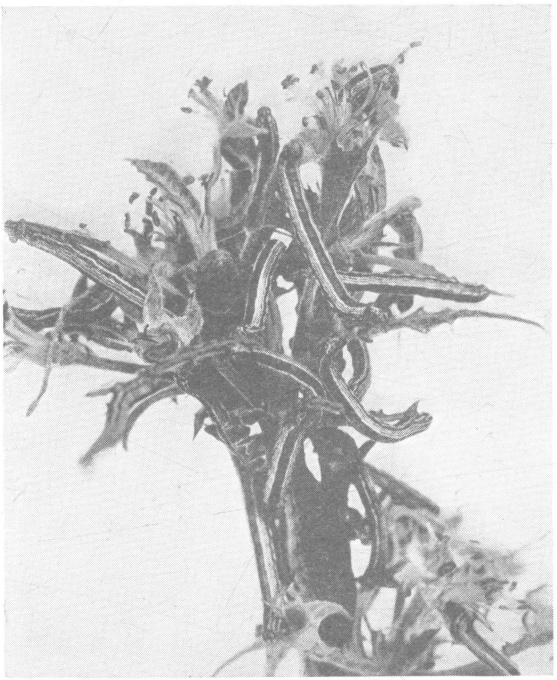

Fig. 7.—Full-grown cankerworms.

Banding elm trees for cankerworms is effective if unbanded elms are not in close proximity and the bands are properly applied and kept in working order. Spraying is a more effective method of control, and should not be delayed when the tiny caterpillars are noticed on the new leaves.

The White-marked Tussock Moth[1]

The white-marked tussock moth is so called because of the peculiar markings carried by the larvae. When full grown the larva is about 1½ inches in

[1] *Hemerocampa leucostigma* S & A.

length with four dense white brushes, or tussocks, of hair on the anterior half of its back. Behind these tufts of hair are two red projections, and the head is red with a fringe of white hairs extending over it from above. On each side of the head and just back of it is a long tuft of black hairs resembling a plume, and a similar tuft of black hairs arises from the rear of the body. A black band, bordered by yellow, extends longitudinally along the back (see Fig. 8).

Such a gorgeous caterpillar cannot help but attract attention when present on shade trees. The insects are voracious feeders, and are common almost every year on the elm and other deciduous trees. It is native to America and is found over the eastern half of the United States, but is always a greater pest of cities and villages than in the open country. Elm, poplar, soft maple, horse chestnut, and linden seem to be its preferred food, though it feeds upon nearly all kinds of shade and forest trees, except conifers. In some cities of Ohio and especially in the city of Sandusky, this insect has been a very serious pest for many years.

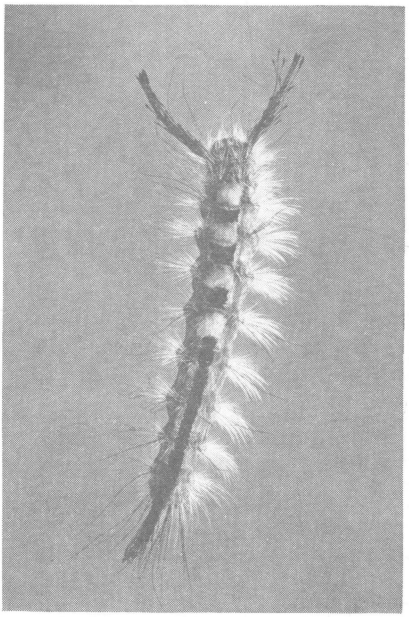

Fig. 8.—White-marked tussock moth larva.

Stages and Habits of the Insect:

The winter is passed in the egg stage. These are deposited in masses of from 100 to 500 and are covered with a frothy substance which hardens and forms an effective protection.

The egg masses are conspicuous for their white color (see Fig. 9) and are placed indiscriminately over the trunks and branches. These hatch late in May and the larvae require 4 to 5 weeks to complete their growth. During that time they devour the leaf tissue with the exception of the mid-ribs and the larger veins, giving the tree a very ragged and unsightly appearance. When exceedingly abundant they may entirely defoliate the tree.

Late in June or early in July the mature caterpillars spin some threads, which they mix with hairs from their bodies, and form gray cocoons that are placed on the rough bark of trunks and branches (see Fig 10).

Within this cocoon the larva changes to a brown pupa, which stage lasts from 10 days to 2 weeks. At the end of that time the adult moth emerges, the male being attracted to lights at night; while the female has no wings and usually remains near the old cocoon, where mating occurs and the eggs are laid in masses as previously described. There are two full generations annually in Ohio.

Injury usually is most severe during the months of June and July and would be more severe, were the insect not preyed upon by natural enemies. About two dozen species of parasitic insects are known to live upon it, and it is

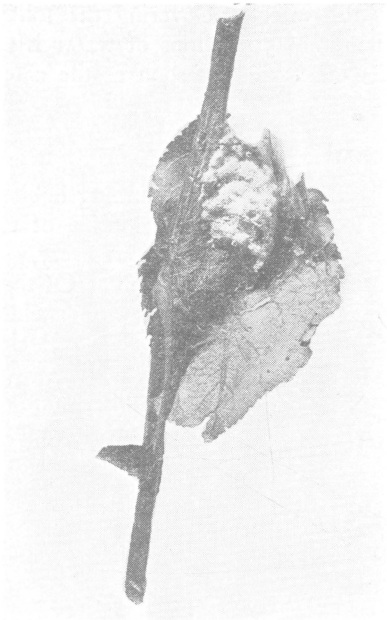

Fig. 9.—Tussock moth egg mass.

also freely fed upon by birds, which may account for its scarcity in open country and woods where native birds abound.

Control:

Although the female moth is wingless, sticky tree bands are of no value against the moths, because they do not emerge from the ground to crawl up the trunks. Regardless of this fact, much of the tree banding that is done in cities is carried on under the supposition that it will control tussock moths. This is because these caterpillars have the habit of wandering up and down the tree trunks in their search for new food.

Since the eggs are laid on the trunk, limbs, and branches, and few of the larvae crawl down the trunk, only a small percentage of the caterpillars would by accident become entangled in sticky bands. Banding the trunk with a cotton b nd, the upper half hanging over a string tied around the middle of the band, is of some value to protect uninfested trees from caterpillars which drop from nearby infested trees. This situation rarely arises, and spraying is preferred to banding.

Locating and destroying the egg masses are sometimes practiced as a method of control. This is a practical method to use where the trees are small and the infestation is light. On large and heavily infested trees the results are likely to be unsatisfactory. It should be remembered also that destroying the egg masses kills beneficial parasites which live within the eggs.

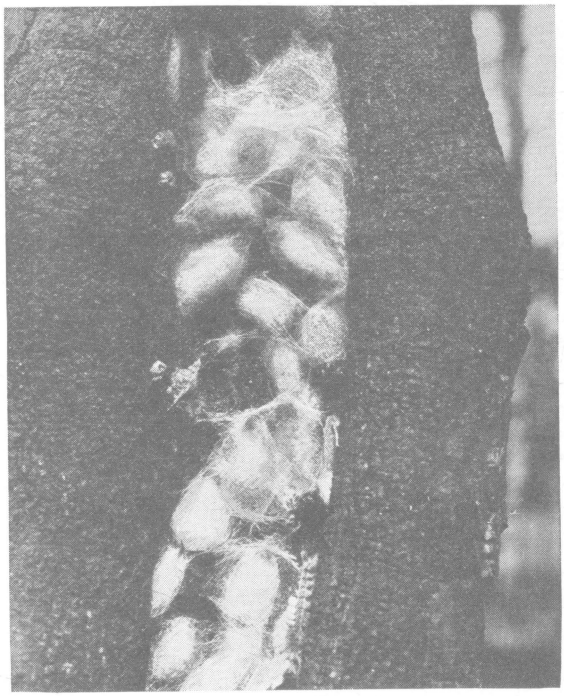

Fig. 10.—Tussock moth cocoons in a cavity of the bark.

Spraying is a very effective control for this insect. Covering the foliage with lead arsenate used at a strength of 3 pounds to 50 gallons of water is the method to follow. The application should be made just as soon as the caterpillars begin feeding.

Fall Webworm[1]

The fall webworm is easily recognized because of its web spinning habit of encircling the leaves with a dense web and feeding in a colony inside of this web. This is a native insect, and appears during midsummer of almost every year when its webs are conspicuous on a large number of trees and shrubs. Of these it prefers box elder, wild cherry, elm, and sycamore.

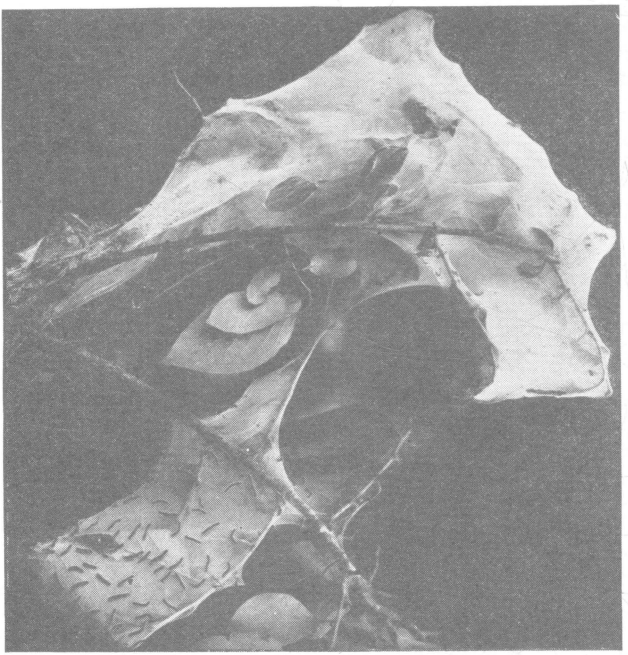

Fig. 11.—Fall webworm larval colony.

Unlike some of the other elm insects, it does not confine its work to city plantings, but the nests are quite commonly seen in open country and on shrubs growing along fence rows and highways. Sometimes the encircling webs measure as much as 2 feet in diameter and 3 to 4 feet in length.

Within the web every leaf will be skeletonized and if there is not enough food to bring the larvae to maturity, they will gradually enlarge the web, or even move to a new limb and start another web.

Life Stages and Habits:

Winter is passed in the pupal stage secure within a small cocoon under loose bark, or just below the ground surface. The adult moths emerge over a period of 2 to 3 weeks in June. The moths are almost pure white, speckled with a few black dots. They lay the eggs in masses upon the leaves of their host, 400 to 500 eggs being found in each mass. These eggs hatch in 10 days to 2 weeks, and the colony of larvae soon constructs a web around itself and feeds within this webbed retreat from 4 to 6 weeks. The larvae vary in color from yellow to brown, and

[1] *Hyphantria cunea* Dru.

are plentifully supplied with white hairs, that grow in clusters from black or orange tubercles.

The caterpillars consume the green coloring matter of the leaf, leaving only the upper membrane and veins. The older larvae do not always confine their feeding to leaves inside of the web. However, they always return to it when through feeding. The caterpillars are so hairy that most birds refuse to feed upon them. Moreover, the web furnishes a protection for the occupants and renders them relatively safe from the attack of predators.

When full grown the larvae either burrow into the ground, or pupate under convenient shelter. We have known them to make their way into basements within which the moths later emerged.

Control:

The control of this insect usually is accomplished by destruction of the webs containing the feeding caterpillars. This can be done by either (a) cutting away the branch carrying the webs and burning it, (b) by stripping away the nests and their occupants without removing the branch, or (c) by burning the nests by means of a torch held by an operator, who is careful not to cause serious injury to the tree from the flame. The abundance of webs and size of the tree will determine which, if any, of these methods is practical. It is sometimes possible to dislodge the larvae with a forcible stream of water.

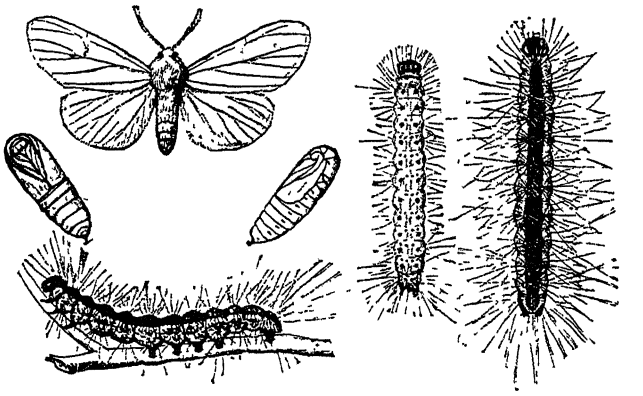

Fig. 12.—Adult, larva, and pupae of the fall webworm (slightly enlarged).

The most dependable method of prevention consists of spraying with lead arsenate at the rate of 2 to 3 pounds in 50 gallons of water. Owing to the habit of the larvae infesting only certain branches, the spraying of elm trees for the fall webworm is rarely resorted to, because the owner finds it more convenient to remove the colony at the point of attack.

Bagworm[1]

Of all insects which devour the foli ge of trees and shrubs, the bagworm has the most unusual habit of carrying around a bag, or protection, into which it retreats upon the slightest hint of danger. The bag-like covering is made of

[1] *Thyridopteryx ephemerae ormis* Haw.

particles of leaves and leaf stems from the plant upon which the larva feeds. Figure 13 shows the general shape and appearance of these conical bag-like coverings.

The caterpillar moves about with only its head and thoracic legs protruding from the end of the bag, the rest of the body being concealed inside the protection. Upon the slightest hint of danger, the larva stops feeding and retreats within the bag until danger is past.

The favorite food plants of the bagworm are arbor vitae, red cedar, and willow. However, it feeds upon most shade trees, and at times causes serious defoliation of elm during the months of July to September, inclusive.

Its injury in Ohio is limited to the southern half of the state.

Life Stages and Habits:

The winter is passed in the egg stage. The eggs are placed inside of the bag-like covering by the wingless female moth, which appears in the fall and does not leave the bag. One bag may contain upward of a thousand eggs, globular in shape, and packed closely together inside of the bag, which the insect has suspended from twigs and branches at the conclusion of its feeding (see Fig. 13). During the winter the bags are quite conspicuous on deciduous trees.

Fig. 13.—Bagworm cases (greatly enlarged).

Hatching occurs in June, when the young larvae leave the bag and wander about on nearby foliage, upon the tender portions of which they feed. Before they are many days old, they construct tiny bags of leaf fragments about their bodies.

When larvae are feeding, these bags stand upright on the leaves, the color of which they resemble, thus making it difficult for the worms to be seen. As the larva grows larger, the bag-like covering is enlarged, and assumes a brown color. The bag is enlarged with bits of leaves and leaf stems fastened together with fine silk spun by the larva. The inside of the bag is then lined with layers of silk, the bag being held in an upright position until it becomes too large and heavy, then it hangs down as the larva protrudes its head and eats the leaves.

The caterpillars become full grown in September, at which time the bags are permanently fastened to the twigs and branches and within which the larvae change to pupae and later to moths. The male moths are winged and are in flight during October. The eggs are laid late in the fall, and there is but one generation annually in Ohio.

Control:

The insect has not been abundant enough in the northern half of Ohio to demand control measures. In central and southern Ohio, however, it is frequently necessary to spray evergreens and occasionally desirable to spray deciduous trees to stop the depredations of this pest. The spray should be applied as early as possible after the presence of the larvae is detected. The bagworm is very easily killed with 2 pounds of lead arsenate to 50 gallons of water, if applied in June, soon after it hatches. If the application is delayed until the caterpillars are more than half grown, at least 4 pounds to each 50 gallons of water are necessary.

Hand picking of the bags containing the caterpillars, or eggs, is practical on shrubs and small trees. This is quite effective and the bags are easily seen when the leaves are down. They can be clipped from the supporting branch with a pair of shears and collected and burned. In some of the eastern states, they are collected in city parks by means of pruning shears on the end of a pole, the shears being operated by means of a long lever.

May Beetles[1]

The larvae of the May beetles, sometimes called June bugs, are commonly known as white grubs. We think of them primarily as feeding on grass roots, but these grubs occasionally become very abundant and destroy the roots of young trees. More important than this, however, is the habit of the adult beetles, which fly at night and feed upon the foliage of trees. Oak is the favorite food plant of these beetles, but other deciduous trees, including elm, are often attacked.

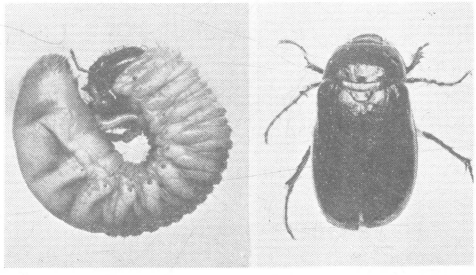

Fig. 14.—May beetle and young. Left, larva or white grub; right, adult May beetle.

Since the beetles feed at night and hide in the grass in the day time, the owner frequently is at a loss to understand what has been feeding upon the leaves of his trees. Inspection during the day reveals no insects present, while each day more and more foliage disappears. To add to this puzzle, the beetles have the habit of cutting off the leaf stems, and many fallen leaves are found on the ground each morning after nightly visitations of the beetles. This injury occurs during late May and June. It is more serious in years when the brood of May beetles, dominant in that community, is in the adult stage.

Most of the white grubs require 3 years to complete their development, hence reach the adult stage during the third year of their lives. Outbreaks of May beetles can, therefore, be expected to come in 3-year cycles, although the broods overlap and some adults are present each year.

While May beetles are not considered primarily as pests of shade trees, they cause more tree defoliation than one suspects. Each summer their work is brought

[1] *Phyllophaga* sp.

to our attention by owners who are at a loss to account for the defoliation. We are forced to conclude that May beetles cause far more injury to shade trees than has been supposed.

The beetles are quite local in their attacks upon trees. Shade trees standing alone are more liable to attack than solid rows of city plantings. Oak, ash, and hickory frequently are more seriously attacked than elm. If these insects are suspected of causing leaf injury, they easily can be discovered by the use of a flashlight at night, when they will be found at work among the leaves if they have been responsible for defoliation.

The only method of control consists of applying a strong spray of lead arsenate. At least 5 pounds in 50 gallons of water should be used to kill May beetles.

Insects Causing Gall-like Growth and Rolled Leaves

The Woolly Elm Aphid[1]

The woolly elm aphid is so called because it secretes a whitened waxy covering on its body, which gives the colony of plant lice a wool-like protection. Pellets of the secreted honey dew fall to the leaves and ground under the tree, causing the leaves to be sticky, and in this honey dew grows a fungus which becomes black and mars the beauty of the tree. The chief characteristic of the insect's presence is the rolling of one side of the elm leaf (see Fig. 15), with greatly thickened and distorted tissues. When the leaf is unrolled, there is revealed a mass of struggling plant lice mixed with honey dew secretion. One is inclined to wonder why so many plant lice do not cause the leaf to drop, or at

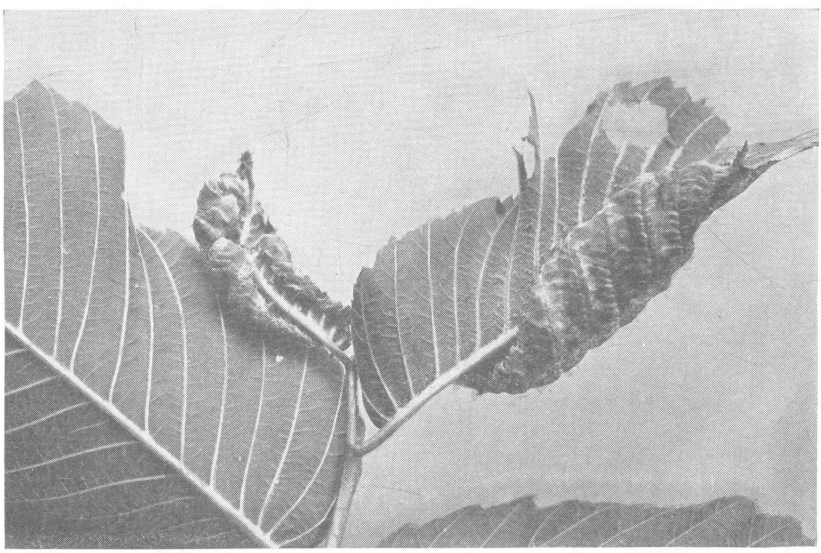

Fig. 15.—Work of woolly elm aphid.

[1] *Eriosoma americana* Riley

least destroy the green tissues. The chief injury, however, is one of distortion of the leaf, together with the presence of honey dew and the accompanying black sooty mold.

Control:

Fortunately, natural enemies usually keep this insect under control. These natural enemies are chiefly insect predators of which ladybugs and their larvae, syrphid fly larvae, and larvae of the lacewing fly are the most important. Before the insect becomes very abundant, these predators usually put in their appearance and devour so many of the plant lice, that the colony is soon eradicated.

Owing to the plant lice being so well protected under the rolled portion of the leaf, it is impossible to kill a high percentage of them with contact sprays. If the aphids are noticed in time, before they have caused the leaf to roll, they can be controlled with a spray consisting of nicotine sulfate solution. Use 1 pint of nicotine sulfate (40 per cent) in 50 gallons of water to which has been added 3 pounds of dissolved soap, or 2 quarts of summer spray oil as a wetting agent. It is necessary to strike the insects with this spray, hence thoroughness is essential.

The Woolly Apple Aphid[1]

The woolly apple aphid is well known in apple orchards, where it is found feeding upon the exposed cambium layer, at pruning scars, or wound scars of apple and pear. The insects place the overwintering eggs in protected places on the bark of elm, and the female aphids hatching from these eggs are the progeny of colonies of bluish-white aphids which feed upon the elm leaves, causing what is known as "rosette" or leaf cluster. Two generations of the insect feed upon elm in the spring, causing these deformed leaves. The aphids then grow wings and migrate to apple, hawthorn, or mountain ash. There they feed during the summer, and in the fall some of the winged individuals return to elm to lay their eggs. Some nymphs pass the winter underground upon apple roots.

While this insect sometimes calls for control on apple, especially on young trees and in the nursery row, it usually is not abundant enough on elm to make control measures necessary. Should it become so, spraying as suggested for the woolly elm aphid is the best procedure.

Woolly Elm Bark Aphid[2]

These aphids collect in white flocculent masses on the bark of elms and around pruning scars in particular. They suck the sap from the unprotected live wood and cause knotted growths of wood at point of attack. These aphids are unable to feed, except at points where the outer bark has been removed. The wool-like secretion is quite abundant and renders the colonies very conspicuous. No other host plant is known.

Control consists of rubbing off the colonies of lice with a brush or broom dipped in soapy water wherever the colonies can be reached. Painting the fresh pruning scars with coal tar creosote will do much to prevent the establishment of these aphid colonies.

[1] *Eriosoma lanigera* Hausm.
[2] *Eriosoma rileyi* Thomas

The Cockscomb Gall Aphid[1]

This insect is a very common one in Ohio and has the peculiar habit of causing enlargements, or growths, on the upper side of the elm leaves — the growths strikingly resembling a cock's comb. These galls first appear during May as ridged elevations (see Fig. 16), and rapidly enlarge, until by late June the complete gall is formed, apparently with little injurious effect upon the leaf itself.

The gall usually is from ¾ inch to 1¼ inches in length and ¼ inch high, with an irregular, or notched crest. Early in the summer the galls are occupied

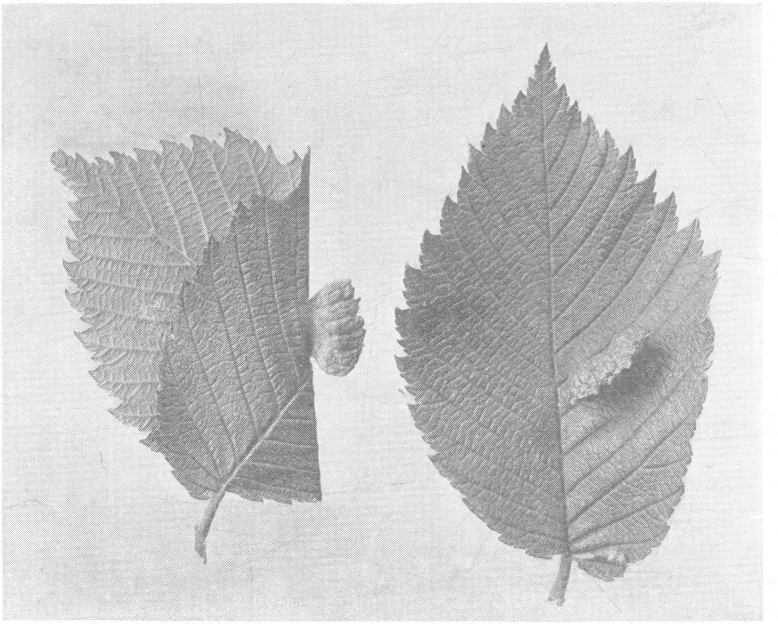

Fig. 16.—Growth caused by the Cockscomb gall aphid.

by colonies of aphids, which feed inside well protected against enemies. The aphids secrete a waxy material giving them a mealy appearance.

Later in the summer, the plant lice leave the gall and migrate to the roots of certain grasses. The gall then becomes brown in color, but does not cause defoliation. Unless very abundant, these galls do not seriously impair the function of the leaf.

One of the chief objections to the presence of these galls is the honey dew which falls from the leaves upon the ground beneath the tree. This usually appears at the time the plant lice escape from the gall at its base through an opening beneath the rough bark. No control measures are found necessary for this insect.

[1] *Colopha ulmicola* Fitch

Scale Insects which Suck Sap from Wood

The European Elm Scale[1]

The European elm scale, or elm bark louse, does the most serious damage of any insect attacking elms in some of our city plantings. It has been responsible for the disfiguration of valuable elm trees in many cities. Complaints of its depredations have reached us from many sections of the state, but they seem to be most numerous in central and southwestern Ohio. In the city of Columbus, we have more complaints about this insect than all other shade tree pests combined. There it has killed the lower limbs on some valuable elm trees, this injury being done principally during the past five years. From a very small beginning the insect multiplies rapidly on trees, and its habit of establishing itself mainly upon the lower limbs causes these limbs to become seriously injured, or die, hence infested trees soon become disfigured.

The European elm scale is so unusual in appearance, that it is not easily mistaken for any other scale insect. While the pest is not conspicuous during the dormant season, its habit of secreting a white, waxy fringe around its body makes it very apparent during the early summer months. This mass of white fringe gives it the appearance of resting in a bed of down, and contrasts strikingly in color with the reddish-brown of the soft bodied insect. When the insects are crushed with the finger, there is left a red stain that further identifies the species. Fig. 17 represents the insect as it appears in early summer on the bark. Its native home is in Europe.

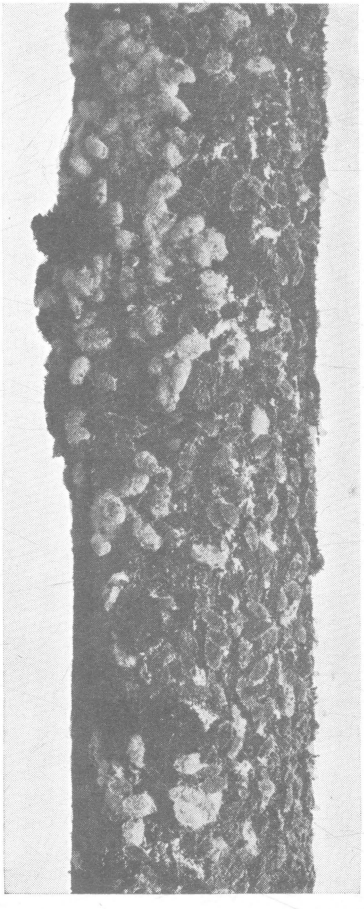

Fig. 17.—European elm scale. Mature females and cocoons of males as they appear in early summer.

Stages and Habits of the Insect:

This insect passes the winter in a partially mature stage on the trunk and older branches. It resumes feeding in the spring and becomes mature in May. The eggs are located under the body of the mature female, and these hatch late in June and during July. The young insects move about and establish themselves upon the leaves, and especially along the mid-ribs, where they feed for a time

[1] *Gossyparia spuria* Modeer

upon the tender leaf tissues. They move about over the leaf in feeding and at this time are easily killed by a contact insecticide, provided it can be applied to their bodies.

By the middle of August most of the young insects have migrated to the twigs and limbs, and later go to the larger limbs and crevices in the trunk, where they feed during the rest of the season. There is but one generation annually. The insect attacks all of our elms, but the red elm and the American elm seem to be its favored hosts. No other shade trees, except elms, are attacked.

Control:

The European elm scale may be controlled by applying a dormant spray of miscible oil during the early spring before leaves appear. The Connecticut Experiment Station recommends a thorough application of nicotine sulfate (40 per cent solution) at the rate of 1 pint to 100 gallons of water late in June,

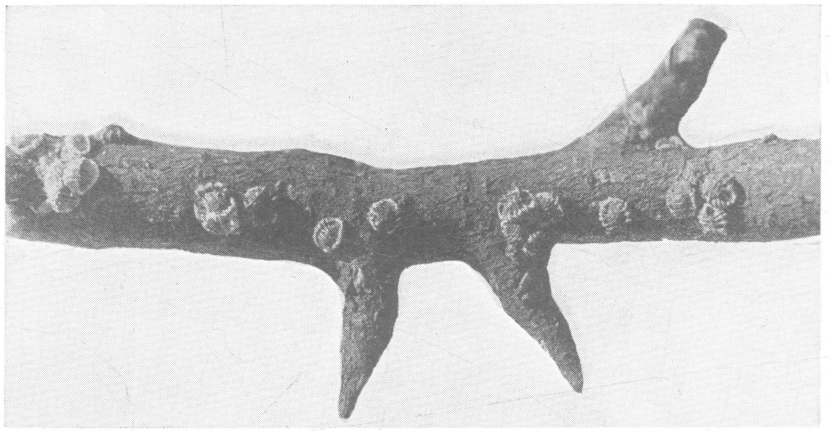

Fig. 18.—European elm scale. Adult females in their waxy nests on branch.

about 10 days after the first eggs have hatched and before the young have secreted a waxy protective covering. To be successful, either of these sprays must be made very thoroughly; under heavy infestation both applications may be required. The dormant spray should be applied before the leaves appear and the spray should carry 6 per cent of oil.

The writer has successfully prevented young elms from becoming infested by periodical inspection each year to detect the presence of the scale, and, if present, scrubbing the trunk and larger branches with a stiff brush, or broom, dipped in soapy water to which a small amount of nicotine sulfate has been added. Two such treatments during the summer have kept the insect from multiplying sufficiently to cause any serious damage.

Elm Scurfy Scale[1]

The elm scurfy scale is rarely injurious to elms in Ohio, but sometimes young trees and especially sprouts from older trees are injured. The female

[1] *Chionaspis americana* Johnson

scale usually is not very noticeable, being covered thoroughly with bits of foreign matter and sooty mold. When it is removed from the bark, it leaves a conspicuous white mark. The male scale is white, slender, and has three distinct lateral ridges on its body. The insect itself is protected under the scale-like covering and sucks the sap from the live wood. The chief food plants are the American elm and Camperdown elm.

Stages and Habits:

Winter is passed in the egg stage beneath the scale covering. These eggs hatch late in the spring and there are two generations annually.

Control consists of applying a miscible oil, or dormant oil emulsion carrying a 4 per cent oil, while the trees are dormant and before new leaves have appeared. A spray of nicotine sulfate solution about June 1 will kill many of the young, should summer treatment be necessary.

Fig. 19.—Elm scurfy scale. Adult females on bark.

The Oyster Shell Scale[1]

This is one of the common insects found on the bark of a large number of trees and shrubs. In Ohio the Carolina and Lombardy poplar are more seriously attacked than other shade trees, but this scale is found on elm along with other valuable shade trees, and at times becomes sufficiently abundant to call for control measures.

The scale is easily identified by its shape, since it resembles the form of an oyster shell, although the scale itself is not more than 1/8 inch long by 1/16 inch wide and usually is curved and somewhat enlarged at one end. This is one of the armored scales, the insect itself living beneath the covering and sucking sap from the twigs and branches.

Stages and Habits of the Insect:

Winter is passed in the egg stage under the scale covering. Fifty to sixty eggs are found under each female scale, and hatching occurs during June. The tiny white young are barely visible to the naked eye and crawl about over the trunk and branches for a short time before they attach themselves and begin suck-

[1] *Lepidosaphes ulmi* Linn.

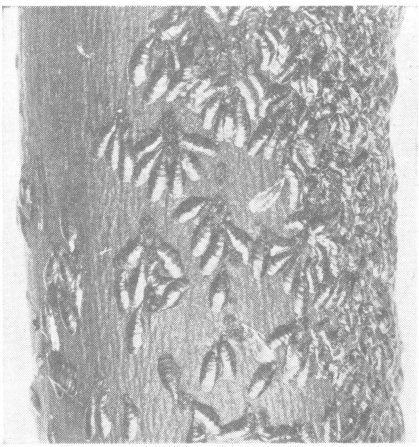

Fig. 20.—Oyster shell scale.

ing the sap. At that time they are known as "crawlers," which stage is important from the standpoint of timing the control sprays. After crawling about for a short time, they insert their beaks into the bark and begin sucking the sap. They remain attached until full grown late in the summer, when the winged males appear, and mating and egg laying take place. After the eggs are laid the female dies and the body shrinks to the small end of the scale-like covering. There is but one generation annually.

This insect as a pest of elms rarely calls for control in Ohio. Should its abundance demand action a spray of nicotine sulfate applied at the time the "crawlers" are present in June will give the best results. One must be alert to time this spray so that it is applied just after hatching has been completed and before many of the little insects have secreted a covering over their bodies. Dormant spraying is not very successful against the oyster shell scale, but where practiced should carry at least 6 per cent oil to be effective.

Bark Beetles and Wood Borers

The elm is known to be attacked in Ohio by one species of bark beetle and a number of species of wood borers, which attack the trunk and large limbs. None of these are very injurious to elms that are in a vigorous and thrifty condition. If for any reason the trees become devitalized, due to drouth, transplanting, or other cause, they are rendered quite susceptible to the attack of borers and bark beetles, which can rapidly bring about their death.

The Native Elm Bark Beetle[1]

This is an American insect which occurs throughout Ohio and is present principally in elms that are in a weakened condition. The importance of this insect as a pest of elms is now taking on an added meaning, because a European species closely related to it, which is present from Boston west to central Pennsylvania, is known to be an agency for transmitting the dreaded Dutch elm disease (see page 31). This disease is now being considered with such seriousness that all weakened and dying elms are being removed and burned in the Dutch elm disease infected area around the port of New York. It is hoped by this method to check the bark beetles in their development, and thus prevent the spread of the disease from dying to healthy trees.

The native American bark beetle may function to spread the disease in a similar way. If this should prove true, the control of the Dutch elm disease in Ohio, should it become well established, might become a difficult task.

[1] *Hylurgopinus rufipes* Eich.

Stages and Habits of the Insect:

The life of this insect is imperfectly known, but the larvae usually tunnel vertically in an elm branch or trunk, and when these tunnels are crowded close together they may greatly reduce the flow of sap in a tree and bring about its death. The dark-brown adult beetles, which are about one-half as large as a grain of wheat, emerge from the bark of the elm in late spring. They emerge from tunnels which have grooved both the inner bark and live wood. The eggs probably are laid at intervals through these tunnels in the devitalized wood, from which a second generation of grubs hatches to injure the trees during the latter part of the summer. There are thought to be two generations annually.

Control:

Control consists of removing and burning dying elm branches and trees. Cut out parts should be removed immediately, otherwise, the beetles will emerge to reinfest other trees. It is best to remove dead limbs during the dormant season when the larvae are present in the wood. The cuts should be made close to and horizontal with the limb from which the branch arises. Pruning wounds should be painted with coal tar creosote to prevent the entrance of water and disease.

The Common Elm Borer[1]

This species of elm borer is the most common wood borer attacking elm in Ohio. It is known as the round headed borer, to distinguish it from the flat headed borer (see page 26). Symptoms of its injury are the dying of certain limbs and the presence of injured, or dead areas, on the trunk, principally of the American elms. The injury is attended by the presence of sawdust which collects in crevices of the bark. This has been kicked out by the larvae, boring in galleries through the inner bark and sapwood. These galleries are filled with brown frass and are widened as the requirements of the growing larvae demand. This insect may girdle the branches and even the entire trunk of an elm and cause its death. The outer bark of an infested limb frequently is loosened, and when removed exposes the tortuous larval galleries. Defoliation of elms by leaf eating insects, insufficient plant food, or lack of water, may render them susceptible to these borers.

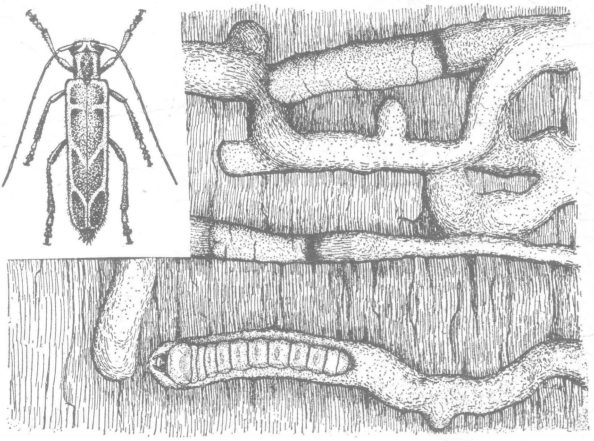

Fig. 21.—Common elm borer and its work.

Stages and Habits:

The insects winter as partially grown larvae in the sapwood. They resume feeding in the spring, tunneling in various directions. The adult beetles emerge

[1] *Saperda tridentata* Oliv.

from these tunnels early in the summer and lay eggs in cracks in the bark. They are long-horned beetles, about ½ inch in length, and are marked with narrow red lines around the margin with three splashes of red band across each wing cover. The larvae are present from midsummer until the next spring, but when conditions are unfavorable, 2 years may be required to complete their growth.

Control:

To guard against injury from the elm borer as well as bark beetles, it is most important to keep the trees in as vigorous condition as possible. Cutting out and burning dead branches and entire trees, which are dead, or dying, should be practiced to safeguard healthy trees.

Flat-Headed Apple Tree Borer[1]

The past several years have been extremely favorable to the flat-headed apple tree borer, which is known to attack nearly all fruit, woodland, and shade trees. In roadside plantings, made during 1934, this insect was responsible for the death of many elm trees. The point of attack on newly transplanted trees is usually on the trunk within 2 or 3 feet from the ground. The white, elongate larva has a very broad, flat, head more than twice as wide as the body, and this unusual appearance gives the insect its name. The presence of the flat-headed borer is revealed by a darkened color of the bark at point of attack, and upon examination it is spongy and lacks firmness when pressed. Sometimes the bark shows a distinct depressed area at the point of attack. In these locations a single larva usually is found working, and cutting a broad path as it progresses up or down and even transversely around the trunk.

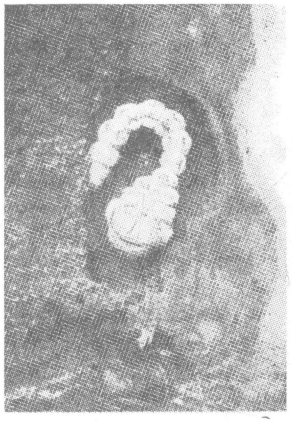

Fig. 22.—Flat-headed apple tree borer feeding beetween bark and wood.

Stages and Habits of the Insect:

Winter is passed in the grub, or borer, stage buried in the wood. In the spring the borers change to pupae and later to beetles. The adult of the flat headed apple tree borer is a dark olive-colored beetle with a dull metallic luster. The eggs are laid from May to July in cracks in the bark of unhealthy or weakened trees. The larvae grow rapidly through the middle and late summer months, cutting away an almost unbelievable amount of live wood under the bark. Most of them complete their growth by November. There is but one generation annually.

Control:

An effective means of controlling this insect in young trees consists of wrapping the trunks of newly set trees tightly with burlap immediately after they are transplanted and leaving this in place until the end of the second year of their growth. This prevents the adult beetles from laying their eggs on the tree trunks. The flat-headed borer is not likely to attack vigorous trees.

Careful inspection of the trunks and larger branches of older trees at intervals during the late summer and early fall frequently reveals the presence of

[1] *Chrysobothris femorata* Oliv.

one of these borers before very serious damage has occurred. Carefully cutting away the injured bark with a sharp knife and killing the larva beneath may prevent serious injury to the tree. The wound should be painted with coal tar creosote or white lead paint after the bark has been cut back to live wood. Dead or dying trees should be cut out and burned before the beginning of May.

Elm Bark Weevils[1]

At least two species of bark weevils, belonging to this genus, are known to infest elm trees in Ohio, according to Mr. J. N. Knull, who has surveyed Ohio trees for the presence of these insects. The beetles are tiny snout beetles about 1/4 inch long, the larvae are small footless white grubs, which tunnel under the bark, scoring inner bark and outer wood. They infest branches in a weakened condition and the weevils emerge through small round holes in the bark of the tree.

Control measures are the same as suggested for the native elm bark beetle.

The Pigeon Tremex[2]

The pigeon tremex is one of our largest wood wasps. The adult female somewhat resembles a large wasp equipped with a strong, stubby ovipositor. Through this ovipositor it lays eggs beneath the bark of various trees, including elm. The first evidence the owner has of its work, however, is the presence of large round holes, almost the size of a lead pencil. This marks the exit hole of one of the wasp-like adults, which is 1 inch to 1 1/2 inches long and marked with yellow and black. The larvae of these insects usually confine their work to diseased or dying trees and bore deep into the wood. While these larvae are seemingly well protected from their enemies from the outside world, they are in reality beset with grave danger from the attack of a parasite, which is a large ichneumon. This specialized insect has an egg-laying tube 3 or 4 inches long, which it inserts into the trunk of the tree over the exact location of the larva beneath. After having laid its parasitic egg in the tunnel of the host, it is sometimes held prisoner there, being unable to remove its ovipositor; it dies a victim of its own specialized habit. The pigeon tremex is held under control by its parasites.

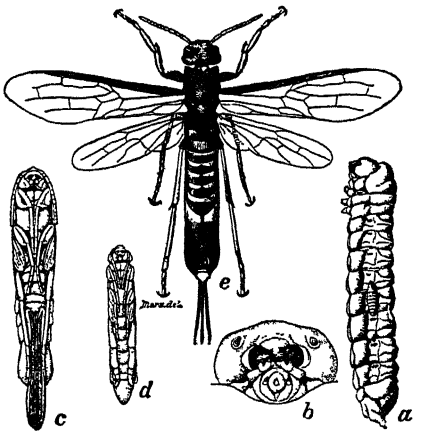

Fig. 23.—Pigeon tremex larva, adult and pupa. About natural size.

Two other species of wood boring larvae are know to live in elms in Ohio. These are without common names, but bear the scientific names: *Physocnemum brevilineum* Say. and *Anthaxia viridifrons* Gory. The former is one of the long-horned beetles, the larva of which tunnels in the trunks of healthy elm trees. The latter is a Buprestid and tunnels usually in the smaller branches of elm and hickory. There is no control known for these two borers.

[1] *Magdalis sps.*

[2] *Tremex columba* Linn.

Twig Puncturing Insects

The Buffalo Treehopper[1]

This insect is a serious pest of young trees growing in the midst of tall grass, or other rank vegetation. Twigs and branches of both shade and fruit trees, growing in such locations, become scarred by the insect, which has the habit of laying its eggs in slits cut in the bark of usually the 2- and 3-year-old wood. This wound enlarges as it heals and the limb presents a badly scarred condition. When very abundant, these wounds seriously impair the health of the tree.

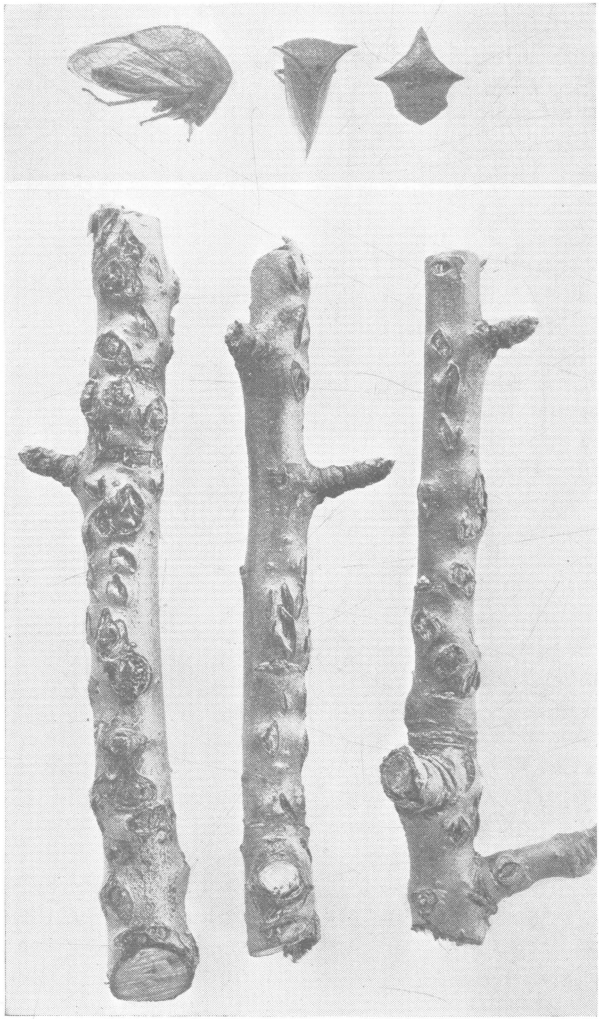

Fig. 24.—Buffalo tree hopper: side, top, and front views. Egg punctures made on twigs in the fall.

Stages and Habits of the Insect:

The insect is a green, triangular treehopper, which is seldom seen on the trees, but which feeds upon grasses and weeds during the summer months. In the fall it seeks branches of trees and shrubs in which to lay its eggs and flies to the trees to remain just long enough to cut slits in the wood and insert its eggs. In this stage the insect passes the winter. The eggs hatch during the following spring into tiny triangular green hoppers which feed upon grass and other vegetation.

Control:

The Buffalo treehopper cannot be controlled with sprays. An excellent preventive method

[1] *Ceresa bubalus* Fabr.

consists of removing tall grass or brambles in the vicinity of new tree plantings. Keeping the ground cultivated or the grass mowed regularly near trees will usually prevent injury, since the hoppers do not migrate far from where they have been feeding.

The Periodical Cicada[1]

One cannot discuss insect injury to shade trees in most parts of Ohio without including the work of the periodical cicada, otherwise known as the 17-year locust.

The insect does not feed upon the foliage of trees, but the swarms of adults appear suddenly during early summer of the seventeenth year of their growth, and fly about in the treetops, depositing their eggs in punctures made in twigs and branches.

These punctures are made quite deeply into the branches, which result in ugly scars, and frequently in the branch breaking at the point of injury.

Though mature trees can withstand the visitation of the periodical cicada, valuable young trees are frequently seriously mutilated and deformed as a result of the egg laying. In some parts of eastern Ohio valuable shade and fruit trees have been several years recovering from the serious setback received during the 1931 visitation of the periodical cicada.

A brood of this insect is due to appear in the western half of Ohio during 1936. The density of this brood, however, is much lighter than that which came in eastern Ohio, during the summer of 1931, and injury to shade trees is not expected to be so severe as experienced at that time.

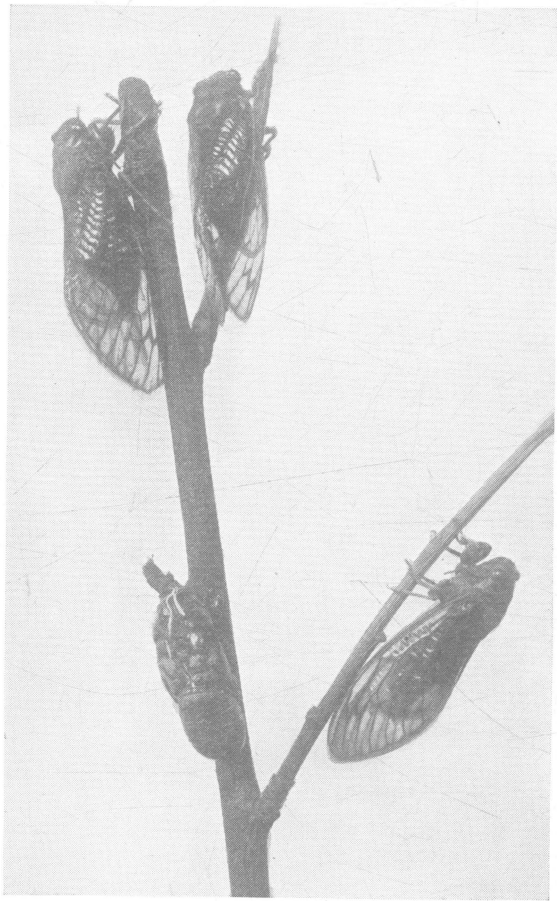

Fig. 25.—Periodical cicada.

[1] *Magicicada septendecim* Linn.

Stages and Habits of the Insect:

Hordes of cicadas emerge from the ground about June 1. Eggs are laid in the twigs and branches of deciduous trees over a period of 3 weeks from the middle of June until the second week of July. These hatch during midsummer and the newly hatched nymphs fall to the ground, into which they burrow, not to reappear above ground until 17 years later. During this time they feed upon the fibrous roots of trees, which damage is difficult to measure because of the slow growth of the larvae. The actual root damage is not thought to be great, but the larvae are known to move about among the fibrous roots, gradually increasing in size and returning to the ground surface in the spring of the seventeenth year. The insect then crawls to the top of a weed, or ascends the tree trunk for a short way, where it molts and unfolds its wings ready for flight. In a few hours the horde flies into the top of trees, later causing the air to resound with the whirring sound made by the males.

Fig. 26.—Branches 3 years after being punctured by adult periodical cicadas.

The adults do not feed during their brief period of life above ground. By the second week of July they have laid their eggs and died. This insect is found only in North America.

Control:

No control is known for this insect. During years when the periodical cicada is due to return as an adult, young trees next to a woods are in great

danger of injury from it. It is advisable to protect newly planted shade and fruit trees in such locations with cheesecloth netting to prevent the cicadas from laying eggs in the branches. The tree tops can be enclosed in the cheesecloth netting late in May and the covering removed by the middle of July. This will prevent injury and may preserve the beauty of choice young trees.

The Dutch Elm Disease

History:

The Dutch elm disease is widely distributed in Europe and has caused the destruction of thousands of elms in continental Europe since 1920. In southeastern Netherlands 60 to 70 per cent of the elms had been cut down in 1931 due largely to this disease, which is caused by a parasitic fungus. The disease was identified in three elm trees growing in Cleveland and one in Cincinnati, Ohio, in 1930. These trees were promptly removed and burned as were four found in Cleveland in 1931, and four more in 1935. In 1933 the disease was found in New Jersey, and during 1934 and 1935 over 13,800 diseased elm trees had been eradicated within a radius of 50 miles of New York City. Apparently the disease is not widespread in Ohio, but trees bearing this disease may be present, and constant watch is necessary to locate and destroy them. The disease attacks only the various species of elms; the American elm is one of the most severely injured both here and in Europe.

In Europe two species of bark beetles are known to transmit the disease and one of these beetles is present in the affected area around New York, but is not known to be in Ohio. The native elm bark beetle may function to spread the disease as well as other agencies not yet discovered.

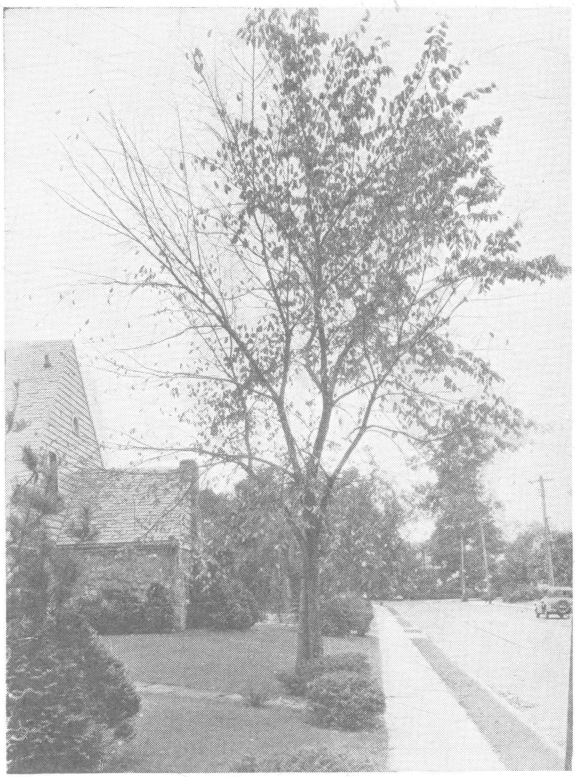

Fig. 27.—Elm tree dying from Dutch elm disease (reproduced from circular 322, U. S. Dept. of Agriculture).

* *Ceratostomella ulmi* Schwarz

Symptoms of Dutch Elm Disease

The symptoms of Dutch elm disease are a sudden wilting of affected trees when the disease is acute, while in the more chronic cases wilting may begin on certain branches and extend with gradual defoliation over the tree during the entire summer. Yellow leaves which appear first on top branches are early symptoms. The leaves begin to fall soon after wilting starts, and in the course of a few weeks the diseased tree will be almost defoliated.

In the wood, itself, a brown discoloration is found in the outer or sapwood, if a diagonal cut is made through a diseased twig, or limb. It may show as a partial or complete brown circle, or a ring of brown spots. The parasitic fungus lives and develops in the sapwood, where it plugs the water conducting vessels and cuts off the supply of water to the leaves. Death of the tree follows promptly and is probably hastened by the infestation of bark beetles that attack the diseased trees

Control of the Disease:

The only control known for the Dutch elm disease consists of cutting out and burning disease infected elms to protect healthy trees from being attacked If certain elms are suspected of having the disease, newly wilted or recently defoliated branches about ½ inch in diameter should be cut in 6-inch lengths and mailed to the Dutch Elm Disease Laboratory, Morristown, New Jersey, for identification.

NOTE For a complete treatise of the Dutch Elm Disease, the reader is referred to circular No 322, United States Department of Agriculture. This will be sent upon the receipt of 5 cents in coin sent to the Superintendent of Documents, Government Printing Office, Washington, D. C.

Acknowledgment

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U. S Department of Agriculture—Figures 4, 11, 12, 14, 22, 23, 27
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New York State Museum Memoir—Figure 3
Hardie Manufacturing Company—Figure 1

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