

UNIVERSITY OF FLORIDA
Agricultural Experiment Station

DISEASES AND INSECT PESTS
OF THE PECAN

By J. MATZ

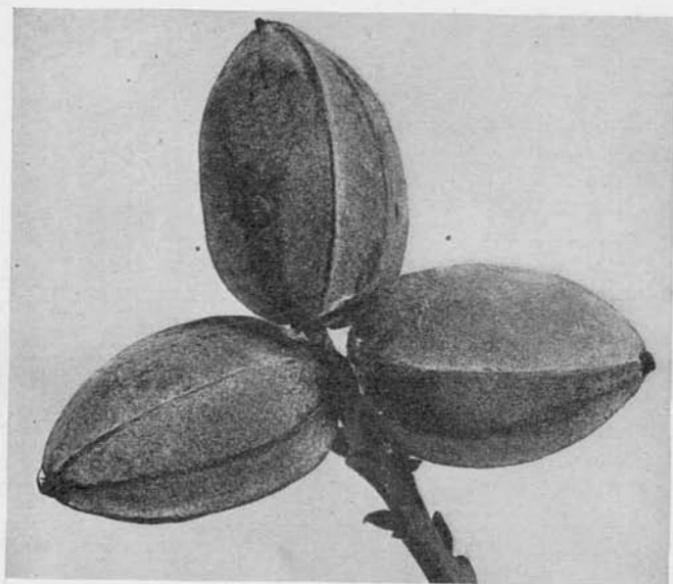


FIG. 45.—Pecan nuts affected with mildew

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DISEASES AND INSECT PESTS OF THE PECAN

By J. MATZ

A number of diseases and insect pests attack the pecan more or less seriously. In order to combat them successfully it is necessary to know their characteristics, to recognize their different stages, and to understand the different methods by which they develop. By recognizing a disease or insect pest in its incipient stage, a great saving in the year's crop of nuts may be made and a more likely check be set against the spread of the disease or insect pest. It often happens that diseases of plants caused by parasitic, plant-like organisms (fungi) and injuries caused by insects are mistaken for one another under the popular but erroneous term, "bugs." Upon close examination one can distinguish the mechanical and often clean-cut injuries that are caused by biting and boring insects from the diseases that are caused by fungi. The latter seldom result in an actual cutting out of the affected parts. Discoloration, wilting, and a breaking up of the plant substance, and the ultimate dropping or dying of the affected parts, are the main characteristics of fungus attacks. It is essential that these two types of injury as well as the different diseases and insect pests be recognized if the correct means of control are to be applied. This bulletin describes the most common pecan troubles and offers methods by which they can be controlled.

Credit for a part of the information in this bulletin is here given to publications of the Bureau of Plant Industry, U. S. D. A., and especially to John B. Gill, Bureau of Entomology, for the use of data on insects and for some illustrations.

PART I.—DISEASES INJURIOUS TO THE PECAN

SCAB

Fusicladium effusum Wint.

Scab affects the leaves, twigs and nuts of the pecan tree, with the result that the leaves are distorted and occasionally are shed, the young twigs are injured and sometimes killed, and the crop is reduced by many of the young nuts dropping before maturity. The fungus which causes scab is evidenced by a dark green, smoky, superficial growth which is usually confined to rounded spots.

On the leaves (figs. 46 and 47), the spots are slightly raised and vary in size from small black specks to one-fourth inch in diameter. Both surfaces of the leaves may become infected, in which case the dark, velvety growth constituting the spore-bearing part of the scab fungus is seen on one side of the spot only, the opposite side being hard, more or less smooth, and black. On the nuts, the first appearance of scab is similar to that on the leaves, except that owing to the fleshy nature of the green outer covering of young nuts the affected areas appear at first more or less sunken in the green and soft tissue. Under conditions favorable for the development of the disease the whole surface of the green nut may



FIG. 47.—Pecan scab on lower surface of leaf



FIG. 46.—Pecan scab on upper surface of leaf

become covered with the black, fungus growth (fig. 48), arresting development and preventing maturity of the kernel. Frequently, the fungus incrustation causes the layer of tissue with which it is in contact to break (fig. 49), thus forming an entrance for other molds, and a general decay follows. On the twigs, particularly the younger ones, the spots are smaller than on either the leaves or nuts and consist of a flat, black, round center of fungus growth in a concave depression in the bark. Affected twigs become stunted and are more or less shrunken. (Fig. 50.) This resultant condition in the nut-bearing stems often causes the immature nuts to drop. The presence of scab fungus on the twigs is a likely source for carrying the infection from one growing season to another.

CONTROL.—Fallen leaves and husks from scabby trees should be removed in the fall and winter and be destroyed. At least one application of a standard fungicidal spray, such as lime-sulphur solution or bordeaux mixture, should be made late in the fall or winter to destroy the fungus spores which may be present in great abundance on the tree, and particularly on the younger twigs.



FIG. 48.—Pecan scab on nearly mature nut



FIG. 49.—Pecan scab on young nut. Note the cracked hull



FIG. 50.—Pecan scab on young twig

Dust, consisting of a mixture of 90 parts finely ground sulphur and 10 parts powdered arsenate of lead, may be applied with a dusting machine to the tree as soon as the buds open.

The practicability of spraying large pecan trees with liquid sprays may be determined chiefly by the degree of susceptibility of the particular variety to scab, and by atmospheric and climatic conditions. In some localities one or two applications of bordeaux mixture will insure a check to the disease, while in others several applications of the same fungicide at intervals of two weeks may not give any appreciable results.

There is a marked difference among pecan varieties in their susceptibility to scab. Many selected and budded standard varieties are less susceptible than unselected seedling trees.

ANTHRACNOSE

Glomerella cingulata (Stonem.) S. & V. S.

Anthracnose affects the leaves and nuts of the pecan. On the leaves it produces somewhat large, light brown to reddish, irregular blotches often covering a greater part of the leaf, and eventually causing the leaves to fall. At this stage the spores of the fungus are developed in large numbers. These are carried over the winter in the dead leaves and are disseminated the following spring, causing, under conditions of high temperature and humidity, fresh outbreaks on the leaves and nuts. On the nuts (fig. 51) the blotches are irregular, black and slightly sunken in the surrounding green tissue of the hull. With the advance of the disease, the whole surface of the nut may become affected and the pink masses of spores are produced in large numbers. Under conditions favorable to the development of the dis-

ease, and especially when a severe attack occurs early in the growing season, dropping of immature nuts may result. These nuts, like the leaves, serve to carry over the disease from one season to another.

The anthracnose fungus is sometimes present in the weakened tissues of twigs, but there is no record of its causing initial in-



FIG. 51.—Pecan nuts affected with anthracnose (Jour. Agl. Res., Vol. 1, No. 4.)

jury to the woody parts of the pecan tree. The attacks of this fungus are not restricted to the pecan alone. Recent investigations have shown it to be identical with the fungus which causes the well known and destructive "bitter-rot" disease of the apple.

CONTROL.—Since the anthracnose fungus reaches greatest development and produces spores more frequently and more abundantly on fallen and diseased leaves and fruits, it is essential as a preventive measure that all dead and infected leaves, hulls, and nuts be removed and destroyed. This should be followed in the winter with a dormant spray, using a strong bordeaux-mixture solution. Another spray should be given soon after the buds open, and if necessary, two or three sprays be given in the earlier part of the growing season. The disease should be checked before the rainy season begins.

MILDEW

Microsphaera alni Wallr.

Pecan mildew is recognized by the superficial, flour-like, whitish coating which sometimes covers whole leaves and nuts.

(Fig. 45.) It may be first observed as small flakes on the leaves and nuts. Later the disease spreads all over the surfaces of the attacked parts and ultimately causes a yellowing and dropping of the leaves. The greatest damage, however, is to the young nuts. Under humid conditions an excessive dropping of immature nuts may result. The disease usually starts from the lower and more or less shaded branches, spreading gradually upward.

The causal fungus is disseminated during the summer by wind or other carriers, from minutely short and erect fungus branches which produce at their tips minute spores in easily detached chains. Toward the end of the growing season, or at a time when conditions of humidity and temperature are less conducive to fungus growth, the white coating becomes less evident, and minute, black and more or less hard and resistant spore cases are produced. These contain another form of spores which are held over on the fallen diseased leaves and hulls of nuts during the winter until conditions again become favorable for their germination and for the development of new infections of mildew in the new pecan growth the following spring or summer. During some seasons mildew may develop into a serious malady and result in a large loss to the crop.

CONTROL.—All fallen infected leaves, hulls and nuts should be removed from the vicinity of the pecan trees to prevent further infection. Spraying with standard bordeaux mixture and lime-sulphur solutions at frequent intervals will prove effective against mildew. Dusting with powdered sulphur is probably the best and cheapest means for checking this disease.

PECAN ROSETTE

Rosette is widely distributed thruout the pecan-growing territory from Florida to Virginia and from Texas to the Atlantic Coast. The disease apparently occurs on all types of soil and at all seasons; wherever it occurs, however, it is most abundant late in the summer. It occurs also more frequently on higher and more exposed soils than on lower and protected territory. Rosette may be found on seedling and budded trees, on nursery stock, and on older trees.

While rosette affects the entire tree, it is chiefly evident by the undersized, crinkled and yellow mottled leaves, which are abnormally narrow at the ends of branches. The veins in these leaves tend to stand out prominently, and light-colored areas occur between the veins. In these areas the tissues are thinner

and almost transparent. (Fig. 52.) Later in the season the leaves frequently become dark reddish-brown and die. The dead leaves do not all drop, and many adhere to the branches during the winter, unless blown off by strong winds.

The diseased branches usually fail to reach their normal length, so the leaves are clustered together on a shortened stem giving the whole group the appearance of a rosette. The extreme and young branches affected with rosette, begin to die in



FIG. 52.—Pecan rosette, showing abnormally narrow leaves, light areas, and prominent leaf veins

late summer. At first, brown spots appear in the green bark, which lengthen into streaks until the entire twig turns brown, takes on a withered aspect, and dies. Numerous succulent shoots come up from near the base of a dead or partly deadened twig; at first they are more or less normal in appearance, but they soon become equally affected with the leaf symptoms and eventually die. As the disease progresses it seems to affect the tree downward, so that the main trunks of severely affected trees may send out spindling shoots giving the entire tree a ragged appearance. This phase occurs also on trunks of pecan trees affected by cold injury.

NATURE AND CAUSE.—Rosette is not of parasitic origin, as no organism is known to be the cause of it. It is not infectious; that is, it is not transmitted by contact from diseased to healthy trees. The disease is not eliminated by careful pruning or even cutting back the affected tree to a stump. On the other hand, diseased stocks when budded with healthy buds are known to have developed rosette in the buds. This can be explained perhaps on the assumption that the characteristic leaf deformities most likely result from abnormal root functions of the affected stock. Certain rosetted trees are known to have recovered when transplanted to new localities. This would indicate that certain unfavorable soil conditions affect the development of rosette in the tree. It is well known that the proper texture of soils is important in controlling the essential requirements for plant growth, which are, moisture, humus content, and temperature.

CONTROL.—In its native forest the pecan is protected by shade from the surrounding forest growth, the soil is rich in humus and is moist and cool. Pecan trees planted beside houses and barns have to some extent an environment not radically different from their native habitat. But in the orchard, where pecan trees are planted from twenty to forty feet apart in high and open sandy soil, and in some cases with a hardpan only a few feet below the surface, the roots lie nearer the surface in the hot, dry, and sandy soils deficient in humus, and can not supply the remote twigs and leaves with the necessary moisture and food required for a normal production of plant tissue. Deficiencies in humus and moisture may be corrected by plowing under green manures, by shallow cultivation, and by other means that will improve soil conditions. With young trees which do not furnish sufficient shade for themselves, some means of protection is necessary. A rather heavy cover (mulch) of cane pulp, straw, or compost should be kept around the bases of the trees and extend for several feet outward, to retain soil moisture and to supply the humus necessary for rapidly growing trees. A thin mulch is not sufficient under dry conditions.

DIEBACK

Botryosphaeria berengeriana DeNot.

Dieback is a twig and limb disease. For a time this disease was not distinctly recognized by pecan growers. It was probably confused with winter injury, "rosette," and in some cases was taken for the after effects of insect injury to the leaves and young twigs which, in instances of severe attack, cause the dying

of twigs and branches. Recent investigations by the writer have shown this disease to be distinct from any of the other pecan diseases, and was found to be caused by a specific fungus. However, dieback may follow in a tree previously weakened either by rosette, winter injury, or insect attack.

Dieback is a fungus disease and is recognized by the presence of minute, black fungus crusts embedded in the somewhat elongated ruptures in the bark of diseased and dead twigs and limbs. (Fig. 53.) Toward the base of a partly diseased twig, the bark is often of a water-soaked, waxy appearance, and there is usually a definite margin between the infected and healthy tissue. The older diseased portions of the bark of twigs and branches are dry and sunken, the longitudinal ruptures in these

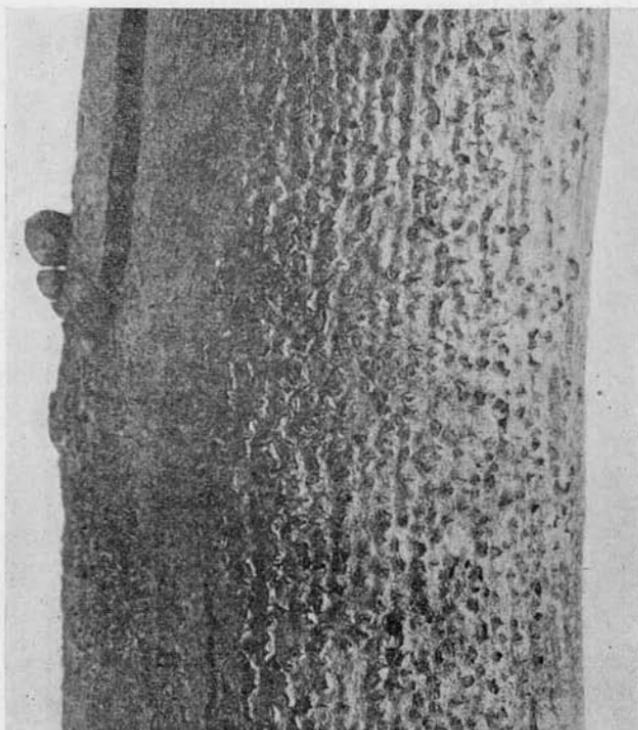


FIG. 53.—Broken bark surface of limb affected with pecan dieback fungus. Twice natural size

being more conspicuous and there the fruiting bodies of the fungus are embedded in a black matrix or stroma. Numerous young shoots often start out farther back on the branches which have

been partly killed. (Fig. 54.) As the disease spreads these young shoots may become infected and ultimately die. These dead clusters of short branches suggest a similar symptom commonly observed in rosette. However, this, as in rosette, is a physiological reaction. No deformity or crumpling of leaves is found to be due directly to dieback, tho it may be associated with it thru some other cause.

CONTROL.—Pecan dieback may be controlled by pruning out all the dead wood and burning it. Owing to the difficulty of recognizing the infected limbs during the dormant season, it is

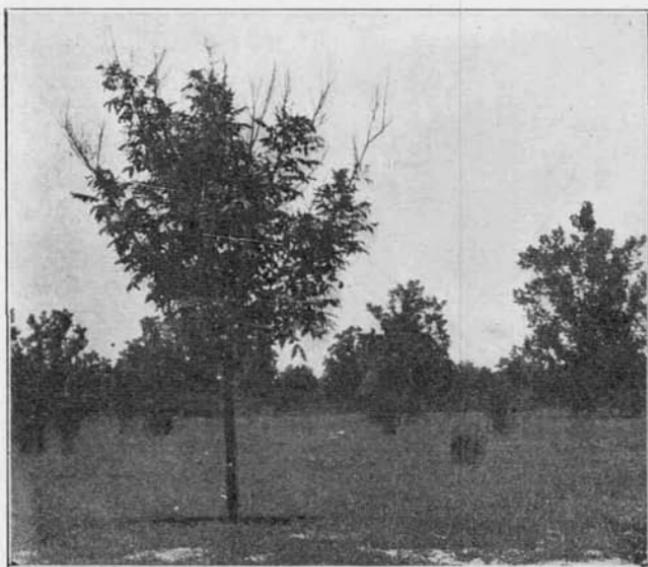


FIG. 54.—Pecan tree seriously affected with dieback

best to prune in the fall and again in the spring. By thoroly pruning in the fall the fungus is prevented from maturing in the recently infected twigs and the spring pruning eliminates infections which may come from infected wood not observed in the fall. It is necessary to cut well beyond the visibly diseased bark, for the fungus often penetrates into the wood for some distance beyond its outward manifestations. Trees which show a tendency toward rosette should be removed as these will form a harboring place for the dieback fungus. The principal point in controlling dieback is to keep out dead or weakened wood, and to eliminate insects or other agencies which tend to weaken the trees.

PINK MOLD*Cephalothecium sp.*

Pink mold sets in and causes rotting of pecan nuts only after a previous injury by other fungi or insects. This moldy condition is frequently found following scab attack. The mold enters first thru cracks which expose moist and broken tissue in the green hull of the nut. Under moist conditions the pink mold

grows rapidly and eventually penetrates the interior of the nut, infecting and digesting the kernel and leaving a mass of pink powder in its place.

CONTROL.—As pink mold is only a secondary disease following scab or insect injury, elimination of the primary causes will also take care of the mold. (See Scab and Husk Borer).



FIG. 55.—Brown spot on upper surface of pecan leaf

KERNEL SPOT

Occasionally different types of unfilled and partly decayed kernels are found in pecans. These cannot with the present data at hand, be classified and attributed to definite and direct causes or indirect agencies, as the case may be. However, kernel spot, a distinct disease, occurs on the meat of the nut and is detected only upon freeing the kernel from the shell, as there are no external indications of the infection. The spots are generally small, rounded, slightly sunken and darker in color than the surrounding meat. The discoloration of the meat beneath the

surface of a spot extends considerably toward the interior, and the kernel is bitter in taste and is more or less dry and pithy. This disease is probably due to a fungus, but it is not certain thru what channel the fungus makes its way into the meat with out leaving traces of its entry on the exterior of the nut. It is

doubtful whether different varieties are by nature more or less susceptible to this disease.

Kernel spot differs from other meat rots of the pecan. The latter usually produce a general softening, while kernel spot, excepting when other organisms follow its initial injury, produce only a dry decay.

CONTROL.—To reduce the chances of further spread of this disease, and in order to protect the market value of the pecan it is suggested to gather and destroy the nuts from badly infected trees.



FIG. 56.—Brown spot on lower surface of pecan leaf

BROWN LEAF SPOT

Cercospora fusca Rand

The brown leaf spot of the pecan is found generally distributed throughout the pecan-growing area. It affects young as well as old trees with no ostensible preference for particular varieties. As the name implies it affects the leaf blade only. The injury resulting to the tree from the attack of this disease is perhaps not obvious since little defoliation results directly from its attack. However, it is certain that a heavy infestation of spots will greatly interfere with the normal functions necessary for vigorous growth and development of the tree and fruit.

This leaf spot which is caused by a fungus appears on the leaves, first as a very small dark, reddish-brown spot that is usually somewhat irregular in outline. Older spots attain considerable size and may run together to form large, dark brown blotches, often covering the greater part of the leaf. Single, old spots have an indefinite margin, are somewhat lighter in the center and have a darker, brown border. The appearance of the spot may vary slightly with the different varieties of trees upon which it occurs. On some narrow-leaf varieties the spots are more nearly round, they possess a sharper outline and are somewhat grayish in color. In all instances the

appearance of the spots is similar on both surfaces of the leaf. (Figs. 55 and 56.)

CONTROL.—Since this disease is confined to the leaves, raking up and destroying all fallen leaves in the fall is necessary to reduce further infection. Wherever practicable, three or more sprayings with bordeaux mixture should be made in the summer.

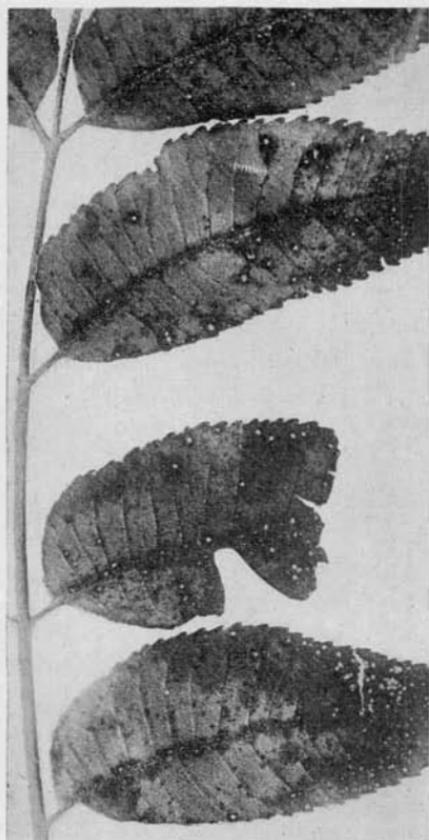


FIG. 57.—Nursery blight; the white specks in the leaves are characteristic of this disease

to five subsequent sprayings should be made at intervals of three to four weeks.

NURSERY BLIGHT

Phyllosticta caryae Peck

Nursery blight occurs on the leaves of young trees and is particularly injurious to young nursery trees. With the first appearance of the disease the spots are more or less round, minute, and dark, reddish-brown on the upper, and black on the lower, surface of the leaf. These spots remain comparatively small but become numerous and in time cover a considerable portion of the leaf blade area. In the older reddish-brown spots the center becomes first gray, then turns white and later falls out leaving the leaf perforated. (Fig. 57.) Considerable defoliation takes place in severe attacks and the young trees have no chance to make a good growth.

CONTROL.—The first spray with bordeaux mixture should be given before the leaflets have quite matured, and three

LEAF BLOTCH

Gnomonia sp.

Leaf blotch is probably the least established and the least common disease of the pecan, yet it is capable of doing considerable damage and this description will help pecan growers to locate and check it before it gains headway. Leaf blotch attacks only

the leaves of the pecan. The blotches vary from irregular, smooth, dark and nearly black specks to more or less round, large, brown areas. (Fig. 58.) The old blotches are grayish in the center on the upper surface of the leaf and light brown on the under surface. Small black specks widely scattered may be detected on the lower side of the old blotches, these specks are the capsules in which the fungus spores are contained. Apparently, this disease is brought to notice only late in the growing season.

CONTROL.—It is advisable to gather and destroy all fallen leaves in the fall.

WINTER KILL (SOUR SAP, COLD INJURY, FROST BITE)

Two types of injury have been observed to occur on pecans; one is an injury to the trunk, taking place usually immediately above ground and extending upward, the other is apparently a bud injury. Both types suggest injury caused by extreme degrees of temperature which occur sometimes in the dormant period of the tree, and especially by sudden changes in temperature, when a sharp cold snap follows a rather prolonged warm period in the winter season.

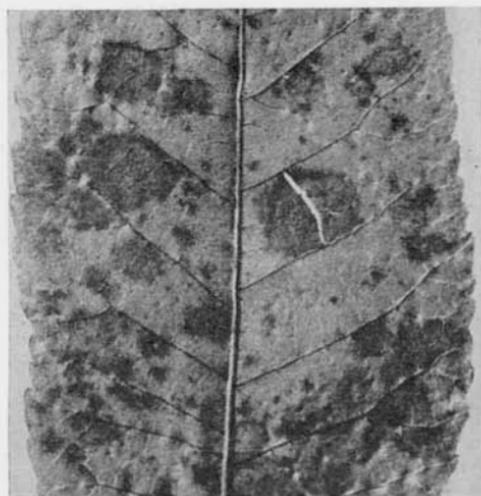


FIG. 58.—Portion of pecan leaf affected with leaf blotch

The trunk injury may be recognized by the somewhat smoky and dark gray coloration of the trunk, the brown inner layer and cambium of the bark, the soaked condition of the wood, and the sour odor of the sap. In many cases swollen lenticels covered with a pinkish, velvety growth are noticeable. Trees thus affected may send out growth in the spring, and they may keep on growing for some time, but they often wilt and die. This injury is probably confined to very young trees. The bud injury was observed on trees of considerable size and age, where the trunks were not apparently affected. The only symptom of this injury is the rounded small leaflets with their outer edges partly

blackened and dried, usually at the edge of the tip. (Fig. 59.) In color these malformed leaves do not differ from normal ones. Apparently this injury does not interfere with the growth of the tree as a whole. It is possible that this type of injury is caused

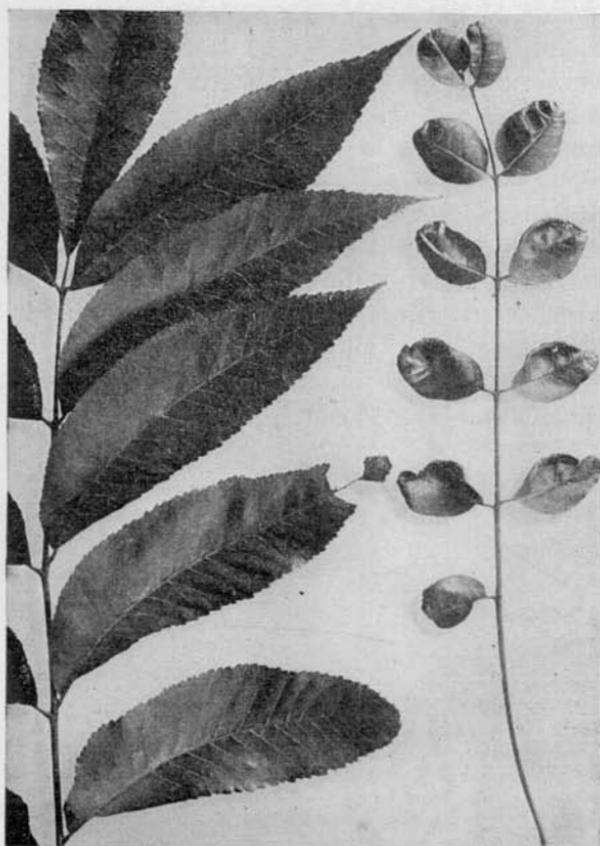


FIG. 59.—Pecan leaves. Those at left, normal; those at right from same tree are suggestive of cold injury.

when a cold snap suddenly arrests the swelling of buds begun during a previous warm period.

The following suggestions have been made to prevent the occurrence of winter injury. First, it is well to mature the trees early by growing a late crop in the fall among the trees to take up moisture from the soil; second, to mound and wrap the trunks of the trees.

SALAMANDERS

Not infrequently does it happen that salamanders (pocket gophers) do a great deal of damage by cutting the roots off young trees about four or five inches below the ground. The following described poisoned bait is suggested for the control of these animals:

Dissolve $\frac{1}{2}$ ounce strychnine sulphate and 1 teaspoonful saccharin in $2\frac{1}{2}$ pints water; add 1 pint fine salt and $\frac{1}{2}$ pint starch; beat thoroly with an egg beater. Pour this mixture over 8 quarts of whole corn and distribute around the trees.

MISTLETOE

Phoradendron flavescens Nutt

Some large seedling pecan trees have been observed to be plentifully inhabited by mistletoe, and while it has not as yet become a real serious pest, nevertheless this parasite should not be allowed to remain in a tree. It usually attacks the smaller branches of the tree and causes them to die. In the winter the large clumps of green mistletoe can be plainly seen, mostly in the tops of the trees.

CONTROL.—Infested branches should be cut off and no berries be allowed to mature, thus preventing the spread of the pest to other trees.

PART II.—INSECTS INJURIOUS TO THE PECAN

PECAN LEAF CASE-BEARER

Acrobasis nebulella Riley

At present the pecan leaf case-bearer is perhaps the worst enemy of the pecan in the southern part of the pecan-growing area. Early in the spring, about the latter part of March or early in April, the young larvae or "worms" emerge from their winter cases and begin feeding on the nearest buds and unfolding leaflets, devouring buds, leaves and blossoms. The injury which this insect causes to the pecan tree is twofold. It is capable of reducing the nut crop to a considerable extent, and of depriving heavily infested trees of their foliage, weakening the tree materially. In many cases twigs from buds injured by this

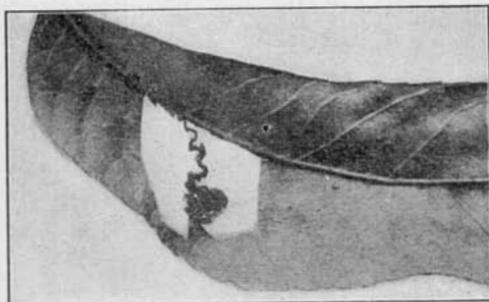


FIG. 60.—Injury by newly hatched larva of the pecan leaf case-bearer on pecan leaf. Part of leaf cut away to show tortuous tube of young larva. (Fla. Agr. Exp. Sta., Bul. 79)

insect in the spring were found late in the summer to be dead for a considerable distance backward from the tips. These dead twigs harbor fungi which may infect the living parts of the tree.

All the stages in the life history of the pecan leaf case-bearer have been fully described by entomologists. For the purpose of recognizing

the insect and its work it will be sufficient to point out the following characteristics: The adult or mature form of this insect is a moth, measuring about two-thirds of an inch across the expanded wings, and while it presents a variation in color, the general color is gray. The head, thorax and base of the forewings and legs are silky-white, in the males, but in the females these parts are dusky gray. The moths are found in hiding in trash at the bases of trees and in the thick foliage.

Like most insects of this type, the moth is not directly injurious to the pecan. It lays its eggs in the summer upon the under side of the pecan leaves, usually along the midrib. The larvae or "worms" hatch from these eggs, emerging during the

period from the middle of May to the first of August. Soon the larva constructs winding or tortuous tubes or cases which are at first considerably longer than its body. One end of the tube is attached to the leaf, while the larva feeds thru the open end. Later as the larva matures the case becomes quite straight, the unattached end being larger than the attached end. The larvae feed sparingly on the leaves during the summer. (Fig. 60.)

From the latter part of September to the middle of October the larvae migrate from the foliage and take up winter quarters in small, oval hibernating cases which they attach loosely around the buds.

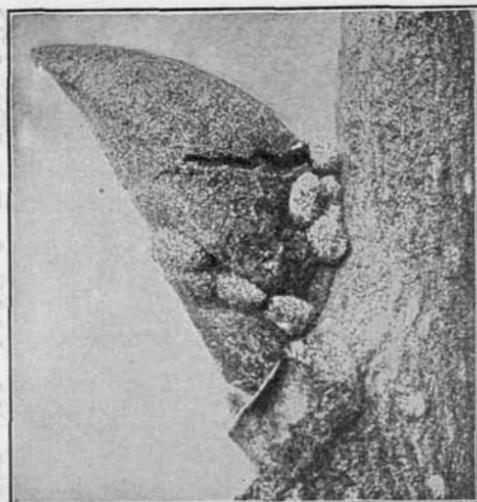


FIG. 61.—Winter cases of the pecan leaf case-bearer around pecan bud. Enlarged. (Bureau of Ent., U. S. D. A.)

(Fig. 61.) They remain in hibernation during the winter months and emerge in the latter part of March or the first part of April to begin feeding on the newly opened buds; commencing at the tips or sides of the swelling buds and devouring the leaflets as fast as they unfold. Consequently, the greatest injury this insect is likely to cause to the pecan is at this stage in its life history. During May and early June most of the larvae reach full growth but some are

ready to pupate by the end of April. Pupation takes place within the case and lasts from 16 to 23 days, the first adult moths appearing by the middle of May. The moths continue to emerge until the first week in August and the life cycle is repeated. Only one generation of this insect develops in the course of a year.

CONTROL.—This insect can be successfully controlled by spraying with arsenate of lead within the period extending from the first part of August to the middle of September. One thorough spraying in that period is sufficient. Use the arsenate of lead at the rate of one pound of the powder, or two pounds of the paste, to fifty gallons of water, to which should be added the milk of

lime obtained from slaking three pounds of stone lime, to prevent burning the foliage.

PECAN NUT CASE-BEARER

Acrobasis hebescella Hulst.

The pecan nut case-bearer is capable of doing considerable damage to the pecan nut crop, and if not checked, may become a serious enemy. In the spring, when the pecan sends out new growth, the immature larvae or "worms"

come out of their cocoons, or hibernating cases, and attack the tender shoots, tunneling and eating out the interior but leaving the outside intact. The moths or the mature adults of the first generation which are the progeny of the moths from the hibernating larvae appear during the month of May and lay their eggs soon after their emergence. The eggs hatch in from 5 to 7 days, the larvae coming out of the egg shell crawl to the base of the young nut, begins feeding and bores into the nut. (Figs. 62 and 63.) Particles of frass and excrement often webbed together in the shape of a tube are commonly seen at the base of an infested nut. The larva matures and pupates in the nut and the moths of the second generation emerge from the middle of June to the first of July. The larvae of this generation are usually not very injurious to the nut crop. A third generation of moths and larvae appears in August but at that time the nuts are more or less hard and the larvae seem to prefer to feed in the leaf petioles and on tender shoots.



FIG. 62.—Young pecan nut infested by larva of the pecan nut case-bearer. (Bureau of Ent., U. S. D. A.)

The larvae of the third generation pass the winter in hibernation around the buds and these come out the following spring ready to repeat the life cycle.

CONTROL.—Since this insect has three distinct generations in the course of a year, it is necessary to spray three times with arsenate of lead, made up at the rate of 1 pound of the powder or 2 pounds of the paste to 50 gallons of water to which should be added milk of lime obtained by slaking 3 pounds of stone lime. The first application should be made shortly after the nuts have set; the second a week or ten days after; and the third spray should follow the second by four or five weeks.

PECAN SHUCKWORM*Laspeyresia caryana* Fitch

The pecan shuckworm is primarily a nut-infesting pest, tunneling into the shucks of the nearly mature nuts and often eating out the interior of the younger nuts (fig. 64). Its injury to the pecan results in the dropping of small and green nuts, in the discoloration of mature ones, and in preventing the proper devel-

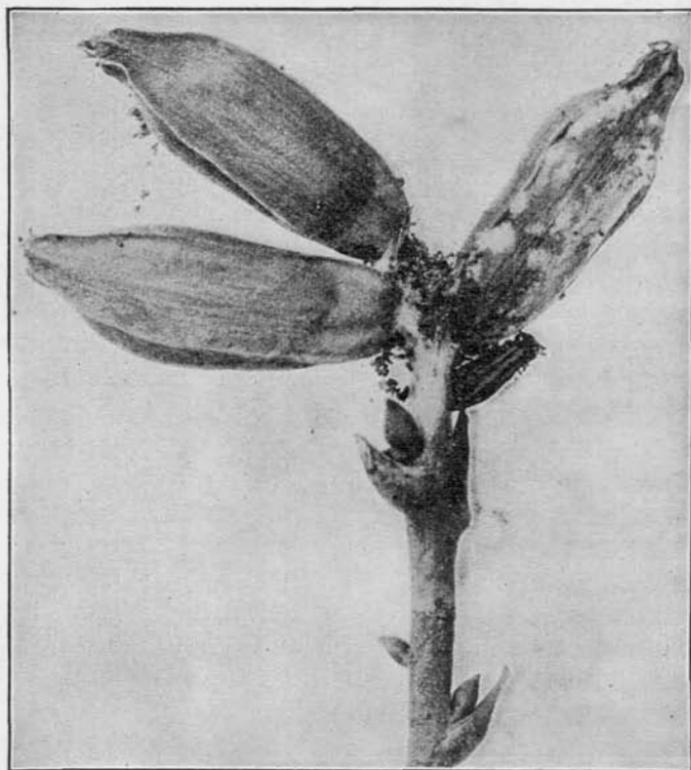


FIG. 63.—Cluster of young pecan nuts infested with the pecan nut case-bearer. (Bureau of Ent., U. S. D. A.)

opment and maturity of half-grown nuts. The larva of this moth is whitish and very small upon hatching, but reaches a length of three-eighths of an inch and has a creamy-white body and light brown head. This insect feeds also on the hickory where it causes a much greater damage to the small green nuts.

The moths begin to appear early and continue to emerge until the latter part of April. Eggs are deposited on the young nut or foliage. The very small pecan nuts seem to escape much injury because the first brood of larvae are probably attacking

earlier host plants, such as the pig nut or white hickory. In about five days the eggs hatch and the larvae enter the nuts, mining the shucks of the mature nuts and in some cases boring into the interior of green nuts. The larvae mature and pupate in the shucks. The activities of this insect are most noticeable during the latter part of June, thru July and August. The last brood of "worms" passes the winter as full-grown larvae in the shucks on the ground or in shucks which remain on the tree.



FIG. 64.—Larva of pecan shuckworm in shuck of nearly matured pecan nut. Enlarged. (Bureau of Ent., U. S. D. A.)

CONTROL.—The best method to reduce infestation by this insect is to destroy all shucks immediately after harvesting the crop. As moths begin to emerge as early as February, it is essential that the shucks should be removed before the middle of that month. Hickory trees in the immediate vicinity of pecan orchards form a source of infestation.

PECAN CIGAR CASE-BEARER

Coleophora caryaefoliella Clem.

The pecan cigar case-bearer sometimes becomes a serious pest on the pecan. The larva feeds first in the

interior of the leaves, leaving the two epidermal layers intact, excepting a small circular opening on one side of the leaf. Later it constructs a light-brown case, resembling a cigar with a flattened end. This case the insect carries along as it feeds. The larvae spend the winter in their cases attached to twigs and limbs. (Fig 65, b, c.) When the pecan buds are opening the hibernating larvae begin feeding, attacking the buds and the

foliage until they transform into pupae about the middle of May. In June the moths appear, eggs are deposited on the foliage, and in a few days the young larvae appear.

CONTROL.—This insect can be controlled by spraying with arsenate of lead during the season of its greatest infestation. The arsenate of lead should be used at the rate of 1 pound of the powder or 2 pounds of the paste to 50 gallons of water to which has been added milk of lime obtained by slaking 3 pounds of stone lime.

FALL WEBWORM

Hyphantria cunea Drury

The fall webworm is the most conspicuous and perhaps most common insect pest of the pecan. The large webs (fig. 66) embracing large numbers of caterpillars are a common sight on

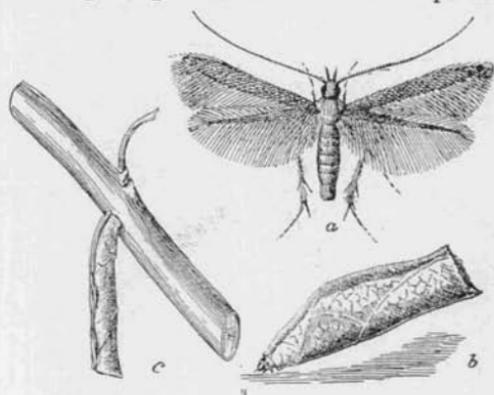


FIG. 65.—The pecan cigar case-bearer: a, Moth; b, c, larvae in cases. Enlarged. (Bureau of Ent., U. S. D. A.)

pecan trees late in the summer and fall, but less common in the spring. The larvae are gregarious and feed in colonies within the web on the pecan leaves. When more food is needed the web is enlarged, taking in new leaves. The caterpillars leave the web late in the fall, pass the winter as pupae, and the moths emerge the following year in April and May. (Fig. 67.) The

eggs are deposited in masses on the leaves, hatching in a week, each group of larvae forming a web within which to feed on the leaves. These larvae mature and pupate and a second brood of moths appears during the middle of the summer, laying eggs out of which the fall webworms hatch.

CONTROL.—Spraying the leaves with arsenate of lead, the same as for the leaf case-bearers will successfully check the fall webworm. Where the webs are scattered and can be conveniently reached, they should be burned or be removed with a long-handled pruner and destroyed.

WALNUT CATERPILLAR

Datana integerrima G. & R.

The walnut caterpillar is similar to the fall webworm in that

it feeds in colonies on the pecan foliage, but unlike the webworm in that it constructs no web. (Fig. 68.) The mature caterpillar is black, with long whitish hairs, and nearly two inches in length. The caterpillars come down the trunks of the tree or large branches in a mass to shed their skins. After molting they return to the upper branches and continue feeding. Afterward they descend and enter the soil to pupate. The moths emerge from over-wintering pupae from the middle of April to the mid-

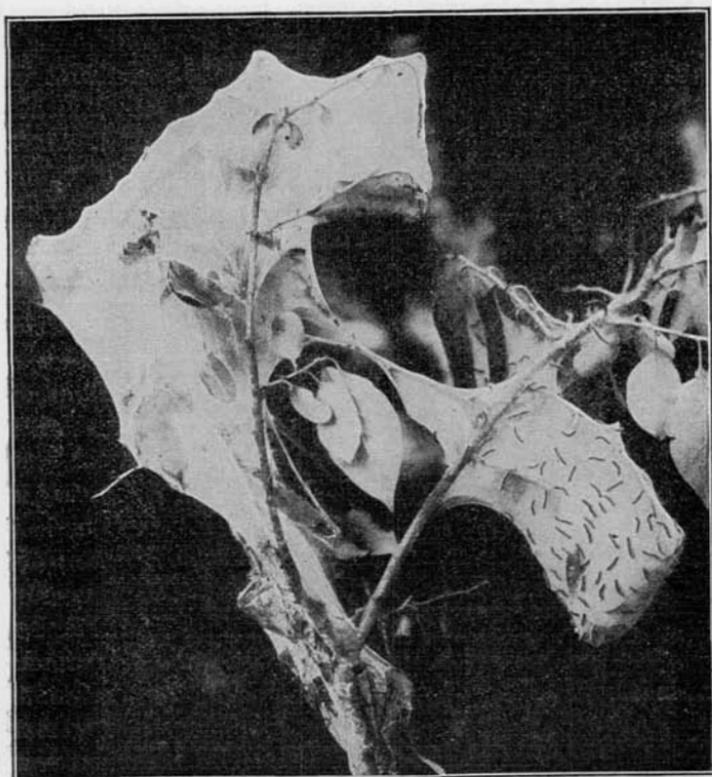


FIG. 66.—Web and caterpillars of the fall webworm. (Bureau of Ent., U. S. D. A.)

dle of July. The eggs are laid in masses (fig. 69) and the larvae coming out of these eggs feed in colonies. The caterpillars molt several times and finally when full grown enter the soil, and the fall generation of moths appears. The second-brood larvae enter the soil late in the fall and winter over as pupae.

CONTROL.—Egg masses or colonies of caterpillars should be destroyed by crushing. Arsenical sprays applied to the leaves will control this pest.

PECAN BUD-MOTH*Proteopteryx bolliana*, Sling.

The pecan bud-moth sometimes causes considerable damage to pecan nursery stock. The larvae of this insect feed on the buds, and in attacking terminal buds of young trees excessive branching and stunted growth result. The larvae may under certain conditions feed on the foliage. During dry seasons pecan

nursery trees may become seriously injured by the larvae of the bud-moth. At the time pecan buds begin to open, the moths which have wintered in the adult stage, begin to lay eggs, usually depositing them on branches near the buds, but after the foliage appears the eggs are laid invariably on the upper surface of the leaves. The life-cycle period of this insect is of short duration in the summer, five or six generations occurring in one season under favorable conditions of temperature.

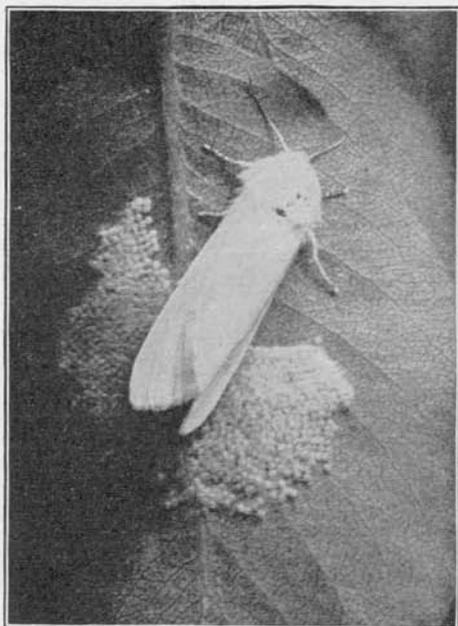


FIG. 67.—Moth and egg mass of the fall we worm. Enlarged. (Bureau of Ent., U. S. D. A.)

CONTROL.—As a nursery practice it is recommended that trees be kept in a vigorous growing

condition. Apparently this insect does not become a sufficiently serious pest in the orchard to warrant special spraying.

FLAT-HEADED APPLE-TREE BORER*Chrysobothris femorata* Fab.

The flat-headed apple-tree borer attacks certain fruit trees as well as the pecan and only in recent years has its injury to the pecan been brought to notice. Generally it is the previously weakened trees that suffer the most from this insect. For instance, pecan trees that have been affected by winter injury are very susceptible to the attacks of this borer. In one grove this borer has girdled and killed a number of good-sized pecan trees; these trees, however, showed signs of previous mechanical in-

jury. The larva or borer is yellowish-white, without legs, and measures about one inch long when full grown. One segment near the head is much broadened, giving the larva the appear-

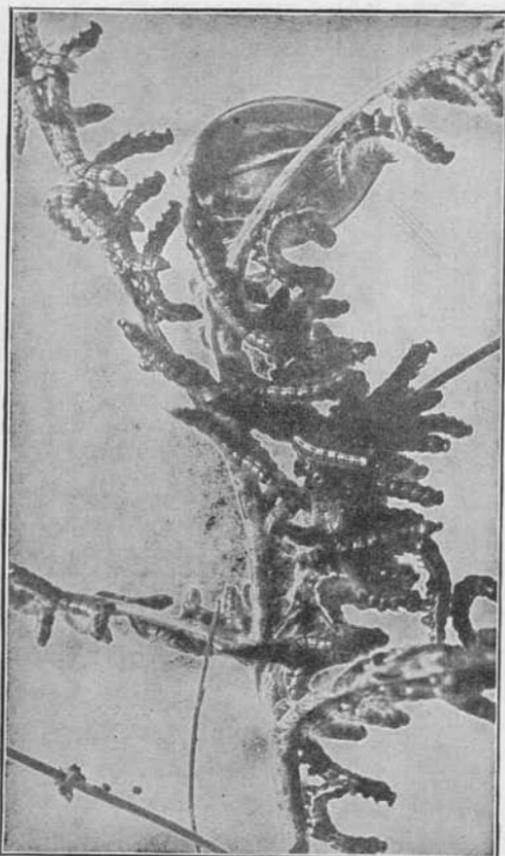


FIG. 68.—Colony of larvae of the walnut caterpillar, on pecan. (Bureau of Ent., U. S. D. A.)

ance of having a large, flattened head. (Fig. 70.) The borers upon hatching from the eggs which are deposited in cracks or under bark scales, bore thru the bark and feed on the sapwood immediately beneath, making tortuous or spiral galleries which are packed with sawdust castings. (Fig 71.) One can often trace these galleries by the slightly depressed condition of the bark above them. Owing to a great variation in the rate of growth of the larvae, and in the time of emergence of the beetles, all sizes of borers may be found at the same time under the bark; however, there is only one generation of this insect during the course of a year.

CONTROL.—The best method of destroying the flat-headed borers is to remove the burrowing larvae with a knife, taking care not to injure the healthy bark unnecessarily. The exposed woody parts should then be painted over. The trap-log method is also recommended. This consists in placing in infested groves, newly cut pecan, hickory, or oak branches or logs of convenient size at intervals of about 100 feet in order to attract the egg-laying beetles of the borer to the dying or dead wood, which it prefers to living trees. These logs should be placed in the grove in the late winter or

early spring, and must be destroyed the following winter. Injection of kerosene oil emulsion into galleries of badly infested tree trunks have given satisfactory results in one grove.

HICKORY TWIG-GIRDER
Oncideres cingulatus Say.

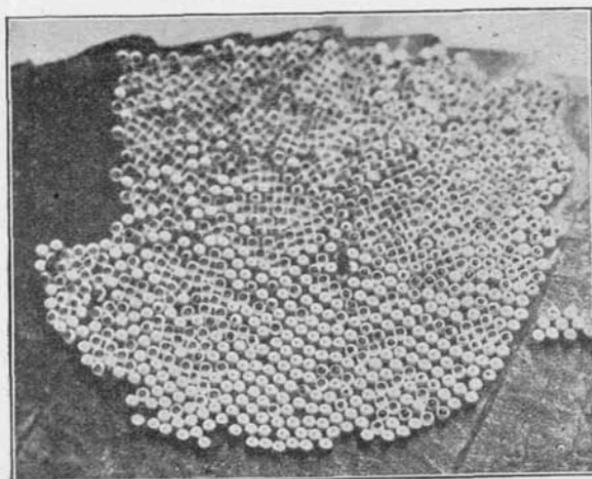


FIG. 69.—Egg mass of the walnut caterpillar. Enlarged. (Bureau of Ent., U. S. D. A.)

are most conspicuous on the pecan and hickory. The twigs are cut for the purpose of egg laying. The eggs are inserted singly beneath the bark near or at the base of the leaf petioles. The portion of the twig containing the eggs is severed by the female (fig. 72) in order that the larvae may develop and subsist on dead wood. The young are unable to subsist on wood containing sap. The eggs hatch in about three weeks and the larvae which are whitish and legless begin to tunnel in the wood, making little growth during the winter. In the spring they grow rapidly and complete their transformation into adult beetles by the latter part of August.

The hickory twig-girdler does a great deal of damage by cutting off numerous twigs of young pecan trees, usually during late summer and early fall. Various other trees of economical importance are attacked by this twig-girdler, but in the South its injurious effects



FIG. 70.—Larva of the flat-headed apple-tree borer, in its burrow. Enlarged. (Bureau of Ent., U. S. D. A.)

CONTROL.—The simplest and best method for the control of this insect is to gather the severed twigs during the fall and winter and burn them. In this way all the eggs and larvae which would develop into a new generation the next summer will be destroyed. If there are adjacent hickory or persimmon trees infested with the same pest, the cut twigs of those should also be destroyed.



FIG. 71.—Burrow in trunk of young pecan tree made by larva of the flat-headed apple-tree borer. (Bureau of Ent., U. S. D. A.)

SHOT-HOLE BORER

Xylobiops basilaris Say.

The shot-hole borer is attracted to dead or dying trees and is not a serious pest as it seldom attacks healthy pecan trees. It makes a small circular tunnel in wood which has been injured by some other agency. (Fig. 73.) Young pecan trees about to die from winter injury have been observed to be infested with this borer.

CONTROL.—To prevent this insect from becoming established in pecan groves it is best to remove all dead limbs and dying trees. Trees kept in a vigorous condition will not be liable to attack by this borer.

OAK OR HICKORY COSSID

Cossula magnifica Strecker

This insect tunnels in the hardwood of the pecan, hickory and oak. Its work is readily detected by the castings of wood which are pushed out by the larva from its galleries and found distributed around the base of the tree on the ground. The young larvae first attack the



FIG. 72.—Work of the hickory twig-girdler. *a*, egg puncture; *b*, larva tunneling underneath the bark; *c*, twig girdled ready to be severed by the wind

ed in early spring, yet galls may be observed throught the season. It is not uncommon to find seedling nursery stock covered with galls while budded or grafted pecan trees in adjacent rows

small twigs, tunneling out the central portions. When the larvae become larger they migrate to the larger limbs or trunk making their galleries parallel with the grain of the wood. The larvae pass their life cycle in the wood of the tree, and they pupate in their galleries in the spring months. The moths appear during the early part of the summer and lay their eggs soon after emergence.

CONTROL.—Locate the openings of the galleries in the limbs and trunk and inject carbon bisulphid in them. The holes should be stopped up immediately after treatment.

HICKORY PHYLLOXERA

Phylloxera caryaecaulis Fitch

Certain pecan trees in orchards are especially subject to attacks by the hickory phylloxera, an aphid which causes tumor-like swellings or galls on the leaves, leafstalks, and succulent shoots. By examining a newly matured gall both the winged and wingless or immature forms of the insect may be found. Before the maturity of the aphids the gall is closed, but by the time they have acquired wings the gall cracks open, allowing the fully developed aphids to escape.

The galls are found on both seedling and improved varieties of the pecan, but more often, perhaps, on seedling varieties. The trouble is more pronounced

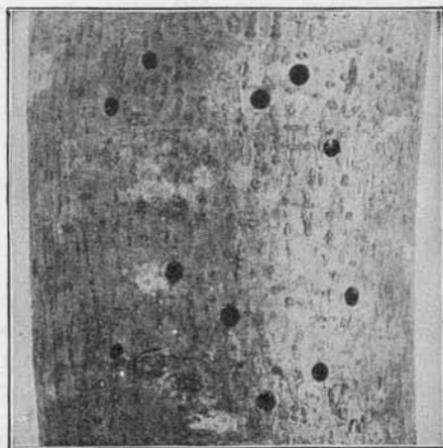


FIG. 73.—Exit holes of adult beetles of the shot-hole borer, made in pecan limb. (Bureau of Ent., U. S. D. A.)

may, and usually do, escape injury. The variation in severity of attack may extend to the field plantings where certain of the trees are exceptionally subject to attack while others sustain little or no injury whatever.

CONTROL.—Fortunately, remedial measures are seldom required to control this insect; natural enemies usually hold it in check. So far as known, no very satisfactory method of control can be employed during the growing season on trees that are so badly affected that the nut crop is seriously interfered with. It has been recommended that badly affected leaves and shoots be clipped off with a long-handled pruner before the galls open, and then destroyed immediately by burning; but this treatment will not prove feasible for extensive plantings of large trees. Spraying with lime-sulphur solution, kerosene emulsion, or miscible oil while the trees are dormant might destroy the insect in the egg stage, but experimental work along this line has not been done.

In selecting trees for new plantings advantage may be taken of the fact that certain varieties are more susceptible to infestation than others. Top-working the more susceptible bearing trees with resistant sorts would doubtless prove a practicable means of avoiding injury by this species of aphids.

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