Carpenterworm

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The carpenterworm (*Prionoxystus robiniae* (Peck)), widely distributed throughout the United States and southeastern Canada, is an important pest of hardwood trees.

First recorded attacking the black locust tree (*Robinia pseudoacacia* L.) in Massachusetts in 1818, this native insect attracted most attention until recent years as a pest of shade and ornamental trees. Foresters are now beginning to take notice of the great damage it also causes to oaks and other hardwoods in forest stands. The larvae construct large tunnels in the bark, sapwood, and heartwood of living hardwoods, hence the common name carpenterworm.

Lumber cut from infested trees is seriously degraded by defects resulting from these tunnels and the associated stain and wood decay. This degrade may reduce the overall value of rough oak lumber by as much as 15 percent. Greater losses result when carpenter ants and wood-rot fungi invade the tunnels. The ants excavate large nest cavities in trunks, which may in time be completely hollowed.

Open-grown trees—shade, roadside, shelterbelt, and edge-of-the-woods trees—are generally more heavily infested than trees within a fully stocked forest. Host trees are seldom killed, although young trees honeycombed by several generations of borers may be broken off by wind.

Carpenterworm damage varies greatly with host species and site. In southern bottom-land forests, the insect is a primary attacker and is the major cause of trunk defects in oaks. In hilly areas it is less common than the large, trunk-boring beetles.

In hilly areas it may be found entering trunk wounds as a secondary attacker. Old scars are frequently reinfested; previously attacked trees may be preferred hosts for successive generations, while trees nearby remain unattacked. Larvae may enter the galleries (tunnels) of other wood borers and supplant them.

A closely related borer, the little carpenterworm (*Prionoxystus macmurtrei* (Guer.)), is often associated with *P. robiniae* in Eastern United States and Canada but has not been reported in the southern bottom lands. Its habits are similar to those of the carpenterworm and the damage is nearly the same.

Hosts

The carpenterworm shows a preference for certain host species depending on location and host availability. In the Eastern and Southern States the oaks, particularly the red oak group, show the heaviest damage. In the Prairie States, green ash (*Fraxinus pennsylvanica* Marsh.) has been the chief host; in the Rocky Mountain region, poplars are favored; and in California, Califor-

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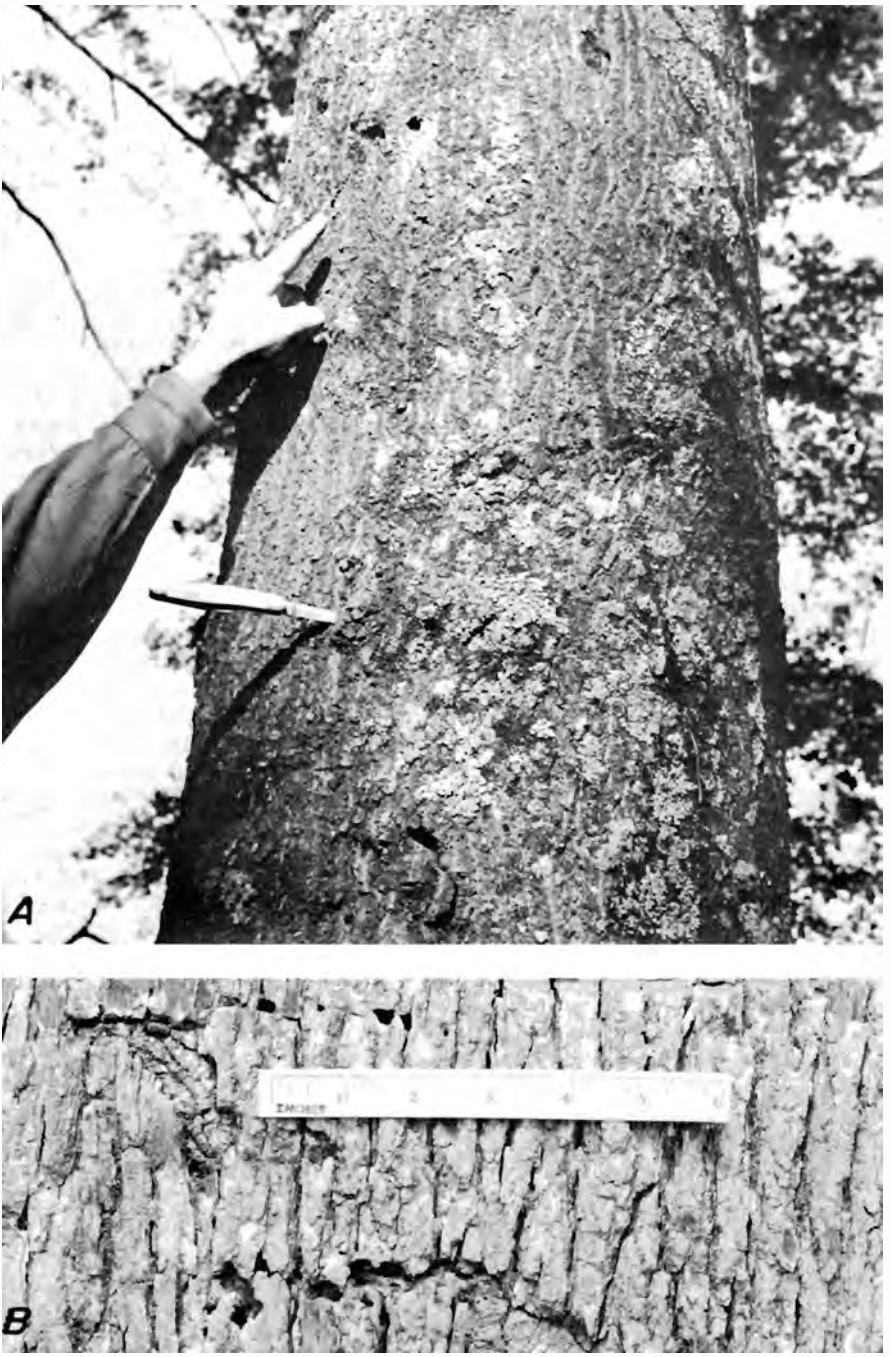

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Figure 1.—Evidence of infestation on outer bark surface of (*A*) scarred Nuttall oak (*Quercus nuttallii* Palmer), and (*B*) overcup oak (*Q. Lyrata* Walt.).

nia live oak (*Quercus agrifolia* Née) and introduced elms are most commonly attacked. Other host species are black locust, maple, willow, cottonwood, and occasionally fruit trees and ornamental shrubs.

In general the carpenterworm appears to have no preference as to size of host trees. Small stems and branches may be infested. Sapling oaks as small as 2 inches in diameter are often riddled in the South.

This insect is not known to infest dead material, but mature larvae can complete their development in dead or dying trees. This is especially true in standing poisoned or girdled trees. Survival is poor in felled stems because moisture accumulates in the larval tunnels. Adults have been known to emerge from woodpiles more than a year after the trees were cut.

Evidence of Infestation

The most evident indication of carpenterworm infestation is the presence of scars in the bark resulting from larval burrowing (fig. 1). These scars, oval or irregular in outline, persist for 20 years or more in thick-barked oaks such as overcup. In red oaks such as Nuttall the scars may disappear after about 10 years. Bark of repeatedly infested trees becomes more roughened and distorted each year as the borer wounds are healed over by thick areas of callous bark tissue.

The initial attacks of young larvae are difficult to detect. By fall or early spring following entry some sap flow and boring dust are evident at entry holes. As the larvae grow and enlarge their tunnels, the stained bark spots become larger and the exuded frass and chewed wood bits become more profuse in bark crevices and around the bases of trees. Usually, an irregular, cave-type initial gallery up to 2 inches or more in diameter is hollowed out (fig. 2).

Damage appears in sawed lumber as oval, oblong, or irregular holes, ½ to 1½ inches in diameter, surrounded by stained wood (fig. 3). The stain may extend as far as 2 feet up and down the trunk from the gallery. Discolored wood damaged by rot fungi such as *Polyporus fissilis* and *Pleurotus ostreatus* also may surround the holes. Pockets of ingrown bark scattered through the lumber result from healed-over borer entries. Carpenter ant damage appears as black-walled cavities where ants enlarged the tunnels.

Description

The adult carpenterworm is a grayish, stout-bodied moth (fig. 4). Its body and wings are uniformly mottled with gray and brown scales. The female, half again larger than the male, has an average wingspread of about 3 inches. She is generally lighter colored than the male. The most striking difference between the sexes is a marking on the male. The posterior half of each of his hindwings is nearly covered by a yellowish to orange spot with a black border (fig. 4, lower left).

The carpenterworm moth is protected by its coloration. When it is at rest on the bark of an oak tree, the gray and brown mottling of its wings is so closely harmonized with the bark color that the moth is all but invisible (fig. 5).

The egg is olive brown, oblong-ovoid, and about three thirty-seconds of an inch long by one-sixteenth inch wide. The surface, seen through a hand lens, is covered with numerous interlacing ridge lines forming a network of shallow pits.

The newly hatched larva is

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Figure 2.—Inner bark injury in tree seen in figure 1, *A*.

about one-fourth inch long and reddish pink with a dark-colored head. The mature larva (fig. 6) is 2 to 3 inches long, greenish white, and is nearly naked, with simple setae. The head is shiny brown, with powerful, nearly black mandibles. The thoracic legs are yellowish and three-jointed, each bearing a curved, pointed tarsal claw. The third, fourth, fifth, and sixth abdominal segments and the anal segment each have a pair of fleshy prolegs. The prolegs bear reddish-brown hooks arranged in an oval pattern on all but the anal segment where the hooks are in a transverse row.

The pupa is dark shiny brown, 1½ to 2 inches long, broad at the head end, and tapering to a blunt point at the hind end. On the dorsal surface of each abdominal segment except the last two or three is a pair of toothed bands. Female pupae have a single row of these toothed bands on the last three segments, while male pupae have a single row on only the last two segments.

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Figure 3.—Board surface injury in heartwood and sapwood of black oak (*Quercus velutina* Lam.).

Life History

The life cycle requires from 2 to 4 years, depending on location. In the Deep South a cycle is completed in 2 or 3 years, in the Central and Western States, 3 years, and in the Northern States and southeastern Canada, 4 years. In all areas there is an overlapping of generations, so one may find larvae in all stages of development at any time and moths in flight every year.

Adults emerge within a period of 5 to 7 weeks. In the Central States, emergence begins the last week of May, peaks in mid-June, and ceases in mid-July. In the South emergence begins the last part of April and in the northern regions the first week of June. The life span of the adult is about 1 week.

Eggs hatch in 1 to 2 weeks. A 2- to 4-year feeding or larval period is necessary for complete development. Pupation occurs in late spring 2 to 3 weeks before adult emergence.

Habits

The female carpenter worm moth lays from 200 to 1,000 eggs. They are most commonly laid in groups of 2 to 6 but may be laid singly. The female prefers to lay the eggs in protected or hidden places, as in bark crevices, under vines, under lichens, or near wounds and scars on the trunk or main limbs. When laid, the olive-colored eggs are covered with a thin, sticky, brown film which causes the eggs to adhere to each other and to the bark.

Following an incubation period of 10 to 13 days, the newly

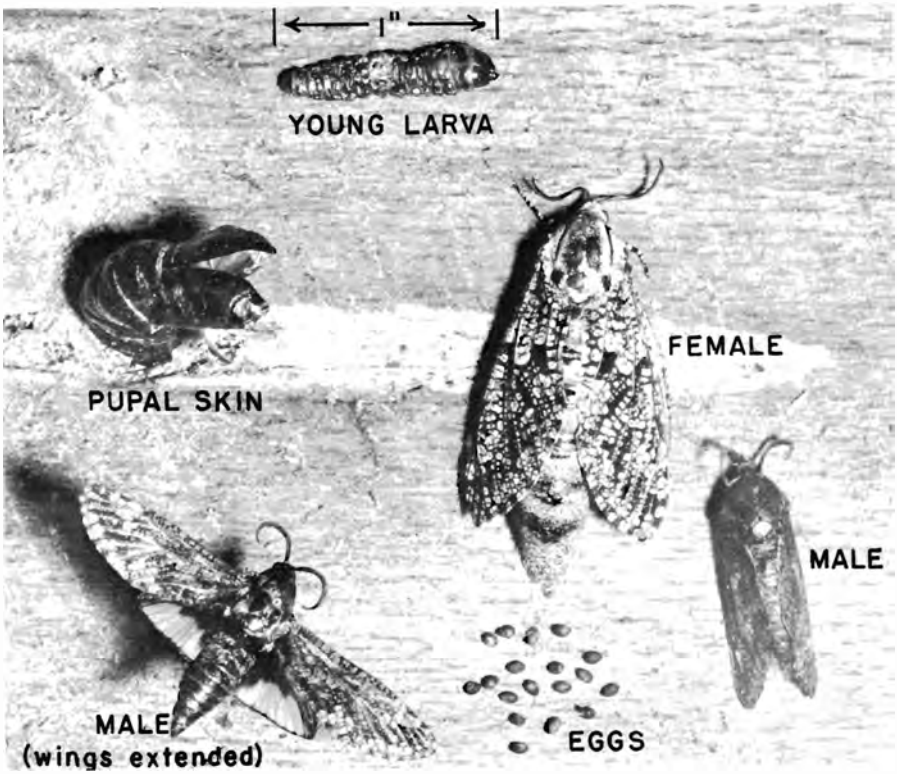

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Figure 4.—Life stages of the carpenterworm.

hatched larvae feed for a short while on the empty egg shells but soon begin to wander over the bark. Usually, within a few hours after hatching, the larvae begin penetrating the bark or entering openings. Many of these larvae establish themselves in bark crevices, constructing a silken web covering. Interspersed in the webbing are small quantities of brown, sandlike castings. Often the young larvae do not penetrate to the inner bark in the webbed bark recesses but move elsewhere to make their entry.

Shallow, irregular tunnels appear in the inner and outer bark within 2 weeks after the larvae hatch. Within a month the tunnels extend into and sometimes through the cambium. Within 2 months all larvae have penetrated the sapwood, each larva forming an upward-slanting tunnel ½ to 2½ inches long. After 4 months a vertical extension of the tunnel is started in the heartwood.

The larva returns to the gallery entrance from time to time to feed on callous tissues, cambium, and inner bark phloem. The destroyed area here increases rapidly during the first 4 months and more slowly afterward. The gallery entrance is kept free of callous tissues. The gallery is extended vertically throughout the remainder of the larval period. As larvae aproach maturity they chew away the sides of the crooked galleries, thus facilitating the exit of pupae.

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Figure 5.—Protective coloration of female carpenterworm moth on bark surface of willow oak (*Quercus phellos* L.).

Completed galleries range from 6 to 9 inches long and have an average diameter of $\frac{6}{10}$ inch (fig. 7). The average size of the inner bark cavity is $1\frac{1}{2}$ square inches. The upward-slanting portion of the wood gallery is 3 inches long, and the vertical portion of the wood gallery is $4\frac{3}{10}$ inches long.

The larvae keep their tunnels open, enlarging them as they grow and pushing the frass to the outside in a daily "housecleaning." The entrance hole is usually plugged when frass is not being expelled.

The larvae are known to wander at times, especially when young, leaving their tunnels and invading other wounds.

When the full-grown larva is ready to pupate, it lines the tunnel with a loose, silky, yellowish-brown web from the plugged entrance hole to the place of pupation, which is usually the tunnel's uppermost extension in the heartwood. Before emerging as an adult the pupa wriggles to the mouth of the tunnel, continuing until its head and thoracic parts are protruding. The empty pupal case remains in place unless knocked or blown out.

Moths emerge throughout the daylight hours, most males emerging in the morning and most females, in the afternoon. The female's scent attracts the male, and mating usually occurs the same day she emerges. Soon after mating, most of her egg complement is deposited on the tree from which she emerged. Until she has deposited most of her eggs her abdomen is so heavily laden that she is unable to fly.

Adult moths are nocturnal in habit and are sometimes attracted to light. Their mouth parts are vestigial.

Natural Control

Little is known about the effect of biotic forces on the carpenterworm. Birds are probably its most important natural enemies. From observations reported by Munro and Fox in North Dakota, woodpeckers, especially the hairy woodpecker (*Dryobates villosus*), were believed responsible for destroying upwards of 75 percent of the young carpenterworm larvae. The Arkansas kingbird (*Tyrannus verticalis*) and the

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Figure 6.—Ventral view of a mature carpenterworm larva. This larva is being reared in a mixture of agar and sawdust.

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Figure 7.—Overgrown tunnel of carpenterworm in the wood of scarlet oak (*Quercus coccinea* Muenchh.). Note distorted callous tissue at lower left where larva burrowed in the inner bark phloem.

common kingbird (*T. tyrannus*) were particularly abundant while the moths were emerging. When the birds' crops were examined, they were found to be filled with pupa and moth remains.

One of two known insect parasites of the carpenterworm is a member of the family Ichneumonidae, *Lampronota prionoxysti* (Rohwer). In 1958, in one locality of eastern Kentucky this parasitic wasp reduced moth emergence by 12 percent. Before then it was known only in Falls Church, Va. The second parasite, a muscid fly, *Helina* sp., was reared from a carpenterworm larva in Mississippi in 1957.

Nitidulid, sap-feeding beetles often are attracted to sap flow at entrances to carpenterworm tunnels. The bettle adults and larvae feed on the sap and associated fungi. The carpenterworm larvae may abandon the tunnel or die in it, from unknown cause. How important these beetles are in natural control of the carpenterworm is not known.

In Mississippi oaks, pupae may be trapped by fast-growing mycelia of wood-decay fungi. The white rot fungus, *Irpex mollis*, has trapped pupae in Nuttall and overcup oaks, and an unidentified brown basidiomycete has plugged galleries in Nuttall and willow oaks.

Preventive and Applied Control

No satisfactory control has been developed for the carpenterworm under forest conditions. Weak, deformed cull trees always have borers, even when the rest of the forest is thrifty. Removing or killing such trees would lessen the number of breeding places for the insect.

Shade trees can be protected from new attacks by the carpenterworm by painting bark wounds with dressing. Larvae can be killed by probing the tunnels with a wire.

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