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Pine Engraver, *Ips pini* (Say), in the Western United States

Sandra J. Kegley,[1] R. Ladd Livingston,[2] and Kenneth E. Gibson[3]

The pine engraver, *Ips pini* (Say), is one of the most common and widely distributed bark beetles in North America. It occurs from southern Appalachia north to Maine and Quebec, westward across the northern United States and Canada, into the interior of Alaska, throughout the Pacific Coast States and the Rocky Mountain region, to northern Mexico. Its range in the western United States is shown in figure 1.

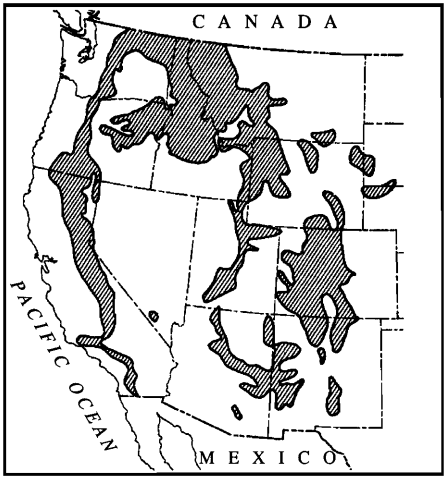

Figure 1. Distribution of *Ips pini* in the western United States.

Hosts

In the western United States, the insect is a significant and frequent pest of ponderosa pine. In some localities it is also an important killer of lodgepole and Jeffrey pines and can be a serious pest in plantations of jack and red pines in the Midwest. In rare instances it may infest pinyon, Coulter, limber, sugar, western white, southwestern white pines, and probably most other pine species occurring within its range.

Damage

In most years, the pine engraver is not an aggressive tree killer, even though large populations commonly infest logging slash, windthrown trees, or trees broken by wind or snow. When populations are low, the beetle may kill or top-kill widely scattered single trees or small groups

[1]Entomologist, U.S. Department of Agriculture, Forest Service, Cooperative Forestry and Forest Health Protection, Northern Region, Coeur d'Alene, Idaho.

[2]Entomologist, Idaho Department of Lands, Coeur d'Alene, Idaho.

[3]Entomologist, U.S. Department of Agriculture, Forest Service, Cooperative Forestry and Forest Health Protection, Northern Region, Missoula, Montana.

usually numbering less than ten. Often these trees have been previously damaged by wind, snow, fire, or lightning. In outbreak years they may kill groups of 50 to more than 500 trees, especially in unthinned young stands (figure 2). Saplings and pole-sized trees averaging 5-8 inches in diameter are most commonly attacked. Larger trees are often top-killed with the lower bole uninfested or colonized by other species of bark beetles or wood borers.

Figure 2. Ponderosa pines killed and top-killed by the pine engraver.

Indicators of Attack

The first indication of attack is reddish-orange boring dust which appears in small mounds on the surface of logs or logging slash at points of beetle entry (figure 3). Spring rains may wash the boring dust off the top surfaces, but it can usually be found in bark crevices or on the ground beneath the slash. In standing trees, boring dust lodges in bark crevices, spider webs, and on the ground at the base of the tree. Foliage of infested standing trees usually begins fading within a few months of attack. The rate of fading depends on tree species and weather. Some infested trees may fade by late summer or early fall during the same year they are attacked, while others may not fade until the following spring.

Figure 3. Pine engraver boring dust marking the entry points of beetles.

Description

Ips pini has four stages in its life cycle: egg, larva, pupa, and adult. Eggs are oval, pearly white and about the size of a pinhead. Larvae are creamy-white, legless grubs with brown heads. When full grown, the larvae are about 3/16 inch long. The pupa is soft and white, with some adult features such as eye spots and wing covers. The adult (figure 4) is cylindrical, about 1/8 to 3/16 inch long, and has four small spines on each side of the elytral declivity at its posterior. The third spine in the male is more prominent than that of the female. A new adult is pale yellow at first (a "callow" adult) but usually turns dark brown or black before flying.

Figure 4. Adult male pine engraver (a "callow" adult). Note prominent posterior declivity and spines.

Life History and Habits

Attacks are initiated by male beetles that bore through the outer bark into the inner bark (phloem) and excavate a nuptial chamber several times the beetle's size. Pheromone attractants released by the male attract one to seven females, though typically two or three. After mating, each female constructs a tunnel or "egg gallery" in the phloem layer, slightly scoring the wood surface in the process. These galleries radiate from the nuptial chamber and frequently form a Y- or H-pattern aligned with the grain of the wood (figure 5). During gallery construction, the boring dust is pushed to the outside, clearing the nuptial chamber and egg galleries. Additional males are also attracted to the vicinity of the initial attack. The attractant pheromone promotes an aggregation of beetles or "mass attack."

A female lays from 30 to 60 eggs along the sides of the egg gallery, which usually ranges from 4 to 7 inches long. Eggs hatch within 4 to 14 days, and larvae mine laterally from the egg gallery for 1 to 2 inches. Larval mines, unlike the parent tunnels, are packed with shredded phloem and excrement collectively called "frass." Larvae feed for 2-4 weeks and then excavate an oval cell at the end of their tunnels where pupation occurs. New adults begin to appear about 12 days after pupation, or about 40-55 days after the initial attack by parent beetles. When mature, new adults bore through the bark and emerge to make new attacks. During late summer, large numbers of beetles may infest living trees during "feeding" attacks. During this time, they mine extensive mazelike galleries under the bark without producing brood (figure 6). Occasionally these feeding attacks result in tree mortality.

The beetle spends the winter almost exclusively in the adult stage, except in warmer, drier areas where some older larvae and pupae may overwinter. Adults overwinter under the bark of infested trees and slash or in duff and litter on the forest floor.

Figure 5. Egg and larval galleries of *Ips pini* in ponderosa pine.

In most parts of the beetle's range, two or three generations per year are common. The first flight usually begins in April or May when the daily maximum temperatures reach 60-70 degrees F. As overwintering beetles become active, they infest fresh slash or trees damaged by wind or snow. This generation normally does not successfully attack standing green trees. However, populations can build up in slash with subsequent generations attacking and killing live trees, although if new slash is available, it will be infested first. At high elevations in the north, only one generation occurs in some years. As many as five generations may occur in southern California.

Figure 6. Mazelike galleries of *Ips pini* produced during feeding attacks in late summer.

Predicting Outbreaks

The percentage of normal precipitation between April and July may be used to predict the intensity of pine engraver outbreaks later in the season. If precipitation is 75% of normal or less, moderate to heavy tree mortality may be expected in overstocked, second-growth ponderosa pine stands. Outbreaks are usually of short duration, seldom lasting more than one season. During extreme droughty conditions, damage may continue for 2 to 3 years.

Minimizing Tree Mortality

Natural Control

Competition among developing brood may reduce adult emergence from small-diameter host material. In larger material, competition with other bark beetles and wood borers may reduce food available for pine engraver broods. Wood borer larvae also unintentionally consume pine engraver brood as they indiscriminately feed through their galleries. Predation by woodpeckers, beetles, flies and mites is common, as is parasitism by wasps and nematodes. However, neither competition nor natural enemies are known to prevent outbreaks from occurring.

Silvicultural Alternatives

The key to preventing tree damage is the promotion of healthy forests. Trees in thinned, vigorous stands are infrequently colonized by pine engraver beetles. During drought years, maintaining stand vigor is even more important. Stands in which basal area has been reduced to 80-100 square feet per acre have been found to be less susceptible to beetle attack.

Most pine engraver problems are associated with disturbances such as windthrow and snow breakage, drought in spring and early summer, logging, fires, road construction, housing development or other human activities. Pine slash or weakened trees created by these disturbances attract beetles and provide ideal conditions for population buildup and subsequent tree killing (figure 7).

Figure 7. Pine slash susceptible to *Ips pini* infestation.

Because pine engraver beetles overwinter as adults and normally only infest fresh slash when they emerge in the spring, logging slash created from early winter through late spring can be especially hazardous by providing large amounts of breeding material. Slash should not be created during this period unless it can be treated prior to beetle emergence.

The optimum period for logging activity in ponderosa pine is late summer to early winter. Slash created at this time will usually dry sufficiently to be unsuitable for pine engravers by the following spring. Slash covered by early snows, however, may still be fresh enough to attract beetles in the spring. Creating slash from about January through July, increases the likelihood of subsequent tree killing. When it is not practical to avoid creating slash during high-risk months, several management practices can be used to help minimize potential impacts:

a. Prompt slash disposal. Bulldozer trampling or chipping effectively reduces the amount of breeding material by decreasing the size of logging debris and by removing and drying the bark. Burning slash also destroys potential brood sites. When burning slash, however, avoid scorching standing trees as this makes them more attractive to numerous species of bark and wood-boring insects.

b. Where slash disposal is impractical, lopping into smaller pieces and scattering it into openings is effective. Reducing the size and exposing the slash to direct sunlight dries it faster making it less suitable for beetle development.

c. When beetle populations in slash constitute a threat, creating a continuous supply of fresh slash during the flight period of emerging adults will generally attract beetles, keeping them out of standing green trees. This technique is known as providing a "green chain." New slash should be produced just as beetles enter the pupal stage. Once started, this technique should be continued for each generation that season. An alternative to this method is the creation of very large slash piles in the spring before initial beetle flight. If piles are big enough so that interior pieces do not dry before beetles from the initial generation emerge, new beetles are attracted deeper into the pile, keeping them out of standing trees. Piles should be about 20 feet wide and 10 feet deep, and distributed throughout the treated area. These methods have been used successfully in the northern portions of the beetle's range.

d. During logging, felling trees into openings and using established skid trails to avoid damaging the residual stand are good practices to reduce pine engraver attacks on the remaining trees. Trees whose roots are exposed or disturbed, and those with large patches of bark torn off should be removed.

During home and lot construction, the roots of trees that are to be left as ornamentals should be protected. Excessive damage to the roots will usually weaken the trees and render them susceptible to beetle attack. Weakened or badly damaged trees should be removed prior to completion of construction. Pine slash created near housing developments should be disposed of as soon as possible.

It should not be left near remaining pines as infested slash piles may attract additional beetles that will attack the standing trees. Avoid backfilling over root areas. Four or more inches of dirt over roots often stresses trees, making them attractive to beetles. Avoid stacking fresh firewood against standing green trees. Beetles may be attracted by the cut logs and broods that develop in the firewood tend to crawl directly to the standing trees to make new attacks.

Pheromones and Behavioral Chemicals

Attractant pheromones of pine engravers have been identified and used in traps to monitor the flight period of beetle populations. Inhibitory behavioral chemicals for pine engravers have also been identified. Application of these inhibitors to prevent slash from being infested until it is no longer suitable for beetle habitation is currently being investigated.

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