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Arizona Fivespined Ips, *Ips lecontei* Swaine, in the Southwestern United States

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The Arizona fivespined ips (*Ips lecontei* Swaine) is a serious pest of ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) and other pines from southern Utah through Mexico and Guatemala into Honduras (Figure 1). However, economically significant damage in the United States is limited primarily to Arizona. The number of trees killed during an outbreak can vary from a few scattered individuals to several thousand trees in concentrated groups (Figure 2). Within an infestation center more than 90 percent of trees 3 inches (7.6 cm) diameter at breast height (dbh) or larger may be killed. Top-kill of trees of all size classes frequently occurs (Figure 3).

Although factors influencing the amount of tree-killing are not completely understood, outbreaks usually occur when there is prolonged drought or other causes that weaken tree defenses. Severe outbreaks of Arizona fivespined ips have occurred periodically on the Prescott National Forest in Arizona as a result of drought and pine on poor

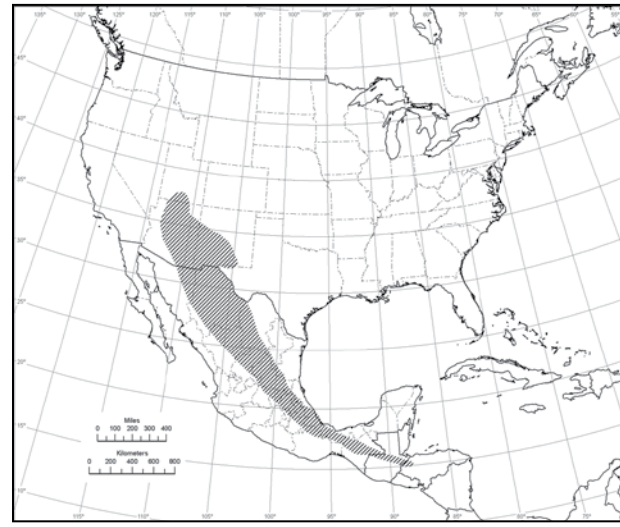

Figure 1. Generalized distribution of the Arizona fivespined ips.

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Figure 2. Ponderosa pine mortality caused by Arizona fivespined ips as a result of a severe drought on the Prescott National Forest, Arizona

Figure 4. Ponderosa pine mortality following a thinning treatment with slash left untreated on site.

growing sites. For example, tens of thousands of ponderosa pine trees were killed on more than 90,000 acres during 2002 and 2003 at the peak of an intense, prolonged drought. Outbreaks also have been initiated by forest management practices that create large quantities of host material (e.g., slash) (Figure 4), particularly in areas having poor site quality or areas treated for two or more consecutive years. However, outbreaks are generally localized and short-lived, usually lasting only one to two years.

Figure 3. Top-kill of ponderosa pine caused by Arizona fivespined ips.

Hosts

In the United States, Arizona fivespined ips principally attacks ponderosa pine, but infestations in Chihuahua pine (*Pinus leiophylla* Schiede and Deppe) have been recorded in the Chiricahua Mountains in southeastern Arizona. This beetle has been collected from several species of pines in Mexico, Guatemala, and Honduras.

Evidence of Infestation

Pines infested by the Arizona fivespined ips are first distinguished by their fading foliage. Within a few weeks after attack, needles in the top of the crown change to a light straw color (Figure 3). The fading progresses until all needles on the tree become yellow or yellowish-brown. Further evidence of attack on standing trees is the presence of tan to reddish-brown boring dust in bark crevices and at the tree base. Small mounds of boring dust can also be found on infested slash (Figure 5).

Figure 5. Boring dust (frass) caused by adult Arizona fivespined ips in fresh slash.

Not all trees with the symptoms mentioned above are infested by Arizona fivespined ips. Several species of *Ips* [*I. pini* (Say), *I. knausi* Swaine, *I. calligraphus* Swaine] and *Dendroctonus* (*D. brevicomis* LeConte, *D. frontalis* Zimmerman, *D. adjunctus* Blandford, *D. valens* LeConte) also attack ponderosa pine in the southwestern United States. However, these other species are not usually as aggressive as the Arizona five-spined ips in killing live trees in low to mid elevation ponderosa pine stands of Arizona. Typically, *Ips* species attack the tops of larger diameter pine while the *Dendroctonus* species infest the lower bole.

Identificaton

New ("callow") adults of the Arizona fivespined ips are light brown, but darken to black as they mature (Figure 6). They are about 0.2 inches (5 mm) long and have five small spines on each side of the posterior end of the hardened wing covers (elytra). Adult females lay white, oval eggs 0.02 to 0.04 inches (0.5 to 1.0 mm) long that are barely visible to the naked eye. Eggs hatch into grub-like, legless larvae (Figure 6) that when fully grown transform into pupae. Pupae are white, about 0.2 inches (5 mm) long, and have many adult characteristics, such as rudimentary antennae and wing covers. Adults of Arizona fivespined ips are very similar in appearance to pinyon ips [*I. confusus* (LeConte)]. However, the distance between the first and second elytral spines of the Arizona fivespined ips is approximately two times greater than on pinyon ips, and by pinyon ips being typically restricted to piñon pine (*Pinus edulis, P. monophylla, P. cembroides, P. quadrifolia*).

Figure 6. Larva (left), pupa (center) and adult (right) of Arizona fivespined ips.

Life Cycle

Male beetles initiate attacks on trees or slash by boring through the bark and forming a nuptial chamber. One to five females (usually three) bore through the bark and join the male. Each fertilized female then constructs an egg gallery up to 25 inches (63 cm) long that radiates away from the nuptial chamber and is kept free of frass (Figure 7). The eggs are laid on each side of the galleries. In the summer, eggs hatch in about 1 week. As they feed on the inner bark (cambium), the larvae construct feeding galleries perpendicular to the egg gallery. After larvae complete their growth, they form pupal chambers between the inner and outer bark, transform into pupae, and then metamorphose into adults. The adults bore out of the tree and begin another generation.

Three generations per year are typically completed at low to mid elevation [5,250-6,750 feet (1,600 to 2,065 m)] ponderosa pine sites in Arizona. Adult beetles, which have spent the winter under the bark of infested trees or in slash, emerge when warm weather arrives in March or April and search for a favorable oviposition site. They prefer to attack freshly cut slash, but live trees can be attacked when populations are high and trees are stressed (e.g., following extremely dry winters). By mid June to early July, adults produced by the overwintering generation emerge and initiate a second generation. The second generation completes development in about a month, because warm July temperatures favor faster development than in the spring. Another adult flight occurs, and a third generation begins in mid-August. Beetles from this generation usually remain under the bark until the following spring; however, significant numbers of flying beetles have been trapped through mid-November at the lower elevational range of this insect [5,250 to 5,750 feet (1,600 to 1,750 m)]. Aggregations of beetles frequently occur in feeding galleries in the lower bole or in slash during the fall and winter (Figure 7).

Figure 7. Egg and larval (left) and adult feeding (right) galleries of Arizona fivespined ips.

Natural Control

Several biotic and abiotic factors help to maintain beetle populations at endemic levels. Although these factors cannot be relied upon to halt outbreaks, they do help to lower epidemic populations. The primary natural enemies are predaceous beetles (Cleridae, Trogositidae) that feed on both mature and immature stages. Several species of small wasps parasitize Arizona fivespined ips, while internal nematode parasites can reduce the egg-laying potential of infested females by as much as 50 percent. Winter temperatures of -5° F (-21° C) and below for a period of a few days can cause extensive beetle mortality. Cold temperatures may limit the northern and upper elevational distribution of this *Ips* species. Few of these beetles have been found above 8,000 feet (2,440 m) in elevation in Arizona.

Minimizing Tree Mortality

Beetle-caused tree mortality can be prevented or substantially reduced through the use of one or more prevention and suppression techniques.

Prevention. The number and combination of prevention methods needed in a management area must be evaluated in relation to the risk of an outbreak occurring. At a minimum, slash should not be created for two or more consecutive seasons in ponderosa pine stands growing at low elevations in central and southern Arizona. Additional techniques may be needed during drought periods, or where trees have been weakened by defoliating insects, tree diseases, fire, or other causes.

The season when trees are cut greatly influences the production of beetles in future generations. Trees cut from July to December dry out during the fall and winter months and are generally unsuitable for beetle habitat the following year. It is best to cut trees in late summer/early fall to permit trees to dry for as long a period as possible. This is particularly important at low elevations and in areas having poor site quality.

Treating or removing slash greater than 4 inches (10.2 cm) will help prevent beetle population increases. Few beetles are produced in pine slash or in trees less than 4 inches (10.2 cm) in diameter because of the limited amount of food reserve in the inner bark. Bucking slash to less than 1 foot in length has been shown experimentally to limit brood production of *Ips* in Arizona.

Any means of destroying green slash (burning, chipping, burying, or other practices) will remove the conditions favoring beetle buildups. Caution should be used when chipping fresh slash during thinning projects. While chips are not suitable material for brood production, volatiles emanating from the chips can attract bark beetles to the treatment area and residual trees may be attacked. Risk can be minimized by (1) chipping when beetles are not actively flying – fall through early winter is optimal; (2) limiting large quantities of chips from directly piling up against residual trees. Raking or use of tarps to prevent chips from accumulating around tree bases may help to reduce bark beetle attacks.

Suppression. After slash or weakened trees are attacked by the Arizona fivespined ips, suppression of populations can be achieved by treating the infested material. However, the decision to conduct a suppression program is difficult because there is no reliable way to determine if beetles will attack live trees in a management unit, fly elsewhere and attack

trees, or decline without causing any significant tree damage. Also, infestations must be detected early enough to allow adequate time to carry out an on-the-ground treatment project.

Brood developing in infested host material 4 inches (10.2 cm) in diameter and larger can be killed by creating small piles of bolts in forest openings, covering piles with clear plastic, and securely anchoring the plastic to the ground. The plastic covering functions like a greenhouse, and temperatures reach a level high enough to kill a brood. However, temperatures may not reach lethal thresholds >113°F (>45 °C) in the middle and bottom of deeply stacked piles (e.g., > three or more layers deep) or when piles are shaded. In addition, care must be taken to minimize holes in the plastic caused by branch stubs or other debris which can result in decreased maximum temperatures through venting of heat. Using thick plastic (>6 mil) will help to prevent rips and punctures in plastic.

Burning, chipping, debarking, or burying infested slash also will kill developing brood. In addition, moving infested slash 3 or more miles (1.8 km) away from ponderosa pine stands will prevent attacks of standing trees by emerging beetles. Treatment activities should be conducted within the first 30 days after slash creation to reduce brood production.

Preventative sprays for protecting uninfested pine trees. Carbaryl and pyrethroid products are registered for use as preventative treatments for bark beetles. They only should be used in consultation with forest health professionals. Preventative sprays are not recommended for treatment of trees already infested by bark beetles. In addition, systemic insecticides are not recommended for either prevention or remedial control.

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