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New Pest Complex in California: The Polyphagous Shot Hole Borer, *Euwallacea* sp., and Fusarium Dieback, *Fusarium euwallaceae*

The polyphagous shot hole borer, *Euwallacea* sp., and *Fusarium euwallaceae*, a fungus it carries, are an exotic pest complex causing dieback and mortality to numerous native and ornamental hardwood trees and shrubs in southern California. The ambrosia beetle carries several symbiotic fungi, including *Fusarium euwallaceae* which was newly identified as a species associated with recent tree dieback symptoms. Injury occurs when the ambrosia beetle bores into a tree to create tunnels (galleries) for its eggs and larvae and, in the process, inoculates the tunnels with its symbiotic fungi that subsequently clog the surrounding water conducting tissue, or xylem. These pests in combination have killed several hardwood species in urban areas and on National Forest lands. This ambrosia beetle attacks over 20 species as hosts, including bigleaf maple, *Acer macrophyllum*, California box elder, *Acer negundo* var. *californicum*, California sycamore, *Platanus racemosa*, coast live oak, *Quercus agrifolia*, castorbean, *Ricinus communis*, red willow, *Salix laevigata*, valley oak, *Q. lobata*, and white alder, *Alnus rhombifolia*, all of which are found on public land. The large number of hosts increases the likelihood that this pest complex could spread to other areas.

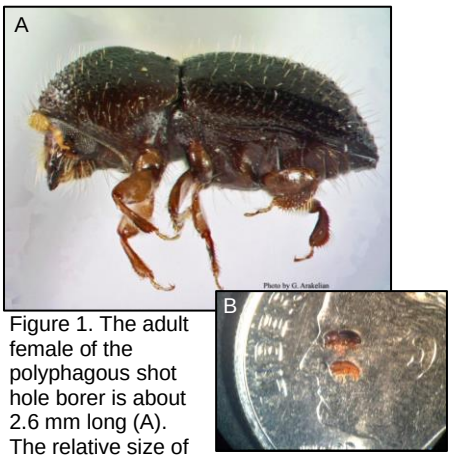

Figure 1. The adult female of the polyphagous shot hole borer is about 2.6 mm long (A). The relative size of the adult female and male can be seen on a dime (B).

Identification

Adults are oval in shape and brown to black in color. Adult females are approximately 2.62 (±0.02) (mean (±s.e.) mm long and 1.07 (±0.02) mm wide (Fig. 1) while adult males are smaller (approximately 1.80 (±0.02) mm long and 0.81 (±0.02) mm wide). Males are rarely observed because they are unable to fly, they typically do not leave the galleries, and very few are produced compared to females. Immature stages (eggs, larvae, and pupae) are white in color and restricted to the galleries in the xylem.


Figure 2. The pest complex can cause bark staining and discoloration around the entry holes on red willow (pictured above) and other species.


Figure 3. Amber-colored staining is commonly associated with polyphagous shot hole borer attacks on California sycamore.


Figure 4. Polyphagous shot hole borer attacks can cause gumming along the stem and branches of several ornamental tree species.

Evidence of attack

The ambrosia beetle commonly attacks the main stem and larger branches of trees and shrubs, but injury can be found on twigs as small as 2.5 cm in diameter. Wet staining and discoloration on the bark of the main stem and branches are early symptoms of beetle attack (Figs. 2 and 3). Depending on the tree species attacked, polyphagous shot hole borer injury can be identified either by staining, gumming (Fig. 4), or a sugaring response on the outer bark (Fig. 5). High densities of attack have been observed on castorbean, California sycamore, red willow, and white alder on National Forest land (Fig. 6). The presence of fine white boring dust in bark crevices and around the base of trees can signify successful ambrosia beetle attacks (Fig. 7) or boring dust expelled by the females can be tightly packed into cylindrical columns extending out from a tree (Fig. 8). Beetle entry/exit holes are round and about 0.85 mm in diameter (Fig. 9). After entering the xylem, females construct branching galleries that can extend approximately 8 cm into the wood and that are dark in color from fungal discoloration of surrounding wood tissue (Fig. 10). Xylem staining may extend out from galleries in advance stages of fungal colonization (Fig. 11). High attack densities can lead to severe crown and branch dieback, basal sprouting, and eventual tree death (Fig. 12).

Figure 5. Polyphagous shot hole borer attacks induce a sugaring response on avocado trees, commonly referred to as “sugar volcanoes.”

Figure 6. Ambrosia beetle attacks can reach high densities on castorbean and span from the main stem to smaller branches.

Figure 7. Adult females do not feed on the wood so expel white boring dust from the galleries. Fine white boring dust can be found in bark cracks by the entry holes and at the base of trees.

Figure 8. Boring dust pushed out by the female can resemble toothpick- or string-like projections on red willow and other host trees.

Figure 9. Adult entry holes are round and the diameter (0.85 mm) is slightly smaller than the tip of a ballpoint pen.

Figure 10. Adult females construct branching galleries in the xylem that appear black in color from the symbiotic fungi. All life stages can be found in the galleries concurrently.

Background and distribution

In 2003, the polyphagous shot hole borer was first collected near Los Angeles, CA, but the pest complex was not linked to tree injury and mortality until the spring of 2012. By 2013, the pest complex was detected in Los Angeles, Orange, and San Bernardino Counties. The origin of the polyphagous shot hole borer is unknown, but it may have come from somewhere between northern Thailand and southern Japan. This beetle was accidently introduced to Israel where it is a threat to hardwood trees in urban and agricultural settings. The polyphagous shot hole borer looks morphologically similar to the tea shot hole borer, *Euwallacea fornicatus*, which is native to southeastern Asia and has been accidentally introduced to several countries throughout the world.

Figure 11. A branch of coast live oak split in half to expose the polyphagous shot hole borer galleries and fungal staining in the xylem.

Biology and potential impacts in California

The polyphagous shot hole borer likely completes two to four generations a year in the urban areas of southern CA, but additional data are needed to verify the life cycle. Preliminary trapping of females and observational data suggest adults are active year round in urban areas and lower elevation (<610 m) forests. Females initiate attacks on hosts and excavate branching galleries in the wood. The female introduces their ambrosial fungi to the galleries during construction, where it is the food source for both the adults and developing larvae.

Figure 12. Severe injury from the pest complex can lead to branch dieback on California box elder (pictured above) and other species.

While in the galleries, female offspring mate with their flightless brothers, referred to as sibling mating. They then leave the galleries to look for locations to start new galleries, often in the same tree.

In southern California, this new pest complex has resulted in mortality of California box elder, California sycamore, castorbean, English oak, *Quercus robur*, red willow, and white alder. California box elder and castorbean are frequently attacked and killed first. In urban areas of southern California, the pest complex threatens numerous ornamental species and an important fruit tree, avocado, *Persea americana*. In native forest stands, preliminary results show elevated levels of injury from the ambrosia beetle on California sycamore, castorbean, red willow, and white alder (ranging in size from 5−81 cm diameter at breast height (DBH)). Over 50% of the trees of several species were attacked over a period of a few years. Tree mortality has occurred at low levels and likely takes greater than one year. Following extensive injury by the beetle, stem breakage has also occurred in smaller diameter trees (<13 cm DBH). It is currently unknown if tree mortality is caused by the large numbers of beetles attacking a tree or their symbiotic fungi clogging the xylem. Likewise, the extent of tree injury and death in native forest stands is not yet known. In February 2013, the pest complex was first detected on the Angeles National Forest, but more monitoring and research are needed to determine how susceptible or preferred other native hardwood species might be.

Mortality of native hardwoods from the pest complex can create potential hazards in and around high-use areas such as campgrounds and picnic areas. Dead trees should be felled to keep the areas safe and the wood should be managed properly to prevent the spread of the pest complex. Loss of hardwood species and canopy cover in riparian areas may cause habitat loss for several threatened and endangered species in southern California, including Bell's vireo, *Vireo bellii*, and the southwestern willow flycatcher, *Empidonax traillii extimus*. Furthermore, excessive tree mortality may alter the structure and composition of the fuel load in areas already prone to wildfire.

Management options

Options are currently being developed for managing this new pest complex, but active management may only be necessary on a few of the most susceptible species. Preventive systemic or contact insecticides may reduce beetle attack and ultimately prevent tree mortality, or systemic fungicides may hinder growth of fungi in the xylem. However, it is premature to recommend preventive management options. Removing heavily infested trees may reduce local populations of the beetle, but no data are available that support this management option. Furthermore, the removal of castorbean (>2.5 cm DBH), a heavily attacked species that is also an exotic, has been proposed at high-value sites to slow the establishment and population growth of beetles while at the same time ridding the site of a weed pest.

Green-infested material and wood from recently killed trees should not be removed from the infested area or taken out of the county. Movement of infested material can introduce the pest complex into additional areas of California. Chipping, grinding, and tarping to heat infested material may reduce the emergence of beetles, but additional research is needed on these management options to determine their efficacy.

If you suspect that you have found the polyphagous shot hole borer or seen symptoms of the Fusarium dieback in your yard, grove, or on National Forest land please contact either your local farm advisor, pest control advisor, local Forest Health Protection representative, California Avocado Commission, or county Agricultural Commissioner office.

References

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