The female eucalyptus longhorn borer, a pollen feeder, doesn't feed on eucalyptus but lays eggs on diseased or moisture-stressed trees. The larvae feed on the inner bark and cambium and can kill even healthy eucalyptus trees.

Max Badgley

Beetle from Australia threatens eucalyptus

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Healthy eucalyptus trees respond to *Phoracantha* larval boring by producing copious quantities of gum that smother the larvae.

Spreading rapidly in southern California

Since the eucalyptus longhorn borer was discovered in October 1984 infesting eucalyptus trees near El Toro, California, it has been spreading rapidly in the southern part of the state. Subsequent surveys (February 1986) by state and county agencies have found the borer along the coast from Long Beach to San Diego and inland to Van Nuys and Hemet.

Eucalyptus has been planted in California since the 1860s but has been free of major pests until the arrival of the borer, *Phoracantha semipunctata* (Fab.), a cerambycid beetle. The borer is the first such pest to reach the United States from Australia, the native home of eucalyptus. In Australia, this beetle occurs throughout eucalyptus forests, but its damage is usually restricted to dead and dying trees. During severe droughts, beetle outbreaks may occur, but its populations normally appear to be limited by a complex of natural enemies, including predators and parasitoids.

Eucalyptus has also been planted in several other countries, including Israel, Morocco, Spain, and South Africa, where the wood is used for lumber, paper pulp, telephone poles, mine supports, and fuel. The eucalyptus longhorn borer has been accidentally introduced into many of these countries, and is killing trees and severely damaging logs intended for structural timber and telephone poles.

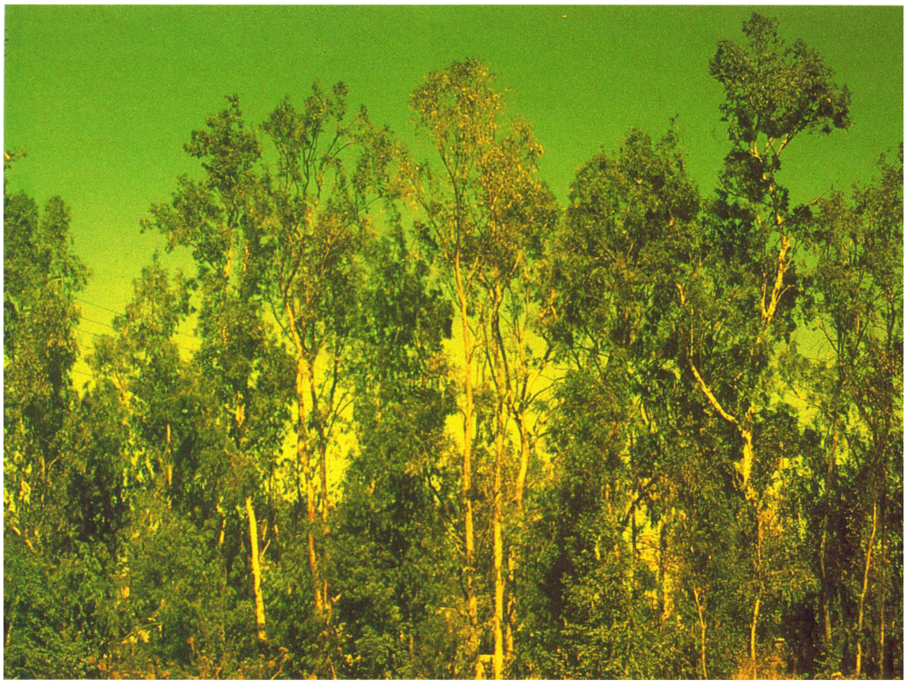
One of the more common broadleaf trees in urban California, eucalyptus is potentially threatened by the beetle in landscape and woodlot plantings, especially when subjected to periodic moisture stress. Such stress, even for brief periods, increases vulnerability to attack. In moist regions of Africa (eastern Transvaal, rainfall 54 inches per year, and Natal, rainfall 38 inches per year), the beetle is reported to have killed apparently healthy trees during brief moisture stress.

Tree susceptibility

The beetle is a strong flyer and has been known to attack isolated trees nine miles from the nearest infested tree. The female usually lays eggs on diseased or moisture-stressed trees or on freshly cut logs. Eggs may be laid on the bark of well-watered healthy trees, but most of the newly emerged larvae die when they attempt to penetrate the bark. Healthy trees respond to larval boring by producing copious quantities of gum that smother the larvae.

In unirrigated woodlots, some trees are under more moisture stress than others. Stress symptoms include sprouting of inactive buds on the tree bole and changes in leaf color. The leaves of such trees viewed through a No. 8 yellow photographic filter appear much lighter than those on healthy trees. The beetles repeatedly lay eggs on such trees and avoid neighboring healthy trees.

Larvae that survive the tree's initial gum defenses and reach the cambium confine their feeding to a limited area, forming a lesion. The beetles continue to



When viewed through a yellow photographic filter, leaves of eucalyptus trees under moisture stress appear much lighter than those of healthy trees. Massive beetle attacks on such trees in southern California are causing major losses.

Longhorn borer larvae can riddle the inner bark and cambium of vulnerable eucalyptus trees. Below, *Phoracantha* lesion and emergence hole on living eucalyptus tree.

lay eggs on these trees, and surviving larvae form additional lesions. Finally, gum production ceases and the tree succumbs to a massive attack; the larvae riddle the inner bark and cambium with frass-packed galleries. Larvae can mine the trunk and branches as small as ¾ inch in diameter.

Our preliminary observations suggest that eucalyptus species vary in susceptibility to attack under comparable drought conditions. Massive beetle attacks quickly kill *Eucalyptus globulus* and *E. viminalis* when their gum defenses decline. In contrast, the gum defenses of *E. blakelyi* continue to cause high mortality of larvae entering the bark, but some larvae survive, producing long narrow lesions. Occasionally, a single larva will girdle the trunk and kill the tree. *Eucalyptus cladocalyx* has substantial gum defenses, even during severe drought, but some larvae penetrate the bark of certain trees and produce large oval-shaped lesions exposing bare wood. We are currently evaluating other species of *Eucalyptus.*

Biology

The beetle is about 1 inch long; the body is shiny black; and a yellow band extends across the upper half of the forewings. Within the yellow band is an irregular black line. The female's antennae are about the same length as the body; those of the male are somewhat longer and heavier with prominent spines at each segment.

Upon emergence, the adult male is ready to mate; the female, however, must wait 48 hours. After mating, which takes 8 to 28 minutes, the female must wait an additional period of 2 to 4 days before she can begin laying eggs. The sex ratio is one to one, and unmated females lay no eggs. We have observed females feeding on the flowers of eucalyptus and other plants, apparently to gain additional nutrition for egg production. Adult females may live 40 days in summer and 180 days in winter and lay up to 300 eggs. However, they tend to live only 3 to 14 days in the laboratory.

Egg laying occurs at night. The eggs are laid under loose bark in groups of 3 to 30 eggs, which incubate in 10 to 14 days. When the eggs hatch, the larvae may feed along the bark surface for a short distance (¼ to 1 inch) forming a conspicuous dark trail. Then they turn into the bark and proceed toward the cambium — the living tissue beneath the bark. They feed in the cambium region until they are nearly mature.

The larvae grow as they feed, and gallery size increases correspondingly. The gallery is oval in cross-section and about twice as wide as the young larva's head. As the larva matures, the gallery widens, increasing to more than three times the head width. A single larval gallery can extend several feet and can girdle a tree. When the larva nears maturity, it first forms a short tunnel to the bark surface then bores several inches into the wood to


Maturing larvae bore tunnel through bark, then several inches into wood to form a pupal chamber. Following pupal stage (left) adult beetle emerges through tunnel.

form a pupal chamber. The tunnel near the bark surface will provide the exit for the emerging adult beetle.

Larvae develop in about 70 days in fresh logs and up to 180 days in dry logs. The pupal stage lasts about 20 days. During the spring and summer, the beetle requires three to four months to complete its life cycle, but in the fall and winter, it may require up to nine months. Two to three generations per year occur in Mediterranean climates similar to that of California.

Chemical control measures

Living eucalyptus trees are not easily protected by pesticides, since the beetles' behavior limits their exposure to the chemicals. The beetles hide during the day under loose bark and do not feed on leaves or bark. The adults are active from February to November, and so it would be necessary to use pesticides with long residual activity or frequent applications to kill adults landing on the tree. Also, since viable eggs can be laid on sprayed trees before the pesticide can kill the female beetle, killing the adult would not necessarily prevent infestation of a susceptible tree.

Eggs are usually protected from exposure to pesticides, because they are laid under layers of loose bark. Once the larvae are inside the bark, they escape pesticide applications.

The long-term cost of repeated applications to large eucalyptus trees also seems economically impractical. Zinc chloride injections into cut logs kill the larvae and prevent infestation, but the procedure is slow and expensive. Removal of the bark on felled logs can also prevent infestation, but labor costs have prevented its adoption in most infested areas. Fumigation may be a practical means of preventing the larvae from developing in cut logs stored for use as firewood. The type of fumigant and dosages required have not yet been determined. Covering uninfested cut logs with sturdy tarpaulins could protect them from beetle attack.

In Spain, freshly cut trap logs, treated with 2 percent lindane, were placed in woodlots to attract adult beetles. The beetles laid eggs on the sprayed logs and then died from contact with the pesticide. The logs were replaced every two weeks with fresh ones, and the old logs were destroyed within two months to prevent beetle emergence. Up to 100 egg masses were laid on one log and about 1,000 dead adults were found nearby. These measures apparently limited the impact of the beetle in some woodlots.

Biological control

Several predators and parasites appear to cause significant mortality to beetle larvae in Australian eucalyptus forests. Two braconid parasites, *Syngaster lepidus* Brulle and *Bracon capitator* F., are common in beetle-infested logs. Also, two predatory beetles, the clerid *Trogodendron fasciculatum* Schr. and a colydiid, *Bothrideres vittatus* Newm., may cause substantial mortality of beetle larvae in cut logs at some sites. In moist areas, the fungus *Beauveria bassiana* (Balsamo) attacks all active stages of the beetle. In Israel, the Syrian woodpecker causes about 28 percent of the larval mortality occurring in the bark. In South Africa, colonization of *Syngaster lepidus* was apparently successful, although no follow-up evaluation is available.

In Orange County, we have seen some woodpecker activity on infested trees, but it appears to be of minor importance. We have also observed the predatory mite *Pyemotes* sp. killing beetle eggs on some trees.

To assess whether native parasitoids have adapted to the beetle in California, we collected exposed logs from sites near Corona, Redlands, and Irvine and placed them in rearing chambers. We monitored beetle and parasitoid emergence. So far, we have recovered two parasitoids, *Xorides humeralis* (Say) and *Atanycolus simplex* (Cresson). Both parasitoids occur on the native cerambicid beetle *Xylotrechus nauticus,* which was also present in the sample logs. We have no evidence that any of the Australian parasitoids or predators are present in California.

Conclusion

Eucalyptus trees are well adapted to California's Mediterranean climate and for many years have been free of major pests. Consequently, several varieties have become important landscape plants and have also been extensively used in windbreak and woodlot plantings. Now these plantings are threatened by the eucalyptus longhorn borer, which is capable of reproducing in living eucalyptus trees. Cut infested logs stored for firewood are a major source of beetles. Dead and dying trees weakened by the beetle's feeding present a public danger, and their removal and replacement will be expensive.

Since chemical control with pesticides appears impractical, alternative measures need to be considered. Beetle populations can be limited by prompt removal of dead trees and protection of infested eucalyptus wood. Using pesticide-treated trap logs to attract and destroy adult beetles may reduce their numbers, but we are uncertain about the degree of control likely. Establishment of parasitoids that attack the beetle larvae and predators that feed on its eggs may be a long-term solution. Limiting the impact of the beetle on eucalyptus in California will probably require the coordinated use of these measures on a communitywide basis.

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