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Eucalyptus Longhorned Borer and California Urban Forests: Exploration of Management Options

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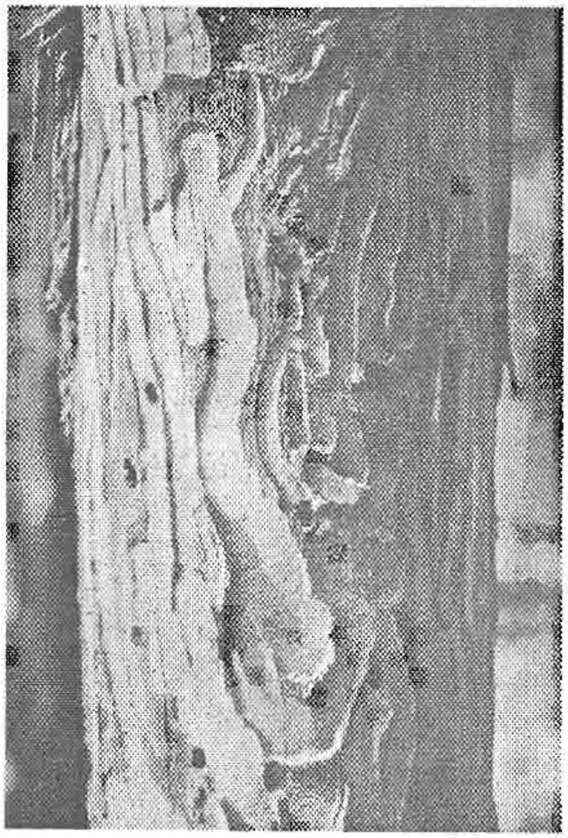

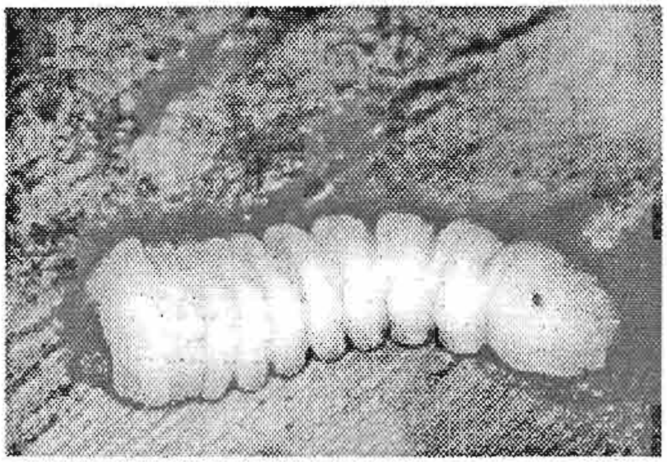

ABOVE - Larvae of the Eucalyptus Longhorned Borer

LEFT - Larval galleries on *E. globulus*

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INTRODUCTION

Eucalyptus is a popular urban tree, and although an exact determination is difficult to obtain, it is estimated that there are more than 90 species of *Eucalyptus* planted in the urban forests of California. In many places, particularly in southern California and in the San Francisco Bay Area, *Eucalyptus* dominate the landscape and give character to the urban environment. Attempts at commercial forestry using these species in California have generally been unsuccessful or unprofitable; however, the market for short fiber cellulose for office paper products is creating renewed interest in several species. The first plantings of *Eucalyptus* were from seed approximately 100 years ago. Because pest insects and diseases have been excluded from California until recently, the tree has gained a reputation for fast growth, minimal maintenance, freedom from pests, and drought tolerance. Introduction of the Eucalyptus longhorned borer, *Phoracantha semipunctata* F., into California has threatened several of these perceptions.

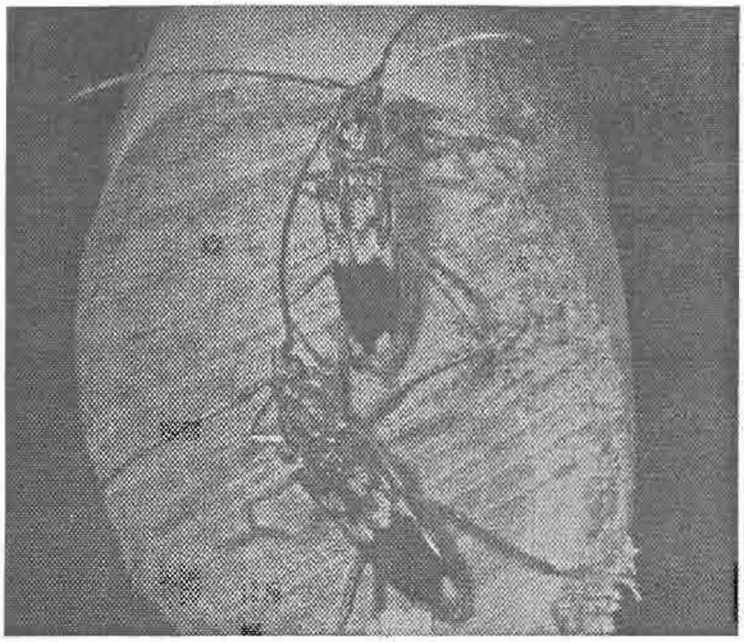
The Eucalyptus longhorned borer arrived in southern California some time prior to 1985 (Scriven et al. 1986). In succeeding years, the beetle has spread in a contiguous distribution from San Diego and Imperial Counties up through Kern and San Luis Obispo Counties. A second area of infestation has established in the San Francisco Bay area, particularly in Alameda, San Mateo, and Santa Clara Counties. As the public becomes more aware of the insect, it is likely that new infested areas will be reported. For example, adult beetles were recently discovered in Sacramento. It is unknown whether the northern California infestation resulted from a second introduction of the insect into the state or whether it resulted from movement of beetles (or infested wood) from the south.

BIOLOGY

Whatever the source of the infestation, it appears inevitable that the beetle will spread throughout the range of *Eucalyptus* in the state. The northern limit of *Eucalyptus* species in California is determined by frost sensitivity of the tree. We have shown in laboratory studies that the insects were quite capable of surviving as larvae in host logs held at temperatures as low as -5⊃C for up to 30 days (Hanks et al. 1991a). Thus, it appears that the problem of managing the insect in California will be statewide, and understanding local conditions as they influence the life cycle of the beetle will be critical.

The life cycle of the insect begins as males and females mate on the bark of suitable host trees. Females lay batches of up to 40 eggs on the bark surface, usually under exfoliated bark or within crevices (Hanks et al. 1993). The eggs hatch in three to six days and the emerging larvae mine through the outer bark to initiate their feeding galleries at the phloem/xylem interface. During the feeding period, larvae consume upper layers of xylem, phloem, cambium, and bark tissues leaving galleries etched into the wood that are packed with sawdust and excrement (together called frass). Mature larvae excavate chambers in the wood where they pupate, packing the tunnels to the surface with frass. Enclosed adults emerge from the tree by chewing through these frass-plugged tunnels. Adults of both sexes feed on

Adult borers on eucalyptus log



Eucalyptus pollen and both sexes are attracted to susceptible trees where they mate and initiate a new generation. The life cycle from egg to adult may take as little as three months in the summer or longer during the cooler parts of the year. Adults live about 30 days in the field but up to 90 days in the laboratory (Hanks et al. 1990, Hanks et al. 1993).

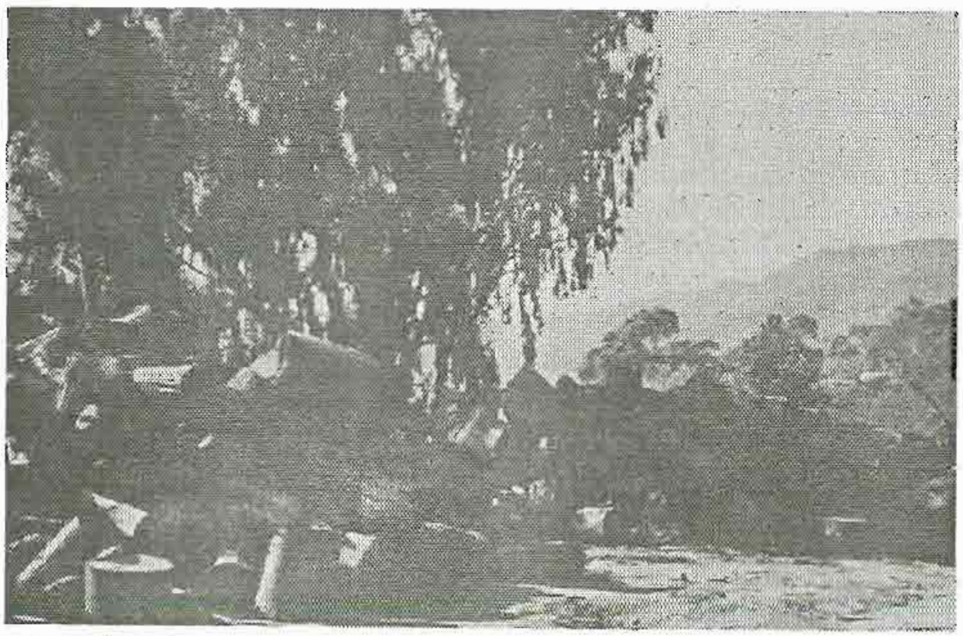
MANAGEMENT OPTIONS

Management of Eucalyptus longhorned borer populations with insecticides is not a reasonable strategy. Contact insecticides would have to be applied at high rates several times each year to the entire bark surface of large standing trees. Complete coverage of this type is very difficult, expensive, and would result in large amounts of material in either water or air. These treatments, particularly in urban environments, carry great potential for adverse effects on non-target arthropods and vertebrate animals, as well as tremendous problems of drift into dwellings or onto landscapes with resulting high risk of exposure to people and pets. Treatment of susceptible trees with systemic insecticides is ineffective and prohibitively expensive (Ali et al. 1989). Manipulation of environmental conditions, host plant resistance, sanitation, and biological control are alternative strategies that can be integrated into an effective and environmentally sound management program.

Oviposition by the beetle is concentrated on susceptible trees. Although the characteristics making certain trees attractive are not known, they are currently under study within our laboratories and in laboratories in other areas of the world. If the volatile chemicals produced by these attractive trees can be identified, it may be possible to use them in traps to monitor adult populations and locate areas with high beetle populations. However, we have identified one of the factors associated with susceptibility of stressed trees, and have developed a profile of resistant and susceptible *Eucalyptus* species. Previous observations from California and other parts of the world have indicated that the beetles are very successful at identifying and colonizing water-stressed trees. Hanks et al. (1991b) showed that when bark moisture content of either cut logs or standing trees is reduced, the larvae are capable of penetrating through the tissue to reach the cambium. Production levels of the thick, dark, and viscous resin, called kino by the Australians, associated with resistance to infection of the trees was not consistently associated with resistance to the beetles or with water stress. However, turgid bark acted as a barrier to successful larval colonization. These results suggest that environmental management, particularly irrigation to maintain high tissue moisture and tree vigor, is a critical component for reducing the probability of tree mortality. In particular, where a tree has grown in good moisture conditions, but these conditions are abruptly changed even for a period as short as a few weeks, the resulting acute stress may place that tree at greater risk than would be experienced by a similar tree that has never received supplemental irrigation.

A long-term management option to avoid tree mortality is proper selection of species to be planted. *Eucalyptus robusta, E. sideroxylon, E. camaldulensis, E. cladocalyx*, and *E. trabutii* have shown indications of resistance to the beetle in provenance trials in southern California, while *E. saligna, E. globulus, E. nitens, E. viminalis*, and *E. diversicolor* appear to be susceptible (Paine et al. 1993). Similarly, there are differences in larval success when colonizing susceptible or resistant tree species (Hanks et al. 1993). However, it is critical to understand that there is an interaction between tree management and species vulnerability; a well-managed tree of a susceptible species may be at a lower risk than a poorly-managed tree of a more resistant species. Cultural management, selection of resistant species of trees, and matching the tree species planted with site and stand conditions are important factors in reducing the risk of individual trees becoming infested by the beetle.

Another important component of a management program is elimination of sources of beetles, also referred to as using sanitation practices. Sanitation involves treating or destroying infested *Eucalyptus* trees and wood to kill the immature stages of the beetle before they can complete their development. Effective techniques include burning, burying, or chipping the wood. If the beetles are still in the feeding larval stage, they can be killed by stripping the bark from the wood. Infestation of freshly cut or recently fallen wood can be prevented by removing the bark which removes the source of food and increases the rate of drying of the wood. Treatment of cut logs with pesticides cannot be recommended because of the lack of registered products and the potential that the wood might be used subsequently for



firewood (Sanborn 1991). A safer and less environmentally hazardous technique is to place the infested logs or wood in direct sun and cover them completely with heavy, clear plastic as a solarization treatment for approximately twelve weeks. The heat absorbed from solar radiation will kill the insects within the wood and prevent dispersal of any beetles which emerge.

Biological Control

Long-term reduction in beetle populations may be achieved and maintained through the introduction and establishment of biological control agents (Paine et al. 1993). We have imported four species of wasp natural enemies from Australia which are specialist parasites of Eucalyptus longhorned borer larvae (two *Doryctes* spp., *Syngaster lepidus*, and a *Callibracon* sp.) and one specialist parasite of the borer eggs (an *Avetianella* sp.). Female wasps are highly specialized to search throughout the environment to locate *Eucalyptus* with the particular life stages of Eucalyptus longhorned borer that they parasitize. The wasps lay eggs on or in the suitable life stages of the beetle host. Developing wasp larvae feed on the host tissues, eventually killing their beetle host.

Biological control is a critical strategy for management of Eucalyptus longhorned borer and many other urban forest pests. However, biological control does not eliminate a pest species; rather, the populations of natural enemies and pests are maintained at low equilibrium levels. Biological control must be integrated with the other management options that we are exploring to produce a successful management program. None of the management tools taken individually can provide a long-term solution; instead, an integrated approach is required. It is our hope that some of the questions we have addressed will contribute to implementation of that integrated approach.

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