WALNUT TWIG BEETLE: UPDATE ON THE BIOLOGY AND CHEMICAL ECOLOGY OF A VECTOR OF AN INVASIVE FATAL DISEASE OF WALNUT IN THE WESTERN U.S.

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ABSTRACT

The walnut twig beetle, *Pityophthorus juglandis* Blackman (Coleoptera: Scolytidae) (*sensu* Wood 2007), is a native North American bark beetle that has been recently implicated as the vector of thousand cankers disease of walnut trees in the western U.S. (Tisserat et al. 2009, Utley et al. 2009, Seybold et al. 2010). The disease, caused by a pathogenic fungus in the poorly studied genus *Geosmithia*, is widespread on *Juglans* in California and evident in urban plantings, trees along rural highways and agricultural lands, and collections of trees in parks and germplasm reserves (Graves et al. 2009, 2010). Disease symptoms and tree mortality in California have also been observed on native walnut trees in the Los Padres National Forest (*J. californica*) and in riparian areas of the lower Sacramento River Valley (*J. hindsii*). The fungus invades the phloem of walnut branches and stems after the beetle has introduced it through its subcortical feeding and reproductive behavior. Large numbers of cankers coalesce and girdle the branches and stem, likely hindering the movement of carbohydrate in the tree. The disease has been observed principally on black walnuts in the section *Rhysocaryon*, but has also been found in several instances on English walnut (*J. regia*, section *Juglans*), as well as on the Paradox rootstock (*J. hindsii* x *regia*) used in commercial culture of *J. regia* in the Sacramento, San Joaquin, and peripheral valleys of the state.

Branches and stem sections from dying walnut trees in California have been placed in rearing cages (Browne 1972) in our laboratory, and other subcortical insects such as herbivorous beetles in the families Bostrichidae, Cerambycidae, and Scolytidae [e.g., the ambrosia beetle, *Xyleborinus saxeseni* (Ratzeburg)], and predaceous beetles in the families Laemophloeidae, Monotomidae, and Trogossitidae have emerged synchronously with *P. juglandis*. Parasitic Hymenoptera in the families Bethylidae and Pteromalidae have also been observed to accompany emerging *P. juglandis*. Some of the associated species of Coleoptera have been captured on yellow sticky card traps in conjunction with the flight of *P. juglandis*, further underscoring their association with the twig beetle.

The origins of the fungal pathogen are not known, but *P. juglandis* is likely native to Arizona, California, New Mexico, and Mexico. In the last 10 to 20 years, apparently aided by the pathogen, *P. juglandis* has expanded its distribution into Colorado, Idaho, Oregon, Utah, and Washington. The hypothesis that *P. juglandis* is native to California is supported by:

(1) An analysis of the North American *P. juglandis* collection history (Bright 1981, Wood and Bright 1992, Seybold et al. in prep), which revealed only eight records from Arizona and New Mexico before the first collection in California in 1959

(2) The broad current distribution of *P. juglandis* in California

(3) The presence of *P. juglandis* at a remote California location (Lassen County) in 1974 before the relatively recent and noticeable increase in trees with symptoms of thousand cankers disease

(4) A relatively rich subcortical insect community, including natural enemies, associated with *P. juglandis*

(5) The presence of two native endemic species of *Juglans* in California

Pityophthorus juglandis appears to be restricted in host range to the genus *Juglans*, but is relatively polyphagous, colonizing and completing development in more than 10 species of *Juglans* or their hybrids in California. The beetle prefers to colonize branches that are greater than 1.5 cm in diameter and will even colonize the main stem, making the common name "twig" beetle something of a misnomer.

In research on the pheromone biology of *P. juglandis*, we have found that the aggregation pheromone is comprised of components contributed by both sexes and that the sex-specific components act in synergy to attract both sexes of the beetle in flight. In California, flight occurs primarily in the early evening, i.e., the species is crepuscular, and more females than males are attracted to the pheromone baits. Research in our lab, and in those of cooperators, is progressing on the production and analysis (GC-EAD and GC-MS) of extracts of volatiles associated with male and female *P. juglandis* feeding in small cut branches of *J. hindsii*. The goal of this effort is to develop a pheromone-baited survey trap to facilitate the early detection of founder populations of *P. juglandis* should they be introduced east of the Great Plains where eastern black walnut, *J. nigra*, is a highly prized timber species.

In summary, preliminary surveys of California for thousand cankers disease suggest that both the beetle and the pathogen have been in California for a long time. The beetle is likely native and co-evolved with *J. californica* and *J. hindsii*; the beetle-pathogen complex has invaded several remote locations. The numerous cankers, even sometimes in association with extremely short attempted feeding galleries, imply that *P. juglandis* appears to be a highly efficient vector of the pathogen. Finally, the aggregation pheromone of *P. juglandis* is a synergistic combination of volatile chemical components from both sexes. When fully developed and commercialized, the pheromone may be a useful survey tool for the eastern U.S. and for California walnut orchards

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