Chemical Ecology of Sudden Oak Death/ Ambrosia Beetle Interactions[1]

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Abstract

Coast live oaks, *Quercus agrifolia*, infected with *Phytophthora ramorum* in California produce a characteristic sequence of symptoms and signs. Ambrosia beetles consistently tunnel into the bark of bleeding cankers in naturally infected trees. In field monitoring conducted since 2000, every bleeding coast live oak that subsequently died had been colonized by beetles while bleeding cankers were the only symptom of *P. ramorum* infection. Although the function of these beetles in decline and death of infected trees has not been confirmed, they likely disrupt nutrient and water conduction and accelerate structural failure (McPherson and others 2005). In mechanically inoculated trees, beetles colonize the cankered areas within nine months of inoculation. This behavior is not consistent with the reported feeding ecology of the saprotrophic insects (Chamberlain, 1958; Furniss and Carolin, 1977; Wood, 1982; McPherson and others 2005). In an inoculation study, we used traps to monitor the response of beetles to both infected and wounded but uninfected trees. Traps placed on inoculated trees caught significantly more scolytid beetles than traps on trees that were only wounded. Six species of saprotrophic beetles are now known to be attracted to these infected trees. This directed response to native oaks infected by a putative introduced pathogen points to the production of volatile chemical attractants (kairomones). Volatile samples were collected in two ways. Firstly, samples of volatiles emitted from the bark of infected and control oaks were collected in the field by strapping the mouths of 1-L plastic bottles directly onto the bleeding produced by cankers on inoculated trees, and over the site of the "inoculation holes" on the uninfected, but wounded trees. The point where each bottle rested against the bark was sealed to minimize mixing with external air. Alternatively, the "blood," the dark colored exudate released by cankers, was placed in a vial and sealed. In both cases, samples were collected 24 h later by exposing solid phase micro-extraction (SPME) fibers to the atmosphere inside the bottles/vials for 30 min. The samples were analyzed by gas

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chromatography-mass spectrometry (GC-MS) using the method of Martin and others (2003). Identification of eluting compounds was based on matching with natural product spectra contained in the Wiley Registry of Mass Spectral Data and the NIST Library. Preliminary results from GC-MS analysis identified, with a high confidence level, 4-ethylphenol, 4-ethlyguaiacol, and 4-propylguaiacol among the peaks. These compounds are volatile phenolics. Phenolics are known to be involved in host defense responses to microbial pathogens. Coast live oaks may respond to *P. ramorum* infection and canker development by producing volatile phenolics that in turn are attractive to ambrosia beetles. Future work to test this hypothesis includes: collecting additional volatiles for GC-MS analysis, initiating quantitative studies, and conducting field experiments to test behavioral effects of the identified compounds.

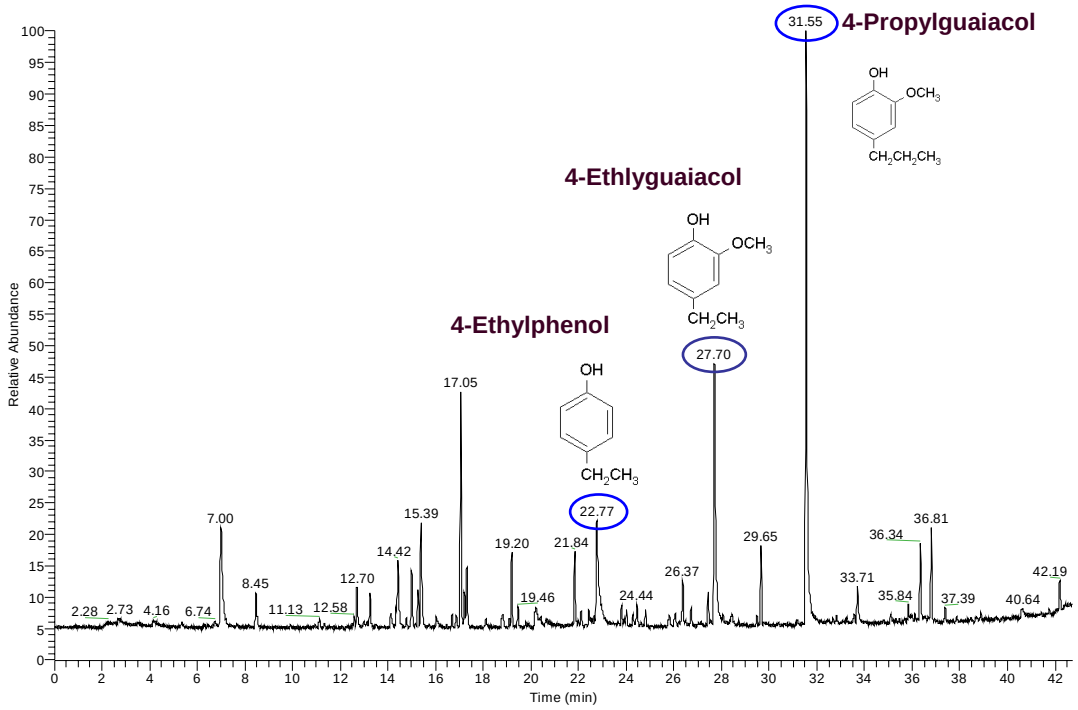

Figure 1— Gas chromatogram of the "blood" displaying subset of compounds identified by GC-MS analysis.

References

Chamberlain, W.J. 1958. **The Scolytidae of the Northwest**. Oregon State College, Corvallis, OR.

Furniss, R.L. and Carolin, V.M. 1977. **Western Forest Insects**. USDA, Forest Service, Washington.

Martin, D.M.; Gershenzon, J.; and Bohlmann, J. 2003. **Induction of Volatile Terpene Biosynthesis and Diurnal Emission by Methly Jasmonate in Foliage of Norway Spruce**. Plant Physiology. 132:1586-1599.

McPherson, B.A.; Mori, S.R.; Wood, D.L.,; Storer, A.J.; Svihra, P.; Kelly, M., and Standiford, R.B. 2005. **Sudden oak death in California: disease progression in oaks and tanoaks**. Forest Ecology and Management. 213:71-89.

Wood, S.L. 1982. **The Bark and Ambrosia Beetles of North and Central America (Coleoptera:Scolytidae), a Taxonomic Monograph.** Brigham Young Univ., Provo.