The Novel Interaction Between *Phytophthora ramorum* and Wildfire Elicits Elevated Ambrosia Beetle Landing Rates on Tanoak[1]

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Abstract

Several species of ambrosia and oak bark beetles (Coleoptera: Scolytidae) are preferentially attracted to *Phytophthora ramorum*-infected coast live oaks (*Quercus agrifolia* Née), and these beetle attacks can greatly reduce the survival time of previously-infected trees. While bark beetle attacks on burned trees in coniferous forests are well documented, very little is known about the attraction of scolytids to burned hardwood trees in the coastal forests of California. The 2008 wildfires in the *P. ramorum*-infested forests of Big Sur provided the rare opportunity to study the interactions between wildfire, an invasive forest pathogen, and associated scolytids. In this study, we measured the landing rate of these beetles on tanoak (*Notholithocarpus densiflorus* (Hook. & Arn.) Manos, Cannon & S.H. Oh), the predominant species impacted by *P. ramorum* in the Big Sur region, to determine if two forest disturbances, *P. ramorum* and fire, interact to create an increased attraction to scolytids in coastal California forests.

To evaluate landing rates, beetles were sampled from forest plots in the Big Sur region during the fall of 2009 and the spring of 2010, approximately 1 and 1.5 years, respectively, following the wildfires. Within each plot, the presence or absence of both *P. ramorum* and fire disturbance were paired so that a fully crossed two-factor design was achieved. This yielded four disturbance treatment combinations: 1) *P. ramorum* and fire disturbance absent = no disturbance, 2) *P. ramorum* disturbance present and fire disturbance absent = *P. ramorum* disturbance, 3) *P. ramorum* disturbance absent and fire disturbance present = fire disturbance, and 4) *P. ramorum* and fire disturbance present = mixed disturbance. The complete design included three replicates (plots) per disturbance treatment type for a total of 12 plots, and beetles were sampled by using 14 x 20 cm yellow sticky cards attached to three tanoaks per plot. Following the quantification of beetles trapped per plot, a two-factor analysis of variance (ANOVA) was used to compare the effect of *P. ramorum* and fire disturbance on scolytid landing rates, as well as the effect of the interaction between the two disturbances on landing rates.

The vast majority of scolytids were trapped on tanoaks in mixed disturbance plots—81 percent in 2009 and 79 percent in 2010—and ambrosia beetles were the most abundant of the scolytids trapped. In 2009, the year in which 75 percent of the total scolytids were trapped, fire and *P. ramorum* disturbance were each significant effects in the ANOVA model, but the interaction effect was not significant. In 2010, fire disturbance was a significant effect, but neither *P. ramorum* disturbance nor the interaction effects were significant. While the landing rates of ambrosia beetles are not necessarily equivalent to their actual rates of colonization, increased landing rates on tanoaks in the plots with multiple disturbances suggest that tanoaks in those areas were particularly attractive to ambrosia beetles. We hypothesize that specific host volatiles may have attracted ambrosia beetles to specific tanoaks. Furthermore, greater quantities of moribund and recently-killed trees in forests affected by both disturbances likely led to greater population densities of ambrosia beetles in those areas.

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