

Variation in Susceptibility of *Umbellularia californica* (Bay Laurel) to *Phytophthora ramorum*¹

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Abstract

Bay laurel (*Umbellularia californica*) is an important foliar host in terms of spore production and transmission of disease. We designed a bioassay to screen for variation in susceptibility to *Phytophthora ramorum* among populations of bay laurel collected along the coast of California to southern Oregon and also from Yosemite. Mature leaves of bay laurel were inoculated with zoospores and nine days later lesions and infection percentage were measured. Results indicated that each population comprises trees of different susceptibility. Data from three separate trials indicated that trees from Oregon were less susceptible than those from California. There was little variation among populations from California. Seasonal variation in susceptibility of bay laurel to *P. ramorum* was observed among populations. It is hypothesized that the interaction of a number of factors are responsible for the observed variation in susceptibility including host resistance, genetic structure of host species in the forests, pathogen variation, and environmental conditions.

Key words: foliar lesion, infection, inoculation, *Phytophthora ramorum*, resistance, susceptibility

Introduction

The coexistence of a number of different hosts in California forests allows *Phytophthora ramorum* to become established. In particular, severe stem cankers on coast live oak (*Quercus agrifolia*) are strongly associated with heavily infested leaves of adjacent bay laurel (*Umbellularia californica*) (Kelly and Meentemeyer 2002, Swiecki and Bernhardt 2002) and, in fact, foliar infections of bay laurel generally precede the infection of oaks (Rizzo and Garbelotto 2003).

Bay laurel is one of the most important epidemiological hosts for *P. ramorum* in California by serving as a reservoir of inoculum (Davidson and others 2002). In Oregon, on the other hand, only one infected bay laurel tree has been found (Hansen and others 2005). Why is there this difference in susceptibility between bay laurel from California and Oregon? Preliminary field and laboratory experiments have indicated that bay laurel plants have varying levels of

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susceptibility to *P. ramorum* (Rizzo and others 2002, Garbelotto and others 2003). In this paper, we investigated the susceptibility of various populations of bay laurel along the coast of California to southern Oregon to *P. ramorum*. We also investigated the seasonal variation in susceptibility within a California population of bay laurel. This knowledge is extremely important in order to develop a full understanding of the epidemiology of sudden oak death in California and Oregon.

Methods

Mature leaves from 15 bay laurel trees along transects of 18 mixed forest populations in Oregon and in California were sampled. Three to six populations were sampled in each of seven separate trials conducted from November 2003 to September 2004. In the laboratory, detached leaves were inoculated with zoospores of *P. ramorum* (isolate Pr-52) similar to the protocol outlined in Hüberli and others (2003) with the modification that detached leaves were placed into 50-ml tubes, tip-side down, and 300 μ l of zoospores (2×10^4 zoospores/ml) added to the tubes. A total of 20 leaves per tree were inoculated. After incubation at 20 °C overnight, leaves were placed into moist chambers and incubated for 9 days at 20 °C. Lesion area was determined using Assess (Version 1.01, APS Press, St. Paul, MN). Sections of the lesions were plated onto P₁₀ARP, a *Phytophthora*-selective agar medium modified with 25 mg of pentachloronitrobenzene (PCNB) to confirm the presence of *P. ramorum* (Rizzo and others 2002).

Results and Discussion

Bay laurel populations were significantly different ($P < 0.05$) in their susceptibility to *P. ramorum*. Within all populations sampled in California and Oregon, consistently less susceptible individuals were found. Bay laurel populations from Oregon had significantly ($P < 0.05$) smaller lesions than those from California (*fig. 1*). Seasonal variation in the susceptibility of bay laurel trees within populations was observed over a period of roughly one year, with maximum susceptibility occurring during the months of March and April. We will be conducting common garden studies of seedlings from Oregon and California, as well as molecular tests, to determine the genetic variation of bay laurel populations.

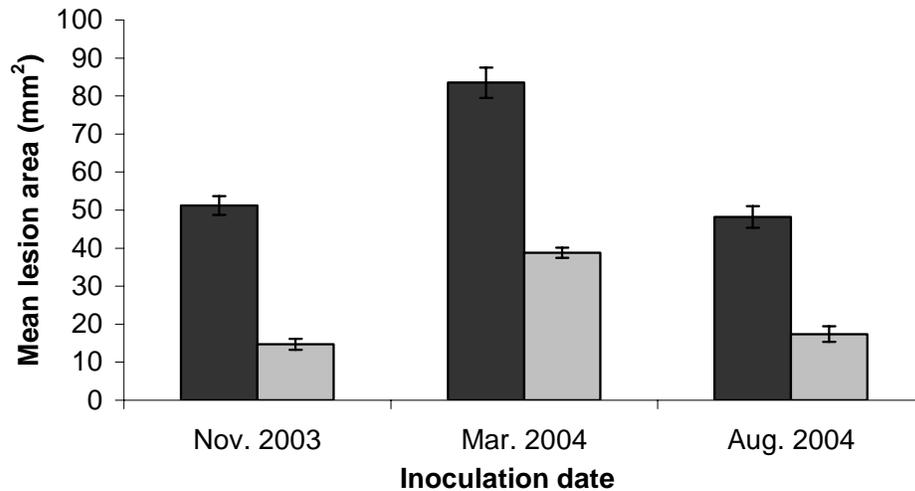


Figure 1—Mean leaf lesion area (\pm standard error) of *Umbellularia californica* (bay laurel) trees from Marin County, California (■) and Curry County, Oregon (□) after inoculation with *Phytophthora ramorum*. (Error bars represent standard error)

References

- Davidson, J.M.; Rizzo, D.M.; Garbelotto, M.; Tjosvold, S.; and Slaughter, G.W. 2002. *Phytophthora ramorum* and Sudden Oak Death in California: II. Transmission and survival. In: Standiford, R.; McCreary, D.; Purcell, K.L. eds. Proceedings of the 5th Symposium on California oak woodlands; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 741-749.
- Garbelotto, M.; Davidson, J.M.; Ivors, K.; Maloney, P.E.; Hüberli, D.; Koike, S.T.; and Rizzo, D.M. 2003. Non-oak native plants are main hosts for sudden oak death pathogen in California. *California Agriculture* 57: 18-23.
- Hansen, E.M.; Parke, J.L.; and Sutton, W. 2005. Susceptibility of Oregon forest trees and shrubs to *Phytophthora ramorum*: A comparison of artificial inoculation and natural infection. *Plant Disease* 89: 63-70.
- Hüberli, D.; Van Sant-Glass, W.; Tse, J.G.; and Garbelotto, M. 2003. First report of foliar infection of starflower by *Phytophthora ramorum*. *Plant Disease* 87: 599.
- Kelly, N.M. and Meentemeyer, R. 2002. Landscape dynamics of the spread of sudden oak death. *Photogrammetric Engineering and Remote Sensing* 68: 1001-9.
- Rizzo, D.M.; Garbelotto, M.; Davidson, J.M.; Slaughter, G.W.; and Koike, S.T. 2002. *Phytophthora ramorum* as the cause of extensive mortality of *Quercus* spp. and *Lithocarpus densiflorus* in California. *Plant Disease* 86: 205-14.
- Rizzo, D.M. and Garbelotto, M. 2003. Sudden oak death: endangering California and Oregon forest ecosystems. *Frontiers in Ecology and the Environment* 5: 197-204.