Phytophthora ramorum and *Phytophthora gonapodyides* Differently Colonize and Contribute to Decay of California Bay Laurel (*Umbellularia californica*) Leaf Litter in Stream Ecosystems[1]

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Abstract

The prevalence of *Phytophthora* species in surface waters has earned increasing attention in the past decades, in great part as a result of "stream monitoring" programs for detection and monitoring of *Phytophthora ramorum* and other invasive species. The potential for *Phytophthora* to survive and reproduce in streams has significant implications for evaluating and managing the risk of spread of pathogenic species. Therefore, it is important to understand the ecology of both introduced and endemic species in aquatic environments.

Leaf litter is a potential substrate for the persistence and propagation of *Phytophthora* in streams. Our previous work showed that *P. gonapodyides* and related ITS clade 6 taxa are effective saprotrophs, colonizing dead leaf tissue; whereas, *P. ramorum* more effectively colonized fresh green leaves, but its colonization is limited in dead leaves. Therefore, *P. ramorum*'s prevalence on stream leaf litter may be limited by direct competition with other taxa as well as by the substrate becoming increasingly unsuitable due to decay. We conducted a field and laboratory study to determine how well *P. ramorum* and "clade 6" *Phytophthora* could colonize, persist, and sporulate on increasingly decayed leaves of California bay, the primary host for *P. ramorum* and a common riparian species in California coastal woodlands.

To determine how well these taxa naturally colonize, persist on and compete in bay leaf litter in streams, green leaves were collected from trees, incubated in two forest streams and sampled over 16 weeks. Leaves were evaluated for *Phytophthora* colonization through isolations and morphological identification. *Phytophthora ramorum* and "clade 6" taxa quickly colonized leaves in streams and persisted throughout the full duration of in-stream incubation despite loss of as much as 70% of leaf mass due to decay. Both *P. ramorum* and "clade 6" taxa could be baited from leaf samples over the entire 16 weeks, demonstrating sporulation potential despite substantial leaf biomass loss. This demonstrated that green bay leaf litter can serve as a persistent source of *P. ramorum* and other *Phytophthora* inoculum in infested streams.

While some leaf litter is green, especially in spring, much leaf fall into streams consists of senescent leaves. To determine the capacity of these taxa for using and competing for green or senescent leaves, we conducted controlled environment experiments in which green bay leaves collected from trees and recently shed, dry senescent leaves collected from the forest floor were exposed to *P. ramorum*, *P. gonapodyides*, or combined inoculum of both species in containers maintained in growth chambers,

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sampled over 16 weeks and evaluated for colonization and degree of decay. *Phytophthora ramorum* was very limited on dry senescent leaves, while *P. gonapodyides* completely colonized them. Both species contributed to early green leaf decay, but not to the decay of dry senescent leaves. In treatments combining inoculum from both taxa, *P. gonapodyides* predominantly and often exclusively colonized all leaves. This competitive advantage is not always observed under natural conditions and may relate to relative abundance of initial inoculum or other conditions of the experiment. A complementary trial was conducted using yellow senescent leaves collected directly from trees. Recovery from these leaves suggests that fresh senescent leaves function more like green leaves than dry senescent leaves as a substrate for these *Phytophthora* species.

Overall, these results indicate that while *P. ramorum* can persist on bay leaf litter in streams, competition with endemic saprotrophic taxa may limit its abundance and frequency.