Persistence of *Phytophthora ramorum* and *Phytophthora kernoviae* in U.K. Natural Areas and Implications for North American Forests[1]

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Abstract

Phytophthora kernoviae (*Pk*) and *Phytophthora ramorum* (*Pr*) are recently introduced pathogens in United Kingdom (U.K.) woodlands. *Pk* is also an emerging threat to coastal heathland where it infects *Vaccinium myrtillus*. In infested woodlands, an invasive plant, *Rhododendron ponticum*, supports sporulation of both pathogens, providing primary inoculum for infection of *Fagus sylvatica*. *R. ponticum* has been removed from several infested woodlands; however, the long term efficacy of *R. ponticum* removal for disease management is unknown. The epidemiology of *Pk* in infested heathland is not yet understood. The aggressiveness of *Pk* in U.K. woodlands and heathland elevate the biosecurity concern associated with its potential introduction to North American forests.

The potential for *Pr* and *Pk* to infect and roots in woodlands was investigated. Roots and associated rhizosphere soil, overlying leaf litter, and foliage were collected from *R. ponticum*-invaded woodlands and woodlands cleared of the invasive plant. In *R. ponticum*-invaded woodlands, adventitious, layered roots of *R. ponticum* were excavated, whereas roots of emergent *R. ponticum* seedlings and mature *F. sylvatica* trees were sampled in cleared woodlands. Both *Pr* and *Pk* were baited from surface-sterilized *R. ponticum* roots and associated leaf litter, but not from rhizosphere soil in uncleared woodlands. In cleared woodland, *Pk* was baited from surface sterilized roots of *R. ponticum* seedlings and mature *F. sylvatica*.

In *Pk*-infested heathland, symptomatic *V. myrtillus* was collected and rhizomes, roots, shoots, and foliage were independently sampled for isolation of *Pk*. Furthermore, roots, stems, and foliage of nursery-reared *V. myrtillus* were inoculated with *Pk* for completion of Koch's Postulates. Although *Pk* was isolated from all plant parts, only leaves and stems were symptomatic. Sporangia were abundant on inoculated foliage, and were observed on the surface of inoculated, asymptomatic root and rhizome tissues. The prolific foliar sporangia production followed by leaf abscission suggest that the pathogen may spread long distances in coastal winds, yet asymptomatic root and rhizome infections may support local spread and survival.

To assess the risk of *Pk* to North American forests, leaves and roots of *Umbellularia californica*, *R. occidentalis*, and *R. macrophyllum* were inoculated with *Pk* for determination of disease incidence and severity, and sporulation potential. As a positive control, *V. myrtillus* and *R. ponticum* were concurrently inoculated. All plants were susceptible to *Pk* and

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supported sporangia production. Oogonia were produced on leaves and roots of *U. californica*. These preliminary data support the proposed threat of *Pk* to North American forests and suggest the necessity for enhanced biosecurity measures to prevent pathogen introduction and establishment.