

Urban Activities Influence on *Phytophthora* Species Diversity in British Columbia, Canada¹

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Abstract

Phytophthora de Bary, a genus of Oomycetes, is known as a plant pathogenic genus. The best-known species infect a wide range of hosts, including economically valuable angiosperm and gymnosperm tree species and important agricultural crops. Many *Phytophthora* are invasive and have been disseminated through nursery and agricultural trade. We hypothesize that such human activities would affect the diversity of these pathogens.

To test this hypothesis, we characterized and compared *Phytophthora* diversity between natural and urban environments in British Columbia. We collected soil samples from sites in urban and natural locations or at the interface of urban/natural areas around Vancouver, British Columbia and south Vancouver Island, in 2012 and 2013. DNA was extracted from 130 soil samples and DNA metabarcoding was carried out using 454 pyrosequencing of the internal transcribed spacer one (ITS1). In 2011, five waterways classified as urban and located around agricultural or residential areas were baited with mesh bags containing *Rhododendron* leaves. Leaves were collected bi-weekly for 10 weeks. *Phytophthora* species were isolated on specific media and barcoded using the internal transcribed spacer (ITS1 and ITS2).

In the 2012 soil DNA metabarcoding analyses, 25 putative *Phytophthora* species were recovered, eight of which are potentially new species. The most widespread species were *P. syringae* and a hybrid between *P. polonica* and an unknown species. Urban sites had the highest average species diversity at eight species and ranging from three to 12 species per site, whereas natural sites had an average of six species and ranged between four to eight species per site. Urban/natural interface sites had an average of five species and ranged from two to seven species per site. In total, 23, 14, and 11 species were found in urban, urban/natural interface, and natural locations, respectively. Interestingly, most of the unknown species were found in urban or urban/natural interface sites. Several species found only in urban sites were present in low frequency and could represent introductions via urban activities.

In the stream baiting experiment, 17 different *Phytophthora* species were found; the most widespread were *P. gonopodyides* and *P. lacustris*. Eight species were common to both DNA metabarcoding and baiting experiments; however, the frequencies varied with *P. gonopodyides* and *P. lacustris* found in low frequency in soil metabarcoding experiments and *P. polonica* in lower frequency in stream baiting. Although *P. syringae* was the most frequent species in the metabarcoding experiment in the soil, it was

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not found in the stream baiting experiment. This study suggests that urban activities influence *Phytophthora* diversity and composition. Future work should focus on establishing whether or not unknown species found in urban environments are the result of introductions and evaluating the likelihood that they could become established invasive species in natural environments.