Comparative Host Range and Aggressiveness of *Phytophthora ramorum* and *Phytophthora kernoviae* sp. nov. on North American and European Trees[1]

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Abstract

Phytophthora ramorum and *P. kernoviae* are recently introduced, invasive pathogens in woodlands in southern Britain. *P. kernoviae*, previously known as *Phytophthora* taxon C, is a newly discovered taxon, (Brasier and others 2005), found during surveys for *P. ramorum* in Cornwall, southwest England in November 2003. Both species are aggressive pathogens on foliage and shoots of understory rhododendron, especially *R. ponticum*. From this infection base they can spread aerially to attack the inner bark of tree stems, especially European beech (*Fagus sylvatica*) and some *Quercus* species, causing bleeding lesions. (Brasier and others 2004). To date *P. kernoviae* has been found causing bleeding lesions on about 50 mature *F. sylvatica* trees, two common European oaks, *Quercus robur*, and a *Liriodendron* at several adjacent woodland sites. The wider international risk to trees that *P. kernoviae* poses is unknown. The comparative host range and aggressiveness of *P. kernoviae* and *P. ramorum* to bark and foliage of North American and European tree species is therefore being investigated.

The potential host range of *P. ramorum* on bark of native and plantation trees in the U.K. has been assessed previously (Brasier and others 2003; http://rapra.csl.gov.uk). The test method comprises wound inoculating fresh cut 1.1-m long by 16 to 20-cm diameter stems at 20°C, and assessing the comparative susceptibility of the inner bark to *P. ramorum*. Thirty hosts have been tested and assigned to 'more susceptible', 'less susceptible' and 'resistant' categories. Tests are carried out under licence in quarantine chambers. Comparative tests of *P. ramorum* versus *P. kernoviae*, begun in 2004, are scheduled to continue in 2005. Present results are therefore provisional. Twenty-eight hosts have been inoculated to date, using three isolates each of *P. kernoviae* and *P. ramorum*. *F. sylvatica* is being used as a control host for most tests.

F. sylvatica fell into the 'more susceptible' category with regard to both *P. kernoviae* and *P. ramorum*. In four tests, *P. kernoviae* was, on average, slightly more aggressive on *F. sylvatica* than *P. ramorum*

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(total lesion areas of 282 cm^2 and 242 cm^2, respectively). However, there was also evidence of marked seasonal or genetic influences on susceptibility, leading to critical threshold effects (Brasier and Kirk 2001). European chestnut, *Castanea sativa*, was moderately susceptible to both species. Some tree species, including *Liriodendron tulipifera*, were resistant to both pathogens. Most of the other tree species tested, whether assigned to 'more susceptible' or 'less susceptible' categories, tended to be more susceptible to *P. ramorum* than to *P. kernoviae*. Among these the oak species *Quercus robur, Q. cerris, Q. ilex, Q. rubra* and *Q. palustris* were all susceptible to *P. ramorum* to some degree, but all these hosts fell into the 'resistant' category with *P. kernoviae*. These tests will be repeated.

The North American tree species *Q. palustris, Abies grandis* and *Tsuga heterophylla* and the European species *Taxus baccata* and *Acer pseudoplatanus* fell into the 'more susceptible' category in these tests with regard to *P. ramorum.* In previous tests in the U.K. with *P. ramorum* these species were either assigned to the 'less susceptible' category, or were not included in the tests (Brasier and others 2003).

The comparative foliage susceptibility tests involve dipping unwounded leaves of about 30 hosts in zoospore suspensions of three isolates each of *P. kernoviae* and *P. ramorum* at 20°C.In tests to date, *P. kernoviae* has been more aggressive than *P. ramorum* on foliage of *L. tulipifera* and *Aesculus hippocastanum*. *P. kernoviae* and *P. ramorum* were equally aggressive on rhododendron and *Magnolia* species. *P. kernoviae* was less aggressive than *P. ramorum* on all other susceptible hosts. These tests will be repeated.

To date, field data on stem susceptibility of U.K. trees to *P. ramorum* and *P. kernoviae* in Cornwall are fairly consistent with the above laboratory data. For example, stems of *F. sylvatica* have proved very susceptible to both *P. ramorum* and *P. kernoviae* in the field. Notable exceptions at present are *Q. robur* and *L. tulipifera*. Bark of these species were 'resistant' to *P. kernoviae* in these preliminary laboratory tests, yet mature *Q. robur* and *L. tulipifera* have been found with bleeding stem lesions caused by *P. kernoviae* in the field. These discrepancies may reflect: (1) environmental influences, such as episodes of very high *P. kernoviae* inoculum levels, or varying degrees of individual tree stress, in the field, or (2) variation in genetic resistance of individual *Q. robur* trees to *P. kernoviae*. In previous laboratory tests, *Q. robur* has been shown to vary considerably in its susceptibility to *P. ramorum*. Most individuals fall in the 'less susceptible' category but some fall in the 'more susceptible' category.

Also European sycamore, *Acer pseudoplatanus*, falls in the *P. kernoviae* 'less susceptible' category in the laboratory tests, yet no infected individuals have been found in the field, despite heavy exposure to the pathogen at the same Cornish sites as the affected beech. This may reflect an inability of *P. kernoviae* zoospores to penetrate unwounded bark of *A. pseudoplatanus.*

Clarification of these discrepancies is needed to more confidently assess the wider risk that it poses to trees in the U.K., in Europe or to trees in global ecosystems, should it escape beyond the present disease management zones in Cornwall.

One suggested approach, in addition to conducting further laboratory tests, is to back up these tests with well replicated field inoculation of trees of *F. sylvatica, Q. robur* and *A. pseudoplatanus* (under regulated conditions) within part of the present *P. kernoviae* management zone. This could help to validate the results of the laboratory tests, give insight into the environmental and seasonal influences on infection processes and disease expression in the field, and provide much needed insight into the

extent of genetic variation in resistance within each species. Infected tree bark is not presently believed to be a significant source of *P. kernoviae* inoculum. Furthermore, small lesions, such as those initiated via artificial inoculations over a few weeks, can usually be excised from trees (A. V. Brown and C. M. Brasier, unpublished studies).

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