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# *Phytophthora ramorum* sp. nov., a new pathogen on *Rhododendron* and *Viburnum*

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Since 1993, a hitherto unidentified *Phytophthora* species has been found associated with twig blight disease in *Rhododendron* and, sporadically, *Viburnum*. The morphology and growth characteristics of fourteen isolates from Germany and the Netherlands were investigated, together with their breeding system, the internal transcribed spacer (ITS) regions of the ribosomal DNA, amplified fragment length polymorphism (AFLP) fingerprints, and isozyme profiles, which were compared to those of a number of outgroup species. Morphologically the isolates are characterized by abundant production of chlamydospores and elongate, ellipsoid, deciduous sporangia with a short pedicel, in which they resemble *P. palmivora*. However, sporangia were semi-papillate, chlamydospores were much larger and cardinal temperatures much lower than those of *P. palmivora*. Oogonia with amphigynous antheridia and plerotic oospores were produced in dual cultures with an A2 mating type strain of *P. cryptogea*. ITS1 and ITS2 sequences of the unidentified species were closest to those of *P. lateralis*, but differed in three and eight nucleotides respectively from the latter species. AFLP fingerprints and isozyme patterns of malate dehydrogenase (MDH-2) and malic enzyme (MDHP) showed that the isolates formed a homogeneous group, distinct from all examined outgroup species, including *P. lateralis*. It was concluded that they represent a new *Phytophthora* species, described here as *P. ramorum* sp. nov. In pathogenicity tests all isolates of *P. ramorum* were pathogenic to *Rhododendron*.

## INTRODUCTION

*Rhododendron* species, hybrids and cultivars are important ornamental commodities worldwide. *Rhododendron* plants are widely planted in gardens, and old *Rhododendron* bushes are important elements in monumental gardens surrounding castles and stately mansions. *Rhododendron* species are attacked by various species in the genus *Phytophthora* (Erwin & Ribeiro 1996, Werres 2000), oomycete fungi that were traditionally placed in the *Fungi* but are now assigned to the kingdom *Chromista* (Cavalier-Smith 1986, Hawksworth *et al.* 1995). Root rot of *Rhododendron* is known to be caused by several *Phytophthora*'s including *P. cactorum*, *P. cinnamomi*, *P. citricola*, *P. citrophthora*, *P. cryptogea*, *P. gonapodyides*, and *P. megasperma* (Hoitink & Schmitthenner 1974, Benson & Jones 1980, Végh 1985, Lindermann 1988, Erwin & Ribeiro 1996, Farr, Esteban & Palm 1996). Twig blight of *Rhododendron* is caused by *P. cactorum*, *P. citricola*, *P. citrophthora*, and *P. nicotianae* (Kröber

1959, Koch 1971, Hoitink & Schmitthenner 1974, Benson & Jones 1979, 1980, Swiech & Gorska-Poczopko 1984, Végh 1985, Erwin & Ribeiro 1996). Leaf spot has been associated with *P. syringae* (Lindermann 1988), and seedling blight with *P. cactorum*, *P. cinnamomi*, and *P. cryptogea* (Swiech & Gorska-Poczopko 1984, Erwin & Ribeiro 1996).

Since 1993, a new twig blight of *Rhododendron* has been observed in Germany and The Netherlands. It kills both nursery plants of *Rhododendron* and mature bushes in gardens. *Phytophthora* isolates obtained from such plants did not fit the morphological description of any known *Phytophthora* species, though they showed some resemblance to *P. palmivora*. Since 1998 similar isolates have been found on diseased *Viburnum* sp., and obtained from water in recirculation systems of nurseries where *Rhododendron* or *Viburnum* plants are grown. Infection trials with the very first isolates showed that they were highly aggressive to *Rhododendron* twigs (Werres & Marwitz 1997).

Identification of *Phytophthora* species on morphology is notoriously difficult due to intraspecific variation and to

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