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Multiple alien *Phytophthora* taxa discovered on diseased ornamental plants in Spain

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The plant trade is unwittingly accelerating the worldwide spread of well-known and new or undescribed *Phytophthora* species and creating novel niches for emerging pathogens. The results of a survey carried out from 2001 to 2006 in garden centres and nurseries of the Balearic Islands and eastern Spain combined with the analysis of samples received from ornamental nurseries from northern Spain reflected the extent of this global issue at the local scale. A total of 125 *Phytophthora* isolates were obtained from 37 different host species and 17 putative species identified on morphological features and direct sequencing of the internal transcribed spacer and four mitochondrial and nuclear genes. Five species, *P. ramorum*, *P. hedraiandra*, *P.* 'niederhauserii', *P.* 'kelmania' and *P.* 'taxon Pgchlamydo' were formally unknown to science prior to 2001. In addition, 37 new host/pathogen combinations were first records for Spain, highlighting the risk of non-coevolved organisms from different biogeographic origins coming into contact under managed environments. The problem generated by new or rare taxa of *Phytophthora* found in nurseries for which no prior information on natural habitat and ecology is available for pest risk analysis is discussed.

Keywords: international plant trade, invasive alien species, ornamental plant diseases, pathogenicity, *Phytophthora* taxonomy

Introduction

The genus *Phytophthora* comprises over 70 known species, many of them exhibiting a wide host range. It includes various pathogens of ornamental plants (e.g. Werres *et al.*, 2001; de Cock & Lévesque, 2004) and forest trees (e.g. Brasier *et al.*, 1993; Jung *et al.*, 1999; Rizzo *et al.*, 2002; Brasier *et al.*, 2004a,b). Despite the significant economic and ecological damages caused by *Phytophthora* species, their centres of origin and natural habitats remain mostly unknown. Of those *Phytophthora* spp. reported from natural ecosystems in Europe, for example *P. quercina*, *P. pseudosyringae* or *P. europaea*, there is little support for them being native to the continent. Indeed, recent population genetic studies indicate that some new *Phytophthora* spp. are probably either introduced, or they may have emerged through hybridization and/or spread via the horticultural trade and forest plantations (Werres *et al.*, 2001; Cooke *et al.*, 2005; Ivors *et al.*, 2006; Brasier, 2007; 2008).

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Species that can establish themselves in new environments and out-compete native species are regarded as invasive alien species (IAS), and are recognized as major threats to natural heritage and biodiversity, second only to that of habitat loss (Mooney & Cleland, 2001). Although it is believed that fungal plant pathogens do not quite fit into the common definition of IAS, particularly with regard to invasiveness, there are noteworthy examples of alien fungi and oomycetes within the genus *Phytophthora* causing significant ecological disturbances and biodiversity impoverishment in natural ecosystems (e.g. Weste & Marks, 1987; Anagnostakis, 1988; Brasier *et al.*, 1993; Rizzo *et al.*, 2002; Desprez-Loustau *et al.*, 2007). Because it is estimated that only approximately 10% of the mycoflora have been catalogued (Hawksworth, 2001; Brasier, 2007), plant pathogenic fungi and oomycetes will be part of this unknown diversity, and therefore are likely candidates for causing future invasions.

Among oomycetes recently raised to an IAS status, *P. ramorum* well illustrates the peril posed by pathogens introduced via the ornamental trade. First isolated from *Rhododendron* and *Viburnum* plants in nurseries in the Netherlands and Germany in the mid-1990s (Werres *et al.*, 2001), it was initially considered as yet another