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Multi-gene analysis of *Pseudocercospora* spp. from Iran

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Abstract

Species of *Pseudocercospora* have gained much attention in recent years owing to their phytopathogenic relevance, and worldwide occurrence on a wide range of economically important hosts. Although these fungi are common in Iran, they have generally been poorly studied and no cultures have been preserved for molecular analyses. The present paper represents the first study of *Pseudocercospora* species from Iran evaluated by employing the Consolidated Species Concept. Nineteen isolates were obtained from seven host plant families in the northern zone of Iran. A phylogenetic analysis based on a combination of LSU, ITS, TEF1-α and ACT loci clustered these isolates into eight clades, of which five are phylogenetically new, delineating two novel species, viz. *P. mazandaranensis* on *Nerium oleander* and *P. sophoricola* on *Sophora alopecuroides*. Furthermore, *P. punicae* is recorded on a wild-grown cultivar of *Punica granatum*, and two additional species reported, namely *Pseudocercospora* sp. A on *Phaseolus vulgaris* and *Pseudocercospora* sp. B on *Diospyros lotus*. *Pseudocercospora norchiensis* is recorded for the first time in Asia, where it occurs on a wide host range, contrary to most other species of *Pseudocercospora*, which appear to be highly host specific.

Keywords: Biodiversity, cercosporoid, host specificity, leaf spot, multilocus sequence typing (MLST), systematics

Introduction

Pseudocercospora (Mycosphaerellaceae, Capnodiales) is the second largest cercosporoid genus known to date. Species are cosmopolitan, occurring on a wide range of monocotyledonous, dicotyledonous and gymnosperm plant hosts growing in arid or wet environments under a wide range of climates (Chupp 1954, Crous & Braun 2003, Crous *et al.* 2013a). Many species are known to be plant pathogens, while some display an endophytic or saprobic life style, or are used as biological control agents of weeds (den Breeÿen *et al.* 2006). Symptoms associated with infection by these fungi include leaf spot, blight, fruit spot and rot (Chupp 1954, Deighton 1976, von Arx 1983, Pons & Sutton 1988, Crous & Braun 2003, Ávila *et al.* 2005). Some important plant pathogenic species include *P. angolensis,* the cause of fruit and leaf spot disease on citrus (Pretorius *et al.* 2003), *P. fijiensis*, *P. musicola* and *P. eumusae*, primary agents of the Sigatoka disease complex on banana (Arzanlou *et al.* 2007, 2008, Churchill 2011), *P. griseola,* the causal agent of angular leaf spot of bean (Crous *et al.* 2006), *Pseudocercospora* spp. associated with leaf spot disease of eucalypts (Braun & Dick 2002, Hunter *et al.* 2006), and *P. macadamiae,* the causal agent of husk spot of macadamia (Beilharz *et al.* 2003).

Pseudocercospora was originally introduced by Spegazzini (1910) based on *P. vitis*, a foliar pathogen of grapevine. The genus *Pseudocercospora* is large and morphologically diverse (Crous *et al.* 2000) and accommodates species with synnematous to fasciculate or solitary pigmented conidiophores, and scolecosporous conidia with neither thickened nor darkened conidial hila and conidiogenous cells with not or very slightly thickened and darkened loci, proliferating sympodially and percurrently (Deighton 1976, Braun 1995, Crous & Wingfield 1997, Crous *et al.* 2000, Crous & Braun 2003). Although *Pseudocercospora* was formerly recognised as an asexual morph of *Mycosphaerella*, it is now treated as a genus in its own right, having mycosphaerella-like sexual morphs (Crous *et al.* 2013a, Hyde *et al.* 2013, Kirk *et al.* 2013). Since the description of the genus *Pseudocercospora*, it has been clouded in controversy, and it was proposed that it should be divided into several genera based on morphological differences (Deighton 1976, Pons &

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