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Genera of phytopathogenic fungi: GOPHY 2

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Abstract: This paper represents the second contribution in the Genera of Phytopathogenic Fungi (GOPHY) series. The series provides morphological descriptions and information regarding the pathology, distribution, hosts and disease symptoms for the treated genera. In addition, primary and secondary DNA barcodes for the currently accepted species are included. This second paper in the GOPHY series treats 20 genera of phytopathogenic fungi and their relatives including: *Allantophomopsiella, Apoharknessia, Cylindrocladiella, Diaporthe, Dichotomophthora, Gaeumannomyces, Harknessia, Huntiella, Macgarvieomyces, Metulocladosporiella, Microdochium, Oculimacula, Paraphoma, Phaeoacremonium, Phyllosticta, Proxypiricularia, Pyricularia, Stenocarpella*, *Utrechtiana* and *Wojnowiciella*. This study includes the new genus *Pyriculariomyces*, 20 new species, five new combinations, and six typifications for older names.

Key words: DNA barcodes, Fungal systematics, 26 new taxa, Six new typifications.

Taxonomic novelties: New genera: *Pyriculariomyces* Y. Marín, M.J. Wingf. & Crous; **New species:** *Apoharknessia eucalypti* Crous & M.J. Wingf., *Cylindrocladiella addiensis* L. Lombard & Crous, *Cylindrocladiella nauliensis* L. Lombard & Crous, *Diaporthe heterophyllae* Guarnaccia & Crous, *Diaporthe racemosae* A.R. Wood, Guarnaccia & Crous, *Dichotomophthora basellae* Hern.-Restr., Cheew. & Crous, *Dichotomophthora brunnea* Hern.-Restr. & Crous, *Harknessia bourbonica* Crous & M.J. Wingf., *Harknessia corymbiae* Crous & A.J. Carnegie, *Harknessia cupressi* Crous & R.K. Schumach., *Harknessia pilularis* Crous & A.J. Carnegie, *Huntiella abstrusa* A.M. Wilson, Marinc., M.J. Wingf., *Metulocladosporiella chiangmaiensis* Y. Marín, Cheew. & Crous, *Metulocladosporiella malaysiana* Y. Marín & Crous, *Metulocladosporiella musigena* Y. Marín, Cheew. & Crous, *Metulocladosporiella samutensis* Y. Marín, Luangsa-ard & Crous, *Microdochium novae-zelandiae* Hern.-Restr., Thangavel & Crous, *Phaeoacremonium pravum* C.F.J. Spies, L. Mostert & Halleen, *Phyllosticta iridigena* Y. Marín & Crous, *Phyllosticta persooniae* Y. Marín & Crous; **New combinations:** *Macgarvieomyces luzulae* (Ondřej) Y. Marín, Akulov & Crous, *Pyriculariomyces asari* (Crous & M.J. Wingf.) Y. Marín, M.J. Wingf. & Crous, *Utrechtiana arundinacea* (Corda) Crous, Quaedvl. & Y. Marín, *Utrechtiana constantinescui* (Melnik & Shabunin) Crous & Y. Marín; **New status and combination:** *Oculimacula acuformis* (Nirenberg) Y. Marín & Crous; **Typification: Epitypification:** *Helminthosporium arundinaceum* Corda, *Phomopsis pseudotsugae* M. Wilson, *Pyricularia luzulae* Ondřej, *Pyricularia zingiberis* Y. Nishik; **Lectotypification:** *Phomopsis pseudotsugae* M. Wilson, *Pyricularia zingiberis* Y. Nishik.

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INTRODUCTION

The series, Genera of Phytopathogenic Fungi (GOPHY), was launched by Marin-Felix *et al.* (2017) to provide a stable platform for the taxonomy of phytopathogenic fungi. The common denominator of the genera included in this series is their association with plant diseases. The authors recognise that many species treated are not well-known plant pathogens or where Koch's postulates have not been proven for them. The focus of the series is mainly to resolve generic and species concepts of the fungi studied. This is particulary important because many taxa have been shown to represent species complexes, or to be accommodated in genera that are poly- or paraphyletic (Crous *et al.* 2015b). The series links to a larger initiative known as the "The Genera of Fungi project" (www.GeneraOfFungi.org, Crous *et al.* 2014a, 2015a, Giraldo *et al.* 2017), which aims to revise the generic names of all currently accepted fungi (Kirk *et al.* 2013). Some of the main problems are that for many genera and species type material has not been designated or/and that the vast majority of these taxa were described before the DNA phylogenetic era (Hibbett *et al.* 2011) and thus lack DNA barcodes (Schoch *et al.* 2012). Another important aim of this project is to secure the application of names by generating DNA barcodes of type species of genera and type specimens of species. In those cases where no type material has been preserved, taxa need to be recollected, epi- or neotypes designated,

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and registered in MycoBank to ensure traceability of the nomenclatural act (Robert *et al.* 2013). The ultimate objective is to move to a single scientific name for fungi (Crous *et al.* 2015b) for which sexual-asexual links have been resolved.

For each paper in the GOPHY series, morphological descriptions and information regarding the pathology, distribution, hosts and disease symptoms are provided for the treated genera. In addition, this information is linked to primary and secondary DNA barcodes of the currently accepted species in each genus. These DNA barcodes are critically important because of problems relating to generic delimitation and species identification based solely on morphology. A clear example is the delimitation of the genera *Bipolaris* and *Curvularia*, treated in the first paper of the GOPHY series (Marin-Felix *et al.* 2017). These two genera share many morphological similarities, and intermediate conidial characters (Manamgoda *et al.* 2012). Species delimitation in both genera based on morphology alone is of limited value because many species have overlapping characters (Sivanesan 1987, Madrid *et al.* 2014, Manamgoda *et al.* 2014). Some genera include species that do not produce reproductive structures and their identification must rely on DNA data. For some phytopathogenic genera, the DNA barcodes for species delimitation have been established in previous studies, but for the vast majority, these data remain unavailable.

Mycologists wishing to contribute to future issues in the GOPHY series are encouraged to contact Pedro Crous (p.crous@westerdijkinstitute.nl) before submitting their contributions. This will ensure there is no overlap with activities arising from other research groups. Preference will be given to genera that include novel DNA data and/or novel species, combinations or typifications. The generic contributions, apart from being published in this series of papers, will also be placed in the database displayed on www.plantpathogen.org.

MATERIAL AND METHODS

Isolates and morphological analysis

Descriptions of the new taxa and typifications are based on cultures obtained from the collection at the Westerdijk Fungal Biodiversity Institute in Utrecht, The Netherlands (CBS), the working collection of P.W. Crous (CPC), housed at the Westerdijk Fungal Biodiversity Institute, and the culture collection (CMW) of the Forestry and Agricultual Biotechnology Institute (FABI), at the University of Pretoria, South Africa. For fresh collections, we followed the procedures previously described in Crous *et al.* (1991a). Colonies were transferred to different media, i.e. cherry decoction agar (CHA), carnation leaf agar (CLA), cornmeal agar (CMA), 2 % malt extract agar (MEA), 2 % potato dextrose agar (PDA), synthetic nutrient-poor agar (SNA), oatmeal agar (OA), water agar (WA) (Crous *et al.* 2009), autoclaved pieces of grapevine canes placed on water agar (grapevine water agar; GWA), pine needle agar (PNA; Smith *et al.* 1996), or malt extract peptone agar (MPA; Speakman 1984), and incubated at different conditions depending on the taxon to induce sporulation. Requirements of media and conditions of incubations are specified in each genus. Reference strains and specimens are maintained at the CBS, CMW and CPC.

Vegetative and reproductive structures were mounted in 100 % lactic acid either directly from specimens or from colonies sporulating on MEA, PDA, PNA, OA or SNA. For cultural characterisation, isolates were grown and incubated on different culture media and temperatures as stipulated for each genus. Colour notations were rated according to the colour charts of Rayner (1970). Taxonomic novelties were deposited in MycoBank (www.MycoBank.org; Crous *et al.* 2004a).

DNA isolation, amplification and analyses

Fungal DNA was extracted and purified directly from the colonies or host material as specified for each genus. Primers and protocols for the amplification and sequencing of gene loci, and software used for phylogenetic analyses can be found in the bibliography related to the phylogeny presented for each respective genus. Phylogenetic analyses consisted of Maximum-Likelihood (ML), Bayesian Inference (BI), and Maximum Parsimony (MP). The ML and the BI were carried out using methods described by Hernández-Restrepo *et al.* (2016b), and the MP using those described by Crous *et al.* (2006b). Sequence data generated in this study were deposited in GenBank and the alignments and trees in TreeBASE (http://www.treebase.org).

RESULTS

Allantophomopsiella Crous, IMA Fungus 5: 180. 2014. Fig. 1.

Classification: *Leotiomycetes, Leotiomycetidae, Phacidiales, Phacidiaceae.*

Type species: *Allantophomopsiella pseudotsugae* (M. Wilson) Crous., basionym: *Phomopsis pseudotsugae* M. Wilson. Lectotype designated here: material deposited in Royal Botanic Garden Edinburgh, E00414771. Epitype and ex-epitype strain designated here: CBS H-23354, CBS 320.53.

DNA barcodes (genus): ITS, LSU.

DNA barcodes (species): ITS, *rpb2.* Table 1.

Conidiomata up to 600 µm diam, pycnidial, immersed, becoming erumpent, irregularly multilocular, dark brown, ostiolate; *conidiomatal wall* composed of 3–4 layers of dark brown cells, *textura angularis*. *Conidiophores* arising from inner layer of conidioma, branched, septate, at times reduced to conidiogenous cells. *Conidiogenous cells* integrated or discrete, ampulliform to subcylindrical or lageniform, hyaline, smooth with minute periclinal thickening at apex. *Conidia* inequilaterally fusiform or naviculate, hyaline, smooth, aseptate, guttulate, bearing mucoid apical appendages, flabelliform to irregular in shape. *Sexual morph* unknown (adapted from Crous *et al.* 2014b).

Culture characteristics: Colonies spreading, flat with sparse aerial mycelium and feathery margins. On PDA surface olivaceous grey, reverse iron-grey. On OA surface olivaceous grey with patches of iron-grey.

Optimal media and cultivation conditions: PNA at 25 °C under continuous near-ultraviolet light to promote sporulation.

Distribution: North America and Europe.

Hosts: Conifers (*Pinaceae*).

Disease symptoms: Canker and dieback.

Notes: This genus was recently introduced by Crous *et al.* (2014b) to accommodate *A. pseudotsugae*, a pathogen of conifers that was found to be very damaging, especially after