TAXONOMY AND PHYLOGENY OF SELECTED FAMILIES OF SORDARIOMYCETES WITH EMPHASIS ON SEEDS AND FRUITS

REKHANI HANSIKA PERERA GODAGAMA VIDANA ARACHCHIGE

DOCTOR OF PHILOSOPHY

IN

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Rekhani Hansika Perera Godagama Vidana Archchige

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ABSTRACT

Sordariomycetes is the largest class of Ascomycota after Dothideomycetes. The majority of the species of Sordariomycetes are terrestrial, while some are found in aquatic habitats. This research is on taxonomic and phylogenetic studies of selected families of Sordariomycetes with emphasis on seeds and fruits.

Hypocreales is an order in the phylum Ascomycota, class Sordariomycetes, subclass Hypocreomycetidae, and consists of fungi with highly diverse lifestyles. This study provides outlines for the Bionectriaceae, Calcarisporiaceae, Hypocreaceae, Nectriaceae, Tilachlidiaceae, Ijuhyaceae, Stromatonectriaceae, Xanthonectriaceae with taxonomic treatments. We provide up-to-date DNA sequence-based phylogenies, including combined gene analysis of ITS, LSU, RPB2, TEF1 and TUB2 for Hypocreales and accept 17 families. Three new families and 14 new species are introduced with descriptions and illustrations, while 14 new records and one new species combination are provided. Here we mainly detail the taxonomy of Bionectriaceae, Hypocreaceae, Nectriaceae and Tilachlidiaceae. The new families Ijuhyaceae, Stromatonectriaceae and Xanthonectriaceae are introduced in this study based on phenotypic and molecular analyses. For each family we provide a list of accepted genera, the taxonomic history, morphological descriptions, taxonomic placement based on DNA molecular data and

illustrate the type genus. Representatives of each family are illustrated based on type herbarium material or fresh specimens where available, or provide relevant references. Summaries on ecological and economic importance of the families are also given.

As a part of this study, taxonomic updates with molecular phylogeny of selected phytopathogenic genera in Hypocreales: *Calonectria*, *Dactylonectria*, *Ilyonectria*, *Fusarium* and *Neonectria* are provided. In addition, a summary of the classification, distribution, disease symptoms and possible hosts of these genera are included in this section. This work also discusses the morphology based and molecular based identification with recommended genetic markers at the genus level and species level of *Calonectria*, *Dactylonectria*, *Ilyonectria*, *Fusarium* and *Neonectria*.

This study also introduced a new order, Falcocladiales in the subclass Hypocreomycetidae to accommodate the family Falcocladiaceae. We review the taxonomic history, morphological characteristics and economic and ecological importance of ten families, Apiosporaceae, Chaetosphaeriaceae, Catabotrydaceae, Cylindriaceae, Delonicicolaceae, Flammocladiaceae, Phaeochoraceae, Pseudotruncatellaceae, Thyridiaceae and Obryzaceae. Illustrations of the type or representative taxa of each family, a list of accepted genera and a key to the accepted taxa are also provided.

We are studying fungi belonging to subclasses of Diaporthomycetidae, Sordariomycetidae and Xylariomycetidae in the class Sordariomycetes, and evaluate fungal species in terms of morphological characters and multi-gene phylogenies. As a result of the phylogenetic analyses *Pseudohalonectria suthepensis* is excluded from *Pseudohalonectria* and a new genus, *Tropohalonectria* is introduced to accommodate the species. The current research introduces a new genus *Delonicicola*, to accommodate *D. siamense* sp. nov., which was found to be associated with *Delonix regia* seed pods, collected in Thailand. Phylogenetic and molecular clock analyses of combined LSU, SSU and RPB2 sequence data provide evidence for a new family Delonicicolaceae and a new

order Delonicicolales in Xylariomycetidae. A new genus *Pseudotruncatella* is decribed here to accommodate a truncatella-like coelomycete species, which was isolated in Italy. *Neotruncatella* is synonymised under *Monochaetinula* based on morphology. Considering both molecular and morphological data we introduce *Eriocamporesia* as a new genus in Cryphonectriaceae. Furthermore, here we introduce seven new species, two new sexual morph records, one new host and two new geographical records and reference specimen of *Phragmoporthe conformis*.

This research work reviewed and determined the fungi growing on seeds and fruits of wild plants in various habitats. Such fungi colonise a wide range of substrates with most reported from cones, cupules, and leguminous pods that are high in cellulose and lignin content. There are 1348 fungal species (belonging to 230 families and 609 genera) reported from wild seeds and fruits in 84 countries, listed in this paper. Of these, 300 fungi were described from wild seeds and fruit substrates. Members of the Fabaceae support the highest number of taxa, namely 19% of the novel wild fruit fungi. Twenty-eight genera, including five fossil fungal genera have been described from wild seeds and fruits: *Agarwalomyces*, *Amorocoelophoma*, *Anisogenispora*, *Archephoma*, *Centrolepidosporium*, *Cylindroaseptospora*, *Cylindromyces*, *Davidhawksworthia*, *Delonicicola*, *Discotubeufia*, *Glaxoa*, *Kionocephala*, *Leucaenicola*, *Naranus*, *Neolindgomyces*, *Pleohelicoon*, *Quercicola*, *Remotididymella*, *Repetoblastiella*, *Restilago*, *Soloacrosporiella*, *Strobiloscypha* and *Tainosphaeria*. *Archephoma*, *Meniscoideisporites*, *Palaeodiplodites*, *Palaeopericonia* and *Xylohyphites* are the new fossil fungal genera. Fungal asexual morphs predominate on wild seeds and fruits rather than the sexual morphs. The dominant fungal genera on wild seeds and fruits include *Alternaria*, *Aspergillus*, *Candida*, *Chaetomium*, *Cladosporium*, *Colletotrichum*, *Curvularia*, *Diaporthe*, *Drechslera*, *Fusarium*, *Mucor*, *Penicillium*, *Pestalotiopsis*, *Restiosporium*, *Rhizopus*, *Talaromyces*, *Trichoderma* and *Xylaria*. Certain assemblages of fungi have specific and distinct relationships with their hosts, especially *Xylaria* species (e.g., *Xylaria magnoliae* on *Magnolia fruits*; *X. xanthinovelutina* (= *X. ianthino-*

velutina) on Fabaceae pods; *X. carpophila* on *Fagus cupules*; *X. persicaria* on liquidambar fruits). Whether these species occur as endophytes and become saprobes following fruit fall requires further investigation. In this study, we also made several sexual morph collections of sordariomycetous taxa from different seed and fruit substrates mainly from Thailand, with a few from the UK. These include one new order, one new family, one new genus, 22 new species, 16 new host records and one new geographical record. The new species are described and illustrated.

During the present study of investigating the microfungi in various substrates in Italy, Russia and Thailand, some taxa in class Dothideomycetes were investigated in terms of morphological characters and multi-gene phylogenies. The study resulted five new species, 1 new host and geographical record and a reference specimen of *Plenodomus agnitus*, in the orders Botryosphaeriales and Pleosporales. The new species describe here are *Alternariaster centaureae-diffusae*, *Camarosporium laburnicola*, *Diplodia arengae*, *Keissleriella cirsii* and *Neosetophoma rosarum*.

Keywords: Fungi, Fungal Diversity, Fungal Systematics, New Combinations, New Genera, New Families, New Orders, New Species

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ABBREVIATIONS AND SYMBOLS

cm	centimeter
com.	combination
diam.	diameter
e.g.	for example
et al.	and others
fam.	family
gen.	genus (singular) and genera (plural)
i.e.	that is
mm	millimeter
nov.	novum (Latin for new thing)
ord.	order
sp.	species
spp.	species (plural)
$\bar{x}$	average
°C	degree centigrade
=	heterotypic (taxonomic, facultative) a synonym
≡	homotypic (nomenclatural, obligate) a synonym
µm	micrometer
µl	microliter
%	percent
v.	version

CHAPTER 1

INTRODUCTION

1.1 Class Sordariomycetes

Sordariomycetes is the largest class of Ascomycota after Dothideomycetes (Kirk et al., 2008; Hyde et al., 2013). Kirk et al. (2008) included 15 orders, 64 families, 1119 genera and 10,564 species in Sordariomycetes, while Lumbsch and Huhndorf (2010) included 18 orders, 63 families and 947 genera. A large number of species of Sordariomycetes are characterized by non-lichenized, perithecial ascomata and inoperculate unitunicate asci (Zhang et al., 2006) or non-fissitunicate asci (Kirk et al., 2008). Most members of the Xylariomycetidae and some of the Sordariomycetidae have dark perithecia, amyloid asci, true paraphyses and periphysate ostioles, while most of the taxa of the Hypocreomycetidae have light coloured perithecia, nonamyloid apical rings in the asci when apical rings are present and the absence of true paraphyses (Zhang et al., 2006).

The most widely used gene regions for phylogenetic studies of Sordariomycetes from the early 1990s were SSU nrDNA and LSU nrDNA (Berbee & Taylor 1992; Spatafora & Blackwell, 1993; Spatafora, 1995). In addition to these ribosomal genes, the phylogenetic relationships among Sordariomycetes were investigated using partial translation elongation factor 1-alpha (TEF) and the second-largest subunit of RNA polymerase (RPB2) protein-coding genes (Zhang et al., 2006). Tang et al. (2007) evaluated the phylogenetic utility of the ß-tubulin gene (TUB) for resolving evolutionary relationships in Sordariomycetes.

1.2 Ecological and Economic Significance of Sordariomycetes

The majority of the species in Sordariomycetes are terrestrial, while some are found in aquatic habitats (Hyde & Wong, 2000; Samuels & Blackwell, 2001; Cai et al., 2006; Jones, Sakayaroj et al., 2009; Jones, Zuccaro et al., 2009; Jones & Pang, editors, 2012; Pratibha et al., 2014). They are pathogens of plants, arthropods and mammals (Sung et al., 2007; Prados-Rosale et al., 2012; Hyde et al., 2014) and have been isolated as endophytes from various plants (Keim et al., 2014). Some taxa are fungicolous (PeiGui et al., 2000; Jaklitsch et al., 2013), while many are saprobes involved in decomposition and nutrient cycling (Jaklitsch & Voglmayr, 2012). Some important plant pathogenic genera belong to Sordariomycetes, including *Colletotrichum*, *Diaporthe*, *Fusarium*, *Magnaporthe*, *Pestalotiopsis* and *Verticillium* (Maharachchikumbura et al., 2012, 2013; Udayanga et al., 2012, 2013; Hyde et al., 2014). Also included are mushroom pathogens, such as some *Hypocrea* and *Verticillium* species (PeiGui et al., 2000; Zare et al., 2007). Some species of Sordariomycetes (ie. *Beauveria bassiana*, *Trichoderma viride*, *T. harzianum*) are economically important biocontrol agents (Wraight et al., 1998; Kaewchai et al., 2009; Thiruvudainambi et al., 2010) as well as important in medicinal and other biotechnological industries (Semenova et al., 2012; Debbab et al., 2013; Xu et al., 2014).

1.3 Historical Overview and Taxonomy of Class Sordariomycetes

Eriksson and Winka (1997) introduced the class Sordariomycetes based on morphological (perithecial ascomata, hamathecium composed of paraphyses, ostioles with periphyses and unitunicate or pseudoprotunicate asci) and molecular data and accommodated in three subclasses: Hypocreomycetidae, Sordariomycetidae and Xylariomycetidae. Meliolomycetidae was added to the class by Kirk et al. (2001), while Diaporthomycetidae and Lulworthiomycetidae were proposed by Maharachchikumbura et al. (2015). The subclass Sordariomycetidae included three orders (i.e. Diaporthales, Ophiostomatales and Sordariales), while Xylariomycetidae was introduced to accommodate a single order Xylariales (Eriksson & Winka, 1997). Eriksson and Winka (1997) separated Onygenales and Eurotiales from Sordariomycetes and placed them in

the class Eurotiomycetes based on morphology and phylogenetic analyses. A comprehensive study of Sordariomycetes based on both morphological characters and SSU rDNA sequence data was carried out by Samuels and Blackwell (2001) and Eriksson (2006). In the classification of Eriksson (2006), the subclass Hypocreomycetidae comprised 4 orders (i.e. Coronophorales, Halosphaeriales, Hypocreales and Microascales). Coronophorales, Halosphaeriales and Hypocreales are recognized as monophyletic and Microascales as paraphyletic. Samuels and Blackwell (2001) excluded Erysiphales and Coryneliales sensu Barr (1990) from Sordariomycetes, while Eriksson (2006) placed Erysiphales in the Leotiomycetes, a sister taxon of the Sordariomycetes. Eriksson (2006) also recognized Melanosporales as a distinct order in the Hypocreomycetidae.

Historically, some of the families of Sordariomycetes, such as Amphisphaeriaceae, Diaporthaceae, Diatrypaceae, Halosphaeriaceae, Hypocreaceae, Polystigmataceae and Sordariaceae, were classified under the order Sphaeriales, an order characterized by sphaerical or flask-shaped fruiting bodies (Müller & von Arx, 1962). Chadefaud (1960) recognized Diaporthales as a separate order based on the characteristic stromatic tissue. Benny and Kimbrough (1980) introduced the orders Microascales, Onygenales and Ophiostomatales. A comprehensive taxonomic study of families and higher taxa of the Sordariomycetes based on morphology was that of Barr (1990). Barr (1990) included the orders Calosphaeriales, Coryneliales, Clavicipitales, Diaporthales, Erysiphales, Eurotiales, Halosphaeriales, Hypocreales, Meliolales, Microascales, Onygenales, Sordariales, Spathulosporales and Xylariales in the class named Hymenoascomycetes.

1.4 Recent Changes in Fungal Nomenclature

Pleomorphism arises from the fact that many ascomycete taxa including the species in Sordariomycetes, occur in either their sexual or asexual morphs alone, or in combination (Wingfield et al., 2012). Asexual and sexual morphs together make up a whole fungus called the holomorph (Seifert et al., 2011). Some taxa also have more than one asexual morph (synanamorph), often linked to unique ecological niches (Wingfield et

al., 2012). Sutton (1980) contributed to summarize the established links between coelomycetous asexual morphs and their sexual morphs. Later Seifert et al. (2011) did the same for genera of hyphomycetes. The asexual and sexual morphs of Sordariomycetes often develop separately, or only one morph is formed, and it is therefore often difficult to develop links between the same species but with different morphs (Wijayawardene, Crous et al., 2014). This is especially true when one or both morphs cannot be cultured or induced to form sporulating structures on artificial media. Observation of two morphs on the same substrate was an earlier method used to link morphs, but this does not prove that the morphs are related (Shenoy et al., 2007). DNA sequence data can irrefutably link asexual and sexual morphs and provide phylogenetic placements for asexual taxa within the sexual morph taxonomic classification schemes. It is difficult to place asexual genera into current classification schemes, when asexual genera are polyphyletic and paraphyletic. Their type species/ specimens need to be recollected to verify their phylogenetic position (Schoch et al., 2009). In addition to this, it appears that even some concepts of sexual taxa will require extensive reconsideration (Schoch et al., 2009). DNA sequencing and analysis have established the natural placements of many sexual and asexual genera and have also proven links between the sexual and asexual morphs (e.g. *Trichoderma–Hypocrea*, *Dyrithiopsis–Monochaetiopsis*, *Cylindrocladiella–Nectricladiella*, *Fusarium–Gibberella, Colletotrichum–Glomerella*; Jeewon et al., 2003; Jaklitsch et al., 2006; Hyde, Cai, Cannon et al., 2009; Hyde, Cai, McKenzie et al., 2009; Rossman et al., 2013), while some links have been not accepted (e.g. *Didymostilbe–Peethambara*, *Discostroma–Seimatosporium*, *Hypomyces–Cladobotyrum*; Subramanian & Bhat, 1978; Tanaka et al., 2011; Rossman et al., 2013). Decisions taken in the XVIIIth International Botanical Congress in Melbourne, Australia in 2011 (Hawksworth 2012) ruled that separate names for asexual and sexual morphs, were no longer allowed; this became effective from 30 July 2011 (Hawksworth, 2012; Wingfield et al., 2012). Based on this ruling, mycologists now have the task to clear up the historical confusion of dual nomenclature. The current study deal with the phylogeny and classification of the class Sordariomycetes. Some asexual genera in this class have been linked to sexual morphs, and some are discussed in Rossman et al. (2013) and Maharachchikumbura et al. (2015, 2016), and these are followed here.

1.5 Order Hypocreales

Hypocreales is an order in phylum Ascomycota, class Sordariomycetes, subclass Hypocreomycetidae and consists of fungi with highly diverse lifestyles (Põldmaa, 2011; Hyde et al., 2020). Lifestyles vary from endophytic, herbicolous, corticolous, caulicolous, foliicolous, fungicolous, entomogenous, bryophilous, lichenicolous, algicolous, coprophilous, while some are associated with humans and animals, some are on myxomycetes, are also isolated from leaf litter, soil, water and air, in terrestrial, freshwater and marine habitats. Ascomata of Hypocreales are mainly perithecial while some genera have cleistothecial ascomata (Rossman et al., 1999). Hypocreales fungi are characterized by having transparent, white, pale, bright or darkly coloured (yellow or shades of yellow, orange, orange-red, brown or shades of brown, red or shades of red, greenish, blue, dark bluish to or purple, bluish-black or black), KOH+/-, LA +/-, soft-textured, fleshy or tough ascomata superficial on the substratum or embedded on or seated in a weakly or well-developed stroma; with 2–8 spored, unitunicate asci; 0–multiseptate, sometimes muriform, non-disarticulating or disarticulating ascospores, and generally hyphomycetous or less commonly ceolomycetous, phialidic asexual morphs (Rossman et al., 1999; Maharachchikumbura et al., 2015, 2016; Hyde et al., 2020).

1.6 Phytopathogenic Genera in Nectriaceae

Only a few plant-pathogenic species are recognized in Bionectriaceae e.g. *Nectriella pironi* causing galls on stems and leaves of woody plants (Alfieri et al., 1980). *Acremonium* species are causal agents of rose dieback in Iran (eg. *A. sclerotigenum*) (Domsch et al., 2007; Mirtalebi et al., 2016). The members of the Nectriaceae are facultative, sometimes virulent plant pathogens, causing serious problems on crop plants, often encountered as asexual morphs, e.g. *Albonectria rigidiuscula*, causes green point gall of cocoa (Ploetz 2007; Pérez, et al., 2012; Yang et al., 2018), while *Fusarium sambucinum* causes hop canker, potato storage rot, and root rot of many crops (Ray & Hammerschmidt, 1998; Wharton et al., 2006). *Fusarium oxysporum* causes root rots, foot rots, and wilt diseases of numerous crop plants (Hyde et al., 2014; Chittem et al., 2015;

McGovern, 2015; Rossman et al., 1999). They also cause cankers, root rots, and other diseases on hardwood and coniferous trees, e.g. *Abies* and *Acer* cankers caused by *Neonectria castaneicola*; beech (*Fagus* spp.) bark disease caused by *Nectria coccinea* and *N. ditissima*, black foot disease of grapevines (*Vitis* spp.) caused by *Neonectria liriodendri*; 'coral spot *Nectria* canker' caused by *N. cinnabarina*; root rots caused by *N. radicicola*; and cankers caused by *N. rugulosa*, among others (Hirooka et al., 2005, 2012; Kobayashi et al., 2005; Castlebury et al., 2006; Halleen et al., 2006; Chaverri et al., 2011).

1.7 Subclass Diaporthomycetidae, Sordariomycetidae and Xylariomycetidae

The subclass Diaporthomycetidae was erected by Maharachchikumbura et al. (2015) for taxa previously placed in Sordariomycetidae but not phylogenetically and morphologically related to Sordariomycetidae. Fungi of Diaporthomycetidae are saprobes, pathogens, or endophytes occurring in aquatic and terrestrial habitats. Maharachchikumbura et al. (2015) and Hongsanan et al. (2017) accepted ten orders in Diaporthomycetidae. Pararamichloridiales and Sporidesmiales were added to the subclass later by Crous et al. (2017) and Crous, Schumacher et al. (2019) respectively. Hyde et al. (2017) proposed Catabotryales in Diaporthomycetidae based on evolutionary data and, Hyde et al. (2020) formally introduced the order. Presently there are 15 orders and 65 families in Diaporthomycetidae (Hyde et al., 2020).

Sordariomycetidae was established by Eriksson and Winka (1997) to accommodate four orders, eight families and one family *incertae sedis*. Members of this subclass are mainly characterized by dark ascomata with inoperculate, unitunicate asci and occur in terrestrial, aquatic and marine habitats and are widely distributed as plant and animal pathogens, endophytes, saprobes as well as coprophilous and lichenicolous taxa (Maharachchikumbura et al., 2015, 2016; Huang et al., 2019). They are mycophilic, rich in coprophilous taxa and associated with invertebrates and their ecological aspects and biotechnological potential have been researched (Zhang et al., 2006; Raghukumar, 2008; Bovio et al., 2018). Currently, there are eight orders and 19 families in this subclass.

Eriksson and Winka (1997) introduced Xylariomycetidae for order Xylariales. Species in the subclass are mostly associated with decaying plant substrates (Maharachchikumbura et al., 2015). Maharachchikumbura et al. (2016), Samarakoon et al. (2016) and Hongsanan et al. (2017) published different outlines for Xylariomycetidae. Perera et al. (2017) introduced Delonicicolales to accommodate Delonicicolaceae. Currently, there are three orders (Amphisphaeriales, Delonicicolales and Xylariales) and 35 families are accepted in this subclass (Hyde et al., 2020).

1.8 Seed and Fruit Inhabiting Fungi

Diverse fungal groups can be found generally on every part of a single plant host (Hyde, 1995). Domesticated, genetically modified commercial seeds (cereals) and fruits are different from wild fruits/seeds in size, nutrient content and chemical defenses (Tang et al., 2003a; HernándezTerán et al., 2017). Disease development of those post-harvest fruits and cereals occur during transportation and storage, which is different to that in nature (Tang et al., 2003a). The few studies that have been conducted on fungi on non-commercial seeds and fruits indicate the occurrence of fungi belonging to diverse taxonomic groups, such as Ascomycota, Basidiomycota, Chytridiomycota, Mucoromycota and Blastocladiomycota (Desjardin, 2000; Vujanovic et al., 2000; Somrithipol, Chatmala et al., 2002; Somrithipol, Jones et al., 2002; Nelson & Abad, 2010; Fukasawa et al. 2012; Jayasiri et al., 2019).

Fungi on seeds and fruits of wild plants in various habitats, colonise a wide range of substrates with most reported from cones, cupules, and leguminous pods that are high in cellulose and lignin content. There are 1348 fungal species (belonging to 230 families and 609 genera) reported from wild seeds and fruits in 84 countries, listed in this study. Of these, 300 fungi were described from wild seeds and fruit substrates.

1.9 Research Objectives

1.9.1 To provide up-to-date phylogenies of Hypocreales taxa and a monograph of genera in Bionectriaceae, Hypocreaceae, Nectriaceae and Tilachlidiaceae based on type herbarium materials and fresh specimens collected from Italy, Russia, Thailand and Ukraine.

1.9.2 To review selected families of Sordariomycetes and provide taxonomic notes.

1.9.3 To study species in Diaporthomycetidae, Sordariomycetidae and Xylariomycetidae and evaluate the species in terms of morphology characters and multi-gene phylogenies.

1.9.4 To study the taxonomy and phylogeny of Sordariomycetes inhabiting wild seeds and fruits in Thailand, Italy and UK.

1.9.5 To provide a checklist of fungi on wild seeds and fruits and discuss their role and importance.

1.9.6 To contribute to the fungal taxonomy and phylogeny by studying fungi in other classes such as Dothideomycetes.

1.10 Research Contents

This thesis is comprised eight chapters.

Chapter 1 is the general introduction, which provides history and background information about Sordariomycetes fungi, their ecological and economic significance, recent changes in fungal nomenclature, a brief introduction of subclass Diaporthomycetidae, Sordariomycetidae Xylariomycetidae and order Hypocreales, and also discussed on the significance of studying seed and fruit inhabiting fungi, and the objectives of this research and the research contents.

Chapter 2 incorporates a profile of Hypocreales families: Bionectriaceae, Calcarisporiaceae, Hypocreaceae, Nectriaceae, Tilachlidiaceae, Ijuhyaceae fam. nov., Stromatonectriaceae fam. nov. and Xanthonectriaceae fam. nov with taxonomic treatments. This chapter provides up-to-date DNA sequence-based phylogenies for

Hypocreales. For each family a list of accepted genera, the taxonomic history, morphological descriptions, taxonomic placement based on DNA molecular data and illustrate the type genus based on loaned herbarium material or fresh specimens and summaries on ecological and economic importance are provided. The taxonomic placement of the recorded taxa discuss in this chapter is based on morphology and phylogeny.

Chapter 3 provides taxonomic notes on Falcocladiales and selected families of Sordariomycetes. This chapter brings together descriptions, notes on the history, and illustrations of the type or representative taxa of each family, a list of accepted genera and a key to the accepted taxa of Apiosporaceae, Chaetosphaeriaceae, Catabotrydaceae, Cylindriaceae, Delonicicolaceae, Flammocladiaceae, Phaeochoraceae, Pseudotruncatellaceae, Thyridiaceae and Obryzaceae.

Chapter 4 provides taxonomic updates and an updated backbone tree of selected phytopathogenic genera in Nectriaceae. This chapter brings together notes on the taxonomic history, classification, hosts, distribution, a brief guide to morphology based and molecular-based identification and recommended genetic markers for identification of fungi in *Calonectria*, *Dactylonectria*, *Ilyonectria*, *Fusarium* and *Neonectria*.

Chapter 5 incorporates an updated backbone trees and natural classification for genera in Diaporthomycetidae, Sordariomycetidae and Xylariomycetidae. This chapter introduces three new genera *Eriocamporesia*, *Pseudotruncatella* and *Tropohalonectria*, and two new species.

Chapter 6 reviews and determines the fungi growing on seeds and fruits of wild plants in various habitats. This chapter provides a checklist of fungi described from seeds and fruits. Fresh specimen collection and morphological and phylogenetic investigations of wild seeds and fruits fungi revealed one new order, one new family, one new genus, 22 new species and 16 new host and geographical records.

Chapter 7 delivers an updated backbone tree and natural classification for Dothideomycetes taxa. This chapter introduces five new species *Alternariaster centaureae-diffusae*, *Camarosporium laburnicola*, *Diplodia arengae*, *Keissleriella cirsii* and *Neosetophoma rosarum* from different hosts

Chapter 8 provides the overall conclusion of this thesis contents and suggestions for future work.

CHAPTER 2

PROFILE OF BIONECTRIACEAE, CALCARISPORIACEAE, HYPOCREACEAE, NECTRIACEAE, TILACHLIDIACEAE, IJUHYACEAE FAM. NOV., STROMATONECTRIACEAE FAM. NOV. AND XANTHONECTRIACEAE FAM. NOV.

2.1 Introduction

Hypocreales is an order in the phylum Ascomycota, class Sordariomycetes, subclass Hypocreomycetidae, and consists of fungi with highly diverse lifestyles (Põldmaa, 2011; Hyde et al., 2020). Lifestyles vary from endophytic, herbicolous, corticolous, caulicolous, foliicolous, fungicolous, entomogenous, bryophilous, lichenicolous, algicolous, coprophilous while some are associated with humans and animals, some are on myxomycetes, are also isolated from leaf litter, soil, water and air, in terrestrial, freshwater and marine habitats. Ascomata of Hypocreales are mainly perithecial while some genera have cleistothecial ascomata (Rossman et al., 1999). Hypocreales fungi are characterized by having transparent, white, pale, bright or darkly coloured (yellow or shades of yellow, orange, orange-red, brown or shades of brown, red or shades of red, greenish, blue, dark bluish to or purple, bluish black or black), KOH+/-, LA +/-, soft-textured, fleshy or tough ascomata superficial on the substratum or embedded on or seated in a weakly or well-developed stroma; with 2–8 spored, unitunicate asci; 0–multiseptate, sometimes muriform, not disarticulating or disarticulating ascospores, and generally hyphomycetous or less commonly ceolomycetous, phialidic asexual morphs (Rossman et al., 1999; Maharachchikumbura et al., 2015, 2016; Hyde et al., 2020).

In this paper the Hypocreales families: Bionectriaceae, Calcarisporiaceae, Hypocreaceae, Nectriaceae, Tilachlidiaceae are re-visited and provide outlines with taxonomic treatments. For each family we provide a list of accepted genera updated after

Wijayawardene et al. (2022). The taxonomic history of each family is provided based on previous literature. Characteristics of type genera and some selected genera are illustrated based on type/authentic herbarium material, drawings or fresh specimens where available, or provide relevant references. Drawings of holotypes, based on original papers are provided when the type material is not available for loaning/studying or some characters are hard to or could not be observed when re-examined. We did not loan type specimens of the recently introduced genera, as they provided detailed morphological descriptions with photo plates. However, they were included in the phylogentic analyses to confirm their taxonomic placement. The current paper also provides up-to-date DNA sequence-based phylogenies including combined gene analysis of ITS, LSU, RPB2, TEF1 and TUB2 for Hypocreales. We accept 17 families in the order with three new families Ijuhyaceae fam. nov., Stromatonectriaceae fam. nov. and Xanthonectriaceae fam. nov., which are introduced based on phenotypic and genotypic analyses. Twelve new species are introduced with descriptions and illustrations, while 14 new fungal records and one new species combination are provided. Furthermore, we provide multi-gene analysis of ACT, CDMA, HIS3, ITS, LSU, RPB1, RPB2, TEF1 and TUB2 regions for genera of Nectriaceae including genera published after the taxonomic treatment by Lombard et al. (2015). Besides, we briefly discuss the ecological and economic importance of each family.

2.2 Materials and Methods

2.2.1 Sample Collection, Phenotypic Study and Isolation

Fresh samples were collected in Thailand, Italy and Ukraine during 2016–2019. Specimens were kept in sterile plastic bags, transported to the laboratory and stored at room temperature (25°C) until they were examined. In addition, herbarium specimens were loaned from BPI, BRIP, CWU, F, G, IMI, K, NY, PC, PDD, S, and UPS herbaria. We found that some of the loaned type specimens are in poor condition for study; and, we were unable to loan some types. Therefore, we provide redrawn illustrations and/or original references where necessary. Fungal fruiting bodies were examined and dissected using a stereoscopic microscope (Motic SMZ-168). Surfaces photos of the fungus were captured using a stereo microscope (SteREO Discovery v8) equipped with a camera

(Axiocam ERc 5s). Fruiting structures were mounted in distilled water for detailed microscopic examinations. When required, Melzer's reagent, 3% KOH (Potassium hydroxide), cotton blue and lactic acid were used as mounting media. Micro-morphological characters were studied and photomicrographs were captured using a Nikon ECLIPSE 80i compound microscope (Nikon, Tokyo, Japan) equipped with a Canon EOS 600D and/or a Cannon EOS 750D camera (Canon Inc., Tokyo, Japan). The measurements of the fungal structures were taken with a Tarosoft (R) Image Frame Work image analysis software. The illustrations were processed with Adobe Photoshop CS6 Portable (Adobe Systems, USA) software.

Fungi were isolated in 90 mm diameter Petri dishes containing WA (water agar) or PDA (potato dextrose agar) following single spore isolation approaches detailed in Senanayake et al. (2020). Germinated single spores were transferred to the PDA and MEA (malt extract agar) media and then incubated at 25℃ or 16°C for obtaining axenic cultures. Macroscopic characterization of the fungal colonies was done on PDA or MEA after 7–14 days of incubation.

Axenic cultures of each isolate were stored in the culture collection at Mae Fah Luang University (MFLUCC). Dry herbarium specimens were prepared and preserved in the Mae Fah Luang University (MFLU) herbarium, Chiang Rai, Thailand. Generic names and species names were registered in Facesoffungi and Index Fungorum databases where necessary, as indicated in Jayasiri et al. (2015) and Index Fungorum (2022). Species are delineated based on recommendations outlined by Jeewon and Hyde (2016), Chethana et al. (2021) and Maharachchikumbura et al. (2021).

2.2.2 DNA isolation, Amplification and Analyses

Genomic DNA was extracted from fungal colonies growing on PDA or MEA or directly from the fruiting bodies as designated in Perera, Maharachchikumbura, Bhat et al. (2016). DNA amplifications were performed by polymerase chain reaction (PCR). Part of the large subunit nuclear rRNA gene (LSU), small subunit nuclear rRNA gene (SSU), 5.8S rDNA region and flanking internal transcribed spacers (ITS), translation elongation factor 1-alpha gene (TEF1), large subunit of the ATP citrate lyase (ACL), RNA polymerase II largest subunit (RPB1), RNA polymerase II second largest subunit (RPB2), beta-tubulin (TUB2), calmodulin (CAM) and Histone H3 (HIS3) regions were

amplified with the primers mentioned in Table 1. PCR was performed following the protocols in Perera, Maharachchikumbura, Bhat et al. (2016). Newly generated sequences were deposited in NCBI GenBank and accession numbers are given at the end of the protologue.

Sequences were obtained from GenBank based on NCBI blast results and following previous publications. Sequences were aligned by using MAFFT v. 7 online server (http://mafft.cbrc.jp/alignment/server/index.html) (Katoh & Standley, 2013) and improved manually using BioEdit v. 7.0.5.2 (Hall, 1999). The phylogenetic analyses of the single and combined loci were performed using maximum-likelihood (ML) and Bayesian inference (BI) analyses as detailed in Dissanayake et al. (2020). ML analyses were performed at the CIPRES web portal (Miller et al., 2010) using RAxML v. 8.2.12 as part of the "RAxML-HPC2 on TG" tool (Stamatakis, 2006). BI was implemented by MrBayes v. 3.2.7 (Ronquist & Huelsenbeck, 2003). Phylogenetic trees were viewed in FigTree v. 1.4 and processed using Microsoft PowerPoint 2016.

Table 2.1 Information on loci used in the phylogenetic analyses

Locus	Primers	References
ACL	acl1-230, acl1-1220l	Gräfenhan et al. (2011)
CAM	CAL-228F	Carbone and Kohn (1999)
	CAL2Rd	Groenewald et al. (2013)
ITS	ITS5, ITS4	White et al. (1990)
LSU	LR0R	Rehner and Samuels (1994)
	LR5	Vilgalys and Hester (1990)
HIS3	CYLH3F, CYLH3R	Lombard and Crous (2012)
RPB1	cRPB1a, RPB1c	Castlebury et al. (2004)
RPB2	fRPB2, f RPB2-7cR	Liu et al. (1999)
SSU	NS1, NS4	White et al. (1990)
TEF1	EF1-728F, EF1-986R	Carbone and Kohn (1999)
	EF2,	O'Donnell et al. (1998)
	EF1567	Carbone and Kohn (1999)
TUB2	T1, T2	O'Donnell and Cigelnik (1997)
	CYLTUB1R	Crous et al. (2004)

2.3 Hypocreales Lindau

The genus *Hypocrea* was introduced by Fries (1825) and placed it in order Sphaeriacei, suborder Sphaerini. Fries (1849) accepted *Hypocrea* with a narrow sense. Lindau (1897) introduced the family Hypocreaceae based on *Hypocrea* and introduced the order Hypocreales to accommodate Hypocreaceae as the only family. Lindau (1897) also recognised six subfamilies within Hypocreaceae; these were Hyponectrieae, Hypomyceteae, Melanosporeae, Nectrieae, Hypocreeae and Clavicipiteae. Later, Earle (1901) elevated those subfamilies to the familial level. Miller (1928) recognised Hypocreales and Sphaeriales are closely related orders which have true perithecia, a Diaportheen type of centrum, true perithecial walls and ostiole. Hypocreaceae has been later accepted in Sphaeriales with Xylariaceae, Lasiosphaeriaceae, Hyponectriaceae, Polystigmataceae and Diatrypaceae (Nannfeldt, 1932). Seaver (1909a, b, 1910a, b, 1911) and Petch (1938) accepted Nectriaceae and Hypocreaceae as separate taxonomic groups, considering ascomatal and stromatal characters. Many authors considered Nectriaceae as a part of Hypocreaceae (Miller, 1949; Luttrell, 1951; Dingley, 1951a, b, 1952a, b, 1953, 1954, 1956; von Arx & Müller, 1954; Müller & von Arx, 1962; Gäumann, 1964; Rogerson, 1970). Furthermore, Munk (1957) considered Clavicipitaceae, Hypocreaceae, Hypomycetaceae, Melanosporaceae and Nectriaceae in Sphaeriales. Gäumann (1964) synonymised Nectriaceae under Hypocreaceae and placed them in Sphaeriales. Kreisel (1969) considered that Hypocreales and Sphaeriale are separate orders based on ascomatal morphology, centrum characters and differences in asexual morphs. Kreisel (1969) characterized Hypocreales with brightly coloured, fleshy ascomata, apical paraphyses, and formation of phialides on free conidiophores. He accepted six families in Hypocreales, namely: Clavicipitaceae, Cordycipitaceae, Hypomycetaceae, Hypocreaceae, Nectriaceae, and Ostropaceae. Rogerson (1970) also synonymised Hypomycetaceae and Nectriaceae under Hypocreaceae, and Hypocreaceae was considered the only family in Hypocreales. Rogerson (1970) characterized Hypocreales as “perithecia (and stromata if present) typically soft and fleshy, or membranous, typically white to brightly coloured; perithecial centrum typically composed of apical paraphyses and asci; ascus wall typically uniformly thin-walled, sometimes thickened at the apex, with or without a pore;

asci forming a single layer lining the base and sides of the perithecial cavity and growing upwards among the apical paraphyses". Nannfeldt (1932) removed the new order Clavicipitales from Hypocreales and accepted Clavicipitaceae as the only family in this order. Due to the differences in ascomatal characters, Hypocreales and Clavicipitales were considered as different orders by Rogerson (1970) and later by Barr (1990). Miller (1949) placed Clavicipitaceae in the Sphaeriales. Following Lundqvist (1980), Barr (1990) separated Pyxidiophoraceae (introduced by Arnold, 1971) from Hypocreaceae and placed it in Hypocreales. Barr (1990) firstly placed Niessliaceae in Hypocreales since it shares similar centrum characters and conidial morphology with other taxa in the order. This was accepted by Eriksson and Hawksworth (1990). In brief, Barr (1990) accepted three families, namely: Hypocreaceae, Pyxidiophoraceae and Niessliaceae, in the order. Later, Pyxidiophoraceae was recognised as a member of the Laboulbeniales and segregated from Hypocreales (Eriksson, 1993; Blackwell, 1994). Luttrell (1951) believed Clavicipitales is taxonomically closer to Xylariales and possesses a xylaria-type centrum. Based on cladistic analysis of SSU sequences, Spatafora and Blackwell (1993) demonstrated that Clavicipitales is a monophyletic sister group to Hypocreales. The fact was supported by SSU and LSU sequences analyses by Rehner and Samuels (1995). Spatafora and Blackwell (1993) confirmed that Clavicipitales is not a member or close relative of Xylariales and indicated that the centrum characters of Clavicipitales should be reconsidered (Spatafora & Blackwell, 1993). White et al. (2000) studied the centrum development of some Clavicipitaceae members and found out they are diverse from both *Nectria*- and *Xylaria*-types.

Taxonomic revision of Hypocreales by Rossman et al. (1999) recognised five families Clavicipitaceae, Hypocreaceae, Nectriaceae, Niessliaceae and the new family Bionectriaceae. Their study correlates with phylogenetic data from previous studies: LSU analysis (Rehner & Samuels 1994, 1995) and, LSU and SSU phylogeny by Ogawa et al. (1997). Phylogenetic analysis of LSU sequences by Rossman et al. (2001) also supports the phylogenetic treatment introduced in Rossman et al. (1999). Samuels and Blackwell (2001) used molecular analyses to reveal interrelationships of orders of pyrenomycetes. This molecular analysis supported the fact that Clavicipitales and Melanosporales might be placed in Hypocreales. Nonetheless, Samuels and Blackwell (2001) accepted only four families (Hypocreaceae, Nectriaceae, Bionectriaceae and Niessliaceae) in Hypocreales.

Sung et al. (2007) segregated Cordycipitaceae from Clavicipitaceae and maintained them in Hypocreales based on morphological data and multi-locus phylogenetic analyses. Stachybotryaceae was established to accommodate *Myrothecium*, *Peethambara* and *Stachybotrys* by Crous, Shivas et al. (2014) and referred to Hypocreales. Further studies on polyphyletic genera *Myrothecium* and *Stachybotrys* resulted 13 new genera in the family (Lombard et al., 2015). Two other families, Flammocladiellaceae and Tilachlidiaceae were recognised in Hypocreales by Crous, Schumacher et al. (2015) and Lombard et al. (2015) respectively. Calcarisporiaceae and Cocoonihabitaceae were added to Hypocreales by Sun et al. (2017) and Zhuang and Zeng (2017). Sarocladiaceae was erected by Crous et al. (2018) and initially maintained in Hypocreales, *incertae sedis*. Later, Hyde et al. (2020) placed Sarocladiaceae in Hypocreales based on phylogenetic evidence.

Fifteen families were accepted in Hypocreales by the latest outlines (Wijayawardene et al., 2022). They are Bionectriaceae, Calcarisporiaceae, Clavicipitaceae, Cocoonihabitaceae, Cordycipitaceae, Cylindriaceae, Flammocladiellaceae, Hypocreaceae, Myrotheciomycetaceae, Nectriaceae, Niessliaceae, Ophiocordycipitaceae, Sarocladiaceae, Stachybotryaceae, and Tilachlidiaceae. Wijayawardene et al. (2022) accepted 320 genera in Hypocreales. Bionectriaceae, Calcarisporiaceae, Hypocreaceae, Nectriaceae and Tilachlidiaceae are revisited and we introduce three new families in this study using both morphology and combined gene analysis of ITS, LSU, RPB2, TEF1 and TUB2 regions. Based on phylogenetic analysis Cylindriaceae is not considered in Hypocreales (Figure 2.1). Here we accept 17 families in Hypocreales including new families Ijuhyaceae, Stromatonectriaceae and Xanthonectriaceae. Furthermore, we introduce 14 new species in this paper based on morphological evidences and phylogeny.

Hypocreales fungi biotrophic, hemibiotrophic, saprobic or hypersaprobic on various substrates (Barr, 1990b). *Aphanotria*, *Anthonectria*, *Bryocentria*, *Bryonectria*, *Laniatria* and *Psychronectria* are examples of bryophilous Hypocreales (Rossman et al., 1999; Döbbeler, 1998, 2010; Döbbeler & Davison, 2018). Bionectriaceae and Nectriaceae taxa share similar morphological characteristics (Rossman et al., 1999; Voglmayr & Jaklitsch, 2019), hence they are difficult to classify without DNA data. Hyphomycetous asexual morphs such as acremonium-like, stilbella-like are synnematous are not restricted

to Bionectriaceae and Nectriaceae (Voglmayr & Jaklitsch, 2019). These forms also can be found in distantly related families of the Sordariomycetes (Rossman et al., 1999; Summerbell et al., 2011; Voglmayr & Jaklitsch, 2019).

2.3.1 Families Included in Hypocreales (*taxonomic details provided)

Bionectriaceae Samuels & Rossman*

Calcarisporiaceae Jing Z. Sun, Xing Z. Liu & K.D.

Clavicipitaceae Rogerson

Cocoonihabitaceae W.Y. Zhuang & Z.Q. Zeng

Cordycipitaceae Kreisel ex G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora

Flammocladiellaceae Crous, L. Lombard & R.K. Schumach.

Hypocreaceae De Not.*

Ijuhyaceae R.H. Perera, E.B.G. Jones, Maharachch., & K.D. Hyde*

Myrotheciomycetaceae Crous

Nectriaceae Tul. & C. Tul.*

Niessliaceae Kirschst.

Ophiocordycipitaceae G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora

Sarocladiaceae L. Lombard

Stachybotryaceae L. Lombard & Crous

Stromatonectriaceae R.H. Perera, E.B.G. Jones, Maharachch., & K.D. Hyde*

Tilachlidiaceae L. Lombard & Crous*

Xanthonectriaceae R.H. Perera, E.B.G. Jones, Maharachch., & K.D. Hyde.*

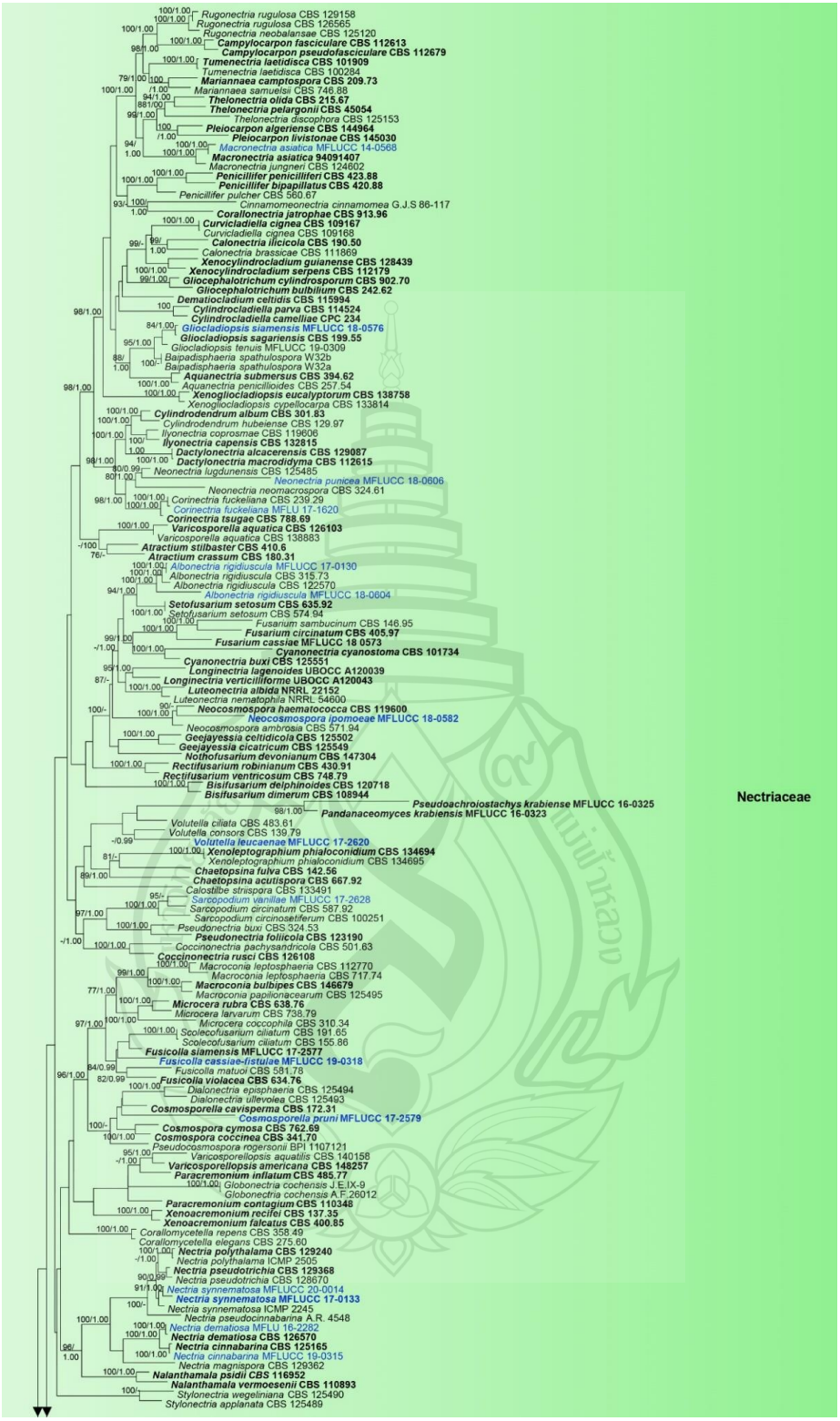


Figure 2.1 Phylogram generated from maximum likelihood analysis based on combined ITS, LSU, RPB2, TEF1 and TUB2 sequence data of Hypocreales

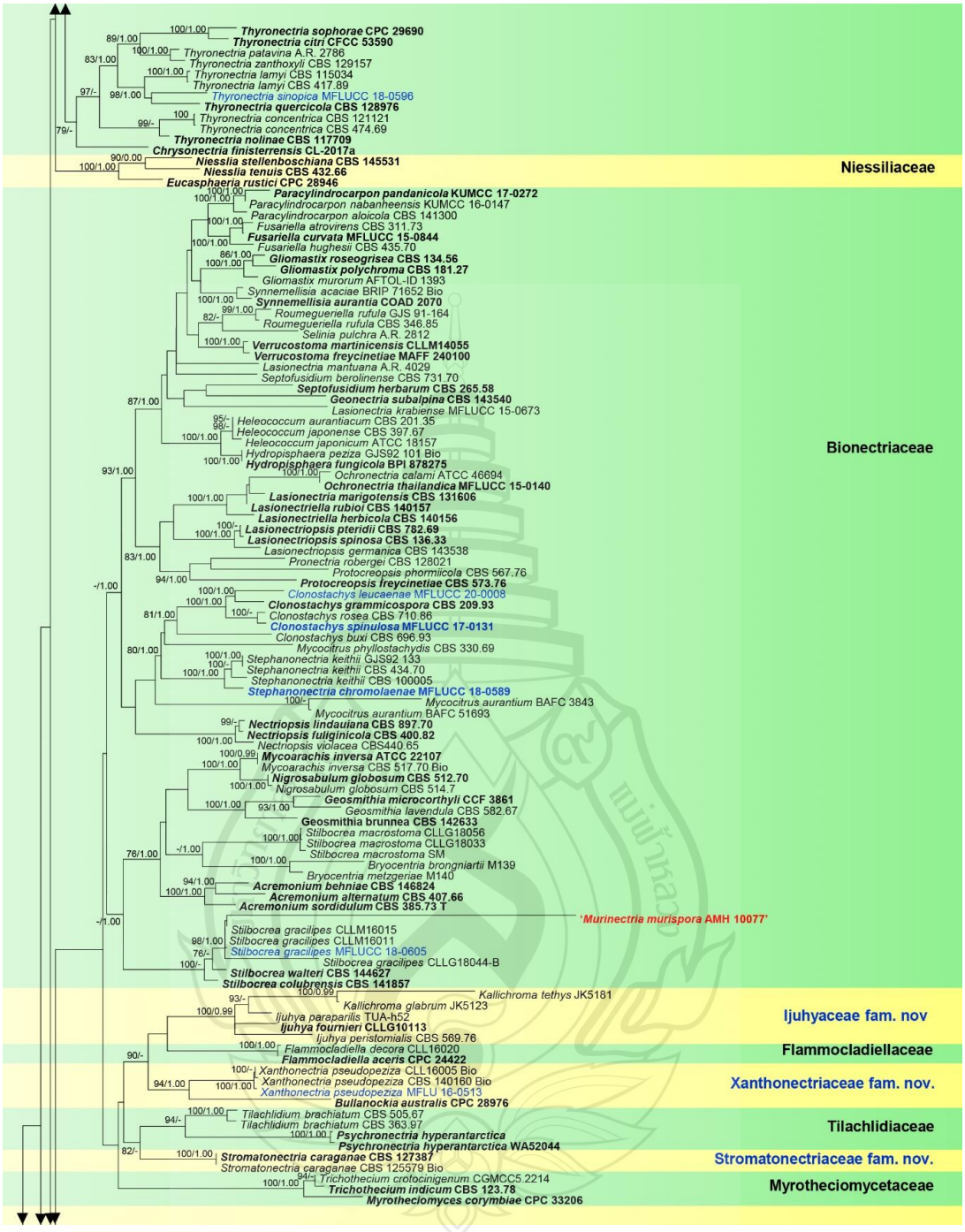
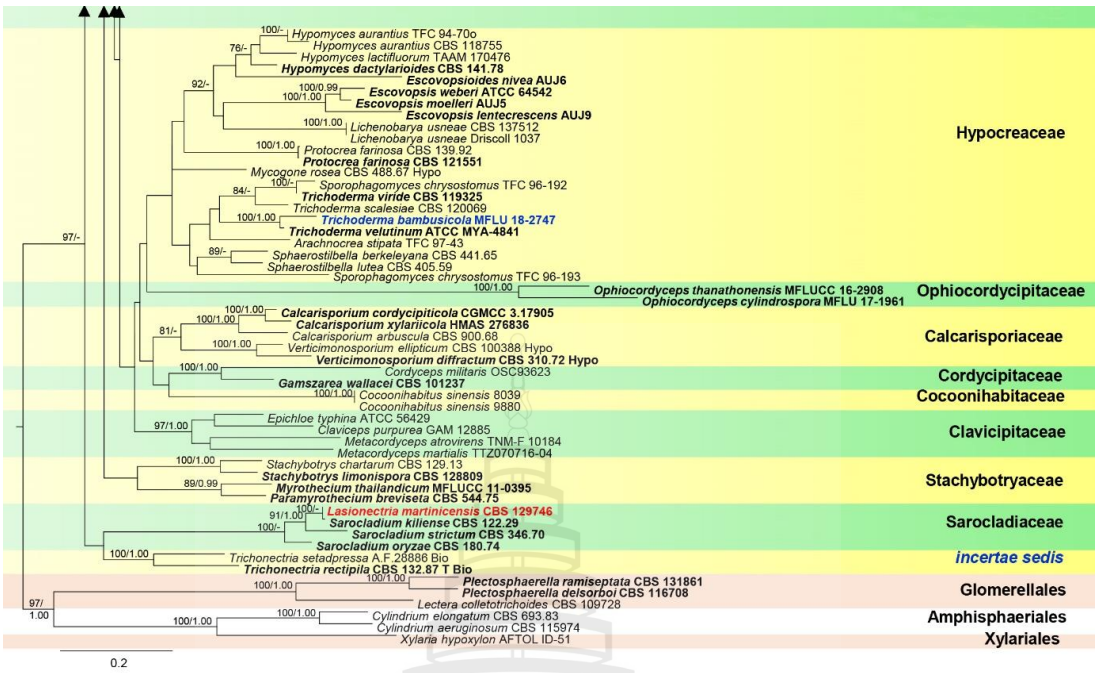


Figure 2.1 (continued)



Note Three hundred and nine strains are included in the combined analyses, which comprised 5497 characters (ITS: 629, LSU: 829, RPB2: 1950, TEF1: 1477, TUB2: 612), including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to *Cylindrium elongatum* CBS 693.83, *Cylindrium aeruginosum* CBS 115974, *Lectera colletotrichoides* CBS 109728, *Plectosphaerella delsorboi* CBS 116708, *Plectosphaerella ramiseptata* CBS 131861 and *Xylaria hypoxylon* AFTOL ID-51. Ex-type strains are in **bold**. The newly generated sequences are indicated in blue. The scale bar indicates 0.2 nucleotide changes per site.

Figure 2.1 (continued)

2.3.2 Bionectriaceae Samuels & Rossman

Rossman et al. (1999) established Bionectriaceae (in the Hypocreales) and placed 26 genera in the family, namely: *Battarrina*, *Bionectria*, *Bryonectria*, *Clibanites*, *Dimerosporiella*, *Emericellopsis*, *Halonectria*, *Heleococcum*, *Hydropisphaera*, *Ijuhya*, *Kallichroma*, *Lasionectria*, *Mycoarachis*, *Mycocitrus*, *Nectriella*, *Nectriopsis*, *Ochronectria*, *Paranectria*, *Peethambara*, *Pronectria*,

Protocreopsis, *Roumegueriella*, *Selinia*, *Stilbocrea*, *Trichonectria* and *Valsonectria*. Five genera are cleistothecial: *Battarrina*, *Emericellopsis*, *Heleococcum*, *Mycoarachis* and *Roumegueriella*. Based on LSU phylogeny Rossman et al. (2001) confirmed the monophyletic nature of the Bionectriaceae and, revealed the family is distinct from other families of Hypocreales (Hypocreaceae, Clavicipitaceae and Nectriaceae). Rossman et al. (2001) also revealed that *Peethambara*, which was previously accepted in Bionectriaceae by Rossman et al. (1999), is not a member of Bionectriaceae based on LSU sequences. Döbbeler and Davison (2018) referred *Bryonectria* to Hypocreales *incertae sedis*. Later, *Emericellopsis* and *Peethambara* were transferred to Myrotheciomycetaceae and Stachybotryaceae, respectively (Lombard et al., 2016; Crous et al., 2018). Hyde et al. (2020) and Wijayawardene et al. (2020, 2022) accepted 47 genera in Bionectriaceae.

Following Rossman et al. (1999), *Peristomialis* was considered as synonymy of *Ijuhya* in this paper. Based on current phylogenetic inference, the genera *Ijuhya* and *Kallichroma* were recognized as a distinct family Ijuhyaceae. New family Xanthonectriaceae was introduced to accommodate *Xanthonectria* and *Bullanockia*, while *Stromatonectria* was accepted in a new family Stromatonectriaceae due to the unique pycnidial asexual morphs and phylogenetic analysis (Figure 2.1). Based on phylogenetic analysis *Globonectria* was transferred to Nectriaceae. Furthermore, *Trichonectria* which was hitherto accepted in Bionectriaceae is left in Hypocreales *incertae sedis* (Figure 2.1). *Septofusidium*, which was previously placed in Nectriaceae and then in Tilachlidiaceae, was transferred to Bionectriaceae based on combined gene analysis (Figure 2.1). Currently we accept 40 genera in the family.

Bionectriaceae is characterized by pale to bright coloured, perithecial, rarely cleistothecial ascomata that are superficial on substrates or stroma or, immersed in a hyphal or well-developed stroma, generally do not change colour in KOH or lactic acid (LA) and have globose, ellipsoid to long-fusiform ascospores (Rossman et al. 1999; Maharachchikumbura et al., 2016). Lactophenol cotton-blue (CB) is commonly used for observing/mounting fungal structures of bryophilous taxa (Döbbeler & Davison, 2018). Cyanophilous fungal structures stain blue in CB, non reactive structures are acyanophilous (Woehrel & Light, 2017). The asexual morphs in Bionectriaceae are hyphomycetous, not-pycnidial, acremonium- or gliocladium-like,

with phialidic conidiogenous cells and produce unicellular to multi-septate, ellipsoidal, fusiform to subfusiform, hyaline to greenish hyaline or bright-coloured conidia (Rossman et al., 1999; Maharachchikumbura et al., 2016; Jaklitsch & Voglmayr, 2011).

Ecological and economic significance of Bionectriaceae

Species of Bionectriaceae are widely used in industrial, medicinal and commercial applications as enzyme producers, biodegraders and biocontrol agents, while only few are plant pathogenic (Alfieri et al., 1980; Goswami et al., 2008; Choi et al., 2009; Wicklow & Poling, 2009; Hadziabdic, et al. 2014; Sun et al., 2020). *Stilbocrea macrostoma* and *Geosmithia morbida* are reported as the cause of cankers disease and wood necrosis (Hadziabdic et al., 2014; Di Lecce et al., 2021). *Acremonium* species are important as enzyme producers (Konishi & Shindo, 1997; Bischoff et al., 2009; de Almeida et al., 2011); while some species such as *A. strictum, A. obclavatum* and *A. zeae* are extensively used in biocontrol studies (Goswami et al., 2008; Choi et al., 2009; Wicklow & Poling, 2009; Sathiyabama & Balasubramanian, 2018). *Clonostachys rosea* is commonly employed as a biological control agent of many fungal plant pathogens, nematodes and insects (Nobre et al., 2005; Cota et al., 2008; Krauss et al., 2013; Sun et al., 2020). *Clonostachys rosea* has also been considered for the biological control of strawberry gray mold (Cota et al., 2008), whitefly (*Bemisia tabaci*) (Anwar et al., 2018), fusarium head blight of wheat (Hue et al., 2009) and *Pythium tracheiphilum* in Chinese Cabbage (M⊘ller et al., 2003). Saprobic species if Bionectriaceae are involved in nutrient cycling (Dighton, 1995).

Bionectriaceae Samuels & Rossman, Stud. Mycol. 42: 15 (1999)

Index Fungorum number: IF82088, Facesoffungi number: FoF01367

Herbicolous, corticolous, lichenicolous, fungicolous, algicolous or coprophilous, mostly in terrestrial or freshwater habitats, rarely in marine habitats, sometimes isolated from soil. **Sexual morph:** *Ascomata* superficial on the substratum or embedded in a weakly or well-developed erumpent stroma, solitary or densely aggregated, crowded, perithecial, rarely cleistothecial, if perithecial, globose, subglobose to pyriform, if cleistothecial, globose, ostiolate or lacking ostioles, white, yellow, orange, reddish-brown, greenish or purple to violet, KOH- (rarely KOH+), LA- (rarely LA+), surface smooth to rough, or warted. *Periphyses* present or absent. *Peridium* of 1–3 strata. *Asci* (2–)8-

spored, unitunicate, clavate, cylindrical, saccate, sessile or short pedicellate, rarely evanescent, apex simple or, with an indistinct or distinct J- apical ring. *Ascospores* uni-seriate, bi-seriate, multi-seriate or irregular, aseptate to multi-septate, sometimes muriform, globose, usually not disarticulating, very rarely disarticulating, fusiform, ellipsoid or broadly ellipsoid, hyaline, walls smooth, spinulose to tuberculate or striate. **Asexual morph:** Hyphomycetous or less commonly ceolomycetous, acremonium-like, gliocladium-like, gyrostroma-like, penicillium-like or stilbella-like, sometimes conidia produced on hyphae. *Conidiophores* dimorphic or monomorphic, mostly sporodochial or synnematous, hyaline, subhyaline to brown or blackish brown, with smooth to finely echinulate-walls. *Conidiogenous cells* phialidic, cylindrical to flask-shaped, hyaline. *Conidia* ellipsoidal, fusiform to subfusiform, sometimes with papillate or truncate ends, aseptate to multi-septate, hyaline to greenish hyaline or olivaceous grey, walls smooth or striate. *Chlamydospores* present or absent (Adapted from Rossman et al., 1999).

Type genus: ***Clonostachys*** Corda

Genera included in Bionectriaceae (* taxonomic notes provided)

Acremonium Link

Anthonectria Döbbeler*

Aphanotria Döbbeler*

Battarrina (Sacc.) Clem. & Shear*

Bryocentria Döbbeler*

Bryotria Döbbeler & P.G. Davison*

Chrysonectria Lechat & J. Fourn.

Clibanites (P. Karst.) P. Karst.*

Clonostachys Corda*

Dimerosporiella Speg.*

Fusariella Sacc.

Geonectria Lechat & J. Fourn. *

Geosmithia J. Pitt

Gliomastix Guég.

Gracilistilbella Seifert

Halonectria E.B.G. Jones*

Heleococcum P.M. Jørg.

Hydropisphaera Dumort*

Laniatria Döbbeler & P.G. Davison*

Lasionectria (Sacc.) Cooke

Lasionectriella Lechat & J. Fourn.*

Mycoarachis Malloch & Cain*

Mycocitrus Möller

Nectriella Nitschke ex Fuckel

Nectriopsis Maire

Nigrosabulum Malloch & Cain*

Ochronectria Rossman & Samuels

Ovicuculispora Etayo*

Paracylindrocarpon Crous, Roets & L. Lombard*

Paranectria Sacc.

Periantria Döbbeler & P.G. Davison*

Pronectria Clem.*

Protocreopsis Yoshim Doi*

Roumegueriella Speg.

Selinia P. Karst.*

Septofusidium W. Gams*

Stephanonectria Schroers & Samuels*

Stilbocrea Pat. *

Synnemellisia N.K. Rao, Manohar. & Goos*

Verrucostoma Hirooka, Tak. Kobay. & P. Chaverri*

Anthonectria Döbbeler, Mycologia 102(2): 405 (2010)

Index Fungorum number: IF514117, Facesoffungi number: FoF10855

Bryophilous, *hyperepiphyllous*; *parasitic* on *Drepanolejeunea* sp. *Hyphae* hyaline, thick-, faintly cyanophilous walled. **Sexual morph:** *Ascomata* perithecial, astromatic, perforating through the host perianth, globose to pyriform, pale to golden-yellow or pale orange, without setae, KOH-. *Ostioles* indefinite, punctiform, periphysate. *Periphyses* filamentous. *Excipulum* 20–30 µm, consisting of irregular, thick-walled

hyphae. *Apical paraphyses* inconspicuous. *Asci* (6-, 7-) 8-spored, unitunicate, varying form, more or less cylindrical, without an apical ring. *Ascospores* uni- or partly biseriate, hyaline, composed of inner fertile cell and outer sterile cell; fertile cell, smaller, 2.5–4 mm diam., ellipsoid to subglobose, sterile cell larger, 6–9 mm diam., subglobose to globose or rarely lunate, wall slightly cyanophilous. **Asexual morph:** *Conidiomata* 25 µm high, pulvinate. *Conidiogenous cells* cylindrical. *Conidia* 1–1.5 µm diam., globose, hyaline (Döbbeler, 2010).

Known distribution: Costa Rica (Döbbeler, 2010)

Notes: Döbbeler (2010) introduced the monotypic genus *Anthonectria* to accommodate *A. mammispora* and classified *Anthonectria* in Bionectriaceae. *Anthonectria* resembles Bionectreaceae by its pale coloured, astromatic perithecia without a KOH reaction (Döbbeler, 2010). No DNA molecular data are available.

Type species: ***Anthonectria mammispora*** Döbbeler, Mycologia 102(2): 405 (2010)

Index Fungorum number: IF514118, Facesoffungi number: FoF10856, Figure 2.2

Parasitic on *Drepanolejeunea* sp. **Sexual morph:** *Ascomata* perithecial, astromatic, develop singly within the distal part of the host perianths, perianth-perforating, globose or pyriform, pale to golden-yellow or pale orange, without setae, KOH-, ostiolate. *Excipulum* 17–30 µm thick, consisting of irregular, hyphae, hyaline to pale yellow. *Asci* 35–52 × 3.5–9 µm, 6–8-spored, unitunicate, of varying form, cylindrical to clavate or obclavate, sessile, delicate-walled, without an apical ring, empty asci with a central, often spirally curved, cytoplasmic strand. *Ascospores* uniseriate to bi-seriate, aseptate, composed of two parts, inner fertile cell 2.5–4.1 µm diam., ellipsoidal or subglobose, with dense cytoplasm content, oriented to the apex or to the base, outer sterile cell 6–8 µm diam., subglobose to globose or lunate, hyaline, smooth-walled. **Asexual morph:** *Conidiomata* about 25 µm tall, pulvinate, ellipsoidal cells (up to 5 mm wide) at base ramify and develop into conidiogenous cells. *Conidiogenous cells* 6 × 1.5 µm diam., cylindrical. *Conidia* 1–1.5 µm diam., globose, hyaline (Asexual morph description adapted from Döbbeler, 2010).

Asexual morph illustrations: see Döbbeler (2010)

Material examined: COSTA RICA, Alajuela: Southern surroundings of the volcano Arenal, Parque Nacional Arenal, 600 m, parasitizing epiphyllous hepatic *Drepanolejeunea* sp., 11 March 2008, P. Döbbeler 8647, (M), M-0299976, **Isotype**.

Notes: Döbbeler (2010) observed the asexual morph (in a leaf axil) only twice in his collection. We observed the isotype specimen of *Anthonectria mammispora*, but did not find asexual morph on the substrate.

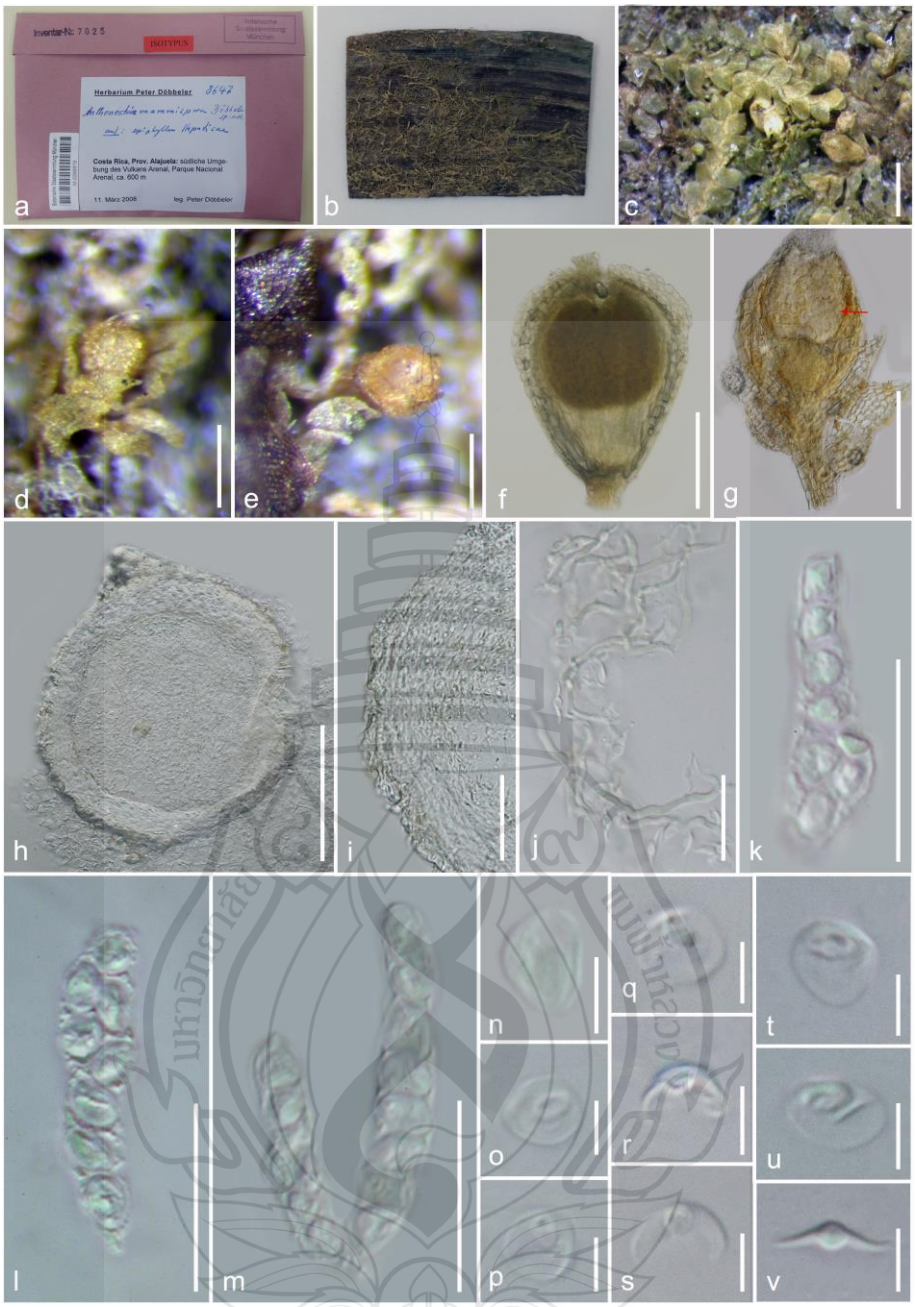
Aphanotria Döbbeler, Mycol. Res. 111(12): 1408 (2007)

Index Fungorum number: IF510591, Facesoffungi number: FoF10857

Bryophilous, *parasitic* on *Polytrichadelphus aristatus*. **Sexual morph:** *Ascomata* perithecial, astromatic, immersed, ellipsoid, hyaline, glabrous, terminating in a rostrum outside the host. *Rostrum* cylindrical or slightly tapering towards the apex, hyaline. *Excipulum and rostrum* composed of longitudinally oriented hyphae, KOH-. *Apical paraphyses* inconspicuous, filamentous, cylindrical, septate. *Asci* 8-spored, unitunicate, cylindrical, straight or slightly curved, apically rounded, without an apical ring. *Ascospores* uniseriate, fusiform, symmetrical, 5-septate, not constricted at the septa, guttualte, hyaline, epispore distinctly warted, cyanophilous. **Asexual morph:** Undetermined (Döbbeler, 2007).

Known distribution: Colombia, Venezuela (Döbbeler, 2007)

Notes: Döbbeler (2007) introduced the monotypic genus *Aphanotria* to accommodate *Aphanotria paradoxa* collected from *Polytrichadelphus aristatus. Aphanotria* is unique in its bryophilous habitat and formation of astromatic, hyaline, KOH- ascomata, immersed with a conspicuous rostrum resembles Bionectriaceae (Döbbeler, 2007). No DNA sequence data are available for the genus.



Note Herbarium material label (b) Herbarium material. (c) Host (d) Uninfected, winged perianth. (e) Infected perianth (f) Uninfected perianth mounted in water. (g) Infected perianth mounted in water (red arrow showing the ascoma). (h) Vertical section of ascoma. (i) Section of peridium in 3% KOH. j Hyphae. k–m Asci. (n–v) Ascospores (n immature, v in 3% KOH). Scale bars: c = 500 µm, d–g = 200 µm, h = 100 µm, i = 50 µm, j–m = 20 µm, n–v = 5 µm.

Figure 2.2 *Anthonectria mammispora* (M-0299976, isotype)

Type species: ***Aphanotria paradoxa*** Döbbeler, Mycol. Res. 111(12): 1408 (2007)

Index Fungorum number: IF510592, Facesoffungi number: FoF10858, Figure 2.3

Parasitic on leaves of *Polytrichadelphus aristatus*. **Sexual morph:** *Ascomata* perithecial, ellipsoid, ending in a rostrum outside the leaf, hyaline, glabrous, KOH-. *Rostrum* cylindrical or slightly tapering towards the apex, often curved, hyaline. *Excipulum* of longitudinally oriented hyphae, in transverse sections composed of small flattened cells, innermost cells rectangular, thin-walled, outer cells with ellipsoid to circular lumina and thickened walls, KOH-. *Asci* 110–180 × 9–11 µm, 8-spored, unitunicate, cylindrical, straight or faintly curved, without an apical ring. *Ascospores* 20–30 × 7–8.5 µm, uniseriate, fusiform, symmetrical, 5- septate, not constricted at the septa, guttulate, hyaline, epispore warted, cyanophilous. **Asexual morph:** Undetermined.

Material examined: COLOMBIA, Department of Cundinamarca, Bogotá Savannah: Páramo de Cruz Verde, on leaves of *Polytrichadelphus aristatus*, Rechard Evans Schultes, May 1951, H 12224, **holotype**.

Battarrina (Sacc.) Clem. & Shear, Gen. fung., Edn 2 (Minneapolis): 279 (1931)

Index Fungorum number: IF526, Facesoffungi number: FoF10859

Fungicolous on *Tuber*. **Sexual morph:** Visible as discoloured areas on the host surface. *Ascomata* about 250 µm, cleistothecial, embedded in the host tissue, globose, hyaline to pale yellow. *Peridium* thin, membranous. *Asci* evanescent, scattered, organised hymenium absent. *Ascospores* globose to angular, aseptate, hyaline, sparsely echinulate. **Asexual morph:** Undetermined (Rossman et al., 1999).

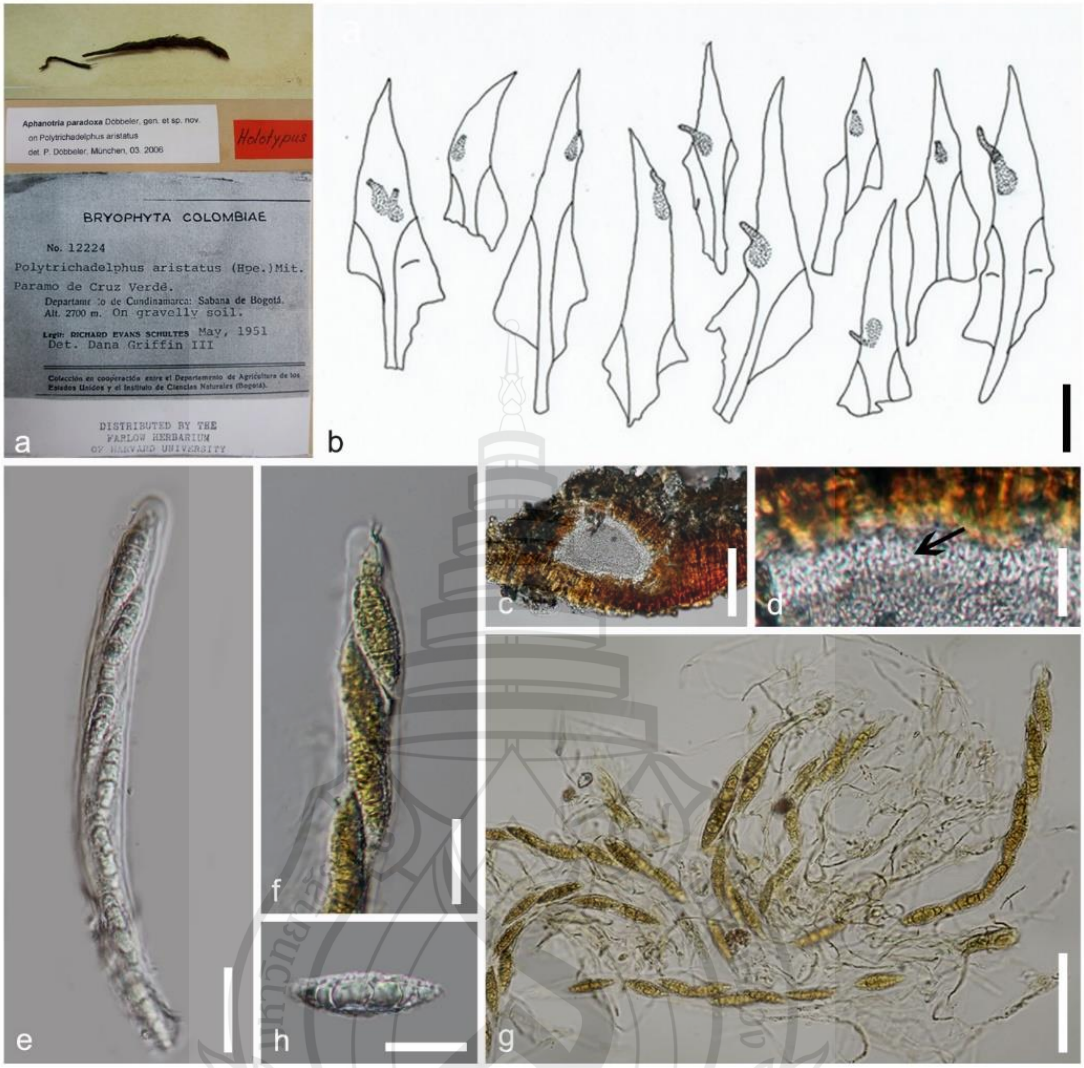
Known distribution: UK (Rossman et al., 1999)

Notes: Saccardo (1883) introduced *Battarrina* as a subgenus of *Hypocrea*, based on *Hypocrea inclusa* Berk. & Broome. Clements and Shear (1931) subsequently elevated *Battarrina* to generic level. Later Rossman et al. (1999) placed this unispecific genus in Bionectriaceae. *Battarrina inclusa* is a rare fungicolous, parasitic species occurring on fruiting bodies of *Tuber* (Clements & Shear, 1931; Hobart, 2016). The genus is known only from the type species and no molecular data are available.

Type species: ***Battarrina inclusa*** (Berk. & Broome) Clem. & Shear, Gen. fung., Edn 2 (Minneapolis): 279 (1931)

Basionym: *Hypocrea inclusa* Berk. & Broome 1861

Index Fungorum number: IF431428, Facesoffungi number: FoF10860, Figure 2.4



Note (a) Herbarium material with label. b Leaves with endobiotic ascomata (redrawn from Döbbeler 2007). (c, d) Transverse section through leaf with an enclosed ascoma (excipulum in arrow). (e) Ascus. (f, g) Asci in Melzor's reagent. (h) Ascospore. Scale bars: b = 1 mm, c = 100 µm, d= 50 µm, e–g = 20 µm, h =10 µm.

Figure 2.3 *Aphanotria paradoxa* (H 12224, holotype)

Parasitic on fruiting bodies of *Tuber puberulum*. Appearing as discoloured areas on the host. **Sexual morph**: *Ascomata* about 50–250 µm diam., cleistothecial, globose, embedded in host tissue, hyaline to pale yellow, lacking ostioles. *Ascomatal wall* membranous, thin, composed of parallel hyphae. *Paraphyses* up to 3.5 µm wide at the

base, septate, filiform, tapering towards the apex, hyaline. *Asci* 24–40 × 4–6 µm, 8-spored, unitunicate, scattered, without an organised hymenium, clavate when young, cylindrical when mature, apex simple, short pedicellate, evanescent, without an apical ring. *Ascospores* 2.6–3.5 µm diam., uniseriate, globose to slightly angular, aseptate, hyaline, thin-walled, sparsely echinulate, echinulations 1 µm high. **Asexual morph**: Undetermined.

Material examined: UK, England, South Somerset, Leigh Woods, on fruit bodies of *Tuber puberulum*, October 1859, E.C. Broome, K(M) 200651, **holotype**.

Note (a) Herbarium material label. (b) Herbarium material. (c) Ascomata immersed in fruit body of *Tuber puberulum*. (d) Section of ascomata. (e) Paraphyses. (f–i) Asci (j) Ascospores. Scale bars: c = 1 mm, d = 50 µm, e–i = 20 µm, j = 5 µm.

Figure 2.4 *Battarrina inclusa* (K(M) 200651, holotype)

Bryocentria Döbbeler, Mycol. Progr. 3(3): 247 (2004)

Index Fungorum number: IF28841, Facesoffungi number: FoF10861

Bryophilous, *biotrophic parasites* or *necrotrophic*, on mosses, thallose liverwort or foliose liverworts. **Sexual morph**: *Ascomata* 100–250 µm diam., perithecial, mostly leaf-perforating, subglobose, ovoid to pyriform, orange, rarely yellow or brown, covered with white hyphae, KOH-. *Setae* absent or few occurring in the apical region, blunt, hyaline. *Ostioles* inconspicuous. *Ostiolar canal* lined with short, filamented periphyses. *Peridium cells* in surface view *textura angularis*. *Apical paraphyses* present, filamentous. *Asci* 8-spored, numerous, cylindrical to clavate, thin-walled, without an apical ring. *Ascospores* up to 10 µm long, 3.5 µm wide, 1-septate, transverse septum not visible (often septum hidden by cyanophilous central band), variable in shape, ellipsoidal, rod-shaped, dumbbell-shaped, fusiform or rhomboid, colourless, epispore smooth or sometimes with cyanophilous warts. **Asexual morph:** *Appressoria* absent. *Intracellular haustoria* present. *Conidiomata* superficial, pulvinate, colourless. *Conidiogenous cells* bottle-like. *Conidia* 3.5–4.5 µm diam., globose, colourless (Adapted from Döbbeler, 2018; Döbbeler & Davison, 2018).

Known distribution: UK, Ireland, Finland, Germany, Austria, Switzerland, Spain, Italy, Greece, Europe, USA, Madagascar, Tanzania, Costa Rica, France, French Guiana, Honduras, Ivory Coast, Uganda, D.R. Congo (Döbbeler & Davison, 2018; Döbbeler, 2004, 2018).

Notes: Döbbeler (2004) introduced *Bryocentria* for *B. brongniartii* and the genus was accepted in Bionectriaceae. Currently there are 15 *Bryocentria* species listed in Species Fungorum (2022), while two species have DNA data. The asexual morph of the genus is only known from *B. perianthiicola* (Döbbeler, 2018). *Bryocentria* species are characterized by orange coloured perithecial ascomata without a KOH reaction, apical setae, differently shaped ascospores usually with a cyanophilous central band and a bryophilous habit (Döbbeler & Davison, 2018).

Type species: ***Bryocentria brongniartii*** (P. Crouan & H. Crouan) Döbbeler, Mycol. Progr. 3(3): 248 (2004)

Basionym: *Nectria brongniartii* P. Crouan & H. Crouan, Florule Finistère (Paris): 37 (1867)

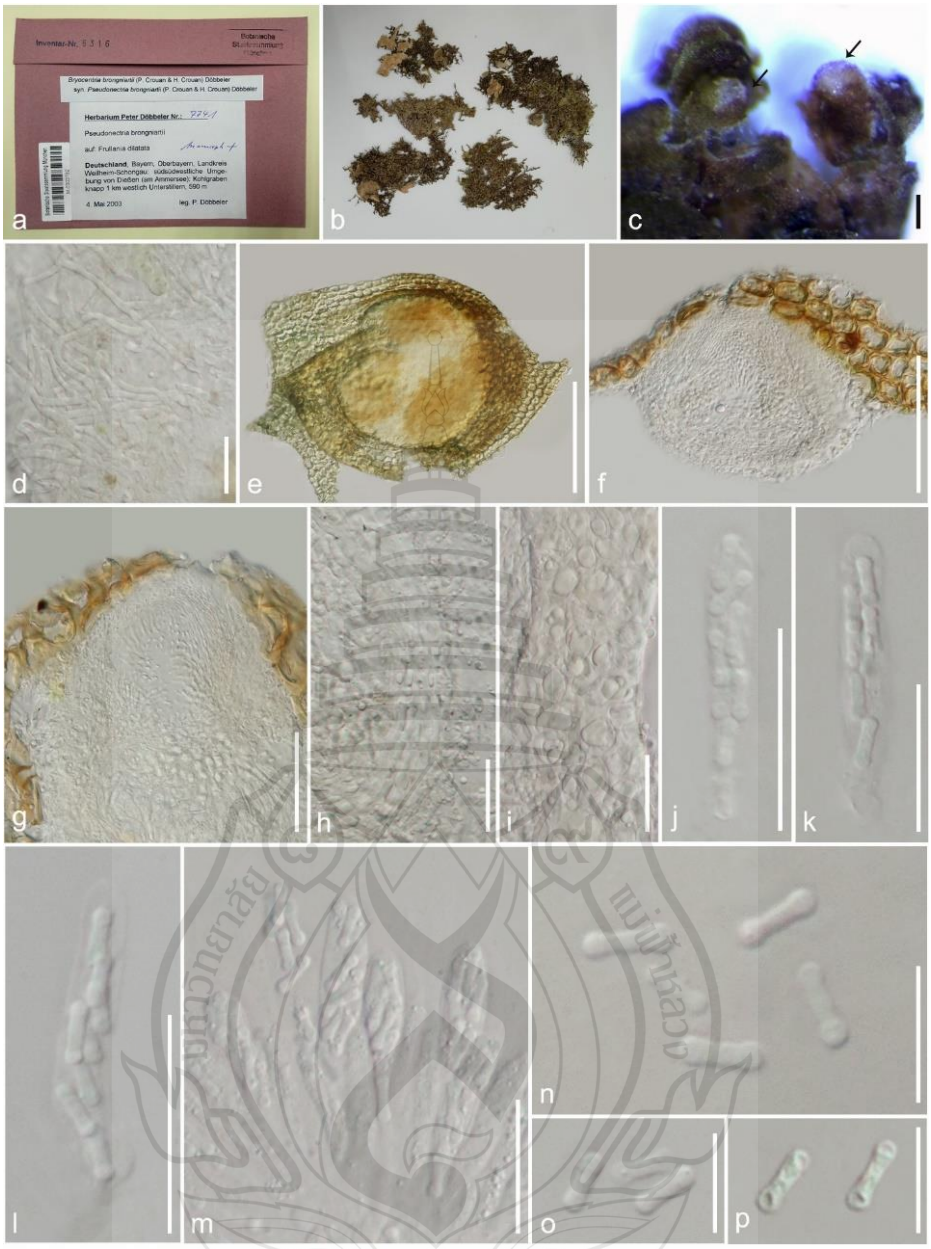
= *Pseudonectria brongniartii* (P. Crouan & H. Crouan) Döbbeler, Mitt. bot. StSamml., Münch. 14: 98 (1978)

Index Fungorum number: IF371392, Facesoffungi number: FoF10862, Figure 2.5

Bryophilous, biotrophic parasite on *Frullania dilatata*. **Sexual morph:** *Mycelium* consisting of arachnoid, hyaine aerial hyphae. *Ascomata* 120–170 high × 160–270 µm diam., perithecial, astromatic, perforating host leaves, globose to subglobose, faintly papillate, ostiolate, KOH-. *Ostiolar canal* periphysate. *Peridium* in surface view composed of 5–12.4 µm wide, globose, hyaline cells; transverse section 12–16 µm wide, apical region up to 30 µm wide, inner cells flattened, hyaline, thin-walled, outer cells globose, hyaline, thick-walled. *Paraphyses* absent. *Asci* 35–43 × 5.6–7.5 µm, 8-spored, unitunicate, cylindrical or clavate, short pedicellate, apex simple. *Ascospores* 6.5–7.4 × 2–2.5 µm, dumbbell-shaped, overlapping bi-seriate to irregularly arranged, 1-septate, septum not clearly visible, hyaline, smooth-walled, without appendages. **Asexual morph:** Undetermined.

Material examined: FRANCE, Dépt. Doubs: Roadside of highway N 83 near Besançon in dicrction Lyon, 15 September 1980, G. & P. Döbbeler 3678, (M), M-0299977, this specimen is in poor condition for the study and we did not observe ascomata on the substrate. GERMANY, Maisinger Schlucht southwest of Starnberg, ca. 630 m alt., 2 November 2002, P. Döbbeler 7627 (M), M-0303781. *ibid.*, Bavaria, Landkreis Weilheim-Schongau, southwestern vicinity of Dießen am Ammersee, Kohlgraben ca. 1 km westof Unterstillern, 590 m alt., on *Frullania dilatata*, 4 May 2003, P. Döbbeler 7741 (M), M-0303782.

Notes: We could not loan the holotype specimen of *Bryocentria brongniartii*, hence we studied authentic specimens of *Bryocentria brongniartii* determined by P. Döbbeler (Figure 2.5).



Note (a, b) Herbarium material label. (b) Herbarium material. (c) Ascoma on the ventral side of host leaves, dorsal view. (d) Hyphae (e) Ascoma perforating host leaf, mounted in water. (f) Longitudinal section of ascoma. (g) Section of ostiole. (h) Section of peridium. (i) Peridium cells with pit-like perforations in face view. (j–p) Asci (k–m in 3% KOH). (n–p) Ascospores in 3% KOH. Scale bars: c = 100 µm, d = 20 µm, e = 200 µm, f = 100 µm, g = 50 µm, h–m = 20 µm, n–p = 10 µm.

Figure 2.5 *Bryocentria brongniartii* (M-0303782)

Bryotria Döbbeler & P.G. Davison, Nova Hedwigia 106(1-2): 232 (2017) [2018]

Index Fungorum number: IF821323, Facesoffungi number: FoF10863

Biotrophic or *necrotrophic* parasites on leafy liverworts. **Sexual morph:** *Ascomata* perithecial, perforating the leaf, subglobose to pyriform, often with a flattened disc at the apex, yellowish to orange-red, surface hairy, not reacting with KOH or iodine, ostiolate, *Setae* usually present, short, blunt, with cyanophilous walls, usually occurring on the apex of the perithecium. *Ostioles* inconspicuous, punctiform, with a richly periphysate ostiolar canal. *Peridium* multilayered, composed of flattened, laterally stretched cells, *textura angularis* in face view, covered by more or less adjacent, irregularly oriented, hyaline or yellowish hyphae, often with cyanophilous walls. *Apical paraphyses* present, variable in shape and size, delicate, evanescent. *Asci* numerous, unitunicate, 8-spored, cylindrical to subclaviform or subfusiform, thin-walled, apex simple without an apical ring. *Ascospores* hyaline, two-celled; small cell narrowly ellipsoidal, with rich in cytoplasm; appendage-like larger cell ellipsoidal or subcylindrical to club-shaped, often with cytoplasm less dense. **Asexual morph:** Undetermined (Adapted from Döbbeler & Davison, 2018).

Known distribution: USA, Italy, Greece (Döbbeler & Davison, 2018)

Notes: Döbbeler and Davison (2018) introduced *Bryotria* for taxa discovered from *Frullania* and *Porella* species (Döbbeler & Davison, 2018). The characteristic features of the genus are unique ascospore characters and parasitic lifestyle on liverworts (Döbbeler & Davison, 2018). *Bryotria adelpha* and *B. foertheri* grow biotrophically, while *B. lagodes* and *B. urophora* are necrotrophic parasites of leafy liverworts (Döbbeler & Davison, 2018). The genus was placed in Bionectriaceae by Döbbeler and Davison (2018). Currently there are four known species of *Bryotria* (Döbbeler & Davison, 2018). No molecular data are available.

Type species: ***Bryotria urophora*** Döbbeler & P.G. Davison, Nova Hedwigia 106(1-2): 237 (2017) [2018]

Index Fungorum number: IF821327, Facesoffungi number: FoF10864

Descriptions and illustrations: see Döbbeler & Davison (2018)

Clibanites (P. Karst.) P. Karst., Bidr. Känn. Finl. Nat. Folk 19: 167 (1871)

Index Fungorum number: IF1107, Facesoffungi number: FoF10865

Sexual morph: *Stromata* superficial, composed of hyphae interwoven in the middle and the base, and highly compacted near the surface. *Ascomata* perithecial, embedded in a stroma, loosely joined in clusters up to 10, globose, dark yellow, not collapsing on drying, ostiolate. *Ostioles* apapillate, ostiolar canal lined with periphyses. *Peridium* of singal stratum, up to 10 µm thick, composed of several layers of small, flattened cells. *Asci* 8-spored, unitunicate, sessile, subcylindrical with a broad, blunt apex, with a J- apical ring. *Ascospores* bi-seriate, narrowly cylindrical, equally 1-septate, not constricted at septum, hyaline, smooth-walled. **Asexual morph:** Undetermined (Adapted from Rossman et al., 1999).

Known distribution: Finland (Rossman et al., 1999)

Notes: Karsten (1871) introduced monotypic genus *Clibanites* for *Clibanites paradoxa*, which was collected from *Quercus* wood. He documented *Clibanites paradoxa* as a discomycete with sessile apothecia. However, Rossman et al. (1999) re-examined the type herbarium material and placed *Clibanites* in Bionectriaceae based on morphological features such as "small, thin-walled, pallid ascomata and not dissarticulating ascospores". We also observed the type herbarium material of *Clibanites paradoxa* and made similar observations with Rossman et al. (1999). The genus is known only from the type species and no molecular data are available yet. The taxonomic treatment by Rossman et al. (1999) has been followed by many authors (Lumbsch & Huhndorf, 2010; Hyde et al., 2020; Maharachchikumbura et al., 2015, 2016; Wijayawardene et al., 2020, 2022).

Type species: ***Clibanites paradoxa*** (P. Karst.) P. Karst., Bidr. Känn. Finl. Nat. Folk 19: 167 (1871)

= *Peziza paradoxa* P. Karst., Not. Sällsk. Fauna et Fl. Fenn. Förh. 10: 155 (1869)

Index Fungorum number: IF487336, Facesoffungi number: FoF10866, Figure 2.6

Associated with decorticated wood of *Quercus*. **Sexual morph:** *Stromata* composed of hyphae, superficial, loosely attached to the host substrate, brownish orange, KOH-. *Ascomata* 120–160 µm, apothecial, embedded in a stroma, aggregated in groups of 2–10, globose, not collapsing upon drying, dark yellow, KOH-, ostiolate. *Ostioles* apapillate, ostiolar canal lined with periphyses. *Peridium* of single stratum, up to 10 µm, composed of several layers of flattened, hyaline cells. *Paraphyses* absent. *Asci* 25–30 µm × 4–5 µm ($\bar{x}$ = 27.8 × 4.6 µm), 8-spored, unitunicate, sessile, subcylindrical with a broad,

blunt apex, apical ring J-. *Ascospores* 7–10 µm × 1.5–2 µm ($\bar{x}$ = 8.4 × 1.7 µm), bi-seriate, long cylindrical, 1-septate, not constricted at septum, straight or faintly curved, hyaline, smooth-walled. **Asexual morph:** Undetermined.

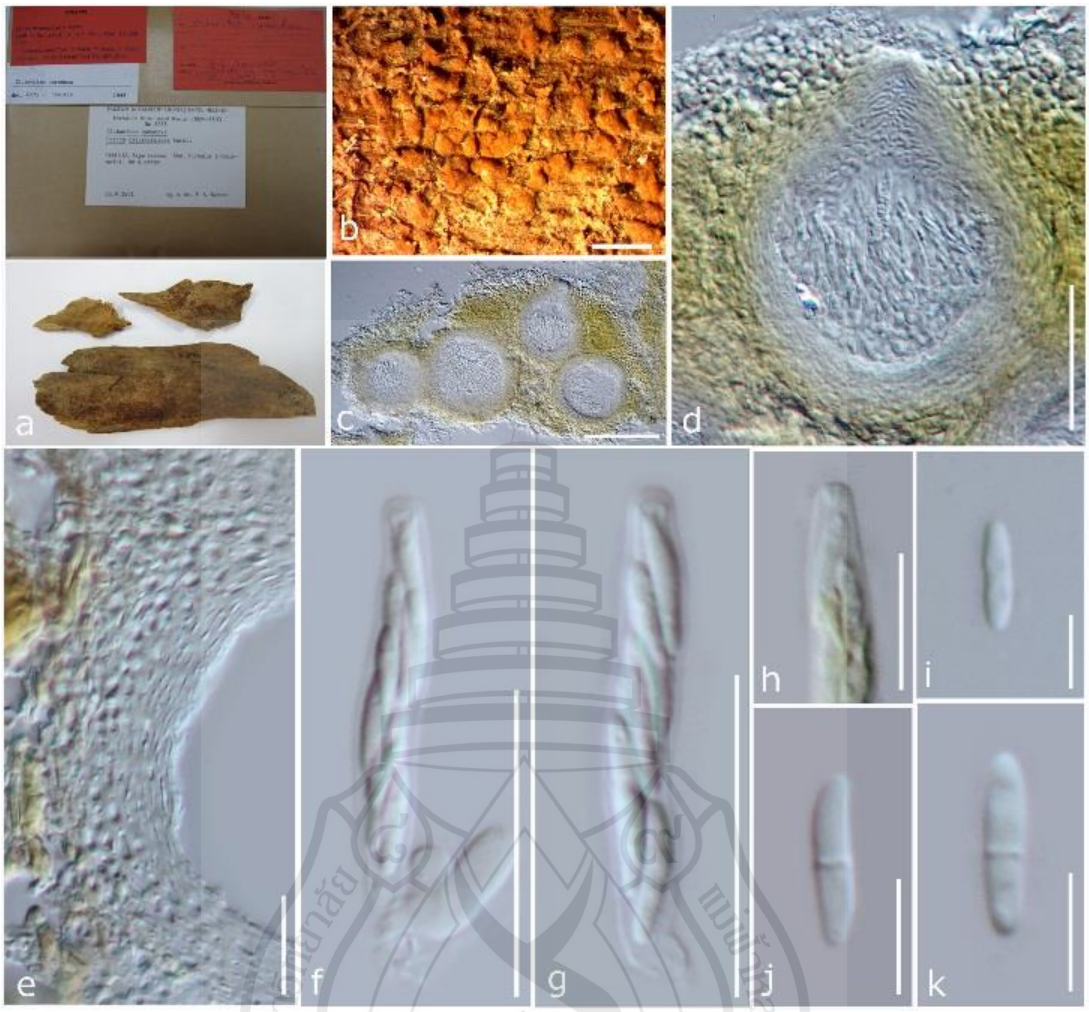
Material examined: FINLAND, Runsala, on wood of *Quercus*, 26 May 1861, P.A. Karsten, 3365 (H), H6051508, **holotype**.

Clonostachys Corda, Pracht-Fl. Eur. Schimmelbild.: 31 (1839)

= *Bionectria* Speg., Boln Acad. nac. Cienc. Córdoba 23(3– 4): 563 (1919) [1918]

Index Fungorum number: IF7701, Facesoffungi number: FoF02102

Herbicolous, *corticolous* or *fungicolous*, sometimes isolated from soil. **Sexual morph:** *Ascomata* usually borne on a well-developed, erumpent stroma, rarely superficial on substratum, aggregated in groups of large numbers, sometimes solitary, perithecial, globose, slightly papillate, without a neck, ostiolate, shades of orange, yellowish orange, pale orange, light orange, brownish orange, KOH-, LA-, surface smooth to roughen or warted. *Peridium* of two or three strata; outer stratum consisting of angular to subglobose cells, merging into the stroma and into the cells of warts (when present), middle stratum of intertwined hyphae forming a *textura intricata* in surface view, inner stratum of layers of lobed cells, with conspicuous pseudopores in the cell wall. *Apical paraphyses* persistence or disappear prior to maturity. *Asci* 8-spored, unitunicate, clavate, apex rounded, flat, or with prominent edges, with or without an apical ring. *Ascospores* ellipsoid, 0–1-septate, not separating into part-spores, hyaline, smooth-walled, spinulose to tuberculate or striate. **Asexual morph:** Hyphomycetous. *Conidiophores* dimorphic or monomorphic, usually differentiated into a stipe and a branched part (penicillus), hyaline, smooth-walled.



Note **a** Herbarium material with label **b** Stromata on host surface **c** Transverse section of stroma with ascomata **d** Transverse section of a ascoma with ostiole **e** Transverse section of peridium **f, g** Asci **h** Ascus apex in Melzer's reagent **i–k** Ascospores. Scale bars: b = 500 µm, c = 100 µm, d, e = 50 µm, f, g = 20 µm, h = 10 µm, i–k = 5 µm.

Figure 2.6 *Clibanites paradoxa* (H6051508, holotype)

Primary conidiophores mononematous, initially formed, sparsely branched, branches and phialides divergent or adpressed, mono- to terverticillate or more-level verticillate, stipes long in relation to the penicilli. *Phialides born on primary conidiophores* relatively long, intercalary phialides absent, conidia held in watery heads. *Secondary conidiophores* mononematous or synnematous, or sporodochial, mostly

frequently branched, bi- to quaterverticillate or more-level verticillate, side branches and phialides divergent and/or adpressed, stipes relatively short or of same height as the penicillus. *Phialides born on secondary conidiophores* relatively short, intercalary phialides absent to abundant, conidia imbricate, held in chains or columns that can collapse to slimy masses. *Conidiogenous cells* phialidic, cylindrical to flask-shaped, with or without truncate apex in secondary conidiophores. *Conidia* ellipsoidal to subfusiform, 0-1-septate, somewhat curved, often with a slightly flattened side, and a laterally displaced hilum, rarely straight with an almost median hilum or entirely symmetrical without a visible hilum, hyaline or greenish, walls smooth or very rarely ornamented. (Adapted from Schroers, 2001; Maharachchikumbura et al., 2016).

Notes: Corda (1839) introduced genus *Clonostachys* based on *Clonostachys araucaria* (current name *Clonostachys rosea*). However, no type material of *Clonostachys araucaria* is currently available, but only original descriptions and drawings (Schroers et al., 1999). Based on morphological similarity Schroers et al. (1999b) recognised *Clonostachys rosea* as the asexual morph of *Bionectria ochroleuca* and, it was confirmed in the phylogenetic studies by Schroers (2001). Schroers et al. (1999b) and Schroers (2001) also suspected *Clonostachys araucaria* should be a synonym of *Clonostachys rosea*. Rossman et al. (2013) linked sexual morphic genus *Bionectria* to *Clonostachys* by giving priority to older and frequently used name *Clonostachys*. Currently there are 73 epithets listed in Species Fungorum (2022) under *Clonostachys*. *Clonostachys* species are characteristics by producing sexual morphs of globose to subglobose perithecial ascomata, narrowly clavate asci with ellipsoidal ascospores (Schroers, 2001). The conidiophores are verticillate or penicillate, phialides arranged in whirls producing typically hyaline, less commonly greenish to olivaceous or green conidia (Schroers, 2001).

The holotype of *Clonostachys moreaui* (CLL19024) clusters within *Clonostachys rosea* in current phylogenetic analyses (Figure 2.7). *Clonostachys moreaui* only has LSU data in the GenBank, which is almost similar to LSU sequnces of *Clonostachys rosea*. Because of morphological differences and lack of other gene regions we keep *Clonostachys moreaui* and follow Lechat et al. (2020).

Type species: ***Clonostachys rosea*** (Link) Schroers, Samuels, Seifert & W. Gams, Mycologia 91(2): 369 (1999)

≡ *Clonostachys araucaria* Corda, Pracht-Fl. Eur. Schimmelbild.: 31 (1839)

≡ *Bionectria ochroleuca* (Schwein.) Schroers & Samuels, Z. Mykol. 63(2): 151 (1997)

Index Fungorum number: IF461067, *Facesoffungi number*: FoF06012

Descriptions and illustrations: see Schroers (2001).

Clonostachys agarwalii (Kushwaha) Schroers [as 'agrawalii'], Stud. Mycol. 46: 90 (2001)

Basionym: *Gliocladium agarwalii* Kushwaha, Curr. Sci. 49(2): 74 (1980)

Index Fungorum number: IF485123, Fig. 2.7

On dead twigs of *Lagerstroemia*. **Sexual morph:** Undetermined. **Asexual morph:** *Conidimata* sporodochial. *Sporodochia* somewhat synnematous, short stipitate, scattered or arrange is small groups on the substrate. *Stipe* up to 145 μm tall, 95–250 μm wide. *Conidiophores* 23–30 × 2–2.5 μm ($\bar{x}$ = 27 × 2.5 μm, n = 15), monomorphic, penicillate, mononematous, densely aggregated, short stipitate, septate, hyaline, smooth-walled. *Conidiogenous cells* arrange in groups of 2 at the tip of conidiophores, 10–15 × 2.1–3.3 μm ($\bar{x}$ = 12.7 × 2.8 μm, n = 25), phialidic, narrowly flask-shaped, straight to slightly curved, tip with a periclinal thickening, with a visible collarette, hyaline, smooth-walled. *Conidia* 3.5–5.1 × 2.2–2.7 μm ($\bar{x}$ = 4 × 2.5 μm, n = 55), ovoid to ellipsoid, somewhat curved or straight, mostly with a slightly flattened side, aseptate, hilum laterally displaced, arranged in imbricate white to pale orange columns, can breakdown into slimy masses, smooth-walled.

Material examined: Thailand, Chiang Mai, Mae Rim, dead twigs of *Lagerstroemia* sp. (Lythraceae), 18 September 2017, R. H. Perera, Rim15, MFLU 19-0976, living culture MFLUCC 18-0568.

GenBank number: ITS: OM276726, LSU: OM276821, TEF1: OM283276.

Known distribution (based on molecular data) – India (Schroers 2001), Thailand (this study)

Known hosts: decomposing buffalo horn pieces (Schroers 2001), *Lagerstroemia* sp. (this study)

Notes: Our new isolate (MFLUCC 18-0568) grouped with *Clonostachys agarwalii* (CBS 533.81) and, three endophytic *Chonostachys* isolates (DJL25, DJL21 and DJL16) obtained from root samples of *Changnienia amoena* (Orchidaceae) in China. No

morphological data have been provided for those endophyte isolates (Weimei et al. 2011). Our collection (MFLU 19-0976) is fitting the descriptions and, conidiogenous cells and conidial measurements of *Clonostachys agarwalii* provided by Schroers (2001). With the evidence of phylogenetic analysis and morphology we identify our new isolate as *Clonostachys agarwalii*. We collected sporodochia of the fungus from natural substrate, but no sporodochia were reported *in vitro* cultures of the fungus so far (Schroers 2001). In this paper we illustrate *Clonostachys agarwalii* growing on a dead twigs of *Lagerstroemia* sp., which is a new host and a geographical record of the fungus.

Clonostachys leucaenae R. H. Perera & K. D. Hyde, ***sp. nov.***

Index Fungorum number: IF559629, Facesoffungi number: FoF10867, Figure 2.9

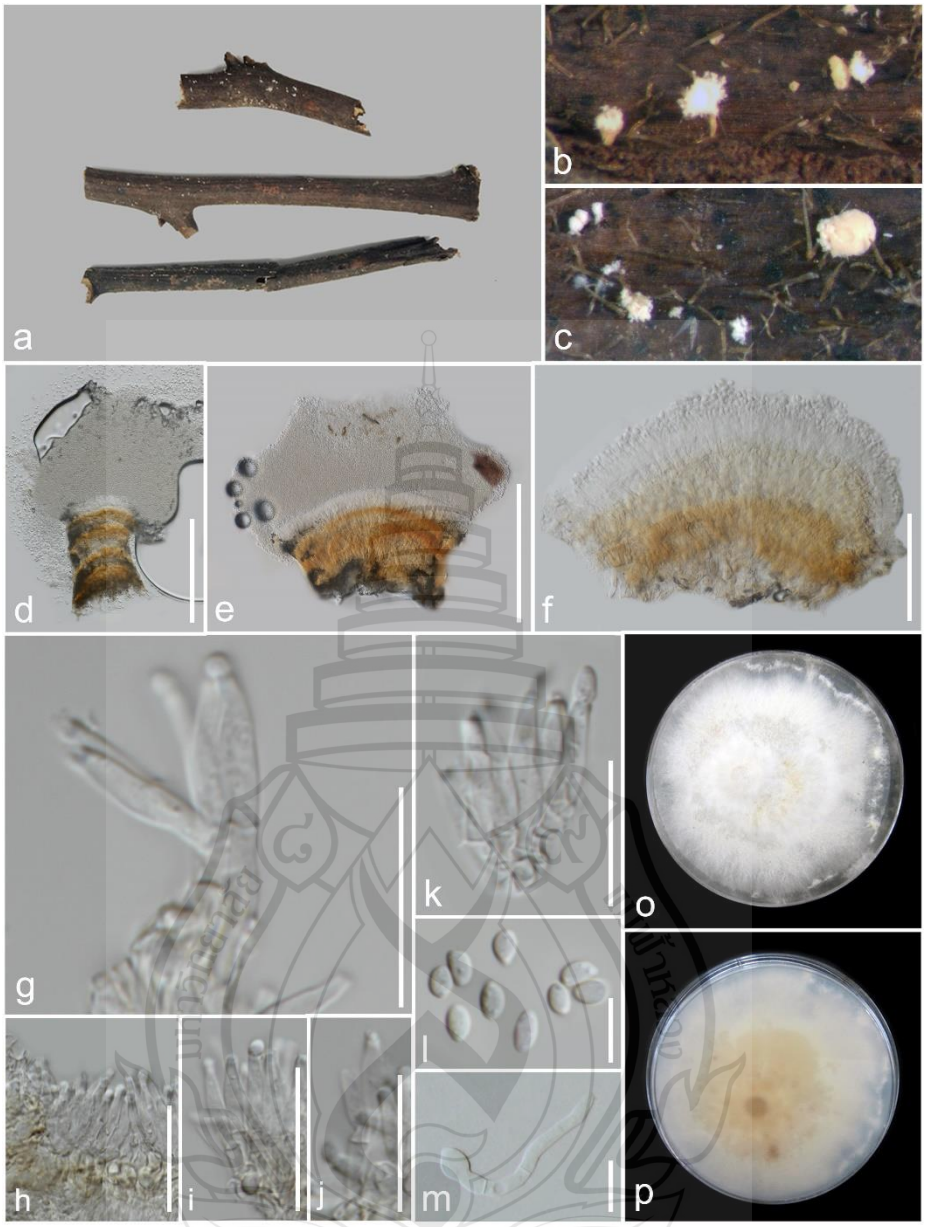
Etymology: Name refers to the host genus *Leucaena* from which it was collected.

Saprobic on stems of *Leucaena leucocephala*. **Sexual morph:** *Ascomata* 250–375 µm diam., perithecial, solitary or aggregated in groups, seated on erumpent stroma, globose to subglobose-depressed, apapillate, with a periphysate ostiolar canal, laterally pinched upon drying, pale yellow, KOH-, surface warted. *Peridium* 20–90 thick, of three strata; outer stratum 25–75 µm, thick including warts, consisting of hyaline, angular to globose, uniformly thin-walled cells, forming perithecial warts; middle stratum 3–4 cell layers thick, consisting of pale brown, angular, thick walled cells; inner stratum 5–6 cell layers thick, consisting of hyaline, elongate, thick walled cells. *Asci* 42–60 × 6–11 µm ($\bar{x}$ = 47 × 7.6 µm; n = 18), 8-spored, unitunicate, clavate, 8-spored, ascospores biseriate above and uniseriate below, short pedicellate, apically flat, with a J- apical ring. *Ascospores* ellipsoid to fusoid, 12–17 × 4–5.8 µm ($\bar{x}$ = 13.8 × 4.7 µm; n = 30), 1-septate, not constricted at the septum, straight to slightly curved, guttulate, hyaline, pale brown when mature, striate, without sheaths or appendages. **Asexual morph:** Undetermined.

Culture characteristics: Colony on MEA reaching 45 mm in 7 days at 25ºC. Colony surface white or pale yellowish, zonate, aerial mycelium abundant in the centre; reverse brownish yellow becoming white at the margins.

Material examined: THAILAND, Chiang Mai Province, Mae Rim District, on recently dead stem bark of *Leucaena leucocephala* (Fabaceae), 18 September 2017, R. H. Perera, Rim09, (MFLU 19-0970, **holotype**), **ex-type** living culture MFLUCC 20-0008.

GenBank numbers: ITS: ON230050, LSU: ON230058



Note (a) Herbarium material. (b, c) Sporodochia on the substrate. (d–f) Sporodochia mounted in water. (g–k) Conidiophores with phialides and conidia. (l) Conidia. (m) Germinating conidium. (o, p) Colony on PDA. Scale bars: d, e = 200 µm, f = 50 µm, g–i = 20 µm, j, k = 10 µm.

Figure 2.7 *Clonostachys agarwalii* (MFLU 19-0976, new host and new geographical record)

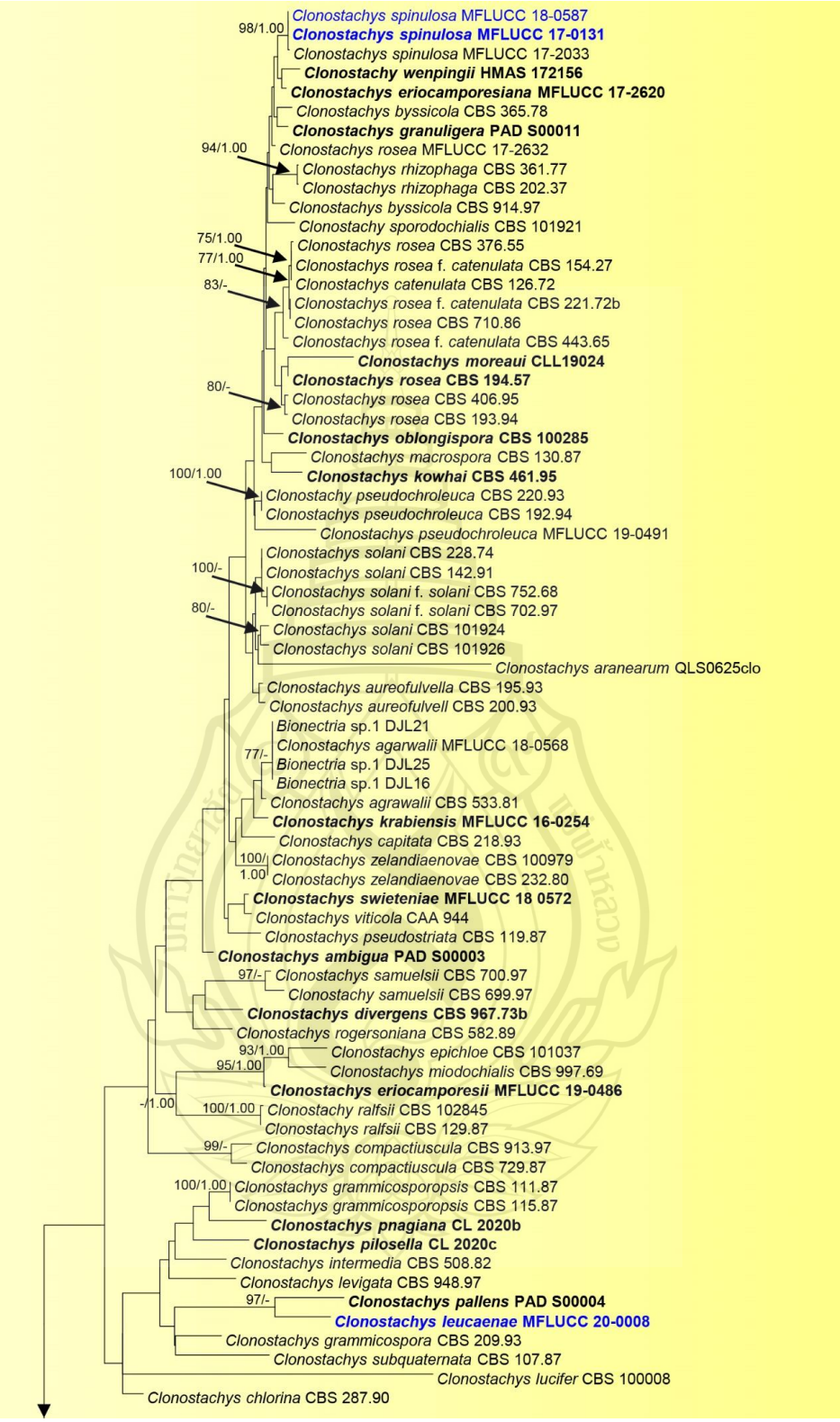
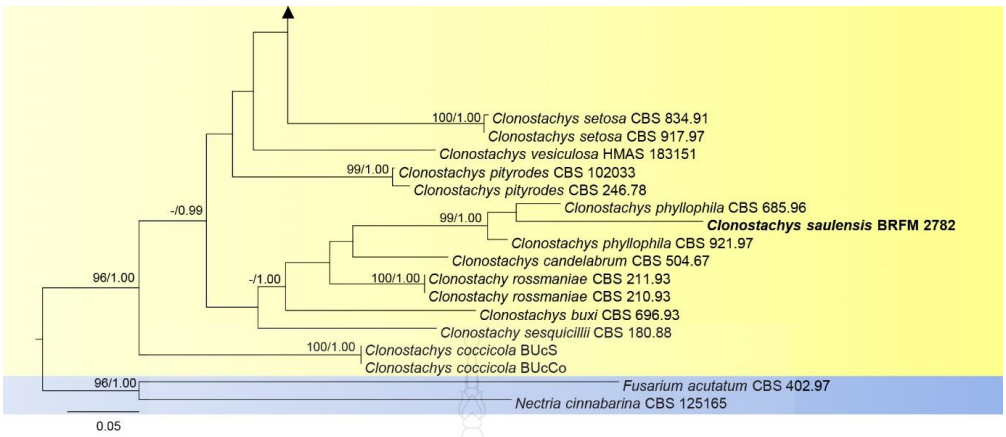


Figure 2.8 Phylogram generated from maximum likelihood analysis based on combined ITS, LSU, TEF1 and TUB2 sequence data of *Clonostachys* taxa



Note Ninety strains are included in the combined analyses, which comprised 2473 characters (ITS: 532, LSU: 859, TEF1: 412, TUB2: 670) including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes respectively. The tree is rooted to *Fusarium acutatum* (CBS 402.97) and *Nectria cinnabarina* (CBS 125165). Ex-type strains are in **bold**. The newly generated sequences are indicated in blue. The scale bar indicates 0.06 nucleotide changes per site.

Figure 2.8 (continued)

Notes: *Clonostachys leucaenae* is morphologically and phylogenetically closely related to *Clonostachys pallens* (PAD S00004) (97% MLBT, Figure 2.7). Ascomata and asci dimensions of *C. leucaenae* are similar to *C. pallens* (Forin et al. 2020). *Clonostachys leucaenae* is morphologically distinguishable from *C. pallens* by its warted ascomatal surface and having smaller ascospores than the latter species (12–17 vs 16.2–18.2 µm) (Forin et al. 2020). There are 25 nucleotides differences (5.1%, 4 gaps) between *C. leucaenae* (MFLUCC 20-0008) and *C. pallens* (PAD S00004) ITS sequences. We therefore, introduced *C. leucaenae* as a new species.

Note (a) Herbarium material. (b, c) Ascomata on host substrate. (d) Vertical section of ascoma. (e) Face view of peridium. (f–i) Asci. (j–m) Ascospores. (n) Germinating ascospore. (o, p) Colony on PDA. Scale bars: d = 200 µm, e = 10 µm, f–i = 20 µm, j–n = 10 µm.

Figure 2.9 *Clonostachys leucaenae* (MFLU 19-0970, holotype)

Clonostachys eriocamporesii R.H. Perera & K.D. Hyde, ***sp. nov.***

Index fungorum number: IF556897, Facesoffungi number: FoF 06964, Fig. 2.10

Etymology: Named after the collector Erio Camporesi

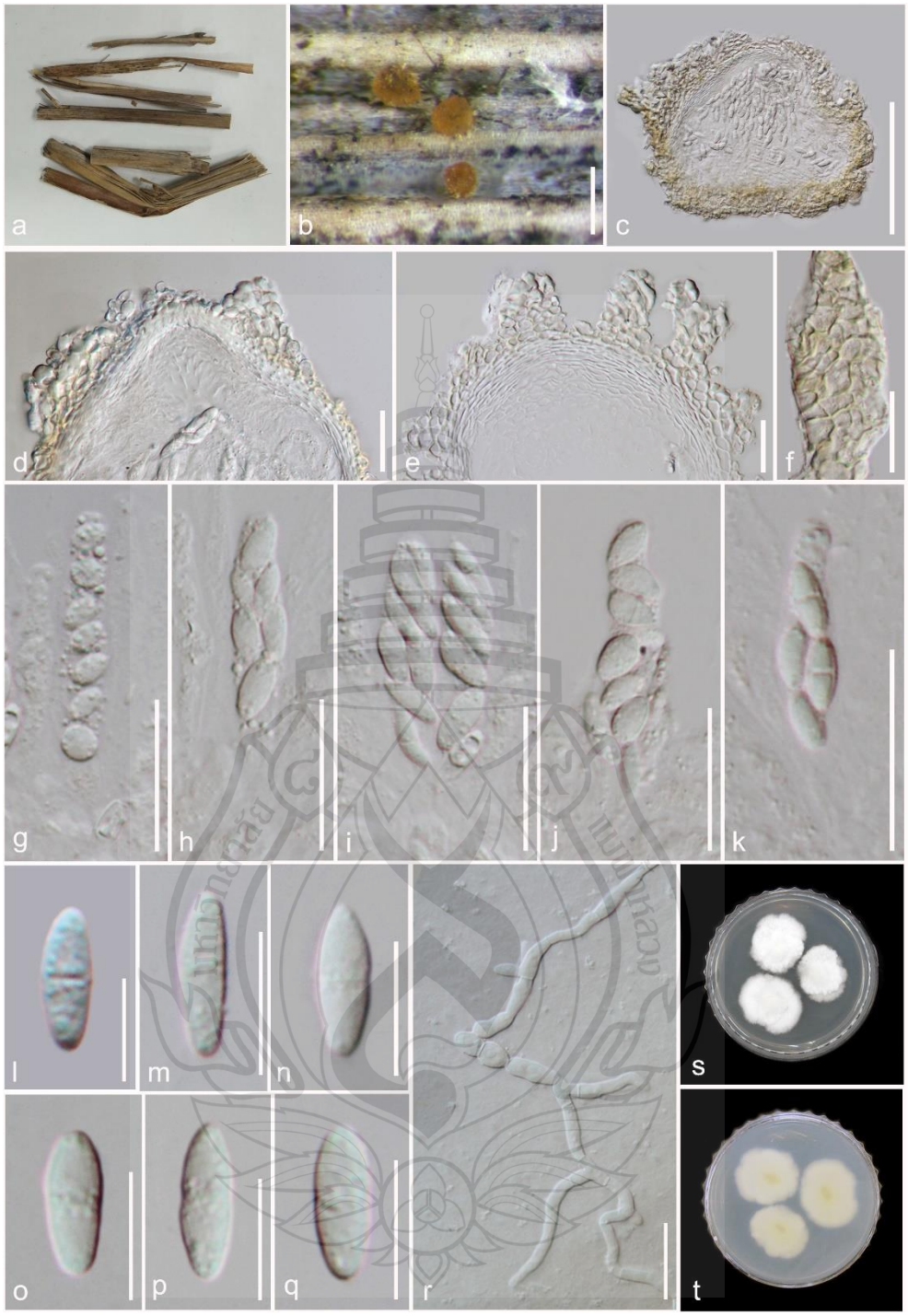
Saprobic on stems of *Pennisetum polystachion.* Stromata absent. ***Sexual morph:*** *Ascomata* 90–150 × 80–170 μm ($\bar{x}$ = 118 × 119 μm), perithecial, superficial, solitary to gregarious, globose to subglobose, not collapsing or sometimes slightly laterally pinched when dry, yellowish orange, KOH-, slightly papillate, surface warted. *Ostiole* periphysate. *Perithecial warts* 30 μm high, mostly developed in the upper part of the ascomata, off-white to yellowish white, cells angular to globose with unevenly thickened walls. *Peridium* 15–21 μm thick, composed of two regions: outer region 5–11 μm, 2–3 cells thick, cells angular to globose, with uniformly thickened walls, merging with the cells of the warts, vacuoles not observed; inner region 9–17 μm thick, composed of flat hyaline cells. *Paraphyses* absent. *Asci* 40–52.5 × 7.4–9.4 μm ($\bar{x}$ = 44.8 × 8 μm, n = 20), 4, 6 or 8-spored, unitunicate, cylindrical to narrowly clavate, apex flat with somewhat rounded edges, short stalked, apical ring J-. *Ascospores* 10–12.7 × 2.7–4.2 μm ($\bar{x}$ = 11.3 × 3.5 μm, n = 30), bi-seriate to uni-seriate, medianly or sub-medianly1-septate, equilateral or inequilateral, slightly constricted at the septum, ellipsoidal to occasionally sub-globose, multi-guttulate, hyaline, smooth-walled. **Asexual morph:** Undetermined.

Culture characteristics: Ascospores germinating on PDA within 12h. Colonies growing on PDA, reaching up to 20 cm in 7 days at 28°C, surface effused, smooth, margin entire to undulate, aerial mycelium abundant, zonate, white, reverse white.

Material examined: THAILAND, Southern Thailand, on dead stems *Pennisetum polystachion* (L.) Schult. (Poaceae), 11 November 2017, A. Karunarathne, Bion 78 (MFLU 18-2718, holotype), ex-type living culture MFLUCC 19-0486.

GenBank numbers: ITS: MN699133, LSU: MN699128

Notes: New isolate (MFLUCC 19-0486) clusters sister to ex-type of *Clonostachys epichloë* (CBS 101037) and *C. miodochialis* (CBS 997.69) with high statistical support (100% MLBT, 100% BYPP; Fig.x). DNA sequences of *C. siamense* and *C. epichloë* (CBS 101037) differed in 6 nucleotides of the ITS region (1.1%), and 4 nucleotides of LSU region (0.8%). DNA sequences of new fungus and ex-type of *C. parva* (CBS 997.69) differed in 8 nucleotides of the ITS region (1.6%), and 10 nucleotides of LSU region (1.2%). *Clonostachys eriocamporesii* similar to *C. epichloë* and *C. parva* in having perithecial warts (Schroers 2001). However, it can be differed from *C. epichloë* by larger ascospores (10–12.7 vs. 9–10.8 μm) (Schroers 2001). *Clonostachys camporesia* can be



Note (a) Herbarium material. (b) Ascomata on host. (c) Section of ascomata. (d) Section of ostiole. (e) Section of peridium. (f) Face view of peridium. (g–k) Asci. (l–q) Ascospores. (r) Germinating ascospore. (s, t) Colony on PDA. Scale bars: b = 200 µm, c = 100 µm, d–k = 20 µm, l–q = 10 µm, r = 20 µm.

Figure 2.10 *Clonostachys eriocamporesii* (MFLU 18-2713, holotype)

distinguished from *C. parva* in having smooth-walled, smaller ascospores while *C. parva* has finely spinulose, larger ascospores (10–12.7 vs. 12.2–13.4 μm) (Schroers 2001). We therefor introduce *C. eriocamporesii* as a novel taxon.

Clonostachys eriocamporesiana R.H. Perera & K.D. Hyde, ***sp. nov.***

Index fungorum number: IF556896, Facesoffungi number: FoF 06963, Fig. 2.11

Etymology: Named after the collector Erio Camporesi

On ascomata of Botryosphaeriaceae fungus. **Sexual morph:** *Stromata* well developed, erumpent. *Ascomata* 160–260 × 160–285 μm ($\bar{x}$ = 200 × 218 μm), perithecial, solitary or densely crowded in groups, globose to subglobose, not collapsing or sometimes slightly laterally pinched when dry, light orange, KOH-, slightly papillate, surface smooth to slightly roughened, but not distinctly warted. *Ostiole* periphysate. *Hamathecium* of catenophyses, up to 9.5 wide, septate, hyaline. *Peridium* 32–40 μm wide, two regions: outer region 21–30 μm wide, comprising unevenly thickened hyaline to brownish yellow cells of *textura globosa*, becoming larger towards the periphery, most cells containing a vacuole; inner region 10–16 wide, consists with, flat, hyaline cells of *textura angularis*. *Asci* 58–66 × 7.3–10.3 μm ($\bar{x}$ = 61.4 × 8.8 μm, n = 20), 8-spored, unitunicate, narrowly clavate, apex flat with somewhat rounded edges, short stalked, apical ring J-. *Ascospores* 10.5–15.2 × 3.6–4.4 μm ($\bar{x}$ = 12.5 × 4 μm, n = 30), bi-seriate to uni-seriate, medianly or sub-medianly1-septate, equilateral or inequilateral, not constricted at the septum, ellipsoidal, 2–4-guttulate, hyaline, spinulose when mature. **Asexual morph:** Undetermined.

Culture characteristics: Ascospores germinating on PDA within 12 h. Colonies growing on PDA, reaching up to 26 cm in 7 days at 28°C, surface effused, smooth, margin entire to undulate, aerial mycelium abundant, white, reverse white, yellowish at the center.

Material examined: THAILAND, Phyao Province, Phachang Noi Pong Distrisct, on ascomata of Botryosphaeriaceae fungus on dead stems of *Chromolaena odorata* (L.) R. M. King & H. Rob. (Asteraceae), 09 November 2017, R.H. Perera, Bion 21 (MFLU 18-2713, holotype), ex-type living culture MFLUCC 17-2620.

GenBank numbers: ITS: MN699132, TEF1: MN699964, TUB2: MN699965

Notes: New isolate clusters with ex-type of *Clonostachys wenpingii* (HMAS 172156) and *C. byssicola* (CBS 364.78) with low statistical support. However, *C.*

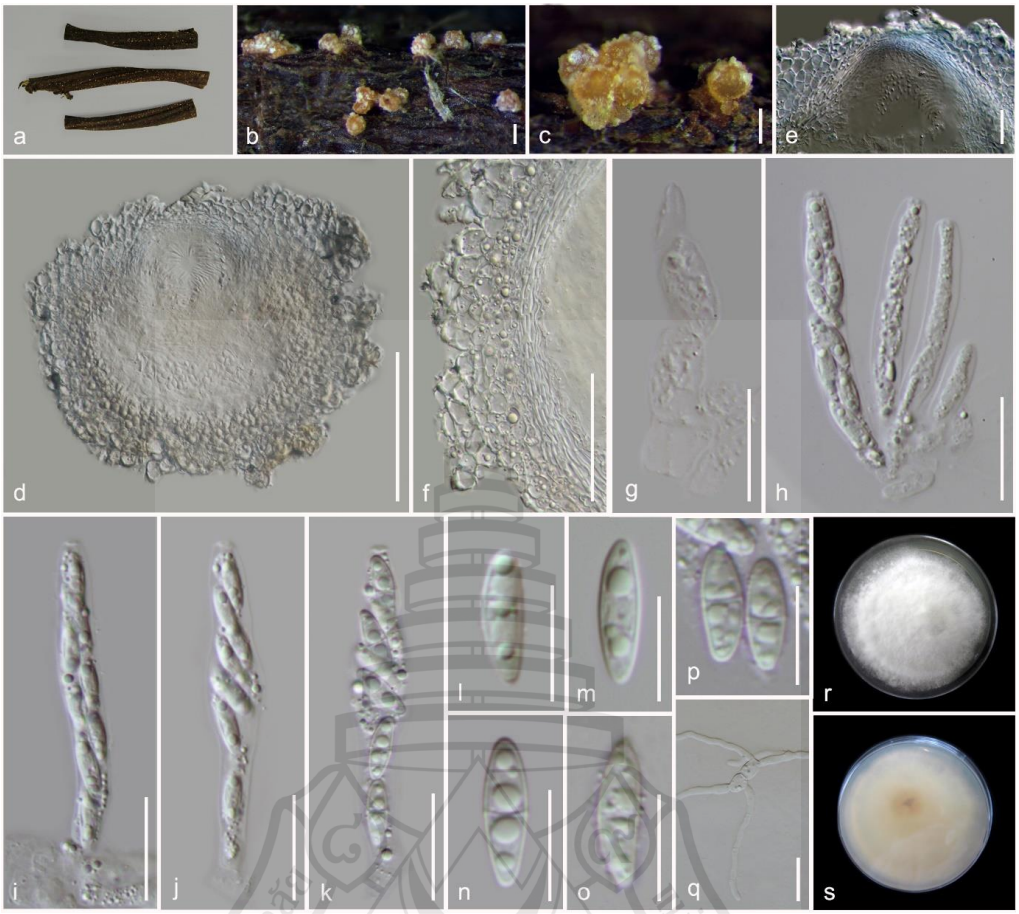
eriocamporesiana differs from *C. byssicola* in having smaller asci (58–66 vs. 68–80 μm) and ascospores (10.5–15.2 × 3.6–4.4 vs.16.8–18.2 × 4.8–5.4 μm) (Schroers 2001). *Clonostachys eriocamporesiana* can also be compared to *C. wenpingii* differs in light orange ascomata vs. yellow ascomata and, larger asci (58–66 × 7.3–10.3 vs. 33−44 × 5.5−8.0 μm) (Luo & Zhuang 2007). A comparison of the ITS and TUB2 nucleotides of *C. eriocamporesiana* and *C. byssicola* (CBS 364.78) shows 6 (1%) and 18 (3.1%) nucleotide differences. Another comparison of the ITS and TUB nucleotides of *C. eriocamporesiana* and *C. wenpingii* (HMAS 172156) shows 6 (1%) and 22 (3.7%) nucleotide differences. ITS and TUB nucleotide differences and significant morphological differences, reveals that *C. eriocamporesiana* is a distinct taxon (Jeewon & Hyde 2016).

Clonostachys spinulosa R.H. Perera, E.B.G. Jones & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF559628, Facesoffungi number: FoF10868, Figures. 2.12, 2.13

Etymology: '*spinulosa*' refers to spinulose ascospores.

On stem bark or ascomycete stromata. **Sexual morph:** *Stroma* superficial to erumpent through bark, cells pseudoparenchymatous, hyaline to pale yellowish, angular to subglobose, integrated with the peridium cells. *Ascomata* 250–400 μm high, 250–385 μm diam., perithecial, mostly in clusters of large numbers, sometimes solitary or in small groups, globose or subglobose to oval, ostiolate, minutely papillate or apapillate, not collapsing upon drying, yellowish orange to brownish orange, KOH-, surface warted to rough. *Perithecial warts* off-white or pale yellowish to pale brownish orange, largest in the upper part of the perithecium or around the ostiole; cells angular to globose, with unevenly thickened walls. *Peridium* 50–80 μm thick without warts, 60–135 μm thick including warts, composed of three strata; outer stratum cells angular to globose, with uniformly thickened walls; vacuoles frequently observed; middle stratum up to 4 cell layers thick, consisting of hyaline angular cells, with moderately thickened walls; inner stratum 4–6 cell layers thick, consisting of hyaline, elongate cells. *Asci* 69–80 × 8.6–11 μm ($\bar{x}$ = 77–9.4 μm; n = 20), 8-spored, unitunicate, narrowly clavate, short pedicellate, apex narrowly rounded or flat, with a J- apical ring. *Ascospores* 12.6–18 × 4.4–6 μm ($\bar{x}$ = 14.8 × 5.2 μm; n = 40), uniseriate below, biseriate above, ellipsoidal to oblong-ellipsoidal,



Note (a) Herbarium material. (b, c) Ascomata on host. (d) Section of ascomata. (e) Section of ostiole. (f) Section of peridium. (g) Catenophysis. (h–k) Asci. (l–p) Ascospores. (q) Germinating ascospore. (r, s) Colony on PDA. Scale bars: b, c = 200 µm, d = 100 µm, e, f = 50 µm, g–k = 20 µm, l–q = 10 µm.

Figure 2.11 *Clonostachys eriocamporesiana* (MFLU 18-2713, holotype)

1-septate, constricted or not constricted at the septum, hyaline, pale brown when mature, spinulose, almost entirely filling the ascus. **Asexual morph:** *Mycelium* not observed on natural substrtate. *Conidiomata* sporodochial. *Sporodochia* scattered or arrange is small groups on the substrate, loosely to tightly attached to the substrate, asetose, conidial masses dome-shaped, whitish or pale- to light orange. *Conidiophores* dimorphic. *Primary conidiophores* verticillium-like, 50–125 µm long, 3–5 µm ($\bar{x}$ = 79–3.7 µm) wide at base. *Conidiogenous cells* in whorls of 2–3 or arrange singly, 11–36 µm long, 2–3.2 µm ($\bar{x}$ = 23–2.4 µm) wide at base, phialidic, divergent or divergent at acute angles, straight,

cylindrical, slightly tapering towards the tip, with a periclinal thichening, collarette lacking or minute, each producing a small, hyaline globule of conidia. *Secondary conidiophores* 30–80 µm long, 2.5–.5 µm ($\bar{x}$ = 51–3.1 µm) wide at base, bi- to quinquiesverticillate, septate, densely aggregated, long or short stipitate, hyaline, smooth-walled. *Conidiogenous cells* in whorls of 2–4, 6–16.6 µm long, 1.5–2.8 µm ($\bar{x}$ = 12.3–2.3 µm) wide at widest point, phialidic, straight to slightly curved, narrowly flask-shaped or almost cylindrical, tapering in the upper part, with a periclinal thichening, collarette lacking or minute, intercalary phialides not observed. *Conidia* 3.8–6.2 × 2.2–3.2 µm ($\bar{x}$ = 5.1–2.8 µm; n = 75) ovoid to ellipsoid, minutely curved or straight, mostly with a slightly flattened side, aseptate, hilum laterally displaced, mostly bi-guttulate, hyaline, smooth-walled.

Culture characteristics: Colony on PDA reaching 40 mm in 7 days at 25ºC. Colony surface not pigmented or pale yellowish, appearing felty to cottony with aerial mycelium, sometimes granular because of exudates; reverse pale yellow.

Material examined: THAILAND, Phyao Province, Phachang Noi Pong District, on fallen dead stem bark of unidentified plant, 9 November 2017, R. H. Perera, Bion11, MFLU 18-2705, living culture MFLUCC 18-0587; *Ibid.*, Chiang Mai Province, on ascomycete stromata on a dead stem of *Chromolaena odorata* (Asteraceae), 02 February 2017, R. H. Perera, BN05 (MFLU 18-2730, **holotype**), **ex-type living culture** MFLUCC 17-0131; *Ibid.*, BN04 (MFLU 18-2729), living culture MFLUCC 17-2033.

GenBank numbers: MFLUCC 18-0587: ITS: ON230048, LSU: ON230056, TEF1: ON238002; MFLUCC 17-0131: ACL: ON238006, ITS: ON230049, LSU: ON230057, TEF1: ON238003, TUB2: ON238009.

Notes: The sexual morph of isolate MFLUCC 18-0587 clusters with the asexual morph isolate of MFLUCC 17-0131 with high statistical support (98% MLBT, 100% BYPP, Figure 2.7). ITS, LSU and TEF1 sequences of both isolates are identical. Therefore, we designate MFLU 18-2705 and MFLU 18-2730 are two morphs of the same taxon *Clonostachys spinulosa*. *Clonostachys spinulosa* isolates (MFLUCC 18-0587, MFLUCC 17-0131) clade with *Clonostachy wenpingii* HMAS 172156 and ex-type of *C. eriocamporesiana* MFLUCC 17-2620 with low statistical support (Figure 2.7). Ascospore dimensions of *C. spinulosa* and *C. eriocamporesiana* are overlapping (12.6–18 vs. 10.5–15.2 µm) (Forin et al., 2020). *Clonostachys spinulosa* is morphologically

distinguishable from *C. eriocamporesiana* by its distinctly warted ascomatal surface and having larger ascomata (250–400 × 250–385 μm vs. 160–260 × 160–285 μm) and larger asci than the latter species (69–80 × 8.6–11 μm vs. 58–66 × 7.3–10.3 μm). DNA sequences of *C. spinulosa* isolates (MFLUCC 18-0587, MFLUCC 17-0131) and *Clonostachys eriocamporesiana* MFLUCC 17-2620 differ in 2 nucleotides of the ITS region (0.4%, no gaps) and 12 nucleotides of the TEF1 region (3.1%, 4 gaps). DNA sequences of *C. spinulosa* isolates and *C. wenpingii* HMAS 172156 differ in 13 nucleotides of the ITS region (2.5%, 6 gaps), 3 nucleotides of the *TUB2* region (0.4%, no gaps), 19 nucleotides of the TUB2 region (3.5%, 2 gaps) and, 17 nucleotides of the *TUB2* region (4.1%, 5 gaps). We therefore, introduce *C. spinulosa* as a new species. Furthermore, due to lack of sexual morph and enough DNA data the strain previously identified as *Clonostachys byssicola* MFLUCC:17-2033 is identified here as *C. spinulosa* (Figure 2.7).

Dimerosporiella Speg., Revta Mus. La Plata 15(2): 10 (1908)

Index Fungorum number: IF1585, Facesoffungi number: FoF10869

Foliicolous, *fungicolous*, *parasitic* on *Meliola*, *Asterina*, *Schiffnerula* and allied species. **Sexual morph:** *Ascomata* perithecial, scattered, superficial on white mycelium or black host mycelium, loosely attached, globose to obovoid or subglobose, often laterally collapsing, pale yellow, KOH-, ostiolate, apapillate, surface smooth or with short flexuous hairs. *Peridium* thin, cells forming a *textura epidermoidea*. *Asci* unitunicate, 8-spored, clavate, apex simple or with an apical ring. *Ascospores* ellipsoid, 1–3-septate, hyaline, smooth-walled, spinulose or striate. **Asexual morph:** Acremonium-like. *Conidiophores* erect, straight or somewhat curved, hyaline, smooth-walled. *Conidia* ellipsoid, hyaline, smooth-walled. *Conidial heads* globose, white or pale pink (Adapted from Hansford, 1946; Rossman et al., 1999).

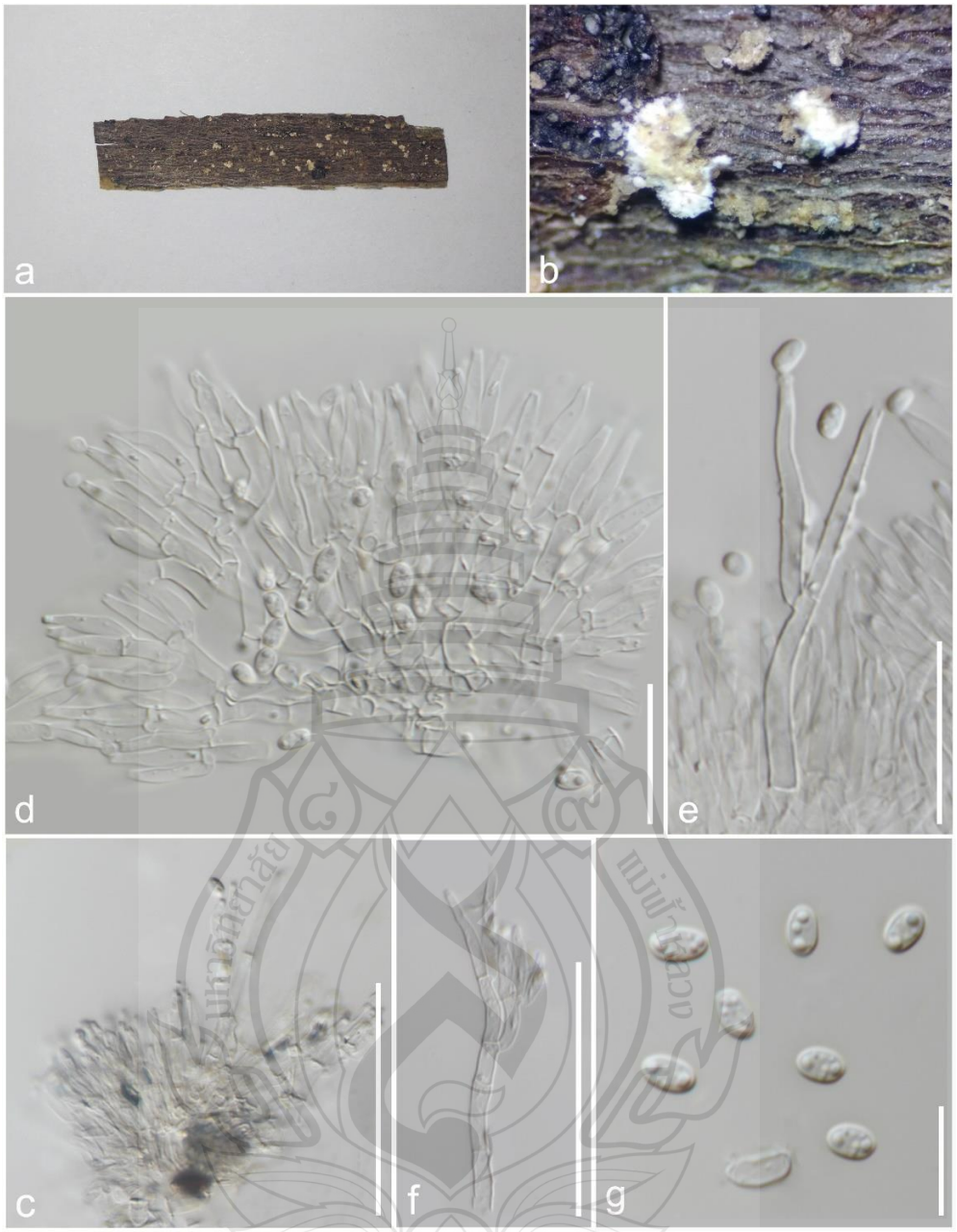
Known distribution: Tropical region (Brazil, Uganda, Philippines, Paraguay, Sri Lanka) (Rossman et al., 1999)

Notes: Rossman et al. (1999) accepted the genus in Bionectriaceae based on morphology. Currently, seven species are accommodated in *Dimerosporiella*. There are no recent records on the *Dimerosporiella* species collected from elsewhere or no molecular data are available. *Dimerosporiella* species are fungicolous or found on living

leaves of *Asterina*, *Meliola*, *Schiffnerula* or related species (Rossman et al., 1999; Sun et al., 2019).

Note (a) Herbarium material. (b) Ascomata on host substrate. (c, d) Vertical sections of ascomata. (e) Vertical section of peridium. (f–i) Asci. (j–n) Ascospores. (o) Germinating ascospore. (p, q) Colony on PDA. Scale bars: b = 500 µm, c = 200 µm, d = 100 µm, e–i = 20 µm, j–n = 10 µm, o = 20 µm.

Figure 2.12 *Clonostachys spinulosa* (MFLU 18-2705)



Note (a) Herbarium material. (b) Conidiomata on the substrate. (c–f) Primary and secondary conidiophores with conidia. (g) Conidia. Scale bars: c = 50 µm, d, e = 20 µm, f = 50 µm, g = 10 µm.

Figure 2.13 *Clonostachys spinulosa* (MFLU 18-2730, holotype)

Type species: ***Dimerosporiella paulistana*** Speg., Revta Mus. La Plata 15(2): 11 (1908)

Index Fungorum number: IF244183, Facesoffungi number: FoF10870

Descriptions and illustrations: see Rossman et al. (1999)

Fusariella Sacc., Atti Inst. Veneto Sci. lett., ed Arti, Sér. 6 2: 463 (1884)

Index Fungorum number: IF8282, Facesoffungi number: FoF10871

Saprobes on plant material, also isolated from soil. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiophores* semi-macronematous, mononematous, unbranched or variously branched. *Conidiogenous cells* phialidic, cylindrical, subulate or lageniform, curved, hyaline to pale brown. *Conidia* catenate, acrogenous, fusiform, cylindrical, clavate or obclavate, clavate to cylindrical, 1–3-septate, straight or slightly curved, hyaline, subhyaline to olivaceous, grey or brown, mostly smooth-walled, sometimes verruculose (Adapted from Lin et al. 2017).

Known distribution: Algeria, Egypt (Mouchacca & Nicot, 1972), China (Pollack, 1947; Liu & Zhang, 2006; Jiang et al., 2017), France (Ellis, 1976), India (Sydow & Mitter, 1933; Roy & Rai, 1968), Israel (Chabelska-Frydman, 1964), Mongolia (Wu et al., 2009), Peru (Matsushima, 1993), Taiwan (Matsushima, 1985), Tanzania (Hennings, 1904a), Thailand (Lin et al., 2017), UK (Saccardo, 1884), Ukraine (Garbowski, 1918), USA (Ellis & Bartholomew, 1896)

Notes: *Fusariella* was established by Saccardo (1884) to accommodate *F. atrovirens*. Natural classification of *Fusariella* was uncertain for decades due to lack of molecular data and a comprehensive taxonomic study (Lin et al., 2017). Lin et al. (2017) showed that the genus belongs in Bionectriaceae with respect to morphology and results of combined gene analysis.

Type species: ***Fusariella atrovirens*** (Berk.) Sacc., Fung. 2: 463 (1884)

Basionym: *Fusisporium atrovirens* Berk., in Smith, Engl. Fl., Fungi (Edn 2) (London) 5(2): 351 (1836)

Index Fungorum number: IF217495, Facesoffungi number: FoF10872, Figure 2.14

Saprobic on *Allium*. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* hyphomycetous. *Conidiophores* up to 33 µm high, up to 4 µm wide, macronematous, mononematous, branched, straight or flexuous, 1-2-septate, hyaline, smooth-walled. *Conidiogenous cells* 7–17 µm high ($\bar{x}$ = 13.0 µm, n = 10), 2.5–4 µm wide ($\bar{x}$ = 3.3 µm; n = 10) at the base, 1.5–2 µm ($\bar{x}$ = 1.7 µm, n = 10) at the apex, terminal or

intercalary, straight to flexuous, monophialidic, hyaline, subulate, smooth, wide at the base and tapering at the apex. *Conidia* 18.5 × 2.8 µm, (n = 1), acrogenous, fusiform to cylindrical, apex pointed, base rounded, 3-septate, pale olivaceous, smooth-walled.

Material examined: Southeastern Europe: Italy, on *Allium*, October 1875, IMI 29419, **slides of holotype**.

Note (a) Herbarium packet. (b, c) Conidiophores and conidiogenous cells. (d) Conidium. Scale bars: b–d = 20µm.

Figure 2.14 *Fusariella atrovirens* (IMI 29419, holotype)

Geonectria Lechat & J. Fourn., in Lechat, Fournier, Vega & Priou, Ascomycete.org 10(2): 81 (2018)

Index Fungorum number: IF824881, Facesoffungi number: FoF10873

On bare soil. **Sexual morph:** *Ascomata* perithecial, astromatic, superficial on soil, solitary to gregarious, subglobose, collapsing or not collapsing upon drying, orange, KOH-, lactic acid-, minutely papillate. *Asci* unitunicate, 8-spored, clavate, short-stipitate, apex rounded, with a discoid apical ring. *Ascospores* biseriate, ellipsoidal to widely fusiform, 1-septate, hyaline, finely striate. **Asexual morph:** Acremonium-like. *Conidiophores* simple, born on smooth, septate hyphae, flexuous, smooth-walled. *Conidiogenous cells* simple, phialidic, subulate with a slightly flared collarette. *Conidia* ellipsoidal to subcylindrical, aseptate, hyaline, smooth-walled, arranged in slimy heads at the tip of phialides (Adapted from Lechat, Fournier, Vega et al., 2018).

Known distribution: France (Lechat, Fournier, Vega et al., 2018)

Notes: Lechat, Fournier, Vega et al. (2018) described monospecific genus *Geonectria* to accommodate a taxon collected on soil. *Geonectria* forms astromatic, subglobose, orange perithecia, without KOH and lactic acid reactions, superficial on soil (Lechat, Fournier, Vega et al., 2018). These typical characteristics to Bionectriaceae and molecular inference of LSU sequences led to the place rest of *Geonectria* in Bionectriaceae (Lechat, Fournier, Vega et al., 2018).

Type species: ***Geonectria subalpina*** Lechat, J. Fourn., M. Vega & Priou, Ascomycete.org 10(2): 81 (2018)

Index Fungorum number: IF824882, Facesoffungi number: FoF10874

Descriptions and illustrations: see Lechat, Fournier, Vega et al. (2018)

Halonectria E.B.G. Jones, Trans. Br. mycol. Soc. 48(2): 287 (1965)

Index Fungorum number: IF2206, Facesoffungi number: FoF10875

On submerged wood in marine habitats. **Sexual morph:** *Ascomata* perithecial, completely or partially immersed in the substrate, solitary or gregarious, globose to subglobose, thin membranous, bright orange to orange brown, with long necks protrude from the wood, lacking setae, KOH-. *Asci* lying without paraphyses, unitunicate, 8-spored, clavate, deliquescing at maturity. *Ascospores* mostly fusiform, occasionally lunate or falcate, aseptate, hyaline, guttulate, smooth-walled, without appendages. **Asexual morph:** Undetermined. (Adapted from Jones, 1965; Rossman et al., 1999).

Known distribution: UK (Jones, 1965)

Notes: Jones (1965) introduced *Halonectria* with the only species *H. milfordensis* isolated from submerged test blocks of *Pinus sylvestris*. *Halonectria* shares similar characteristics with Halosphaeriaceae but differs in having ascospores which lack appendages (Rossman et al., 1999). *Halonectria milfordensis* possess immersed ascomata with elongated necks and long asepate ascospores, which are not common among hypocrealean fungi (Rossman et al., 1999). Rossman et al. (1999) accepted *Halonectria* in Bionectriaceae based on wall surface characristics and KOH-negative ascomata. The holotype specimen of *H. milfordensis* (IMI 86722) is in poor condition for the study as there are no remaining fruiting structures. DNA sequence data are not available for *H. milfordensis*. Hence, this taxon needs to be recollected and sequenced to confirm the phylogenetic placement of the genus.

Type species: ***Halonectria milfordensis*** E.B.G. Jones, Trans. Br. mycol. Soc. 48(2): 287 (1965)

Index Fungorum number: IF331648, Facesoffungi number: FoF10876

Material examined*:* UK, South Wales, Pembrokeshire, Dale Fort Field Centre, on Scots pine test block submerged for 24 weeks, E.B. Gareth Jones, 19 April 1961, IMI 86722, **holotype**. This specimen is in poor condition for the study.

Descriptions and illustrations: see Jones (1965)

Heleococcum C.A. Jørg., Bot. Tidsskr. 37: 417 (1922)

Index Fungorum number: IF2253, Facesoffungi number: FoF10877

Saprobic, on moist or saline alkaline soil, isolated from submerged wood in seawater. **Sexual morph:** *Ascomata* astromatic, cleistothecial, superficial, scattered or in groups of a few, globose, yellow, salmon-coloured, light orange to orange or dark brown, KOH-, lactic acid-, lacking ostioles. *Peridium* multilayered. *Asci* unitunicate, 8-spored, cylindrical, clavate, subglobose to ovoid or saccate, evanescent, occasionally sessile, without an apical ring, lying without paraphyses. *Ascospores* 1-septate, ellipsoidal or ovoid, hyaline, pale yellow or pale brown, smooth or with verruculose walls, occasionally with wing-like ridges, with or without a gelatinous sheath. **Asexual morph:** Acremonium-like. *Conidiophores* semi-macronematous or micronematous, mononematous, usually unbranched, septate basally hyaline, smooth-walled. *Conidiogenous cells* (phialides) cylindrical to subulate, straight or slightly curved,

hyaline, smooth-walled, with non-flared small collarettes, without a prominent peridinal thickening. *Conidia* ellipsoidal to ovoid or cylindrical to allantoid, hyaline, smooth-walled, grouped in slimy heads.

Known distribution: Denmark, UK (Rossman et al., 1999), Japan (Tubaki, 1967; Udagawa et al., 1995), Indonesia, Philippines (Udagawa et al., 1995).

Notes: Jørgensen (1922) introduced the cleistothecial genus *Heleococcum* based on *H. aurantiacum* isolated from moist soil in Denmark. Jørgensen (1922) accepted *Heleococcum* in Aspergillaceae considering the cleistothecial ascomata. Later, another four species were added to the genus (Rehner & Samuels, 1995; Udagawa et al., 1995; Bilanenko et al., 2005). However, *Heleococcum alkalinum* (an alkali-tolerant species) was transferred to *Sodiomyces*, Plectosphaerellaceae based on multi-locus phylogeny (Bilanenko et al., 2005; Grum-Grzhimaylo et al., 2013). Even though they lack a nectria-like centrum and have deliquescent asci. *Heleococcum* species resemble to hypocrealean taxa by their vividly coloured ascomata and acremonium- asexual morphs. Rehner and Samuels (1995) proposed to place *Heleococcum japonense* in Bionectriaceae based on morphological characteristics and SSU sequence data. Grum-Grzhimaylo et al. (2013) also confirmed the placement of *Heleococcum aurantiacum* and *Heleococcum japonense* in the Bionectriaceae based on combined LSU, ITS, SSU, RPB2 and TEF1 phylogeny. Currently, four species are accommodated in *Heleococcum. Heleococcum aurantiacum* and ex-type of *H. japonense* has DNA sequences.

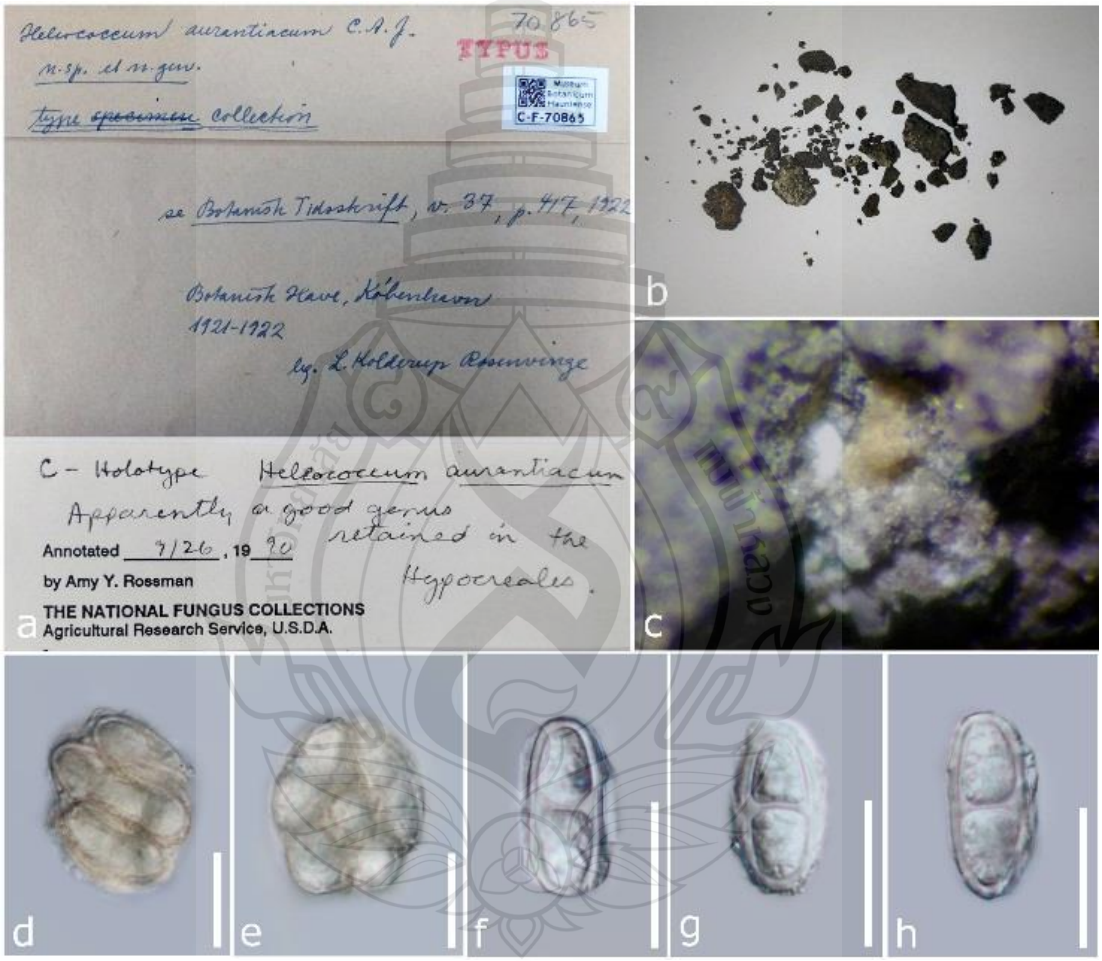
Type species: ***Heleococcum aurantiacum*** C.A. Jørg., Bot. Tidsskr. 37: 417 (1922)

Index Fungorum number: IF250876, Facesoffungi number: FoF10878, Figures. 2.15, 2.16

Saprobic, on soil. **Sexual morph:** *Ascomata* 500–750 µm diam., astromatic, cleistothecial, superficial, globose, translucent, areolated, light orange, KOH-, LA-, lacking ostioles. *Asci* unitunicate, 8-spored, globose, sessile, without an apical ring, lying without paraphyses. *Ascospores* 25–30 × 10–15 µm, 1-septate, ellipsoide, hyaline to pale orange, with an irregular mucoid sheath. **Asexual morph:** Undetermined (Adapted from Jørgensen, 1922; Udagawa et al., 1995).

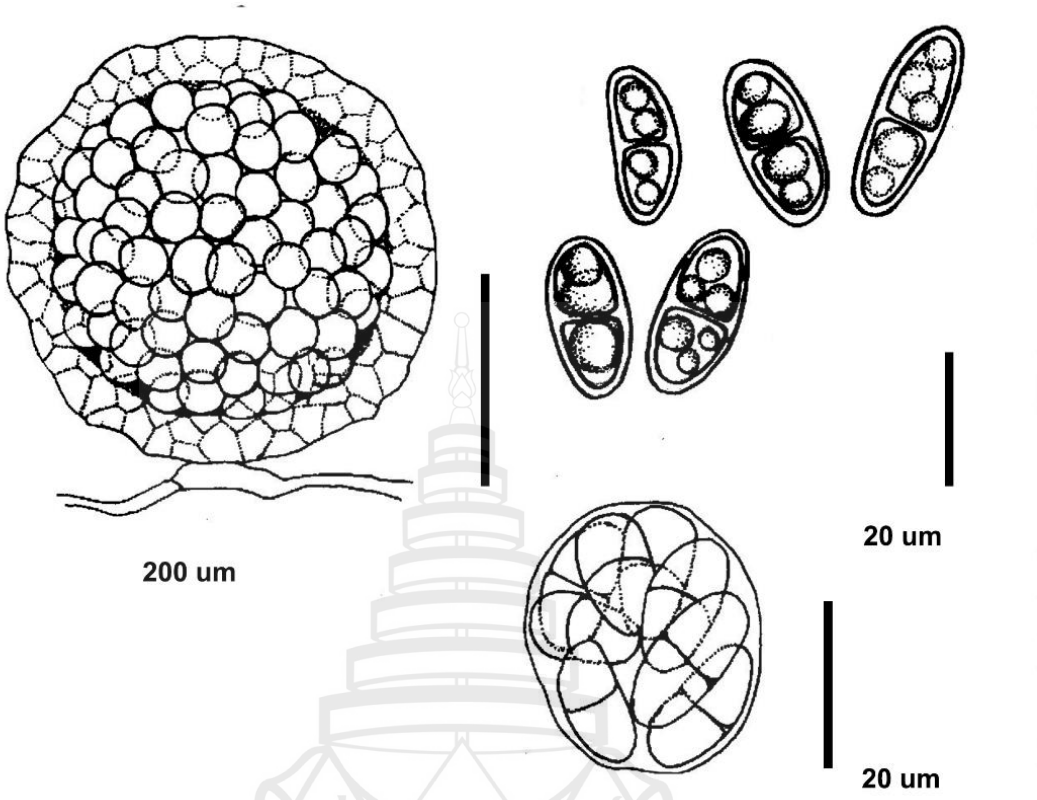
Material examined: DENMARK, Botanical Garden of the University of Copenhagen, on moist soil, L. Kolderup Rosenvinge, 1921–1922, C, C-F-70865, **holotype**.

Notes: The holotype specimen (C-F-70865) is in poor condition for the study and, fruiting structures were not observed on the substrate. Asci and ascospores can be found as pale-yellow masses on the substrate (Figure 2.12). Ascomata, asci and ascospores are redrawn from Jørgensen (1921) (Figure 2.13).



Note (a) Specimen label. (b) Herbarium material. (c) Asci and ascospore masses on the host. (d, e) Asci in 3% KOH. (f–h) Ascospores in 3% KOH. Scale bars: d–h = 20 µm.

Figure 2.15 *Heleococcum aurantiacum* (C-F-70865, holotype)



Note (a) Mature cleistothecium. (b) Ascus. (c) Ascospores. Scale bars: a = 200 µm, b, c = 20 µm.

Figure 2.16 *Heleococcum aurantiacum* (redrawn from Jørgensen, 1921)

Hydropisphaera Dumort., Comment. bot. (Tournay): 89 (1822)

Index Fungorum number: IF2407, Facesoffungi number: FoF10879

Saprobic on dead herbaceous or well-rotten woody substrates, dead leaves, dung, some are fungicolous. **Sexual morph:** *Ascomata* astromatic, superficial, perithecial, globose to subglobose or doliliform, often collapsed and cupulate when dry, yellow, orange to brown, KOH-, lactic acid-, surface smooth or with fasciculate hairs, with a papillate apex, ostiolate. *Peridium* greater than 110 µm thick, composed of two strata, outer stratum consisting of large, thin-walled cells and inner stratum of flattened hyaline cells. *Asci* 8-spored, unitunicate, clavate, apices rounded, with or without a J- apical ring. *Ascospores* bi-seriate, obliquely uniseriate, fusiform, aseptate or one-septate to multi-

septate, rarely slightly constricted, often bi-guttulate, hyaline, generally striate, sometimes verrucose, rarely smooth or spinulose. **Asexual morph:** Mostly acremonium-like, rarely gliomastix-like. *Conidiophores* occurring on aerial hyphae, macronematous, mononematous, unbranched, elongate, erect, straight to flexuous, hyaline to light brown, surface smooth to very faintly roughened. *Conidiogenous cells* sparse, integrated, monophialidic, terminal, aseptate, long, narrow, tapering towards the apex, rarely with a minutely flared collarette. *Conidia* occurring at apex of conidiogenous cells, variable in length, ellipsoidal with rounded ends or obpyriform to fusiform, aseptate, hyaline or becoming dark brown, walls smooth to verrucose, forming small globose heads, rarely solitary or catenulate in short chains (Rossman et al., 1999; Luo & Zhuang, 2010b; Lechat, Farr et al., 2010; Lechat & Fournier, 2020b).

Known distribution: Cosmopolitan, common in temperate areas

Notes: Dumortier (1822) introduced *Hydropisphaera* based on *Hydropisphaera peziza* as the type. However, *Hydropisphaera* was treated as a synonym of *Nectria* for decades by subsequent authors (Booth, 1959; Samuels, 1976a; Rossman, 1983). Rossman et al. (1999) resurrected the genus in Bionectriaceae to accommodate taxa that had earlier been recognised in the *N. peziza* group (Dingley, 1951b; Booth, 1959; Samuels, 1976a; Rossman, 1983). *Hydropisphaera* is distinguishable from other nectria-like taxa as *Hydropisphaera* has a relatively thick peridium (usually greater than 25 µm), that comprises large thin walled globose cells (Rossman et al., 1999). Rossman et al., (1999) made 17 species additions to the genus. Currently, 30 species are accommodated in *Hydropisphaera* (Lechat & Fournier, 2020b; Lechat, Farr et al., 2010).

Type species: ***Hydropisphaera peziza*** (Tode) Dumort., Comment. bot. (Tournay): 90 (1822)

= *Sphaeria peziza* Tode, Fung. mecklenb. sel. (Lüneburg) 2: 46 (1791)

Index Fungorum number: IF431721, Facesoffungi number: FoF10880

Descriptions and illustrations: see Booth (1959) (as *Nectria peziza*); Rossman et al. (1999)

Laniatria Döbbeler & P.G. Davison, Nova Hedwigia 106(1-2): 239 (2017) [2018]

Index Fungorum number: IF821328, Facesoffungi number: FoF10881

Bryophilous, parasitic on *Frullania kunzei*. **Sexual morph:** *Ascomata* up to 300 µm diam., perithecial, astromatic, immersed between host leaves, ovoid to pyriform, laterally collapsing and becoming colourless upon drying, light orange to orange or white, KOH-, tomentose (covered with coarse hairs and setae), usually with a fringy apical ring, apex glabrous, ostiolate. *Ostioles* tiny, central, at times covered by gelatinous material. *Ostiolar canal* lined with periphyses of short, tapering filaments. *Setae or hairs*, very short, straight or curved, concentrated around the apex. *Peridium* in optical section composed of flattened, tangentially stretched cells, cells in surface view *textura angularis*. *Apical paraphyses* present. *Asci* 8-spored, unitunicate, numerous, subcylindrical to clavate, straight or slightly curved, sessile or with a rather long, thick foot, very thin-walled, without an apical ring. *Ascospores* mostly bi-seriate or irregularly arranged, aseptate or mostly 1-septate, bacilliform, usually symmetrical, septum thin or not distinguishable, sometimes guttulate, colourless. **Asexual morph:** Undetermined. (Adapted from Döbbeler & Davison, 2018).

Known distribution: USA (Döbbeler & Davison, 2018)

Notes: Döbbeler and Davison (2018) described *Laniatria* with the only species *L. myxostoma*, a bryophilous species. Bright coloured ascomata, not changing colour in KOH or lactic acid. *Laniatria* lack cyanophilous structures, which are typical to other bryophyllous taxa in Bionectriaceae (Döbbeler & Davison, 2018). No DNA molecular data are available.

Type species: ***Laniatria myxostoma*** Döbbeler & P.G. Davison, Nova Hedwigia 106(1-2): 239 (2017) [2018]

Index Fungorum number: IF821329, Facesoffungi number: FoF10882

Descriptions and illustrations: see Döbbeler & Davison (2018)

Lasionectriella Lechat & J. Fourn., Ascomycete.org 8(2): 59 (2016)

Index Fungorum number: 815673, Facesoffungi number: FoF10883

On dead stems of *Ruscus aculeatus* and herbaceous plants. **Sexual morph:** *Ascomata* up to 180 µm diam., perithecial, superficial, astromatic, gregarious, solitary or crowded in groups of 3–8 or 2–9, subglobose, cupulate upon drying, at first white, later pale yellow, pale brownish orange to reddish brown, KOH-, LA, surface covered by thick-walled hyphal hairs developing from as base, agglutinated and proliferating to form a fringe around upper margin of ascomata. *Peridium* 18–25 µm thick, composed of thick-

walled, globose or ellipsoidal to flattened cells. *Paraphyses* moniliform. *Asci* 8-spored, clavate to fusoid, apex flattened, without an apical ring. *Ascospores* irregularly biseriate, fusoid, straight to lightly curved, equally 1-septate, constricted at septum, bi-guttulate, hyaline, smooth-walled or spinulose. **Asexual morph:** Hyphomycetous Acremonium-like. *Conidiophores* arising from aerial hyphae, macronematous, mononematous, unbranched, flexuous, hyaline, faintly roughened. *Conidiogenous cells* phialidic, monophialidic, with a flared collarette. *Conidia* aseptate, narrowly ellipsoidal to subcylindrical with rounded apex, attenuated at base with an apiculate hilum, initially hyaline, becoming dark green, smooth-walled, aggregated at tip of phialide to form a mucous head, appearing nearly black in mass (Adapted from Lechat & Fournier 2016a).

Known distribution: France, Spain (Lechat & Fournier, 2016a)

Notes: Lechat and Fournier (2016a) established the genus for *Lasionectriella rubioi* and *L. herbicola* based on morphology and LSU phylogeny. The genus is typical to Bionectriaceae by KOH and lactic acid negative ascomata and acremonium-like asexual morphs (Lechat & Fournier, 2016a). Currently, two species are recognised in the genus with molecular data.

Type species: ***Lasionectriella rubioi*** Lechat & J. Fourn., Ascomycete.org 8(2): 59 (2016)

Index Fungorum number: IF815674, Facesoffungi number: FoF10884

Descriptions and illustrations: see Lechat and Fournier (2016a)

Lasionectriopsis Lechat & P.-A. Moreau, in Lechat, Moreau & Bender, Ascomycete.org 11(1): 1 (2019)

Index Fungorum number: IF828975, Facesoffungi number: FoF10885

Probably *saprobic*, on woody substrates. **Sexual morph:** *Ascomata* perithecial, gregarious, astromatic, partially immersed in a subiculum of hyaline hyphae, globose with a conical apex, whitish to pale orange becoming brownish orange when dry, cupulate or laterally pinched upon drying, ostiolate, KOH-, lactic acid-. *Ostiolar region* lined with periphyses, not covered by the hyphae. *Peridium* of single stratum, composed of subglobose to globose or ellipsoidal cells. *Asci* unitunicate, 8-spored, clavate, short-stipitate, with an apical ring. *Paraphyses* present, evanescent, filamentous to narrowly moniliform. *Ascospores* biseriate or irregularly arranged in upper part, uniseriate in lower part, narrowly ellipsoidal to fusiform, 1-septate, not or slightly constricted at septum,

hyaline, pale yellow in mass, verruculose. **Asexual morph:** Acremonium-like, hyphomycetous. *Conidiophores* simple or branched, arising from the aerial mycelium, flexuous, smooth-walled, giving rise to a conidiogenous cell. *Phialides* simple, septate, with an unflared collarette. *Conidia* ellipsoidal to subcylindrical, aseptate, basal abscission scar visible, hyaline, smooth-walled, aggregated in a mucoid head. (Adapted from Lechat et al., 2019).

Known distribution: South America, UK, Germany (Lechat et al., 2019; Gams, 1971; Summerbell et al., 2011)

Notes: Lechat et al. (2019) established *Lasionectriopsis* to accommodate *Lasionectriopsis germanica* and two non-melanised *Acremonium* species: *Acremonium pteridii* and *A. spinosum* (Gams, 1971; Summerbell et al., 2011). The genus is typical to Bionectriaceae in its astromatic, globose, pale coloured, KOH and lactic acid negative ascomata and acremonium-like asexual morphs. *Lasionectriopsis* was identified as a distinct genus based on partially immersed ascomata in a subiculum, peridium of single stratum, verruculose ascospores and LSU phylogeny (Lechat et al., 2019). Currently, three species (with molecular data) are accommodated in *Lasionectriopsis.* (Lechat et al., 2019).

Type species: ***Lasionectriopsis germanica*** Lechat, P.-A. Moreau & H. Bender, Ascomycete.org 11(1): 1 (2019)

Index Fungorum number: IF828976, Facesoffungi number: FoF10886

Descriptions and illustrations: see Lechat et al. (2019)

Mycoarachis Malloch & Cain, Can. J. Bot. 48(10): 1820 (1970)

Index Fungorum number: IF3304, Facesoffungi number: FoF10887

On herbivore dung. **Sexual morph:** *Ascomata* cleistothecial, astromatic, superficial, subglobose to globose, dark olive-green to black, glabrous, lacking ostioles. *Peridium* two strata, outer stratum of hyaline to pale brown angular cells; inner stratum of dark brown flattened cells. *Asci* unitunicate, 4-8-spored, subglobose to globose, evanescent, irregulary disposed, astipitate. *Ascospores* cylindrical to broadly ellipsoidal, equally 1-septate, strongly constricted at the septum, hyaline, smooth-walled, lacking germ pores. **Asexual morph:** Acremonium-like. *Conidiophores* simple or rarely branched, sepate, tapering towards the apex, bearing a simple phialide at the apex. *Conidia* aggregated at the tips of phialides, ellipsoid, fusiform, ovoid, cylindrical or

allantoid, aseptate, hyaline, smooth-walled. (Adapted from Malloch & Cain 1970; Rossman et al., 1999).

Known distribution: Brazil (Melo et al., 2017), USA, Africa (Tanzania, Uganda) (Malloch & Cain, 1970), Iraq (Abdullah & Alutby, 1999), Spain (Valldosera & Guarro, 1988).

Notes: *Mycoarachis* was established by Malloch and Cain. (1970) for *Mycoarachis inversa*. and placed in cleistothecial family Pseudeurotiaceae. Valldosera and Guarro (1988) added second species *Mycoarachis tetraspora* to the genus. Benny & Kimbrough (1980) believed that the genus belonged in Hypocreales by considering the ascospore characters and acremonium-like asexual morph. Later, some authors recognised *Mycoarachis* as a Hypocreales member related to *Bionectria*, based on LSU phylogeny (Rehner & Samuels, 1994, 1995; Suh & Blackwell, 1999). Rossman et el. (1999) treated *Mycoarachis* in Bionectriaceae and this was followed by subsequent authors (Maharachchikumbura et al., 2015, 2016; Wijayawardene et al. 2020, 2022; Hyde et al. 2020). *Mycoarachis* species are coprophilous isolated from herbivore dung (Malloch & Cain, 1970; Valldosera & Guarro, 1988; Abdullah & Alutby, 1999; Rossman et al., 1999). Currently, two species are accommodated in *Mycoarachis*.

Type species: ***Mycoarachis inversa*** Malloch & Cain, Can. J. Bot. 48(10) 1822 (1970)

Index Fungorum number: IF318044, Facesoffungi number: FoF10888, Fig. 2.17

Isolated from elephant dung. *Mycelium* composed of branched, septate, hyaline hyphae. **Sexual morph**: *Ascomata* 50–150 µm diam., astromatic, cleistothecial, subglobose to globose, dark green to black, lacking ostioles. *Peridium* of two strata, pale outer stratum and darker inner stratum; outer stratum of hyaline to pale brown angular cells; inner stratum of dark brown flattened cells. *Asci* 5.5–10 µm diam., unitunicate, 8-spored, subglobose to globose, evanescent, irregulary disposed, astipitate, without an apical ring. *Ascospores* 4–5 × 2.8 µm, cylindrical to broadly ellipsoidal, equally 1-septate, strongly constricted at the septum resulting a peanut-shape, lacking visible germ pores, hyaline, smooth-walled. **Asexual morph:** *Conidiomata* hyphomycetous, acremonium-like. *Conidiophores* arising from the submerged mycelium, simple or rarely branched, sepate, tapering towards the apex. *Conidiogenous cells* phialidic, simple, terminal, originating singly at the apex of conidiophore. *Conidia* 3–4 × 1.5–2 µm, aggregated at the

tips of phialides, ellipsoid, fusiform, ovoid, cylindrical or allantoid, aseptate, hyaline, smooth-walled (Asexual morph description adapted from Rossman et al., 1999).

Material examined: UGANDA, Queen Elizabeth National Park, Mweya Lodge, isolated in pure culture from elephant dung, Cain, Griffin and Krug, 27 July 1966, TRTC 66.2166f, **holotype**.

Notes: *Mycoarachis inversa* grows on elephant and cattle dung and unidentified herbivore dung (Melo et al. 2017; Rossman et al. 1999).

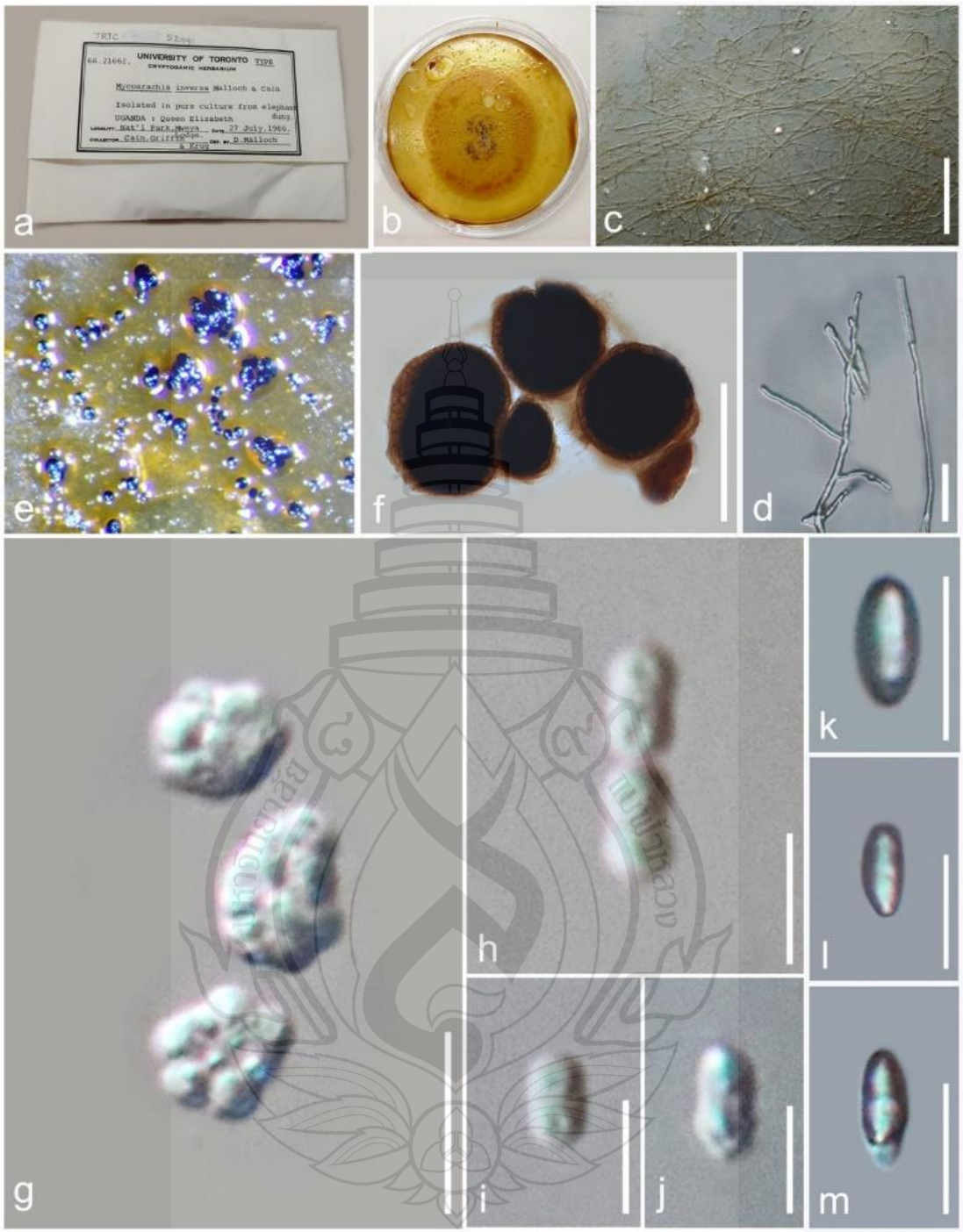
Nigrosabulum Malloch & Cain, Can. J. Bot. 48(10): 1822 (1970)

Index Fungorum number: IF3507, Facesoffungi number: FoF10889

Coprophilous, on animal dung, sometimes isolated from soil. **Sexual morph:** *Ascomata* 75–350 µm diam., cleistothecial, astromatic, subglobose to globose, smooth, glabrous, black, nonostiolate. *Peridium* up to 33 µm thick, carbonaceous, of two strata, outer stratum composed of dark brown, nearly isodiametric, thick-walled, pseudoparenchymatous cells; inner stratum of hyaline, thin-walled, evanescent cells. *Asci* 6–9 µm diam., 8-spored, borne in irregularly arranged groups, subglobose to globose, evanescent, nonstipitate. *Ascospores* 3–4 diam., globose, aseptate, hyaline, smooth-walled, lacking germ pores. **Asexual morph:** *Conidiomata* cephalosporium-like, hyphomycetous. *Conidiophores* 20–32 × 2–3 µm, arising from the mycelium, tapering, unbranched, each bearing one phialide. *Conidia* 3.5–8.5 × 1–3 µm, ellipsoidal, fusoid, ovoid or allantoid, aseptate, hyaline, aggregated in wet masses at the tip of the conidiophore (Adapted from Malloch & Cain, 1970).

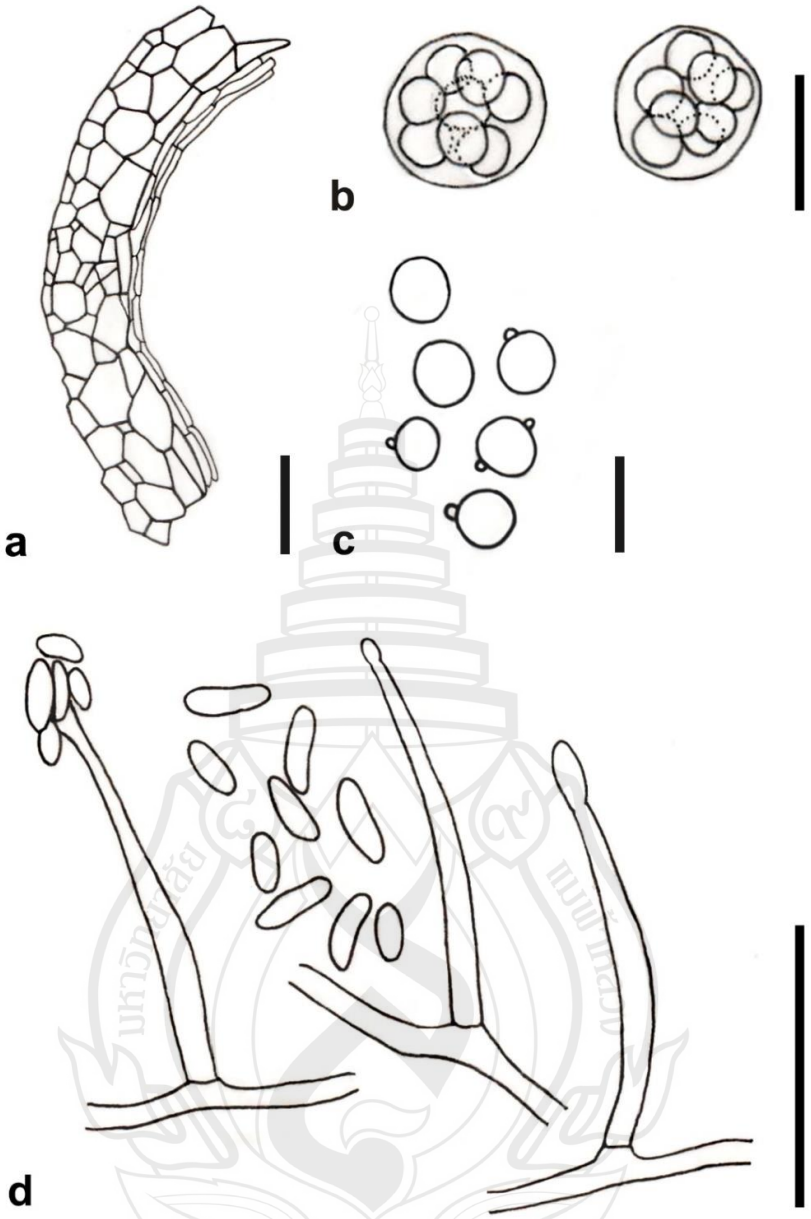
Known distribution: Australia, Europe, Africa and North America (Malloch & Cain, 1970; Plishka et al., 2009)

Notes: Malloch and Cain (1970) introduced the monotypic, cleistothecial genus *Nigrosabulum* for *N. globosum* and initially placed it in Pseudeurotiaceae. Currently there is one species in the genus and LSU DNA data are available. *Nigrosabulum* is more related to *Mycoarachis* (Bionectriaceae; reported from animal dung) and *Pseudeurotium* (Pseudeurotiaceae; a soil fungus) in morphology (Malloch & Cain, 1970).



Note (a) Herbarium material label. (b) Pure culture. (c, d) Mycelium. (e) Appearance of ascomata on culture. (f) Ascomata. (g) Asci. (h–j) Ascospores. (k–m) Conidia. Scale bars: c = 100 µm, d = 10 µm, f = 100 µm, g = 10 µm, h–m = 5 µm.

Figure 2.17 *Mycoarachis inversa* (TRTC 66.2166f, holotype) (d, i–m on permanent slides)



Note (a) Peridium cross section. (b) Asci. (c) Ascospores. (d) Conidiophores with conidia. Scale bars: a = 20 µm, b = 10 µm, c = 5 µm, d = 20 µm.

Figure 2.18 *Nigrosabulum globosum* (TRTC 43288, holotype, redrawn from Malloch & Cain, 1970)

Type species: ***Nigrosabulum globosum*** Malloch & Cain, Can. J. Bot. 48(10): 1823 (1970)

Index Fungorum number: IF318661, Facesoffungi number: FoF10890, Figure 2.18

Descriptions: see Malloch and Cain (1970)

Ovicuculispora Etayo, Bull. Soc. linn. Provence 61: 110 (2010)

Index Fungorum number: IF565893, Facesoffungi number: FoF10891

Lichenicolous. **Sexual morph:** *Ascomata* 150–500 μm diam., occur on upper surface of host thallus, scattered or arrange in groups, globose to subglobose, with small papilla, covered with long hairs, orange pink or pink to red, KOH-, K/I-. *Peridium* hyaline to slightly orange. *Asci* with 1–2 macrospores and 3–4 microspores/ascus, clavate. *Ascospores* of two types: macrospores and microspores; *Macroascospores* ellipsoid to rarely obovoid, rounded or very rarely acute at the apices, constricted at the septum, mostly 1-septate or very rarely 2-septate, easily disarticulating into part ascospores, with small guttules, hyaline, smooth-walled; *Microascospores* mostly ellipsoid, 0–1-septate, not or slightly constricted at the septum, with small and large guttules, hyaline, finely verruculose. **Asexual morph:** Undetermined. (Adapted from Etayo, 2010; Tadome & Ohmura, 2021).

Known distribution: Worldwide (Japan, South Korea, Bolivia, Dominica, Lithuania, Russia, UK, Panama, Canada, Peru) (Tadome & Ohmura, 2021; Motiejūnaitė, 2017).

Notes: *Ovicuculospora* is a lichenicolous genus introduced by Etayo (2010) to accommodate *Ovicuculispora parmeliae* and *Ovicuculispora macrospora*. *Ovicuculospora* species occur on various lichen genera such as *Anaptychia*, *Candelariella*, *Cladonia*, *Erioderma*, *Graphis*, *Heterodermia*, *Lobariella*, *Parmelia*, *Pertusaria*, *Physcia*, *Punctelia*, *Pyxine*, *Rinodina* and *Sticta* and, family Gomphillaceae (Etayo, 2010; Zhurbenko, 2014; Flakuset al., 2019; Tadome & Ohmura, 2021). There are two accepted species of the genus. Sequence data are available for *Ovicuculispora parmeliae*. The genus is characterized by orange perithecia and produces macrospores and microspores in the same ascus (Etayo, 2010).

Type species: ***Ovicuculispora parmeliae*** (Berk. & M.A. Curtis) Etayo, Bull. Soc. linn. Provence 61: 112 (2010)

Index Fungorum number: IF565895, Facesoffungi number: FoF10892

Descriptions and illustrations: see Etayo (2010), Tadome and Ohmura (2021)

Paracylindrocarpon Crous, Roets & L. Lombard, in Crous et al., Persoonia 36: 367 (2016)

Index Fungorum number: IF817039, Facesoffungi number: FoF10893

Associated with leaves and twigs of *Aloe* sp. or *saprobic* on dead leaves of *Pandanus*. *Mycelium* consisting of hyaline, smooth, branched, septate hyphae. **Sexual morph:** *Ascomata* up to 370 µm diam., visible on the host surface, solitary, scattered to gregarious, globose to subglobose, unilocular, with a flat base, superficial, easy to remove, orange, surface covered with hyaline or pale brown papilla, ostiole central. *Peridium* composed of several layers of thick-walled cells forming *textura angularis* or *textura prismatica*. *Paraphyses* ellipsoid and cellular or, cylindrical and filamentous, unbranched, septate, guttulate. *Asci* 8-spored, unitunicate, cylindrical-clavate, apical ring J-. *Ascospores* fusiform, conical at both ends, 3–5 or 6-septate, not constricted at septa, hyaline to subhyaline, guttulate, without mucoid sheath, smooth-walled. **Asexual morph:** Hyphomycetous. *Conidiophores* solitary or sporodochial, originating from superficial hyphae, erect, straight to geniculate-sinuous, septate, unbranched or branched, hyaline, smooth-walled. *Conidiogenous cells* phialidic, terminal or lateral on conidiophores, subcylindrical with slight apical taper, straight to slightly curved, with a minute periclinal thickening, hyaline, smooth-walled. *Conidia* granular, cylindrical or filiform, (0–)2–3-septate, sometimes slightly constricted at septa, guttulate, hyaline, smooth-walled, without appendages or mucilaginous sheath (Adapted from Crous, Wingfield, Richardson et al., 2016; Tibpromma et al., 2018).

Known distribution: China, Hong Kong (Tibpromma et al., 2018), South Africa (Crous, Wingfield, Richardson et al., 2016).

Notes: *Paracylindrocarpon* was established by Crous, Wingfield, Richardson et al. (2016) based on *Paracylindrocarpon aloicola*. (Crous, Wingfield, Richardson et al., 2016). Later another three species including sexual morphs were added to the genus by Tibpromma et al. (2018). *Paracylindrocarpon* species are saprobic on dead leaves of *Pandanus*, while *P. aloicola* was found from leaves and twigs of *Aloe* (Crous, Wingfield, Richardson et al., 2016; Tibpromma et al., 2018). Ex-type sequence data are available for all the species of this genus.

Type species: ***Paracylindrocarpon aloicola*** Crous, Roets & L. Lombard, in Crous et al., Persoonia 36: 367 (2016)

Index Fungorum number: IF817040, Facesoffungi number: FoF10894

Descriptions and illustrations: see Crous, Wingfield, Richardson et al. (2016).

Periantria Döbbeler & P.G. Davison, Nova Hedwigia 106(1-2): 242 (2017) [2018]

Index Fungorum number: IF821330, Facesoffungi number: FoF10895

Bryophilous, biotrophic or necrotrophic, perianthicolous on *Frullania* species. **Sexual morph:** *Ascomata* up to 330 µm in diam., perithecial, occur within the perianths of *Frullania*, ovoid or pyriform, light yellow to mostly orange or orange red, KOH-, ostiolate, lacking setae, tomentose. *Hyphae covering the ascomatal wall* white, sometimes cyanophilous. *Ostioles* punctiform in face view, periphysate, periphyses strongly react with CB. *Peridium* plectenchymatous, thick and compact, of two strata, outer stratum comprising of small cells with merging walls and attenuated, reduced lumina; inner stratum not sharply separated from the outer stratum, composed of extended, angular cells, with cyanophilous walls. *Apical paraphyses* filamentous, numerous. *Asci* 8-spored, unitunicate, almost cylindrical, thin-walled, without apical structures. *Ascospores* narrowly ellipsoidal and 1-septate or, narrowly cylindrical and with 3–7 transvese septa, straight or slightly curved, poor in cytoplasmic content, hyaline with many coloured droplets, sometimes slightly cyanophilous, smooth-walled. *Hyphae* individual or forming compact plectenchymatous layers, restricted in or between different parts of sporophytic and gametophytic host tissue as superficial, inter- or intracellular mycelia, hyaline, thick-walled. **Asexual morph:** *Conidiomata* sporodochial, tubercularia-like, gelatinous, occur at the outer surface of the perianths, one to several, forming small to large filmy layers or cushions 50 or more µm thick, sometimes pustulate and up to 220 µm high, whitish, greyish to brownish. *Conidiophores* numerous, compact, palisade-like; laterally, dichotomously or verticillately branched; with phialidic end cells. *Phialids* up to 10 µm long. *Conidia* 1–2 µm diam., globose to very broadly ellipsoidal, mostly occur singly, rarely in short rows of 2 or 3, hyaline (Adapted from Döbbeler & Davison, 2018).

Known distribution: USA., Europe (Döbbeler & Davison, 2018)

Notes: Döbbeler and Davison (2018) introduced *Periantria* to accommodate two bryophilous taxa: *Periantria bellacaptiva* and *Periantria frullaniae*, and placed in

Bionectriaceae. The light yellow to orange or orange red, KOH-, ascomata of *Periantria* are typical of Bionectriaceae. No DNA data are available.

Type species: ***Periantria frullaniae*** (Racov.) Döbbeler & P.G. Davison, Nova Hedwigia 106(1-2): 247 (2017) [2018]

Index Fungorum number: IF821332, Facesoffungi number: FoF10896

Descriptions and illustrations: see Döbbeler and Davison (2018).

Pronectria Clem., in Clements & Shear, Gen. fung., Edn 2 (Minneapolis): 78 (1931)

Index Fungorum number: IF4370, Facesoffungi number: FoF10897

Lichenicolous, algicolous, possibly parasitic. **Sexual morph:** *Ascomata* astromatic, solitary or gregarious, immersed, with apex erumpent through the surface, subglobose to pyriform, red, slightly papillate, orange to pale yellow, KOH-, lactic acid–, ostiolate. *Ostiolar canal* lined with periphyses. *Peridium* cells angular in surface view, outer strata composed of thick-walled, ellipsoid cells; inner stratum of hyaline, compressed, thin-walled cells; ostiole surrounded by parallel layers of elongate cells. *Paraphyses* anastomosing, only noticeable when young, early deliquescing. *Asci* generally 8-spored, unitunicate, clavate to subclavate, thin-walled, I–. *Ascospores* biseriate in the centre, uniseriate in above and below, ellipsoid, usually aseptate, hyaline, smooth- to verruculose-walled. **Asexual morph:** Acremonium (cylindromonium)-like (Berger et al., 2021; Diederich et al., 2018).

Known distribution: Worldwide (Etayo, 1998; Zhurbenko et al., 2005; von Brackel & Etayo, 2010; Khodosovtsev et al., 2012)

Notes: Clements and Shear (1931) introduced *Pronectria* for the lichenicolous taxon *P. lichenicola*, which had been hitherto considered in *Nectriella*. Clements and Shear (1931) segregated *Pronectria* from *Nectriella* and placed the taxon with lichenicolous lifestyle and one-septate, hyaline ascospores in *Pronectria*. However, Rogerson (1970) treated *Pronectria* as a synonym of *Nectriella*. Lowen (1990, 1991) believed *Pronectria* is a distinct genus and resurrected the genus provideding new species combinations. This taxonomic treatment was followed by subsequent authors (Rossman et al., 1999; Etayo, 2002; Maharachchikumbura et al., 2015, 2016; Wijayawardene et al., 2018, 2020, 2022; Hyde et al., 2020; Berger et al., 2021). *Pronectria* species occur on lichens and algae (Clements & Shear, 1931; Rossman et al., 1999; Etayo, 2002;

Khodosovtsev et al., 2012). They are characterized by astromatic, KOH-, perithecial ascomata, often 1-septate (rarely 2–7-septate), hyaline ascospores with smooth or ornamented-walls and, lichenicolous or algicolous habit (Rossman et al., 1999; Berger et al., 2021). Currently, 48 species are accommodated in the genus *Pronectria* (Species Fungorum 2022).

Type species: ***Pronectria lichenicola*** (Ces.) Clem., in Clements & Shear, Gen. fung., Edn 2 (Minneapolis): 282 (1931)

Basionym: *Cryptodiscus lichenicola* Ces., in Rabenhorst, Klotzschii Herb. Viv. Mycol., Edn Nov, Ser. Sec., Cent. 6: no. 523 (1857)

= *Pronectria robergei* (Mont. & Desm.) Lowen, Mycotaxon 39: 462 (1990)

= *Nectria robergei* Mont. & Desm., Bull. Soc. bot. Fr. 4: 999 (1857)

Index Fungorum number: IF269382, Facesoffungi number: FoF10898, Figure 2.19

Lichenicolous, on *Peltigerae carinae*. **Sexual morph:** *Ascomata* 200–250 × 190–235 μm, appearing as small red spots on moistened lichen thallus, perithecial, astromatic, solitary or in groups, fully immersed or sometimes apex erumpent through the substrate, globose to ovate, with a slightly papillate apex, light brown-red or orange-red, KOH-, ostiolate. Ostiolar channel lined with delicate, hyaline periphyses. *Peridium* 18–35 μm thick, of two strata, outer stratum composed of pale brown, globose to ellipsoid, thick-walled cells forming *textura globulosa*; inner stratum of hyaline to pale brown, elongated, thin-walled cells foming *textura primatica*. *Paraphyses* not observed. *Asci* 45–70 × 10–15 μm ($\bar{x}$ = 62 × 12 μm), 8-spored, unitunicate, clavate, with a narrowed, rounded, with a somewhat thickened apex, short pedicellate, apical ring J-. *Ascospores* 12–17 × 5–6.7 μm ($\bar{x}$ = 15.4 × 5.8 μm), bi-seriate at the above, uni-seriate at the below, ovoid to ellipsoid, rounded at both edges, 1-septate, not or slightly constricted at septum, guttulate, hyaline, smooth to slightly roughened-, thick-walled, without appendages. **Sexual morph:** Undetermined.

Material examined: FRANCE, Calvados, dunes d'Oystreham, on thallus of *Peltigerae carinae*, M. R. Roberge, (M), M-0043171, **isotype of *Nectria robergei*.**

Notes: *Pronectria lichenicola* is associated with thalli of *Peltigerae carinae* and other species of *Peltigerae* (Rossman et al., 1999). No DNA data are available.

Note (a, b) Herbarium material label. (c) Herbarium material. (d) Face view ascomata in the host thallus. (e, f) Vertical section of ascomata. (g) Section of peridium in 3% KOH. (h–j) Asci. (k–p) Ascospores in 3% KOH. Scale bars: d = 500 µm, e, f = 100 µm, g = 50 µm, h–j = 20 µm, k–p = 10 µm.

Figure 2.19 *Pronectria lichenicola* (M-0043171, isotype of *Nectria robergei*)

Protocreopsis Yoshim. Doi, Kew Bull. 31(3): 551 (1977)

Index Fungorum number: IF4384, Facesoffungi number: FoF10899

Saprobic on decaying monocotyledonous plant parts, mainly leaves. **Sexual morph:** *Ascomata* perithecial, superficial on the substrate, solitary or in groups, enclosed in a white to tan or rarely greenish hyphae, globose or subglobose, collapsing when dry,

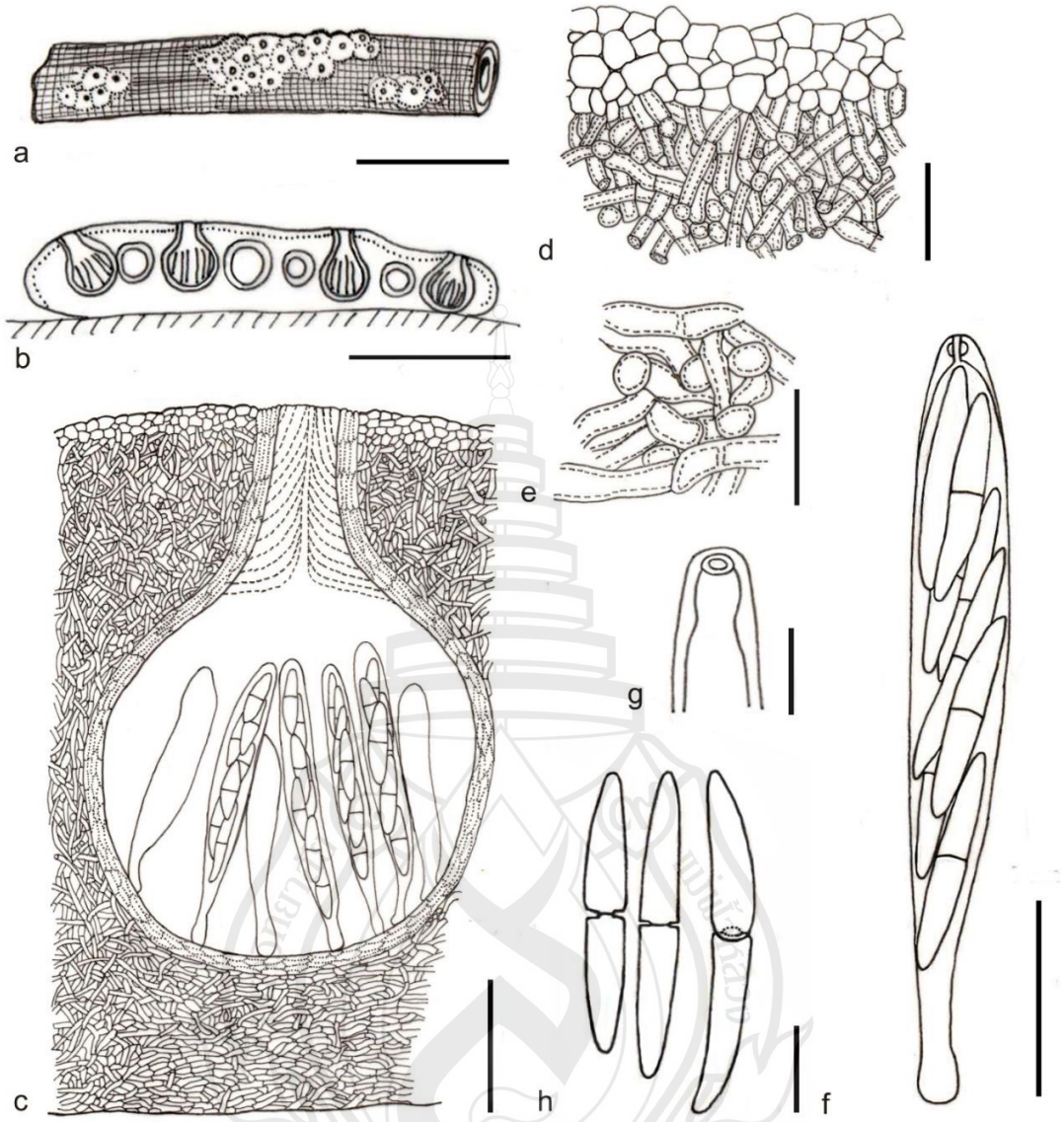
hyaline to pale yellow to pale orange or brownish-orange, KOH-, LA-, papillate or apapillate, ostiolate. *Peridium* >20 µm thick, of one or two strata, composed of brick-like cells. *Asci* 8-spored, unitunicate, sometimes evanescent, clavate to fusiform, apex simple or with an indistinct apical ring. *Ascospores* bi- to pluriseriate, fusiform to ellipsoid, straight or slightly curved or sigmodial, 1-septate, hyaline, usually striate, occasionally smooth-walled, punctate-striate or tuberculate, without mucilagenous appendages or sheaths. **Asexual morph:** Acremonium-like, *Conidiophores* monophialidic, unbranched, typically septate, smooth-walled or sometimes spinulose on phialides. *Conidia* ellipsoid to fusiform or oblong, aseptate, hyaline, smooth-walled, arange in a hyaline, fluid head at the tip of phialide.

Known distribution: Cosmopolitan, mainly tropics and subtropics (Doi, 1977; Rossman et al., 1999; Lechat & Fournier, 2015)

Notes: Doi (1977) introduced *Protocreopsis* to accommodate two nectria-like species with ascomata surrounded by a hyphal mat, thus mentioned as hypocrea-type. The genus was based on *Protocreopsis zingibericola* as the type (Doi, 1977). The pale yellow to orangish, KOH-, LA- ascomata led to the place meet in Bionectriaceae (Rossman et al., 1999). *Protocreopsis* species are characterized by ascomata enclosed in white to tan or greenish hyphal stroma, striate ascospores, acremonium-like asexual morphs and their monocotyledonous hosts (commonly on leaves of palms, *Heliconia* or Musaceae hosts) (Doi, 1977; Rossman et al., 1999; Lechat & Fournier, 2015). The taxonomic placement of *Protocreopsis* in Bionectriaceae was confirmed by inference of LSU sequences (Hirooka et al., 2010; Lechat & Fournier, 2015; Lechat et al., 2016b). Currently, 16 species are accommodated in *Protocreopsis*, five species with sequence data.

Type species: ***Protocreopsis zingibericola*** Yoshim. Doi, Kew Bull. 31(3): 552 (1977)

Index Fungorum number: 321027, Facesoffungi number: FoF10900, Figure 2.20



Note (a) Ascomata on host. (b, c) Vertical section of stroma. (d) vertical section of superficial tissues of stroma. (e) Vertical section of inner tissue of stroma. (f) Ascus. (g) Apical structure of ascus. (h) ascospores. Scale bars: Scale bars: b = 1000 µm, c = 100 µm, d–f = 20 µm.

Figure 2.20 *Protocreopsis zingibericola* (TNS, F-I9296, holotype, redrawn from Doi, 1977)

Selinia P. Karst., Meddn Soc. Fauna Flora fenn. 1: 57 (1876)

Index Fungorum number: IF4996, Facesoffungi number: FoF10901

Coprophilous. **Sexual morph:** *Ascomata* stromatic, perithecial, subglobose to globose, rarely obpyriform, small, immersed in a stroma, becoming erumpent, ostiolate. *Ostiolar canal* filled with hyaline, filiform periphysate. *Stromata* partially or completely immersed in the substratum, diplostromatic, ectostroma composed of reddish-brown, small, strongly melanised cells; endostroma of thin-walled cells forming *textura epidermoidea*, surface sometimes tomentous. *Peridium* fleshy, layered. *Paraphyses* mostly absent, if present filiform, hyaline. *Asci* unitunicate, 4–8-spored, short-stalked, clavate to cylindric-clavate ephemeral asci, with or without an apical ring, if present J-. *Ascospores* ellipsoid to fusiform, aseptate, hyaline, thick-walled, often surrounded by a hyaline gelatinous sheath. **Asexual morph:** Sporodochial, sitting on a thin subiculum, irregularly pulvinate, sparse or in groups, pale yellow to orange. *Conidiophores* arising from basal hyphae, hyaline, branched. *Phialides* cylindrical to clavate, with a conspicuous collarette. *Conidia* ovoid to oblong, aseptate, hyaline, held in slimy masses. *Chlamydospores* globose, present or absent (Ranalli & Mercuri, 1995; Rossman et al., 1999).

Known distribution: Cosmopolitan (von Arx & Müller, 1955; Khan & Krug, 1989; Ranalli & Mercuri, 1995; Rossman et al., 1999; Watling & Richardson, 2010; Yul et al., 2020).

Notes: Winter (1875) introduced *Hypocreopsis* based on *Hypocreopsis pulchra* G. Winter. However, this name was not valid as *Hypocreopsis* P. Karst. (homonym) was already published by Karsten (1873). Karsten (1876) introduced a new genus *Selinia* to accommodate *Hypocreopsis pulchra*. However, the familial placement of *Selinia* has been debated for decades. *Selinia* was regarded in the Hypocreaceae, Hypocreales by Saccardo (1883) and Clements and Shear (1931). Later this genus was placed in new family Seliniaceae, Sphaeriales (von Arx & Müller, 1955; Dennis, 1978). Udagawa (1980) suggested to maintain *Selinia* near Hypocreaceae as a representative of the primitive pyrenomycetes. *Selinia* species are typical of Hypocreales by their soft-textured, vividly coloured perithecia. Rossman et al. (1999) recognised *Selinia* as a unique genus due to its coprophilous lifestyle and ascospore wall characteristics. Rossman et al. (1999) maintained *Selinia* in Bionectriaceae and taxonomic placement was supported by

molecular analysis of LSU sequences (Rossman et al., 2001). The genus was regarded in Bionectriaceae by subsequent authors (Kirk et al., 2008; Maharachchikumbura et al., 2015, 2016; Hyde et al., 2020). *Selinia* species are coprophilous growing on animal dung (ie. cow, hare, horse, sheep, opossum, goose) (von Arx & Müller, 1955; Khan & Krug, 1989; Ranalli & Mercuri, 1995; Watling & Richardson, 2010; Yul et al., 2020).

Type species: ***Selinia pulchra*** (G. Winter) Sacc., in Saccardo, Syll. fung. (Abellini) 2: 457 (1883)

Basionym*: Hypocreopsis pulchra* G. Winter, Hedwigia 14: 26 (1875)

Index Fungorum number: IF179559, Facesoffungi number: FoF10902

Descriptions and illustrations: see Rossman et al. (1999)

Septofusidium W. Gams, Cephalosporium-artige Schimmelpilze (Stuttgart): 147 (1971)

Index Fungorum number: IF9882, Facesoffungi number: FoF10903

Parasitic on foliicolous fungi. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiophores* basitonously verticillate, arising laterally from submerged hyphae. *Conidiogenous cells* phialidic, sometimes integrated in septate branches, cylindrical to allantoid, hyaline to yellow, smooth-walled, becoming verrucose. *Conidia* cylindrical to fusiform, 0–7-septate, sometimes with distinct hilum at both ends, hyaline to yellow, smooth or roughened to verrucose, formed in long divergent chains (Adapted from Lombard et al., 2015).

Known distribution: UK (Lombard et al., 2015)

Notes: Gams (1971) accepted *Septofusidium* in the family Nectriaceae based on morphological data. Later Lombard et al. (2015) provided DNA data of *Septofusidium* (*S. berolinense* and *herbarum*) and introduced the family Tilachlidiaceae to accommodate *Septofusidium* and *Tilachlidium*. However, no molecular data are available for the generic type *Septofusidium elegantulum*. Relying on DNA analysis, we recognize *Septofusidium berolinense* and *S. herbarum* in Bionectriaceae (Figure 2.1).

Type species: ***Septofusidium elegantulum*** (Pidopl.) W. Gams, Cephalosporium-artige Schimmelpilze (Stuttgart): 147 (1971)

Index Fungorum number: IF323444, Facesoffungi number: FoF10904

Descriptions and illustrations: see Gams (1971), Samson (1974)

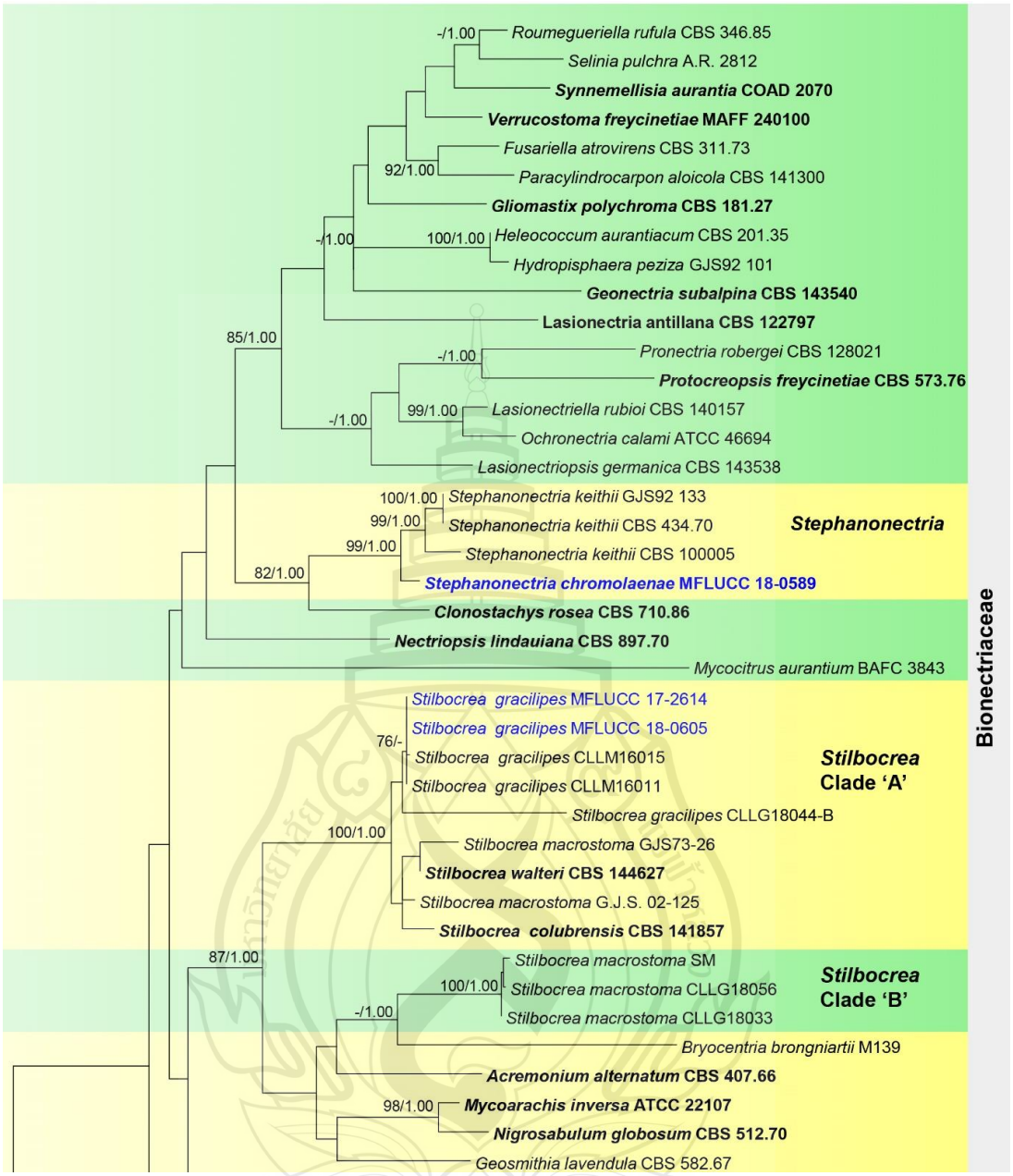
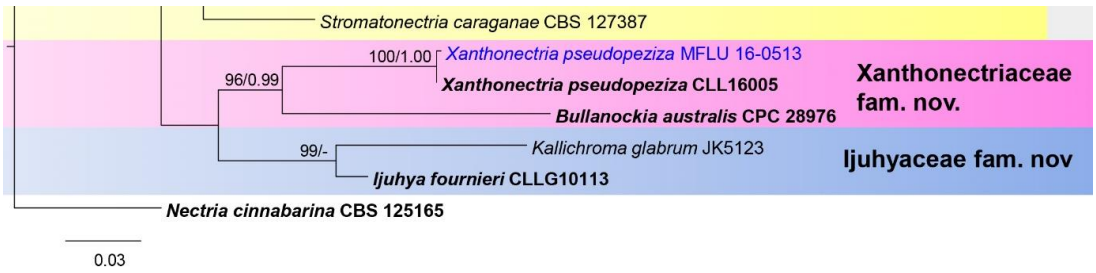


Figure 2.21 Phylogram generated from maximum likelihood analysis based on combined LSU and ITS sequence data of Bionectriaceae taxa



Note Fourty-seven strains are included in the combined analyses, which comprised 1421 characters (LSU: 812, ITS: 609) including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes respectively. The tree is rooted to *Nectria cinnabarina* (CBS 125165). Ex-type strains are in **bold**. The newly generated sequences are indicated in blue. The scale bar indicates 0.03 nucleotide changes per site.

Figure 2.21 (continued)

Stephanonectria Schroers & Samuels, in Schroers, Samuels & Gams, Sydowia 51(1): 116 (1999)

Index Fungorum number: IF28373, Facesoffungi number: FoF10905

Associated with dead woody or herbaceous plants, sometimes isolates from soil. *Stroma* superficial and minute or erumpent through the substrate. **Sexual morph:** *Ascomata* perithecial, emerging from stroma, gregarious to crowded, superficial, brown, smooth to rough, minutely papillate, KOH-, ostiolate. *Ostioles* surrounded by a crown-like structure. *Peridium* two strata; outer stratum and the crown composed of irregular, angular to elongated, tooth-like cells; inner stratum of slightly lobed cells in surface view, oblong and flat in longitudinal section. *Ascospore*s 1-septate, covered with short striae. **Asexual morph:** *Conidiomata* myrothecium-like, sporodichial. *Sporodichia* flat to cup-shaped. *Conidiophores* dense, parallel. *Conidiogenous cells* phialidic. *Conidia* brownish orange, or white to pale orange en masse, arrange in chains, aseptate, ellipsoidal, symmetrical or asymmetrical, hilum slightly laterally displaced, hyaline, smooth walled (Adapted from Schroers et al., 1999a).

Known distribution: Possibly cosmopolitan; UK, France, Japan, New Zealand, French Guiana, Netherlands (Schroers et al., 1999a), Thailand (This study)

Notes: The monotypic genus *Stephanonectria* was introduced for *Nectria keithii* by Schroers et al. (1999a). *Stephanonectria* is characterized by a peculiar crown-like structure around the ascomatal ostiole and myrothecium-type asexual morph (Schroers et al., 1999a). *Stephanonectria keithii* has been found from dead parts of *Brassica* sp. and various dead woody substrata and soil (Schroers et al., 1999a).

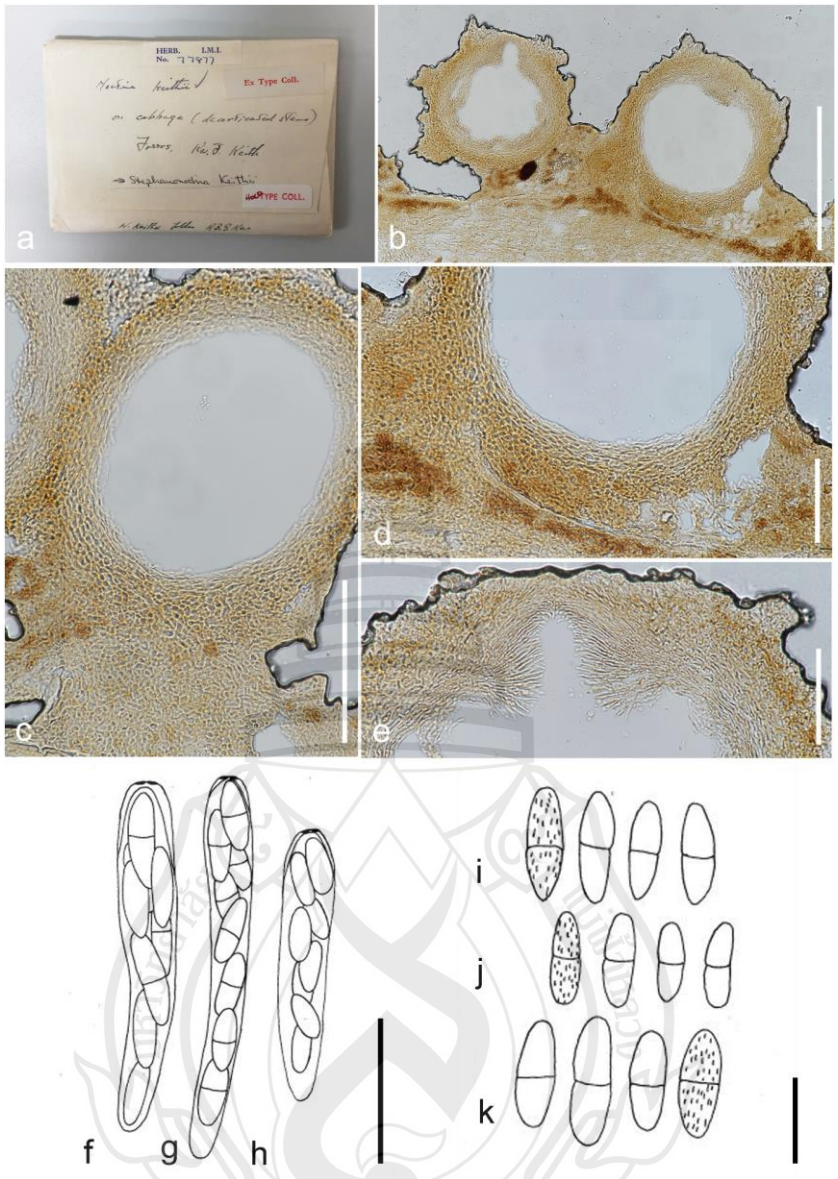
Type species: ***Stephanonectria keithii*** (Berk. & Broome) Schroers & Samuels, Sydowia 51(1): 116 (1999)

Basionym: *Nectria keithii* Berk. & Broome, Ann. Mag. nat. Hist., Ser. 4 17: 144 (1876)

Index Fungorum number: IF460028, Facesoffungi number: FoF10906, Figure 2.22

Associated with decorticated stems of cabbage. **Sexual morph**: *Ascomata* 175–270 µm high, 175–255 µm diam. ($\bar{x}$ = 224.5 × 204 µm, n = 10), perithecial, stromatic, superficial on stroma, globose to subglobose, orange to golden brown or brown, ostiolate, surface smooth to rough, warted around the ostiolar region. *Stromata* flat, composed of golden brown, round to angular cells. *Ostioles* 45–60 µm high, 30–45 µm diam. ($\bar{x}$ = 54.7 × 40.5 µm, n = 5), periphysate, surrounded by a crown-like warts; cells of the warts paler than the rest of the ascomatal wall, oblong to angular, merging with cells of ascomatal wall. *Peridium* comprising two strata; outer stratum 10–30 µm thick, 3–6-layered, merging with cells of the basal stroma, made up of orange to pale brown, thick-walled cells of *textura angularis;* inner stratum 10–20 µm thick, composed of orange or pale brown to hyaline, compressed cells. *Asci* (38–)43–53(–64) × (5.5–)6.4–8(–11.5) µm ($\bar{x}$ = 48 × 7.4 µm), 8-spored, clavate, apex broadly rounded, rarely flat, with a barely visible refractive ring. *Ascospores* (7.5–)10–13.1(–17) × (2.4–)3.1–4.1(–5.6) ($\bar{x}$ = 11.6 × 3.6µm), biseriate above, uniseriate below, almost completely filling the ascus, ellipsoidal, 1-septate, hyaline, with short, more or less longitudinally oriented striae or appearing smooth (Asci and ascospore description adapted from Schroers et al., 1999a). **Asexual morph**: See Schroers et al. (1999a).

Notes: We did not observe asci and ascospores in the slides of the holotype of *Stephanonectria keithii* (IMI 77877). Asci and ascospores are redrawn based on Schroers et al. (1999a).



Note (a) Herbarium packet. (b) Vertical sections of ascomata. (c, d) Vertical sections of stroma and peridium. (e) Vertical section of ostiole. (f–h) Asci. (i–k) Ascospore. Scale bars: b = 200 µm, c = 100 µm, d, e = 50 µm, f–h = 20 µm, i–k =10 µm.

Figure 2.22 *Stephanonectria keithii* (a–e: IMI 77877, slides of holotype, f–k: redrawn from Schroers et al., 1999a)

Material examined: UK, Forres, on decorticated stems of cabbage, Rev. J. Keith, IMI 77877, **slides of holotype**.

Stephanonectria chromolaenae R.H. Perera & K.D. Hyde, ***sp. nov*.**

Index Fungorum number: IF559630, Facesoffungi number: FoF10907, Figure 2.23

Etymology: Name refers to the host genus *Chromolaena* from which it was collected.

Saprobic on dead stem of *Chromolaena odorata*. **Sexual morph:** Undetermined. **Asexual morph:** *Sporodochial*. *Sporodochia* up to 150 µm tall, flat to cup-shaped, composed of dense, parallel conidiophores, hymenium consisting of densely arranged phialides. *Conidiophores* up to 90 µm long, monomorphic, penicillate, irregularly branched, septate, hyaline, smooth-walled, with 1–5 phialides on each supporting cell. *Conidiogenous cells* 7–14 µm long × 2–3.1 µm wide at the widest point ($\bar{x}$ = 10 × 2.4 µm; n = 25), phialidic, cylindrical to clavate, sometimes widening in the upper part, apical periclinal thickening visible, with a minute collarette. *Conidia* 4.5–5.6 × 2–2.5 µm ($\bar{x}$ = 5.1 × 2.3 µm; n = 45), aseptate, ellipsoidal, symmetrical or asymmetrical, with a median or slightly laterally displaced hilum, bi-guttulate, hyaline, smooth-walled. *Conidial masses* white to pale orange, arranged in disconnected linear or somewhat imbricate chains.

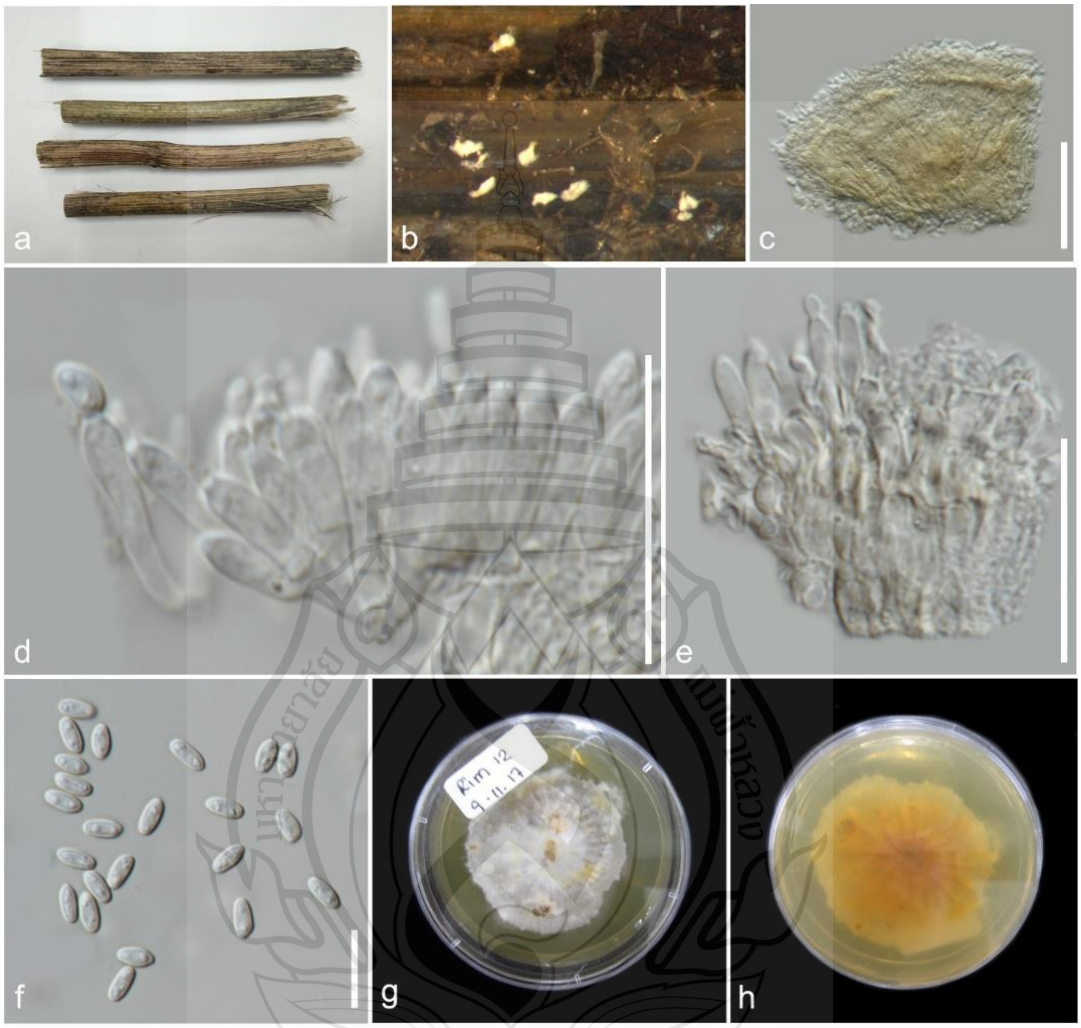
Culture characteristics: Colony on PDA reaching 25 mm in 30 days at 25°C, circular with irregular margin, flat, surface transparent to somewhat cottony at the center, aerial mycelium sparse, tufted, colony reverse transparent or orange-white to pale orange.

Material examined: THAILAND, Chiang Mai Province, Mae Rim District, on dead stem of *Chromolaena odorata* (Asteraceae), 18 September 2017, R. H. Perera, Rim12 (MFLU 19-0972, **holotype**); **ex-type** living culture MFLUCC 18-0589.

GenBank numbers: ITS: ON230051, LSU: ON230059, TUB2: ON238010

Notes: *Stephanonectria chromolaenae* (MFLUCC 18-0589) is morphologically and phylogenetically related to *Stephanonectria keithii* (99%MLBT, 100% BYPP; Figure 2.21). DNA sequences of *S. chromolaenae* and *S. keithii* strain CBS 434.70 differ in 16 nucleotides of the ITS region (3%), and 11 nucleotides of LSU region (1%). DNA sequences of new species and *S. keithii* strain CBS 100005 differ in 17 nucleotides of the ITS region (3%). *Stephanonectria chromolaenae* and *S. keithii* strain GJS92-133 differ in

11 nucleotides of the LSU region (1%). *Stephanonectria chromolaenae* having shorter phyalides than *S. keithii* (7–14 µm vs 8.5–20.5 µm) (Schroers et al., 1999a). Based on molecular and morphological evidence we introduce *S. chromolaenae* as a new species.



Note (a) Herbarium material. (b) Appearance of conidiomata on the host. (c) Vertical section of conidiomata. (d, e) Conidiophores, phialides and conidia. (f) Conidia. (g, h) Colony on MEA. Scale bars: c = 50 µm, d, e = 20 µm, f = 10 µm.

Figure 2.23 *Stephanonectria chromolaenae* (MFLU 19-0972, holotype)

Stilbocrea Pat., Bull. Soc. mycol. Fr. 16(4): 186 (1900)

Index Fungorum number: IF5263, Facesoffungi number: FoF10908

Saprobic on dead woody plant material and decaying ascomycetes stromata. **Sexual morph:** *Stromata* erumpent through the substrate; globose, elliptical or irregular in outline, surface white, orange or pink, grey or brown to dull buff. *Ascomata* perithecial, superficial or partly immersed to entirely immersed in stroma, globose to elliptical or ovoid, cupulate or laterally collapsing when dry, pale yellow to orange, becoming red-brown, dark olive green to black with age, KOH-/+ red brown, LA-/+ olivaceous to umber brown. *Peridium* more than 25 µm thick. *Asci* 8-spored, unitunicate, oblong, narrowly clavate to cylindrical, ellipsoid to ellipsoid-fusiform, apex simple, without an apical ring. *Ascospores* uniseriate, biseriate or irregular, ellipsoid to ellipsoid-fusiform, 1-septate, not constricted or slightly constricted at the septum, guttule, hyaline, verrucose to verruculose, echinulate or conspicuously spinulose. **Asexual morph:** Acremonium-like or stilbella-like. *Acremonium-like conidiophores* giving rise to intercalary, terminal or lateral phialides. *Phialides* lageniform to cylindrical. *Conidia* aseptate, allantoid, hyaline, commonly guttulate, smooth-walled. *Blastoconidia* when present ellipsoid to subglobose or globose, hyaline, becoming thick-walled when mature. *Stilbella-like conidiophores* forming synnemata. *Synnemata emerging from sexual morph stroma* or from a basal subiculum, cylindrical-capitate, subulate-capitate or clavate, slender or robust, branched or unbranched, stipe white, orange, orange-pink, grey, black or grey-brown. *Conidiophores* more or less verticillately branched. *Phialides* cylindrical or subulate, straight or curved, lateral, lateral and terminal, or in terminal whorls of 3–4. *Conidial mass* hemispherical, globose, ovoid or ellipsoid, orange or green, pink-orange, yellow-orange or red-brown. *Conidia* ellipsoid, oblong or ovoid, cylindrical or obovate, straight or slightly curved, aseptate, hyaline (Adapted from Rossman et al., 1999).

Known distribution: Pantropical and warm temperate regions (Cuba, Colombia, Northern South America: Brazil, French Guiana, Guyana), Sri Lanka, USA (Rossman et al., 1999), French West Indies (Lechat & Fournier, 2019a), French Guiana, Portugal (Voglmayr & Jaklitsch, 2019), Thailand (This study).

Notes: There are 10 epithets under *Stilbocrea* in Species Fungorum (2022). Voglmayr and Jaklitsch (2019) and Lechat and Fournier (2019a) provided sequence data for *S. macrostoma* along with detailed morphological descriptions and illustrations. In the present phylogenetic analysis *S. macrostoma* strains (SM, CLLG18056, CLLG18033) formed a distinct clade (Clade ‘B’) sister to *Bryocentria* (Figure 2.1, 18). Other *Stilbocrea*

species (Clade ‘A’) clustered distantly to clade ‘B’ might have belonged to a different genus (Figure 2.21). However, Clade ‘A’ also represented by another two putatively named *S. macrostoma* strains. Lechat and Fournier (2019a) believed that *S. macrostoma* is not monophylectic due to cryptic or misidentified species. Seifert (1985) and Rossman et al., (1999) observed two types of synnemata in *Stilbocrea macrostoma*. Lechat and Fournier (2019a) noticed that *S. macrostoma* associated with *S. gracilipes* and, stromata of *S. macrostoma* overlain on stromata of *S. gracilipes*. Similar observations were made by Guu et al. (2010) and found out two types of synnemata belongs to two different species. Therefore, *S. macrostoma* was shown to possess one type of synnemata (Lechat & Fournier, 2019a). Species in Clade ‘A’ might belong to a new genus, but needed further investigations with type material of *S. macrostoma* sequenced.

There are 50 different positions, including 7 gaps, observed in ITS region of putative strain of ‘*Stilbocrea gracilipes’* CLLG18044-B when compared to ITS sequences of *Stilbocrea gracilipes* strains, CLLM16015, CLLM16011 and MFLUCC 17-2614. Thus, ‘*Stilbocrea gracilipes*’ CLLG18044-B is probably a new taxon, but further studies are required to resolve its taxonomy.

Type species: ***Stilbocrea macrostoma*** (Berk. & M.A. Curtis) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1185 (1909)

= *Nectria macrostoma* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc., Bot. 10(no. 46): 378 (1868) [1869]

= *Stilbocrea dussii* Pat., Bull. Soc. Mycol. Fr. 16: 186 (1900)

Index Fungorum number: IF198350, Facesoffungi number: FoF10909

Descriptions and illustrations: see Rossman et al. (1999); Voglmayr & Jaklitsch (2019), Lechat & Fournier (2019a)

Stilbocrea gracilipes (Tul. & C. Tul.) Samuels & Seifert, in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 73 (1999)

≡ *Sphaerostilbe gracilipes* Tul. & C. Tul., Select. fung. carpol. (Paris) 3: 102 (1865)

= *Nectria gracilipes* (Tul. & C. Tul.) Wollenw., Angew. Bot. 8: 198 (1926)

Index Fungorum number: IF460110, Facesoffungi number: FoF10910, Figure 2.24

Saprobic on dead twigs of *Mangifera indica*. **Sexual morph:** *Stromata* erumpent through the substrate, hyaline to white in section, becoming orange or pink and finally grey brown with age; composed of 3–7 µm wide, smooth walled, hyaline hyphae forming a *textura intricata*. *Ascomata* 200–365 µm diam., perithecial, superficial or partly immersed in stroma, agreagate in groups several (10–30), rarely solitary, globose to subglobose or ellipsoidal, slightly cupulate at the centre upon drying, apapillate, with a central ostiole, pale yellow, becoming orange to orange brown to dark olive green or black with age, KOH-, surface smooth to granulose. *Periphyses* lining the ostiolar channel, filiform, hyaline. *Peridium* 20–50 µm thick, consisting of three strata: outermost stratum 22–40 µm thick, composed of hyaline to orange brown to dark brown hyphae forming *textura intricta*, hyphae 2.3–7 µm wide; middle stratum 8–14 µm thick, of 5–7 layers of orange brown, elongate, thick-walled cells forming *textura prismatica*; inner stratum 7–12 µm wide, of hyaline, thin-walled cells forming *textura angularis*. *Asci* 67–90 × 6.7–9 µm ($\bar{x}$ =76.3 × 6.7 µm, n = 25), 8-spored, unitunicate, narrowly clavate to cylindrical, almost completely filled with ascospores, short pedicellate, without an apical ring. *Ascospores* 10–14.5 × 3.5–5.2 µm ($\bar{x}$ =11.5 × 4.2 µm, n = 40), obliquely uniseriate, ellipsoid to ellipsoid-fusiform, 1-septate, not constricted at the septum, straight or slightly curved, often flattened on one side, guttulate, initially hyaline, become pale brown when mature, spinulose; walls smooth and spores bi-guttulate in 3% KOH. **Asexual morph:** Seifert (1985) and Lechat and Fournier (2019a)

Culture characteristics: Colony on PDA reaching 55 mm in 14 days at 25ºC. Colony circular, moderately dense, surface white, appearing cottony with aerial mycelium, edge entire; reverse white to pale yellow.

Material examined: THAILAND, Chiang Mai Province, Mae Rim District, on fallen dead twigs of *Mangifera indica* (Anacardiaceae), 18 September 2017, R. H. Perera, Rim04 (MFLU 19-0966); living culture MFLUCC 17-2614; *Ibid.*, Rim05 (MFLU 19-0967); living culture MFLUCC 18-0605.

GenBank numbers: MFLUCC 17-2614: ITS: ON230052, LSU: ON230060, TEF1: ON238004, TUB2: ON238011; MFLUCC 18-0605: ITS: ON230053

Notes: Our new collections are phylogenetically related to strains of *Stilbocrea gracilipes* CLLM16015 and CLLM16011 (Figure 2.21). The new collection shares similar morphological features with the holotype of *Stilbocrea gracilipes* (Seifert, 1985;

Rossman et al., 1999). However, Seifert (1985) mentioned "basal 10–20 µm of ascus empty", but we observed almost completely filled asci in the present collection from Thailand. DNA sequences of new isolates (MFLUCC 17-2614 and MFLUCC 18-0605) and CLLM16015 differ in 3 nucleotides of the ITS region (0.6%, 1 gap). DNA sequences of strains MFLUCC 18-0605 and CLLM16011 are almost similar except 1 nucleotide gap of the ITS region, while LSU sequences are identical. Considering morphological data, we identify our collection as *Stilbocrea gracilipes*, which is new to Thailand and a new host record (*Mangifera indica*).

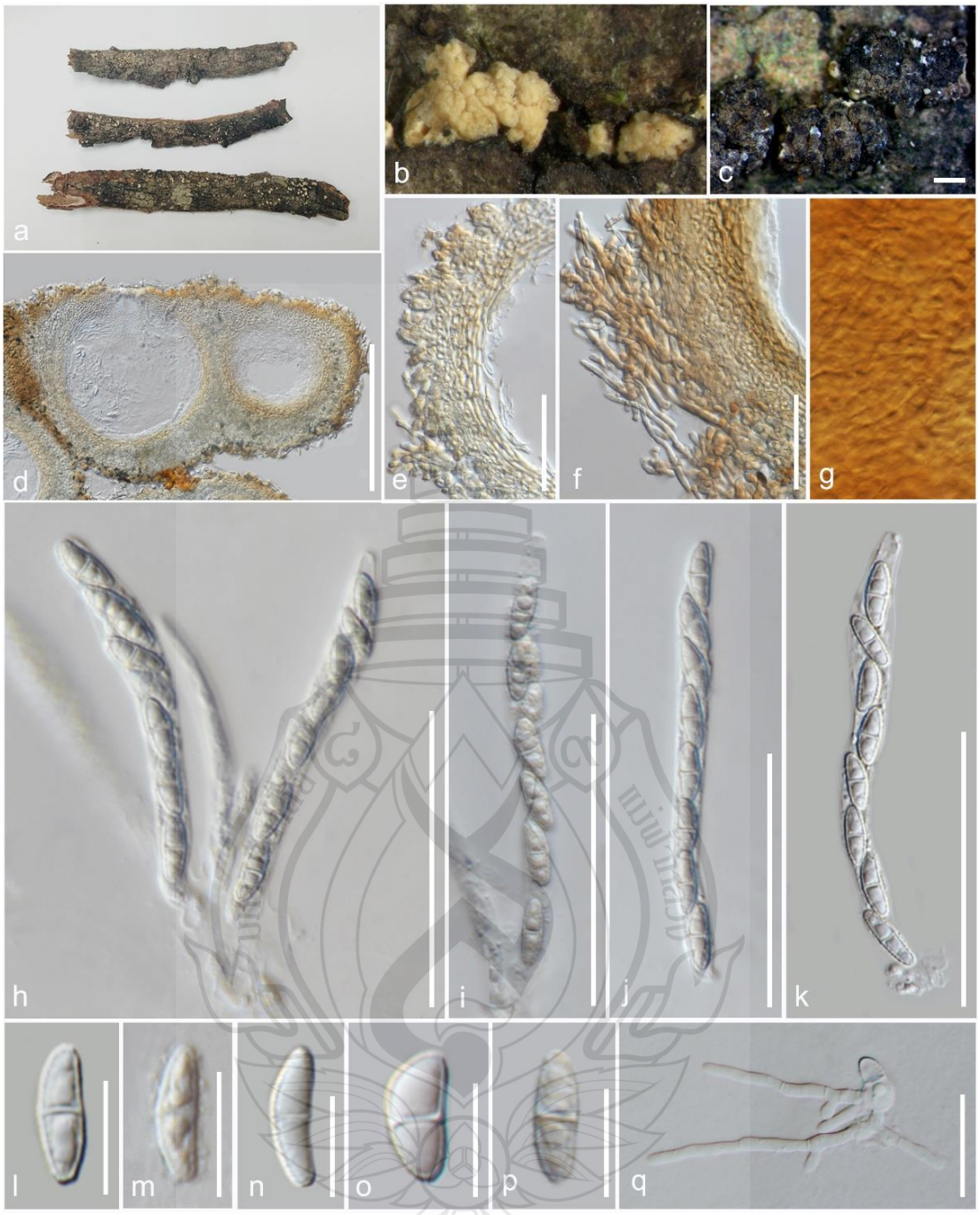
Synnemellisia N.K. Rao, Manohar. & Goos, Mycologia 80(6): 896 (1989) [1988]

Index Fungorum number: IF11201, Facesoffungi number: FoF10911

Probably *saprobic*. **Sexual morph:** Undetermined. **Asexual morph:** Synnematal. *Synnemata* astromatic, superficial, determinate, conspicuous, distinct, erect, obconical, grayish-brown to pale brown. *Constituent hyphae* generally unbranched, septate, pale brown, smooth-walled. *Conidiophores* cylindrical, septate, unbranched, subhyaline, smooth-walled. *Conidiogenous cells* integrated, terminal, fusiform, monoblastic, hyaline, smooth-walled. *Conidia* aseptate, navicular to fusiform, sometimes slightly curved, hyaline, smooth-walled, solitary or aggregated on a cushion-like head (Rao et al., 1988; Crous, Wingfield, Burgess et al., 2016).

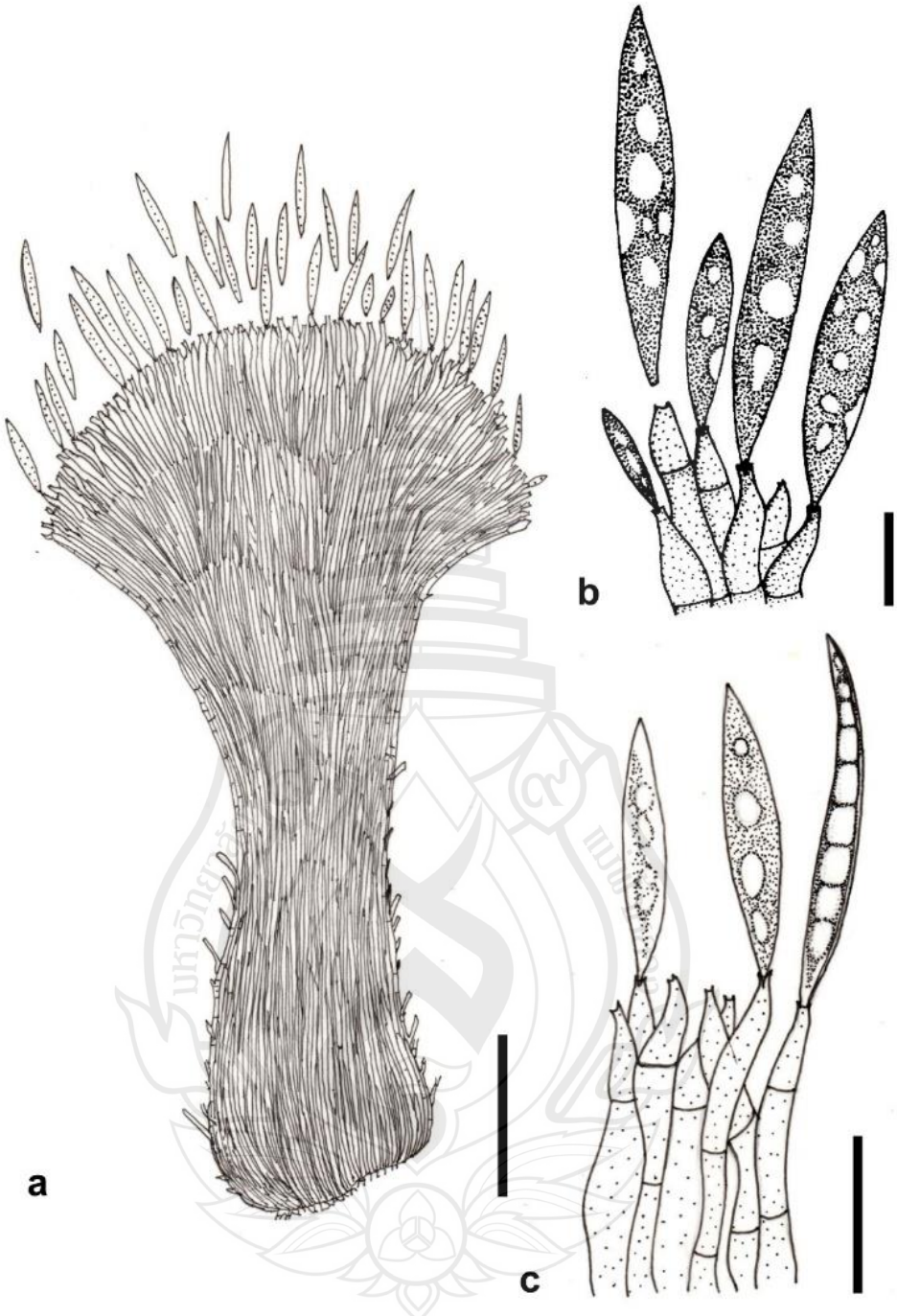
Known distribution: Brazil (Crous, Wingfield, Burgess et al., 2016), India (Rao et al., 1988)

Notes: Rao et al. (1988) introduced *Synnemellisia* to accommodate single species *S. hyalospora*. Crous, Wingfield, Burgess et al. (2016) introduced the second species *S. aurantia* and provided first DNA sequences for the genus. Species of *Synnemellisia* occur on woody substrates (Rao et al., 1988; Crous, Wingfield, Burgess et al., 2016). We could not loan the holotype specimen of *Synnemellisia hyalospora*, hence we provide illustrations (Figure 2.22) redrawn from Rao et al. (1988).



Note (a) Herbarium material. (b) Ascomata on the host. (c) Old ascomata on the host. (d) Section of stromata with ascomata. (e, f) Peridium in vertical section (f in 3% KOH, showing hyphae). (g) Peridium in surface view. (h–k) Asci. (l–p) Ascospores. (q) Germinating ascospore. Scale bars: c = 500 µm, d = 200 µm, e, f = 50 µm, h–k = 50 µm, l–p = 10 µm, q = 20 µm.

Figure 2.24 *Stilbocrea gracilipes* (a, b, e–q = MFLU 19-0966; c, d = MFLU 19-0967)



Note (a) Synnema and conidia. (b, c) Conidiogenous cells and conidia. Scale bars: a = 20 µm, b, c = 10 µm.

Figure 2.25 *Synnemellisia hyalospora* (IMI 296876, holotype; redrawn from Rao et al., 1988)

Type species: ***Synnemellisia hyalospora*** N.K. Rao, Manohar. & Goos, Mycologia 80(6): 896 (1989) [1988]

Index Fungorum number: IF135491, Facesoffungi number: FoF10912, Figure 2.25

Descriptions: see Rao et al. (1988)

Verrucostoma Hirooka, Tak. Kobay. & P. Chaverri, in Hirooka, Kobayashi, Ono, Rossman & Chaverri, Mycologia 102(2): 422 (2010)

Index Fungorum number: IF513353, Facesoffungi number: FoF10913

Possibly saprobic, on dead plant material. *Ascomata* perithecial, superficial, seated on a thin minute stroma, solitary or in small groups, subglobose to doliiform, slightly cupulate upon drying, white to pale orange or pale yellow, KOH-, LA-. *Ascomatal apex* conical to truncate, with protuberances around upper margin of ascomata. *Peridium* up to 40 µm thick, of two strata; outer stratum composed of globose to ellipsoidal, thick-walled cells; inner stratum of thin-walled, subglobose to elongate or oblong to fusiform cells; protuberances around ascomatal apex composed of globose or angular, thin-walled cells. *Asci* 8-spored, unitunicate, clavate, apices rounded, without ring. *Ascospores* bi-seriate, ellipsoidal to fusiform, 1-septate, often vacuolate, hyaline, smooth or spinulose-walled. **Asexual morph**: Acremonium-like, without forming *sporodochia*. *Conidiophores* monophialidic, unbranched, erect, arising from smooth-walled hyphae. *Conidiogenous cells* monophialidic, terminal, long cylindrical, hyaline, without apical thickening or collarettes, thin-, smooth-walled. *Conidia* fusiform to clavate or narrowly ellipsoidal to cylindrical, aseptate, slightly curved, hyaline, with a basal abscission scar, smooth-walled, aggregated in mucoid heads (Adapted from Hirooka et al., 2010).

Known distribution: Japan, French West Indies (Martinique) (Hirooka et al., 2010; Crous, Wingfield, Guarro et al., 2015)

Notes: This genus was introduced by Hirooka et al. (2010) based on DNA sequence data. Later, second species was added to the genus by Crous, Wingfield, Guarro et al. (2015). Currently, two species are accommodated in the genus with sequence data. *Verrucostoma* are associated with dead leaves of *Freycinetia boninensis* and dead stems of *Danaea elliptica*.

Type species: ***Verrucostoma freycinetiae*** Hirooka, Tak. Kobay. & P. Chaverri, in Hirooka et al., Mycologia 102(2): 422 (2010)

Index Fungorum number: IF513354, Facesoffungi number: FoF10914

Descriptions and illustrations: see Hirooka et al. (2010)

2.3.3 Calcarisporiaceae Jing Z. Sun, Xing Z. Liu & K.D. Hyde

Calcarisporiaceae was erected by Sun et al. (2017) to accommodate *Calcarisporium*, which was hitherto treated as genera *incertae sedis* in Hypocreales (Hausner & Reid, 2004) and later in Sordariomycetes (Maharachchikumbura et al., 2015).

Ecological and economic significance of Calcarisporiaceae

Calcarisporium arbuscula, the type species of the genus, is fungicolous. It can be found on the basidiomata of different macromycetes. More frequently it can be collected on *Mycena*, *Lactarius* and *Russula* spp. It is a typical endotroph that for a long time develops in tissues of host-fungus asymptomatic, but sporulation occurs mostly on dead or dying basidiomata (Watson, 1955; Akulov, 2011). Sometimes it can be isolated from wood that is partially decomposed by fungi (Sun et al., 2017).

Calcarisporium xylariicola, isolated from fruiting body of *Xylaria* sp. another fungicolous species, was described recently from Italy (Sun et al., 2017). There are some still unpublished finds of this species, collected by A. Akulov in Ukraine. The culture of one of them (CPC 39115) kindly examined by P.W. Crous is identical to the type. In Ukraine, *C. xylariicola* was registered on *Rosellinia corticium* and *Nemania serpens* ascomata (in total five specimens from different places). This suggests that *C. xylariicola* is a host-specific parasite on Xylariaceae representatives.

Mycoparasite *Calcarisporium cordycipiticola* is a pathogen of white mildew disease of *Cordyceps militaris*, which is one of the commercial *Cordyceps* species (Liu et al., 2021). Liu et al. (2018, 2021) studied the biosynthetic capabilities and mycotoxin production ability of *Calcarisporium cordycipiticola*. *Calcarisporium arbuscula* is also capable of producing the antibiotic, calcarin which inhibits the growth of various fungi (Watson, 1955). *Calcarisporium arbuscula* is capable of producing an array of secondary metabolites with anti-cancer, anti-nematode and antibiotic activities (Cheng et al., 2020). Furthermore, they revealed several gene regions that might have potential of producing mycotoxins (including aflatoxin, alternariol, destruxin, citrinin and isoflavipucine)

(Cheng et al., 2020). Hayakawa et al. (1975) isolated and characterized vertisporin produced by *Verticimonosporium diffractum*, an antibiotic with cytotoxic activity.

Calcarisporiaceae Jing Z. Sun, Xing Z. Liu & K.D. Hyde, in Sun et al., Mycol. Progr. 16(4): 435 (2017)

Index Fungorum number: IF817660, Facesoffungi number: FoF02511

Fungicolous, parasitic, endophytic or saprobic on higher ascomycetes and basidiomycetes, and leaves and branches of trees, sometimes isolated from soil. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* hyphomycetous. *Conidiophores* macronematous, mononematous, erect, straight or flexuous, unbranched or branched simply or verticillately, hyaline, sometimes bearing verticillate conidiogenous cells. *Conidiogenous cells* phialidic, holoblastic, monoblastic to polyblastic, discrete, subulate, hyaline. *Conidia* globose or subglobose, ovoid to ellipsoid, or acerose to narrowly obclavate, straight to curved, aseptate, hyaline, smooth-walled (Adapted from Matsushima, 1971; Sun et al., 2017; Hyde et al., 2020).

Type genus: ***Calcarisporium*** Preuss

Notes: *Verticimonosporium* was previously treated as a member of Hypocreaceae (Gams et al., 1998; Wijayawardene et al., 2020, 2022). Combined-gene analysis in this study revealed *Calcarisporium* and *Verticimonosporium* form a monophyletic lineage within Hypocreales (Figure 2.1). Therefore, *Verticimonosporium* was transferred to Calcarisporiaceae.

Genera included in Calcarisporiaceae (*Taxonomic notes provided)

Calcarisporium Preuss*

Verticimonosporium Matsush.

Calcarisporium Preuss, Linnaea 24: 124 (1851)

Index Fungorum number: IF7465, Facesoffungi number: FoF00753

Fungicolous, *parasitic*, *endophytic* or *saprobic* on different higher basidiomycetes including *Mycena*, *Russula* and *Lactarius*, and some ascomycetes including *Cordyceps*, *Nemania Rosellinia* and *Xyalria*, sometimes on leaves and branches of trees. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* hyphomycetous. *Conidiophores* macronematous, mononematous, erect, straight or flexuous, hyaline, unbranched or

verticillately branched. *Conidiogenous cells* holoblastic, monoblastic to polyblastic, discrete, subulate, with sympodial and denticulate apex, with visible conidiogenous scars, hyaline. *Conidia* unicellular, globose or subglobose, or acerose to narrowly obclavate, straight to curved, aseptate, hyaline (Adapted from Sun et al., 2017).

Known distribution: Argentina (Spegazzini, 1902), Canada (Sutton, 1973), China (Sun et al., 2016), Germany, Italy (Sun et al., 2017), India (Rao & Rao, 1964), Japan (Matsushima, 1975), Sri Lanka (De Hoog, 1978), Thailand (Somrithipol & Jones, 2006), Tanzania (Deighton & Pirozynski, 1972), UK (Evans, 1971), USA (Barnett, 1958), Ukraine (This study)

Notes: *Calcarisporium* is phylogenetically close to *Verticimonosporium* (81% MLBT; Figure 2.1). Besides, *Calcarisporium* is a fungicolous genus and is also associated with plant material, while *Verticimonosporium* is associated with rotten leaves and soil (Sun et al., 2017; Wang et al., 2005). Only asexual morphs were reported for the both genera (Matsushima, 1971; Sun et al., 2017).

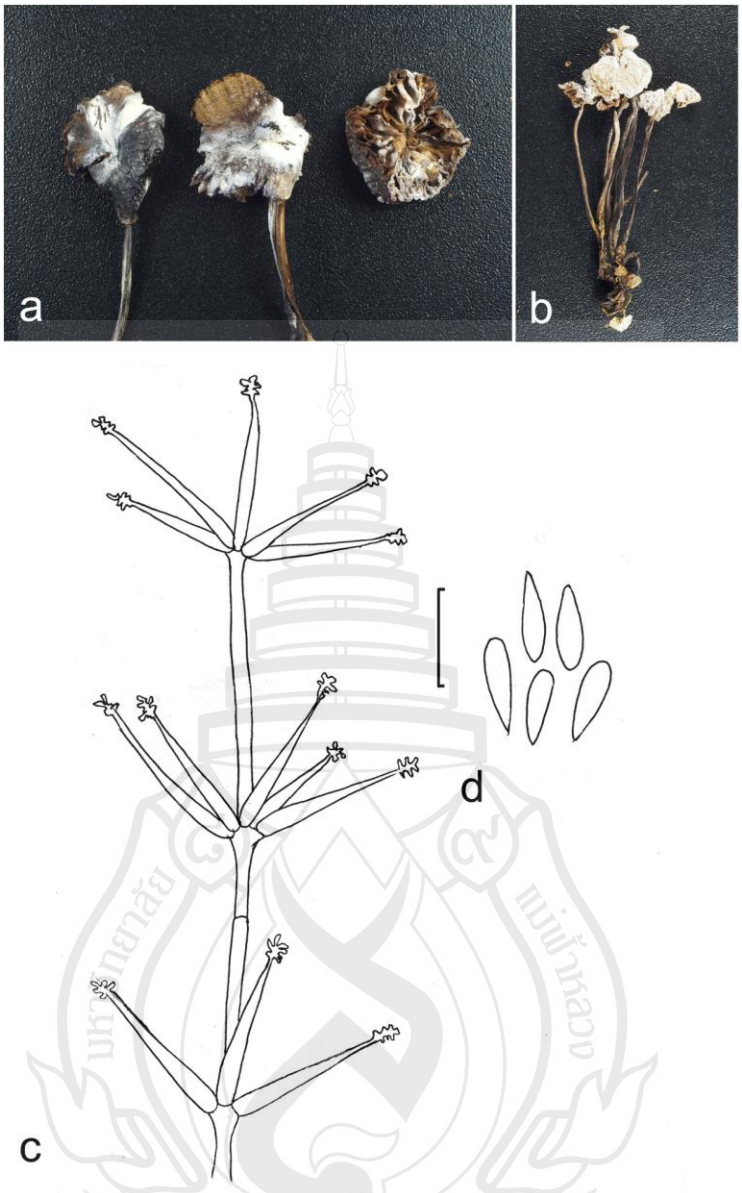
Type species: ***Calcarisporium arbuscula*** Preuss [as *arbusculum*], Linnaea 24: 124 (1851)

For synonyms see Index Fungorum (2022)

Index Fungorum number: IF196959, Facesoffungi number: FoF10915, Figure 2.26

Fungicolous (parasitic, endophytic or saprobic) on different higher basidiomycetes including *Mycena*, *Russula*, *Lactarius*, *Hypholoma*, *Cortinarius*, *Laccaria*, *Trichaptum* etc. **Sexual morph:** Undetermined. **Asexual morph:** Hyphomycetous. *Conidiophores* 300–500 (up to 1000) × (1–) 2 (–4) μm, straight, hyaline, with 3–9 whorls of conidiogenic cells of (2–)4(–7). *Conidiogenous cells* (10–)14–17 μm long, 2–3 (–4) μm wide at the base, awl-shaped, with progressive plagiotropic growth, gradually narrowing towards the apex. *Apex of each conidiogenous cell* bearing a group of 4–8 (–12) teeth, each tooth grows sympodially and gradually elongates from 2–3 μm in the young state to 6–13 μm in old conidiogenous cells. *Conidia* variable in size: 4.6–13 (–17) × 1.5–3.5 μm ($\bar{x}$ = 7.9 × 2.2 μm), aseptate, hyaline, inverted ovate to spindle-shaped, with thin smooth walls, usually with beak-like elongation at the base.

Material examined: UKRAINE, Donetsk Region, Lyman district, National Nature Park “Sviati Hori”, Drobyshevs`ke forestry, floodplain forest on the right bank of



Note (a, b) Herbarium materials (c) Conidiophores and conidiogenous cells (d) Conidia. Scale bar: 10 µm.

Figure 2.26 *Calcarisporium arbuscula* (a, c, d: CWU (Myc) AS 3283, b: CWU (Myc) AS4128)

Siverskyi Donets river, on the basidiomata of *Mycena galericulata* (Scop.) Gray, 19 May 2009, leg. O. Prylutskyi, det. A. Akulov, CWU (Myc) AS3283; *Ibid*., Kharkiv Region, Izium district, Regional Landscape Park “Iziumska Luka”, Petrivs`ke forestry, vicinities of Spivakivka village, native oak forest on the right bank of Siverskyi Donets

river, on the basidiomata of *Mycena inclinata* (Fr.) Quel., 07 November 2010, leg. det. A. Akulov, CWU (Myc) AS4128.

2.3.4 Hypocreaceae De Not.

Lindau (1897) accepted Hypocreaceae in order Hypocreales and divided it into six subfamilies. Seaver (1909a, b, 1910a, b, 1911) divided the Hypocreales into two families, the Nectriaceae and Hypocreaceae, based on stromatic and perithecial characteristics. Seaver (1909a) defined Hypocreaceae as fungi with "stroma or stromatic base always present and forming a conspicuous matrix in which the perithecia are partially to entirely immersed, rarely subsuperficial". Petch (1938) also accepted two families: Nectriaceae and Hypocreaceae in the order but using another perspective. He defined Hypocreaceae as fungi with bright coloured perithecia immersed in a stroma, which is fleshy, parenchymatous, superficial or immersed in the host. Petch (1938) accepted 11 genera in the family and provided an identification key to genera. However, Dennis (1960, 1968) believed Nectriaceae and Hypocreaceae should be two different families but placed them in Sphaeriales. Boedijn (1964) identified Nectriaceae and Hypocreaceae as the two families in Hypocreales. However, many authors fused the two families (Miller, 1949; Luttrell, 1951; Dingley 1951a, b, 1952a, b, 1953, 1954, 1956; von Arx & Müller, 1954; Müller & von Arx, 1962; Gäumann, 1964; Bessey, 1950). Rogerson (1970) treated Hypocreaceae in a broad sense as the only family in Hypocreales, and provided an identification key to the genera in the family. Kreisel (1969) believed Nectriaceae and Hypocreaceae should be two families and accepted them in the order Hypocreales with four other families (Hypomycetaceae, Clavicipitaceae, Cordycipitaceae and Ostropaceae). Barr (1990) followed Rogerson (1970) and synonymised Nectriaceae under Hypocreaceae.

Rossman et al. (1999) revised the family Hypocreaceae in a narrow sense and treated Nectriaceae and Hypocreaceae as separate families. They accepted 12 genera in Hypocreaceae, namely: *Aphysiostroma*, *Arachnocrea*, *Dialhypocrea*, *Hypocrea*, *Hypocreopsis*, *Hypomyces*, *Podostroma*, *Protocrea*, *Pseudohypocrea*, *Rogersonia*, *Sarawakus* and *Sphaerostilbella*. Maharachchikumbura et al. (2015, 2016) accepted 19 genera in the family. Summerbell (2018) introduced the soil fungal genus *Kiflimonium* to the family. *Verticimonosporium*, which was maintained in genera *incertae sedis* of

Sordariomycetes was also placed in the Hypocreaceae based on multi-locus phylogeny by Hyde et al. (2020) which was followed by Wijayawardene et al. (2020, 2022). In the current study *Verticimonosporium* was transferred to Calcarisporiaceae based on phylogenetic analysis (Figure 2.1). We accept 16 genera in Hypocreaceae, which are listed below.

Hypocreaceae is characterized by ascospores generally disarticulating at the septum, ascomata immersed in stroma; if ascospores not disarticulating, then the ascal apex is often thickened and ascomata immersed in a thin to cottony subiculum on fleshy, leathery, or woody basidiocarps; if ascoamata superficial, then on a thin compact stroma on Aphyllophorales, rarely subiculum absent and having a *Gliocladium* asexual morph; or with transversely striate ascospores (Rossman et al. 1999).

Ecological and economic significance of Hypocreaceae

Species of Hypocreaceae are important in agriculture as biocontrol agents, applied in pharmaceutical industry, and some are important pathogens of mushroom and colonies of Attini-ants. Species of *Trichoderma* have been known for decades as biocontrol agents as well as increasing plant growth and induce resistance to plant stresses, and are increasingly used in commercial agriculture (Harman, 2011; Freeman et al., 2004; Elad et al., 1980; Chet & Inbar, 1994). The mycoparasitic genera *Hypomyces* and *Cladobotryum* are important mushroom pathogens on Agaricales, Boletales, Helotiales, Pezizales and Polyporales (Yu et al., 2020; Back et al., 2010). *Mycogone perniciosa* is a destructive pathogen of *Agaricus* spp. in artificial cultivations (Fletcher et al., 1995; Kouser & Shah, 2013). Microbial natural compounds produced by *Hypomyces chrysospermus* are important in the pharmaceutical and drug industry. Researchers report antioxidant, antimicrobial and anticancer properties, including the antiproliferative and antimetastatic activity of *Hypomyces chrysospermus* (Chakraborty et al., 2016; Dikmen et al., 2020). Saprobic Hypocreaceae species are involved in nutrient cycling (Dighton, 1995).

Hypocreaceae De Not. [as 'Hypocreacei'], G. bot. ital. 2(1): 48 (1844)

Index Fungorum number: IF80892, Facesoffungi number: FoF01904

= Trichodermataceae Fr. [as 'Trichodermacei'], Syst. orb. veg. (Lundae) 1: 144 (1825)

Biotrophic, hemibiotrophic, saprobic or hypersaprobic on various substrates, including plants, animals, other fungi, lichens and myxomycetes, in terrestrial and aquatic

habitats. **Sexual morph:** *Stromatic tissue* present or absent, when present soft and fleshy, pallid or brightly pigmented to light brownish, immersed erumpent, effuse, tuberculate or pulvinate, occasionally stipitate, then fertile region clavate, or subiculum of interwoven pallid or brightly pigmented hyphae. *Ascomata* perithecial, solitary or often arranged in groups, immersed in or erumpent to superficial on substrate, globose, ovoid, obpyriform or spheroid, collabent at times, apex papillate, with periphysate ostiole, pallid, brightly pigmented, or shades of light brown or blue to violet (appearing black), rarely brown, KOH+/-, surface glabrous or warted or bearing hyaline or pallid hyphal appendages or rarely thick-walled setae. *Peridium* outer layers comprising pseudoparenchymatous cells, sometimes with thick, sclerotial walls; inner layers comprising pallid to brightly pigmented or brown, blue or violet compressed rows of cells. *Paraphyses* apical (periphysoids), usually deliquescent, occasionally visible at maturity, as cellular remnants among asci or as remnants apical fringe. *Asci* basal to peripheral, mostly 8-spored, occasionally polysporous or less than eight, cylindric, oblong or inflated, apical ring often lacking, when present shallow, refractive, J-. *Ascospores* uniseriate, biseriate or in a fascicle, aseptate or one to several septate, occasionally with longitudinal septa, disarticulating into part-spores at times or budding to form conidia within ascus, ellipsoid, fusoid, allantoid, elongate or globose, hyaline, yellowish, pinkish to greenish or green, or occasionally brown, smooth-walled, verruculose or longitudinally striate. **Asexual morph:** Primarily phialidic. *Conidiomata* lacking to sporodochial or synnematal, conidiogenous cells enteroblastic phialidic. *Conidia* hyaline to bright coloured. Thick-walled structures present at times, less commonly produce aleurioconidia and ampulloconidia (Adapted from Hyde et al., 2020).

Type genus: ***Trichoderma*** Pers. (= *Hypocrea* Fr.)

Genera included in Hypocreaceae

Arachnocrea Z. Moravec.

Dialhypocrea Speg.

Escovopsioides H.C. Evans & J.O. Augustin

Escovopsis J.J. Muchovej & Della Lucia

Hypocreopsis P. Karst.

Hypomyces (Fr.) Tul. & C. Tul.*

= *Cladobotryum* Nees

= *Sibirina* G.R.W. Arnold

Kiflimonium Summerb., J.A. Scott, Guarro & Crous

Lichenobarya Etayo, Diederich & Lawrey

Mycogone Link*

Protocrea Petch

Rogersonia Samuels & Lodge

Sepedonium Link

Sphaerostilbella (Henn.) Sacc. & D. Sacc*

= *Gliocladium* Corda

Sporophagomyces K. Põldmaa & Samuels

Stephanoma Wallr.

Trichoderma Pers.*

= *Aphysiostroma* Barrasa et al.

= *Hypocrea* Fr.

= *Podocrea* (Sacc.) Lindau

= *Podostroma* P. Karst.

= *Pseudohypocrea* Yoshim. Doi

= *Sarawakus* Lloyd

Hypomyces (Fr.) Tul. & C. Tul., Annales des Sciences Naturelles Botanique 13: 11 (1860)

= *Cladobotryum* Nees, Syst. Pilze (Würzburg): 56 (1816) [1816-17]

= *Sibirina* G.R.W. Arnold, Nova Hedwigia 19(1-2): 299 (1970) [1969]

Index Fungorum number: IF2446, Facesoffungi number: FoF10847

Fungicolous, mycopathogen, generally on Basidiomycota, sometimes associated with other Ascomycota, sometimes on bark or wood, mosses, and the ground. **Sexual morph:** *Subiculum* mostly present, sparse to dense, white to buff, yellow to pale brown, brown or red, dark green to black. *Subicular hyphae* septate, branched, densely compacted, usually remaining filamentous. *Ascomata* perithecial, solitary to densely gregarious or caespitose, superficial on or immersed to semi-immersed in the subiculum, subglobose, pyriform or ovate or obpyriform, papillate, sometimes collapsing laterally

when dry, hyaline, yellow, orange, tan, brown to dark brown or green, KOH-/+ red, purple or purplish black, surface smooth, occasionally with a furfuraceous coat of pale orange to yellow hyphae. *Peridium* up to 25 µm thick. *Asci* 8-spored, cylindrical, with a more or less thickened apex, mostly with a pore. *Ascospores* uniseriate, partially overlapping, ellipsoidal, lanceolate with rounded ends, or fusiform with blunt or acute, obscure to conspicuous apiculus at each end, 0–1-septate, rarely 3-septate, hyaline, smooth-walled, spinulose to verrucose or tuberculate. **Asexual morph**: Hyphomycetous, effused on host, also on subiculum or, occurring on cultures. *Conidiophores* usually micronematous, sometimes semimacronematous to macronematous, borne on mycelium or aerial or submerged hyphae, sometimes arranged in tufts, ascending to erect or suberect, aseptate or with 1 septum or septate abundantly, simple or branching verticillate dichotomous, drepanoid or irregular, sometimes confined to upper half giving conidiophores tree-like aspect, thin-walled, hyaline to yellowish, yellowish ochraceous, pale green or brownish yellow, forming verticils of conidiogenous cells. *Conidiogenous cells* formed directly on conidiophores or on lateral branches arising singly or 2–13 in a verticil, subulate to cylindrical or ampulliform to long ampulliform attenuating to the tip, aseptate or rarely with one septum, producing one to several conidiogenous loci, not proliferating, or proliferating sympodially or percurrently, rarely with a periclinal thickening, occasionally bearing a collarette. *Conidia* solitary, ellipsoidal to fusiform, cylindrical, clavate, obovoid or ovoid, occasionally suballantoid, sometimes irregularly shaped, straight or curved, rarely sigmoid or semicircular, hyaline or pale yellowish green or green, apex sometimes refractive, 1–3(–4) septate, with a conspicuous or minute basal hilum, held in imbricate chains appearing as radiating heads or columns. *Chlamydospores* present or lacking, formed on host tissue or cultures, subglobose to globose or ellipsoidal, hyaline to pale or yellowish ochraceous, pale brown or dark green, smooth-walled or rarely with roughened walls, occur as single cells or held in chains, sometimes forming irregular clusters or pigmented sclerotia-like aggregations, very rarely forming 3-celled aleurioconidia (*Hypomyces mycogones*) (Adapted from Rossman et al., 1999; Põldmaa, 2011).

. Known distribution: Temperate, tropical and subtropical regions (Rossman et al., 1999; Põldmaa, 1997, 2011; Rogerson & Samuels, 1993, 1994; Põldmaa et al., 2003)

Notes: *Hypomyces* was raised from the subgenus of *Hypocrea* Fr., recognised by Fries (1825), to the rank of the genus by Tulasne and Tulasne (1860). Verrucose and apiculate ascospores are unique characters of *Hypomyces* (Rogerson & Samuels, 1993). The link between *Hypomyces* and *Cladobotryum* asexual morphs have previously been revealed based on morphology (Rogerson & Samuels, 1993, 1994). Põldmaa et al. (2003) and Põldmaa (2011) confirmed the link based on multigene phylogeny. Rossman et al. (2013) proposed to link sexual morphic genus *Hypomyces* with asexual genus *Cladobotryum* is followed in subsequent authors (Maharachchikumbura et al., 2016; Hyde et al., 2020, this paper).

Type species: ***Hypomyces lactifluorum*** (Schwein.) Tul. & C. Tul., Annls Sci. Nat., Bot., sér. 4 13: 11 (1860)

Basionym: *Sphaeria lactifluorum* Schwein., Schr. naturf. Ges. Leipzig 1: 30 [4 of repr.] (1822)

Index Fungorum number: IF212693, Facesoffungi number: FoF10848, Figure 2.27

Fungicolous, on *Lactarius* spp. **Sexual morph:** *Subiculum* thin, effused, covering the hymenium and entirely obliterating the gills, pale yellowish, orange to bright orange to becoming dark red or reddish-purple to very dark purple, usually covering the host surface. *Subicular hyphae* 2.5–5 µm wide, septate, irregularly branched, often at right angles, densely compacted but remaining filamentous, smooth-walled, occasionally some cells swollen to 10 µm diam., KOH+ purple. *Ascomata* 200–355 µm high × 240–300 diam., perithecal, numerous, densely scattered, with faintly protruding necks, immersed in the subiculum except for papilla, ovate to obpyriform, orange to reddish purple, usually darker than the surrounding subiculum, ostiolate, KOH+ purple, surface smooth. *Ostiolar canal* periphysate. *Peridium* 20–30 µm thick, composed of fusoid, hyaline cells of *textura angularis*, circular to elliptic in the ostiolar region. *Asci* 145–186 × 7–8 µm, 8-spored, unitunicate, long cylindrical, apex thickened and with a pore. *Ascospores* 39–40 × 5–7.6 µm, uniseriate with the ends overlapping, fusiform with an apiculus at each end, 1-septate, straight or curved, inequilateral, septum median, hyaline, prominently verrucose. **Asexual morph:** Undetermined.

Material examined: USA, Salem, on *Lactaria* sp., Rev. G. Arnold, 06.01.1965 (PH00076754).

Notes: Recent new species *Hypomyces pseudolactifluorum* have been introduced by Yu et al. (2020).

Note (a, b) Herbarium material labels. (c, d) Herbarium material. (e, f) Ascomata on host. (g, h) Vertical section of ascomata. (i) Moniliform hyphae from the subiculum in 3% KOH. (j) Vertical section of peridium in 3% KOH. (k–n) Asci (n empty ascus). (o–t) Ascospores. Scale bars: e = 1 mm, f = 500 µm, g, h = 200 µm, i, j = 50 µm, k–n = 100 µm, o–t = 20 µm.

Figure 2.27 *Hypomyces lactifluorum* (PH00076754)

Mycogone Link, Mag. Gesell. naturf. Freunde, Berlin 3(1-2): 18 (1809)

Index Fungorum number: IF9026, Facesoffungi number: FoF10849

Fungicolous (mycopathogenic) on carpophores of some Basidiomycota and Ascomycota representatives, sometimes isolated from decaying plant parts. **Sexual morph** Undetermined. **Asexual morph** *Conidiophores of phialidic stage* semimacronematous, stipe straight or flexuous, hyaline, smooth-walled, verticillate, bearing fewer to dense verticils of phialides. *Conidiogenous cells* monophialidic, discrete, arrange verticillately, determinate, subulate, ampulliform. *Phialoconidia* arranged in shiny heads, variable, ovoid to oblong, ellipsoid, obpyriform to clavate, aseptate or 1-septate, hyaline, smooth-walled. *Aleurioconidia bearing hyphae* hyphae micronematous or semi-macronematous, short, branched or unbranched. *Aleurioconidia bearing cell* occur terminally on lateral branches of vegetative hyphae or intercalary, monoblastic, determinate, cylindrical or ampulliform. *Aleurioconidia* solitary, dry acrogenous, globose or pyriform, bi-cellular (1-septate), not constricted at the septum, upper cell larger, yellow-brown, black, thick-walled, tuberculate or spinose; lower cell smaller, conical or barrel-shaped, thin-walled, wall smooth or finely warted.

Known distribution: Worldwide (Petch, 1917; Gray & Morgan-Jones, 1980; Matsushima, 1987; Glamočlija et al., 2008)

Notes: Link (1809) described *Mycogone* for a single species *M. rosea*. Later several species were added to the genus based on morphology. Currently 28 species are listed in the genus (Species Fungorum, 2022). No DNA data are available. *Mycogone cervina* and *M. perniciosa* are currently recognised in the genus *Hypomyces* (Rogerson & Simms, 1971). Gams (1983) reported *Mycogone calospora* with *Sibirina* synanamorph, while Samuels (1985) reported *Hypomyces mycogones* with a mycogone-like aleuriosporic asexual morph. However, *Hypomyces mycogones* has 3-celled aleuriosporic conidia while *Mycogone* is characterized by 2-celled conidia. The relationship between *Hypomyces* and *Mycogone* has not been confirmed by molecular data. New collections of *Mycogone* with molecular data are required to confirm the generic status and relationship with *Hypomyces* finally.

Mycogone rosea Link, Mag. Gesell. naturf. Freunde, Berlin 3(1-2): 18 (1809)

Index Fungorum number: IF225015, Facesoffungi number: FoF10850, Figure 2.28

= *Mycogone incarnata* var. *rosea* (Link) Pers., Mycol. eur. (Erlanga) 1: 26 (1822)

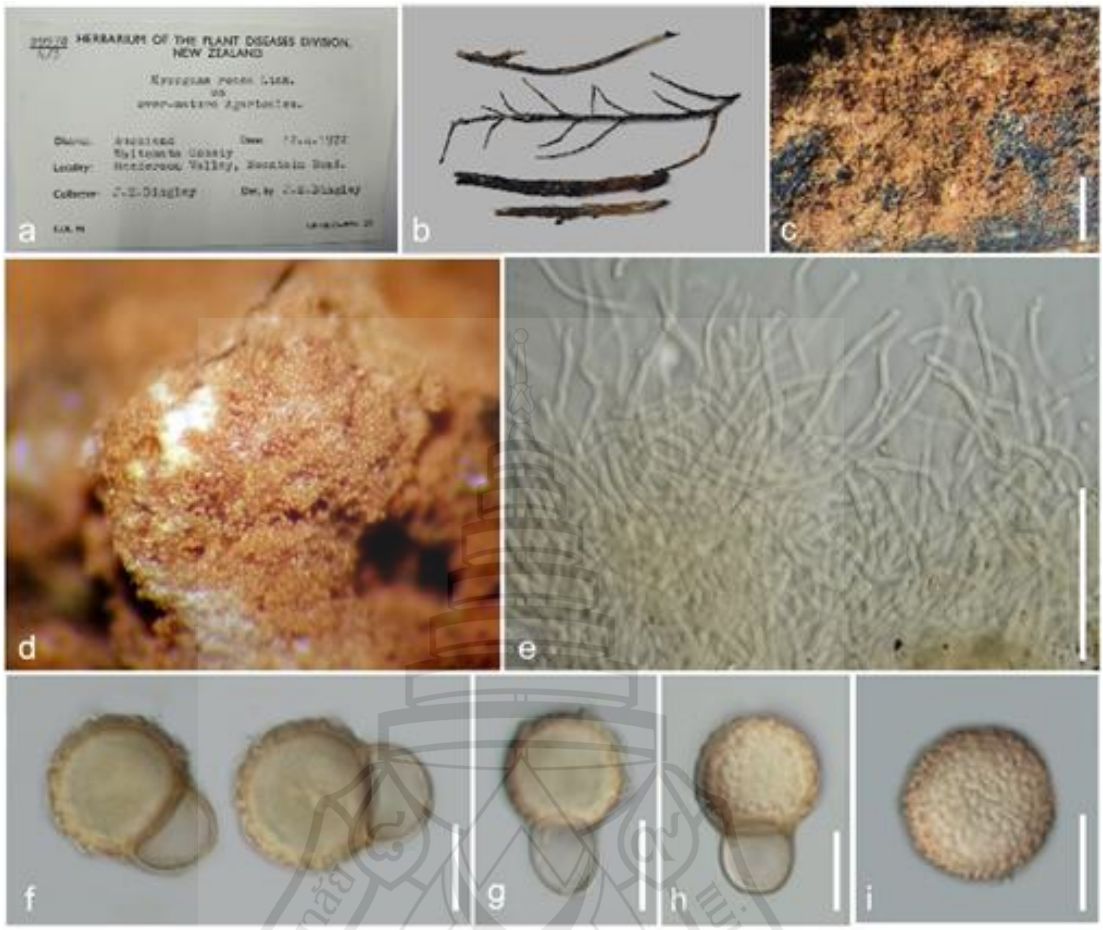
= *Mycogone rosea* var. *jaapiana* Henn., Verh. bot. Ver. Prov. Brandenb. 45: XVIII (1903)

= *Mycogone rosea* var. *clavariae* Sacc., Bulletino dell'orto Botanico della R. Universitá di Napoli 24: 21 (1918)

Fungicolous on Agaricales, most common on *Amanita* spp. **Sexual morph:** Undetermined. **Asexual morph: Colony** growing on the surface of the host with a fluffy cottony appearance, become powdery, pale ochraceous-salmon colour appearance when sporulate. *Hyphae* up to 4 µm wide, cylindrical, branched, flexuous, hyaline, smooth-walled. *Aleurioconidia* formed on short lateral hyphae, pyriform, 2-celled; upper cell 20–32 µm wide, larger, globose, yellowish brown, thick-walled, verrucous; basal cell 12–15 µm wide, smaller, globose to subglobose, sub hyaline, smooth-walled. *Conidiophores* micronematous to semimacronematous, mononematous, *Verticillium* like, straight or slightly flexuous, septate, hyaline, smooth-walled, producing 1–3 phialides terminally, and 1 or 2 laterally, immediately bellow transverse septa, or with formed laterally on undifferentiated hyphae. *Conidiogenous cells* 20–30 × 3–4 µm, monophialidic, discrete, determinate, cylindrical, narrowing gradually towards the apex. *Phialoconidia* 10–15 × 3–4 µm, enteroblastic, oblong to cylindrical, obtuse at the ends, aseptate, occasionally 1–2 septate, hyaline, smooth-walled, held in basipetal succession at the phialide tips (Conidiophore and phialoconidial morphology adapted from Gray & Morgan-Jones, 1980).

Material examined: NEW ZEALAND, Auckland, Waitemata, Henderson valley, Mountain Road, on over-mature Agaricales, 1972 April 12, J.M. Dingley, PDD 29978.

Notes: We did not observe phialoconidia in specimen PDD 29978.



Note (a) Herbarium material label. (b) Herbarium material. (c, d) Surface view of a large, nodular fruit body covered by fluffy hyphae producing spores. (e) Hyphae. (f–i) Aleurioconidia. Scale bars: c = 500 µm, e = 50 µm, f–i = 20 µm.

Figure 2.28 *Mycogone rosea* (PDD 29978)

Sphaerostilbella (Henn.) Sacc. & D. Sacc., Syll. fung. (Abellini) 17: 778 (1905)

= *Gliocladium* Corda, Icon. fung. (Prague) 4: 30 (1840)

Index Fungorum number: IF5122, Facesoffungi number: FoF10851

Fungicolous, mycoparasitic, mostly on decaying Aphyllophorales, rarely on decaying wood. **Sexual morph:** *Subiculum* not conspicuous, at most, forming a thin compact layer on the host, cottony, composed of hyaline hyphae, densely compacted below ascomata. *Ascomata* perithecial, superficial or semi-immersed in subiculum, solitary to gregarious, obpyriform, apapillate or papilla pronounced, ivory, yellowish

white to ochraceous, KOH-, surface smooth, sometimes covered with white mycelial weft. *Asci* 8-spored, cylindrical, apex slightly thickened. *Ascospores* uniseriate with ends overlapping, fusiform to naviculate or ellipsoid, 1-septate, not disarticulating in asci, hyaline, finely spinulose or grossly warted-tuberculate. **Asexual morph:** *Conidiomata* gliocladium-like. *Conidiophores*/ *conidiogenous branches* micronematous, arising from hyphae on host or aerial hyphae in the culture, ascending or erect, single to fasciculate, more or less penicillately branched or unbranched, septate, hyaline to pale ochraceous, smooth-walled, bearing one to few phialides; or form conidia directly from simple conidiophores. *Conidiogenous cells* phialidic, almost cylindrical, tapering gradually to apex. *Conidial mass* translucent, globose. *Conidia* variable in size and shape, ellipsoidal to oblong or allantoid, narrow clavate or narrow obclavate, 0–1(−3)-septate, straight to curved or bent, sometimes apiculate, base flattened or rounded, hilum inconspicuous or rarely pronounced. *Chlamydospores* not observed on host fruitbodies, present in in cultures, subglobose, hyaline to pale ochraceous, smooth-walled, formed singly or, in simple or divergent intercalary chains, sometimes forming irregular clusters (Adapted from Rossman et al., 1999).

Known distribution: Worldwide (Rossman et al., 1999; Põldmaa et al., 2019)

Notes: *Sphaerostilbella* was originally described as a subgenus of *Sphaerostilbe* having one species *Sphaerostilbe lutea*. *Sphaerostilbella* has been re-established based on morphology of the type by Seifert (1985), while subsequent authors confirmed the generic status based on molecular phylogeny (Rehner & Samuels, 1994; Põldmaa, 2000; Põldmaa et al., 2019). Furthermore, Rehner and Samuels (1994) merged the asexual genus *Gliocladium* with *Sphaerostilbella* based on phylogenetic analysis of LSU sequences. *Sphaerostilbella* and *Hypomyces* are allied genera, while some species in the genus *Sphaerostilbella* were treated as *Hypomyces* species by previous authors (Põldmaa ,2000; Põldmaa et al., 2019). Rossman et al. (1999) placed *Sphaerostilbella* in Hypocreaceae with placement confirmed by phylogenetic analysis of LSU sequences (Rossman et al., 2001) and cladistics analysis of SSU sequences (Spatafora & Blackwell, 1993). Recent taxonomic studies also confirmed the existence of the genus (Maharachchikumbura et al., 2016; Hyde et al., 2020).

Type species: ***Sphaerostilbella aurifila*** (W.R. Gerard) Rossman, L. Lombard & Crous, in Lombard, van der Merwe, Groenewald & Crous, Stud. Mycol. 80: 243 (2015)

Basionym: *Sphaerostilbella aurifila* (W.R. Gerard) Rossman, L. Lombard & Crous, in Lombard, van der Merwe, Groenewald & Crous 2015

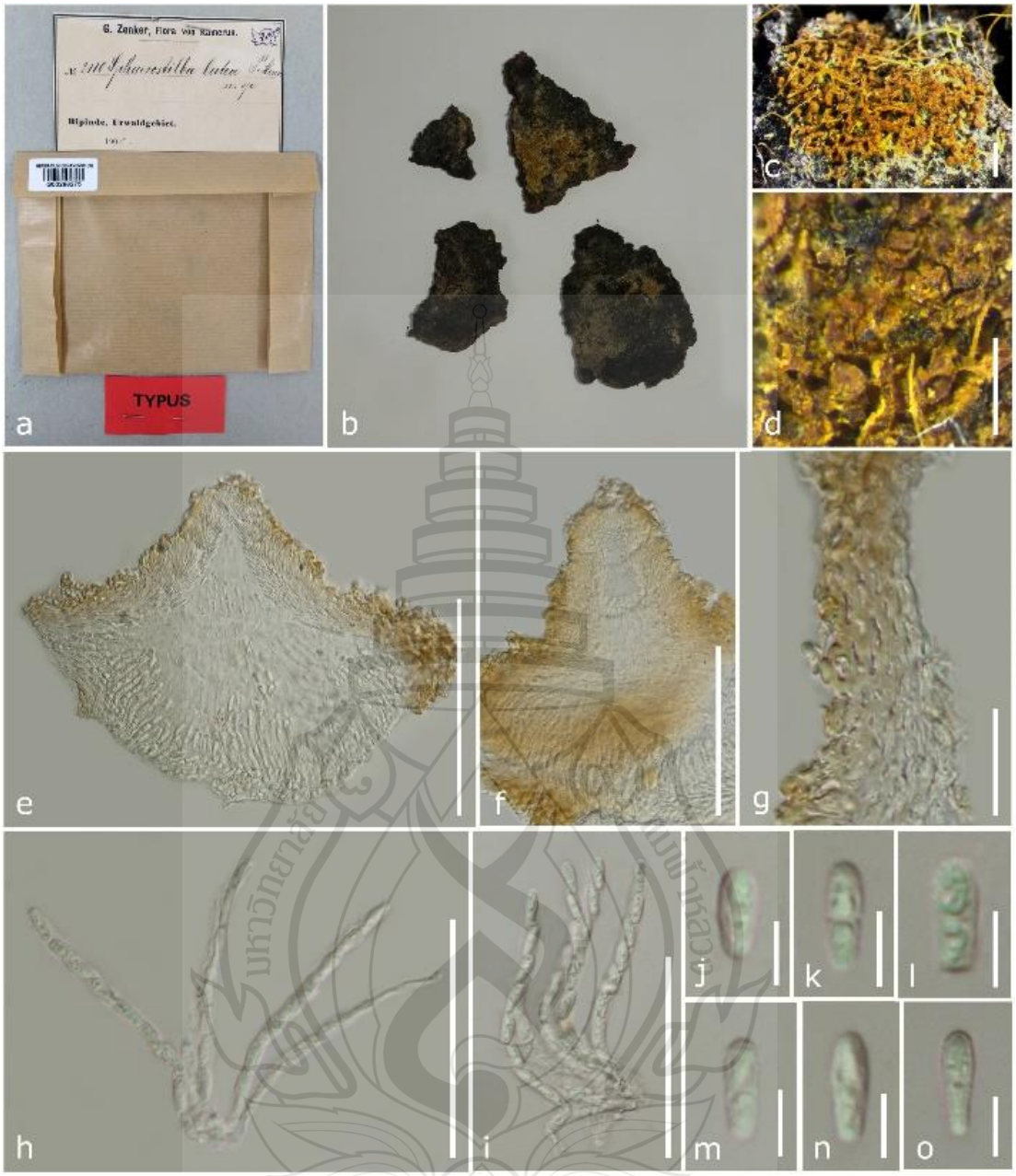
For synonyms see Index Fungorum.

Index Fungorum number: IF810979, Facesoffungi number: FoF10852, Figures. 2.29, 2.30

Sexual morph: *Subiculum* thin, spreading over the surface of host, white, yellow over developing perithecia, KOH+ violet. *Ascomata* 170–240 µm high, 160–200 diam., perithecial, scattered to densely gregarious, base immersed in subiculum, pyriform, with an acute papilla, ostiolate collapsing upon drying, yellow, KOH+ violet, surface smooth. *Ostioles* periphysate. *Peridium* composed of *textura epidermoidea* in face view; in section 13–20 µm thick, composed of ellipsoidal to fusiform cells, becoming thinner-walled and more compressed towards the locule. *Papilla* composed of hyphal elements from perithecial wall and clavate cells, progressively narrowing towards the ostiolar canal and merging with the periphyses. *Asci* 62–70 × 3–4 µm, 8-spored, unitunicate, cylindrical, with a minute apical ring, sometimes appearing simple, lying without paraphyses. *Ascospores* 6.8–8.6 × 2–3 µm µm, uniseriate, ellipsoid to slightly naviculate, 1-septate, septum median, not constricted at septum, hyaline, multi-guttulate, minutely echinulate, without appendages. **Asexual morph:** *Conidiomata* synnematous. *Synnemata* 450–1700 µm tall, 36–70 µm wide, scattered, gregarious to subcaespitose, cylindrical-capitate, subulate-capitate, erect, unbranched, slender, smooth-walled, yellow to orange yellow, KOH+ dark purple. *Synnematal hyphae* 2–3 µm wide, smooth or slightly roughened-walled. *Conidiophore* branching ter- to quarter-verticillate. *Conidiogenous cells* 10–16 µm long, 1–1.5 µm wide, phialidic, cylindrical to subulate, held in compact terminal or sometimes intercalary whorls of 3–6, collarettes not flared, periclinal thickening not visible, smooth-walled. *Conidial mass* 50–100 µm diam., globose, reddish orange. *Conidia* 2–3 × 1–1.5 µm, oblong-ellipsoidal, hyaline, smooth-walled.

Material examined: CAMEROON, Bipinde, Urwaldgebiet, 1900, Zenker G., no. 2110, G00266275 (**isotype of *Sphaerostilbe lutea***).

Notes: The type species of *Sphaerostilbella*, *S. lutea* was synonymised under *Sphaerostilbella aurifila* by Lombard et al. (2015).



Note (a) Herbarium material label. (b) Herbarium material. (c, d) Ascomata on the host. (e) Vertical section of ascoma. (f) Vertical section of ostiole. (g) Vertical section of peridium. (h, i) Asci. (j–o) Ascospores. Scale bars: c, d = 500 µm, e, f = 100 µm, g = 20 µm, h, i = 50 µm, j–o = 5 µm.

Figure 2.29 *Sphaerostilbella aurifila* (G00266275, isotype of *Sphaerostilbe lutea*)

Note (a) Herbarium material. (b, c) Synnemata on host. (d) Synnema mounted in water. (e) Hyphae of conidiophores. (f, g) Conidiogenous cells and conidia. (h) Conidia. Scale bars: b = 1 mm, c, d = 500 µm, e = 100 µm, f = 50 µm, g = 20 µm, h = 10 µm.

Figure 2.30 *Sphaerostilbella aurifila* (G00266275)

Trichoderma Pers., Neues Mag. Bot. 1: 92 (1794)

= *Aphysiostroma* Barrasa, A.T. Martínez & G. Moreno, Can. J. Bot. 63(12): 2439 (1986) [1985]

= *Hypocrea* Fr., Syst. orb. veg. (Lundae) 1: 104 (1825)

= *Podocrea* (Sacc.) Lindau, in Engler & Prantl, Nat. Pflanzenfam., Teil. I (Leipzig) 1(1): 364 (1897)

= *Podostroma* P. Karst., Hedwigia 31: 294 (1892)

= *Pseudohypocrea* Yoshim. Doi, Bull. natn. Sci. Mus., Tokyo, N.S. 15: 655 (1972)

= *Sarawakus* Lloyd, Mycol. Notes (Cincinnati) 7(6): 1258 (1924)

Index Fungorum number: IF10282, Facesoffungi number: FoF02075

Saprobic, hypersaprobic, biotrophic or *hemibiotrophic*, on various plants, less commonly on grasses, bamboo and herbaceous substrates, mycoparasitic, on fungi including members of Basidiomycota, or on decaying perennial bracket fungi, also occurring as endophytes, rarely human *pathogenic*, sometimes isolated from soil, peat and animal dung. **Sexual morph:** *Stromata* discrete to effused, pulvinate, turbinate, discoid or undulate, with or without a true cortex, composed of pseudoparenchyma cells and/ or highly compacted hyphae, ascomatal elevations inconspicuous or distinctly prominent, stromatal surface smooth, variously wrinkled, tuberculate, granulose or creased or tubercular, sometimes with short hairs, margins of stromata free from or adherent to the substrate, hyaline, white, yellow, orange, reddish brown, dark brown to black, olivaceous, ostiolar dots distinct or indistinct, KOH+/-. *Ascomata* embedded in the stroma, crowded, perithecial, flask-shaped, globose, subglobose to ellipsoidal, hyaline, ostiolate, KOH+/-. *Ostiolar* canal lined with hyaline periphyses. *Peridium* hyaline, subhyaline or yellow, sometimes yellow-brown, yellow-orange, dull green or brown. *Asci* 8-spored, unitunicate, cylindrical, apex thickened, sometimes with a minute J- apical ring. *Ascospores* uniseriate or sometimes obliquely biseriate, bi-cellular, disarticulating into two equal or unequal, subglobose, globose, ovoid, oblong or wedge-shaped part ascospores, guttulate, hyaline or green, sometimes dull green to brown-green, typically spinulose or warted, rarely smooth-walled. **Asexual morph:** Hyphomycetous, mostly formed in pustules, on natural substrates associated with stroma. *Conidiophores* simple, conspicuously curved to sinuous or conspicuously curved, without or with weakly

developed or well-developed main axis, branched, branching irregular, verticillate or sometimes tree-like, hyaline, smooth, septate. *Phialides* divergent or parallel, solitary or originating in whorls, sometimes repetitive, forming chains, lageniform, ampulliform, cylindrical or subulate, symmetric or inequilateral, curved to sinuous or straight, hyaline, smooth. *Conidia* unicellular, globose to subglobose, ovoid, ellipsoidal, oblong, green or hyaline, usually guttulate, rarely aguttulate, scar indistinct or indistinct, smooth-walled or verruculose, spinulose or warted. *Chlamydospores* absent or present, terminal and/or intercalary, globose, subglobose, oblong or ellipsoid or oblong, usually aseptate, sometimes 1-septate (Adapted from Maharachchikumbura et al., 2016).

Known distribution: Cosmopolitan (Rossman et al., 1999; Chaverri & Samuels, 2003; Jaklitsch et al., 2006; Jaklitsch, 2009; Jaklitsch & Voglmayr, 2015).

Notes: The family Hypocreaceae was initially introduced based on the sexual morph genus *Hypocrea* Fr. 1825. Rossman et al. (2013) proposed to conserve the older and more widely used name *Trichoderma* Pers. 1794 (asexual morphic genus) over *Hypocrea* following Melbourne Code of Nomenclature (ICN) rules. Jaklitsch and Voglmayr (2013) linked *Hypocrea* species with *Trichoderma* species based on molecular data providing 46 new name combinations in *Trichoderma*.

Species of *Hypocrea* with stipitate stroma have been traditionally accepted in the genus *Podostroma* (Karsten, 1892; Doi, 1967; Rogerson & Samuels, 1992; Rossman et al., 1999). Atkinson (1905) proposed synonymised *Podocrea* under *Podostoma* and was supported by Chamberlain et al. (2004). Later *Podostroma* and *Podocrea* species were transferred to *Hypocrea* due to their stromatal characters and formation of *Trichoderma* asexual morphs (Samuels & Lodge, 1996; Chamberlain et al., 2004), which is followed in this study.

Type species: ***Trichoderma viride*** Pers., Neues Mag. Bot. 1: 92 (1794)

= *Hypocrea rufa* (Pers.) Fr., Summa veg. Scand., Section Post. (Stockholm): 383 (1849)

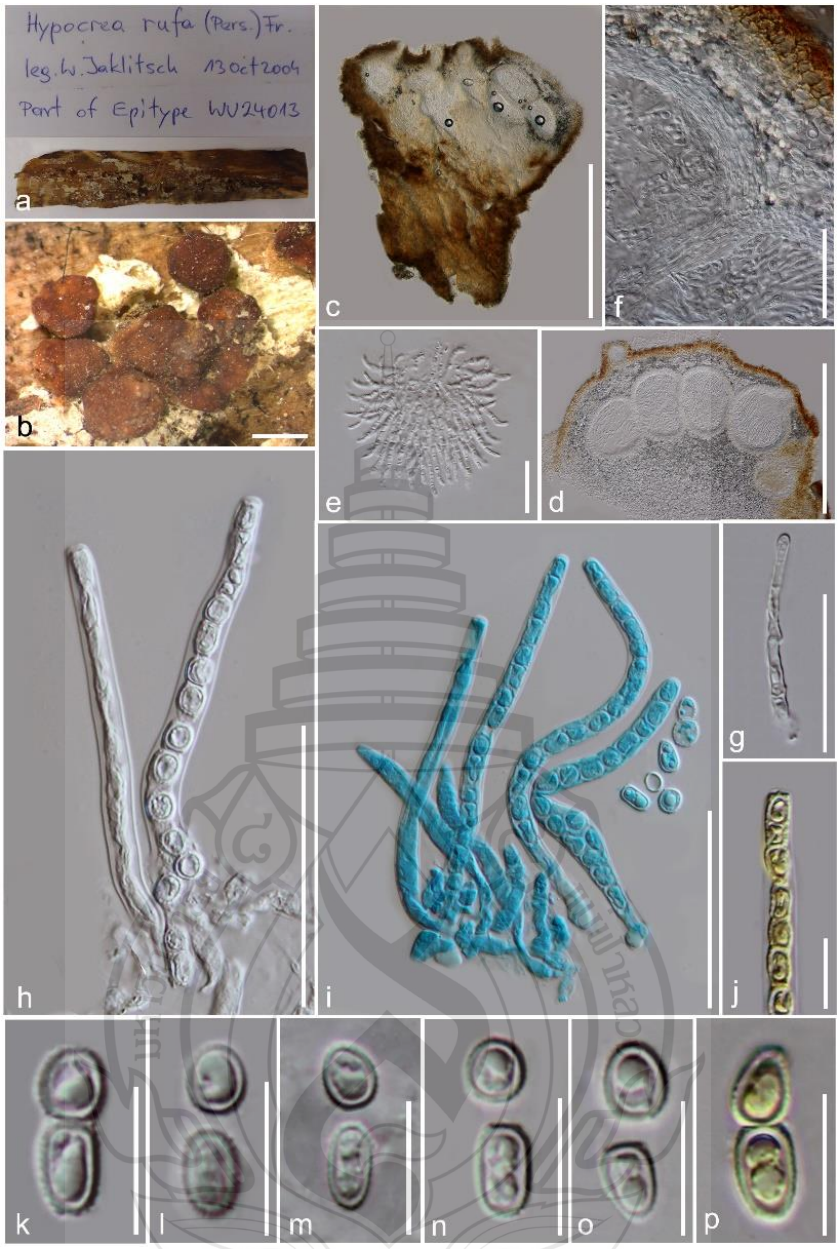
For other synonyms see Index Fungorum.

Index Fungorum number: IF181950, Facesoffungi number: FoF09614, Figures. 2.31, 2.32

On decorticated logs of *Pinus sylvestris.* **Sexual morph:** *Stromata* 0.5–4 mm diam., 0.3–1.5 tall, discrete or gregarious to aggregate, superficial, becoming pulvinate,

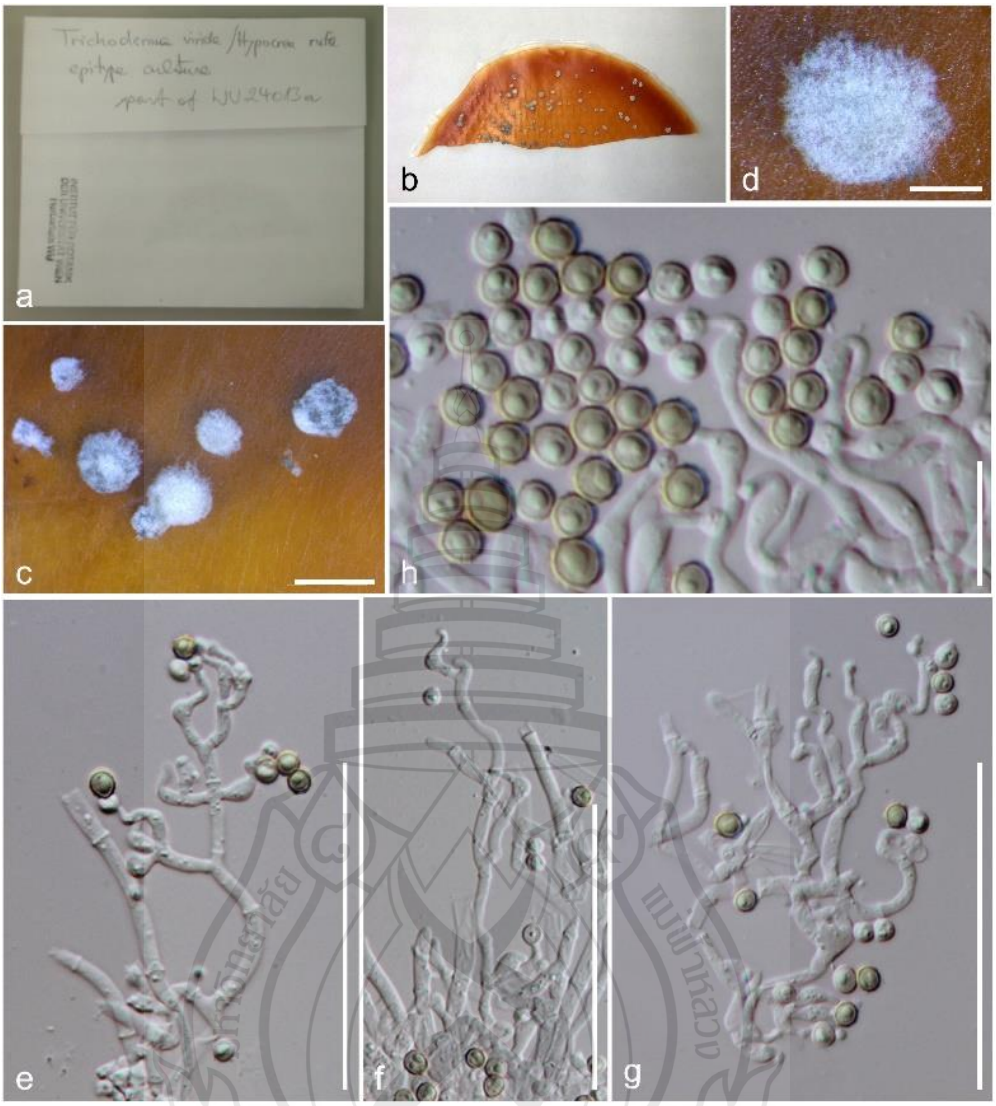
rarely turbinate or discoid, yellow- to orange or light to dark reddish brown, consists with outer region of 3–5 celled, orange to reddish brown cells forming a *textura angularis*; inner tissue of globose to ellipsoidal, thin-walled, hyaline cells, forming a *textura epidermoidea*; surface with short prominent hairs, ostioles not noticeable or appearing as hyaline or brown spots on stroma surface, KOH-. *Stromatal hairs* 10–40 µm long × 2–6.3 µm wide, arising from stroma surface, apex rounded, 2–5 celled, occasionally branched, yellowish to pale brown, smooth-walled. *Ascomata* 190–260 µm × 150–220 µm, immersed in stromatal tissue, perithecial, flask-shaped, globose to ellipsoidal, hyaline, ostiolate. *Ostiolar canal* lined with septate, hyaline periphyses. *Peridium* 15–25 µm wide, wider around the ostiolar neck, of single stratum, consisting of compressed hyphae, pseudoparenchymatous in base and ostiolar region, integrating with the surrounding tissue, hyaline. *Asci* 75–110 µm × 4.8–7 µm, 8-spored, unitunicate, long cylindrical, short stipitate, with a knob-like base, with a minute apical pore, J-, lying without paraphyses. *Ascospores* 10.5–13 µm × 4–5.4 µm, uniseriate, bicellular, disarticulating into two unequal part ascospores: upper part subglobose to oval or slightly tapered towards the upper end, hyaline, verrucose; lower part oblong to cuneate, base broadly rounded, hyaline, verrucose. **Asexual morph:** *Conidial pustules* 0.5–3 mm, diam., 0.5–1.5 mm high, pulvinate, dense to cottony, white to greenish. *Conidiophores* 8–11 µm wide, conspicuously curved to sinuous, without or with faintly developed main axis, septate, branched, asymmetrically branched or sometimes tree-like, hyaline, smooth-walled. *Phialides* 6.8–12.2 µm long × 2.2–3.3 µm at the widest point, solitary or forming in groups of 2–3, flask-shaped to long cylindrical, with long necks, curved to sinuous, rarely straight, hyaline, smooth-walled. *Conidia* 3.5–5.0 × 3.2–4.0 µm, aseptate, globose to subglobose, occasionally ovoid, olive-green, guttulate, coarsely warted. *Chlamydospores* rarely present.

Material examined: CZECH REPUBLIC, South Bohemia, Frymburk, on partly decorticated logs of *Pinus sylvestris*, leg. W. Jaklitsch, W.J. 2753, 3 October 2004. WU 24013, **epitype**; WU 24013a, **epitype culture**.



Note (a) Herbarium material with label. (b) Stromata on host substrate. (c, d) Vertical section of stroma with ascomata. (e) Periphyses. (f) Vertical section of peridium and layers of stroma. g Stromal hair. (h, i) Asci. (i in cotton blue) (j) Ascus apex in Melzer's reagent. (k–p) Ascospores (l–o part ascospores separated from each other, p in Melzer's reagent). Scale bars: b = 1 mm, c = 50 µm, d = 200 µm, e = 10 µm, f–i = 20 µm, j–p = 5 µm.

Figure 2.31 *Trichoderma viride* (sexual morph, WU 24013, epitype)



Note Herbarium material label. (b) Herbarium material. (c, d) Sporulating colony on CMD. (e–g) Conidiophores with conidia. (h) Conidia. Scale bars: c = 2 mm, d = 500 µm, e–g = 50 µm, h =10 µm.

Figure 2.32 *Trichoderma viride* (WU 24013a, epitype culture, asexual morph)

Trichoderma bambusicola R.H. Perera, Maharachch. & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF559631, Facesoffungi number: FoF 10971, Figure 2.34

Etymology: Name refers to the host from which it was collected.

Saprobic on decaying stem of a bamboo plant. **Sexual morph:** *Stromata* 0.5–1.5 mm diam., discrete or gregarious, superficial, discoid, slightly stipitate, without a true cortex, composed of pseudoparenchyma cells, yellow-orange or brownish orange, KOH-, ascomatal elevations distinctly prominent, stromatal surface smooth, variously wrinkled, without hairs, ostioles appearing as hyaline or brown spots on stroma surface. *Ascomata* 140–190 µm high × 100–170 µm diam., numerous, immersed in stromatal tissue, perithecial, globose to ellipsoidal, brownish orange, ostiolate. *Ostiolar canal* lined with septate, hyaline periphyses. *Peridium* 6–25 µm wide, wider around the ostiolar neck, of single stratum, consisting of pigmented, thin-walled, compressed, angular cells; pseudoparenchymatous in ostiolar region, integrating with the surrounding tissue, brownish orange. *Asci* 68–86 µm × 3.7–5 µm ($\bar{x}$ = 78.3 × 4.4 µm), 8-spored, unitunicate, long cylindrical, short stipitate, with a knob-like base, with a minute apical pore, J-, lying without paraphyses. *Ascospores* 7.6–9.3 µm × 3–4µm ($\bar{x}$ = 8.5 × 3.4 µm), uniseriate, bicellular, disarticulating into two unequal part ascospores: upper part subglobose to oval or slightly tapered towards the upper end; lower part oblong or wedge-shaped; guttulate, green, verrucose. **Asexual morph:** Undetermined.

Material examined: THAILAND, Phyao Province, on fallen decaying stem of a bamboo, 04 August 2017, R.H. Perera, PH09 (MFLU 18-2747, **holotype**).

GenBank numbers: ITS: ON230047, LSU: ON230055, RPB1: ON238007, TEF1: ON238001, TUB2: ON238008.

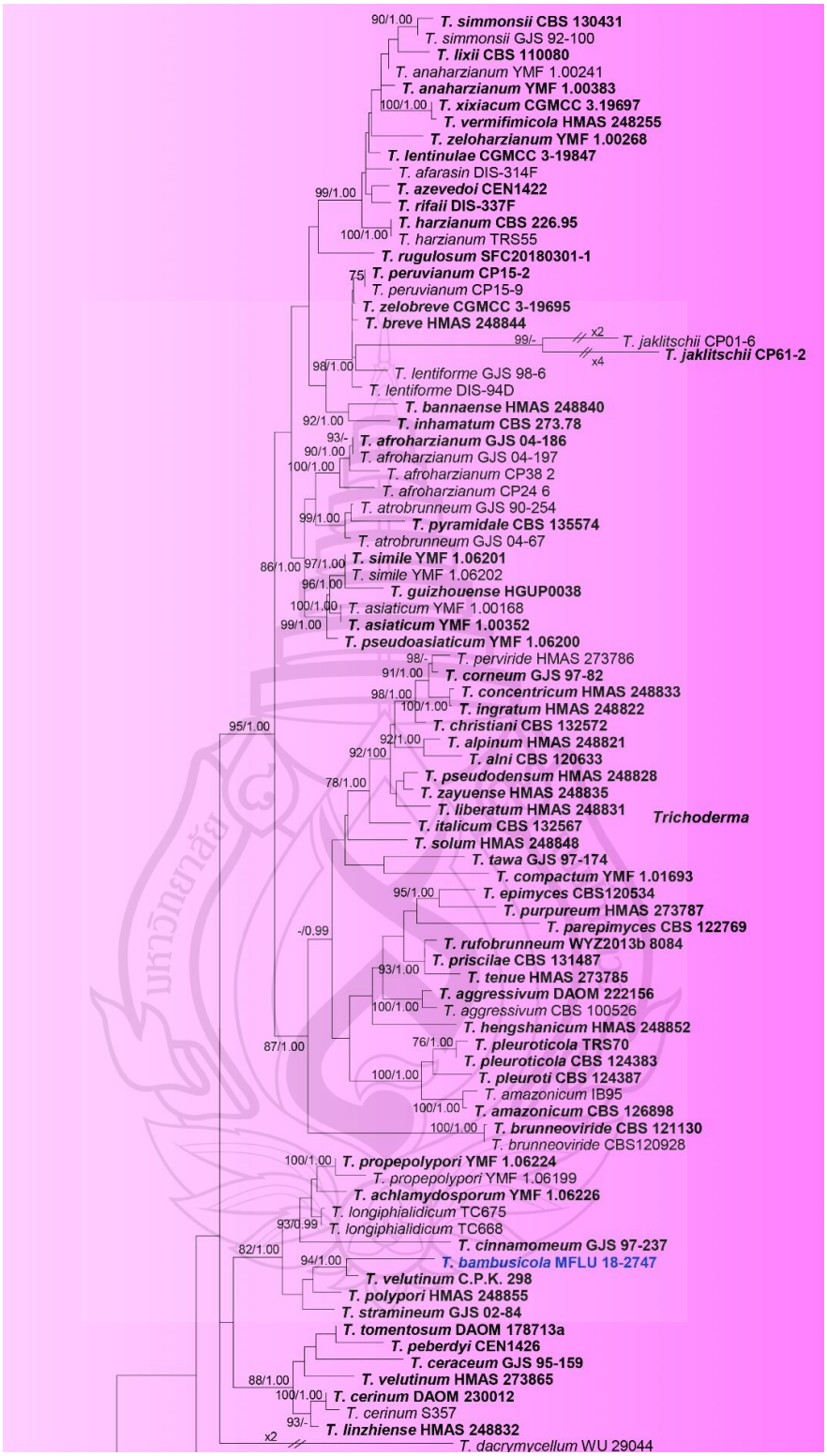
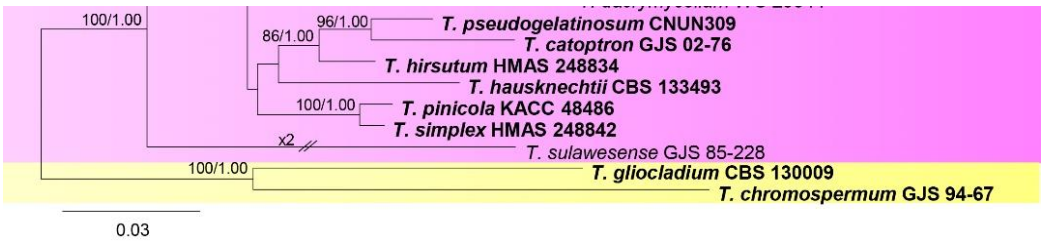


Figure 2.33 Phylogram generated from maximum likelihood analysis based on combined ITS and TEF1 sequence data of *Trichoderma* (*harzianum* species complex) taxa



Note Ninety-five strains are included in the combined analyses, which comprised 2031 characters (ITS: 632, TEF1: 1399) including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes respectively. The tree is rooted to *Trichoderma gliocladium* CBS 130009 and *Trichoderma chromospermum* G.J.S. 94-67. Ex-type strains are in bold. The newly generated sequences are indicated in blue. The scale bar indicates 0.03 nucleotide changes per site.

Figure 2.33 (continued)

Notes: Our collection MFLU 18-2747 belongs to the *Trichoderma harzianum* species complex and is phylogenetically related to the ex-type of *Trichoderma velutinum* (C.P.K. 298) with high statistical support (94% MLBT, 100% BYPP, Figure 2.33) (Bissett et al. 2003). DNA sequences of MFLU 18-2747 and *T velutinum* (C.P.K. 298) differ in 53 nucleotides of the ITS region (10.8%, 22 gaps) and 14 nucleotides of the TEF1 region (3%, 5 gaps). Cai & Druzhinina (2021) observed that ITS is polymorphic in the *harzianum* group. Therefore, they suggested to delineate species in *harzianum* group based on TEF1 and RPB2 sequences. However, no *RPB2* data are available for the ex-type of *T. velutinum* in the GenBank. Neocleotide similarity of the TEF1 region of our collection and ex-type of *T. velutinum* is 97%; which leads to identify our collection as *T. velutinum* (Cai & Druzhinina, 2021). However, an asexual morph has only been reported for *T. velutinum* to date (Bissett et al., 2003) and, our collection is a sexual morph. Considering the highly different ITS region and unavailability of morphological comparisons we introduce our collection as a new species *T. bambusicola*. We could not maintain the living cultures of this fungus therefore, DNA was extracted directly from the fruiting bodies.

Note (a) Herbarium material. (b–e) Stromata on host substrate. (f–i) Vertical section of stromata and ascomata. (j–o) Asci (p–v) Ascospores. (v part calls separated from each other. Scale bars: b = 1000 µm, c = 200 µm, d = 500 µm, e = 1000 µm, f = 500 µm, g, h = 200 µm, i = 100, j = 10 µm, k–p = 5 µm, q–w = 10 µm.

Figure 2.34 *Trichoderma bambusicola* (MFLU 18-2747, holotype)

2.3.5 Ijuhyaceae R.H. Perera, E.B.G. Jones, Maharachch., & K.D. Hyde, *fam. nov.*

Ijuhyaceae R.H. Perera, E.B.G. Jones, Maharachch., & K.D. Hyde, ***fam. nov.***

Index Fungorum number: IF559641, Facesoffungi number: FoF10916

Saprobic on wood and herbaceous debris, occurring on fresh plant material, sometimes *fungicolous* or *parasitic* on nematodes. **Sexual morph:** *Ascomata* perithecial, solitary or in groups, astromatic, sometimes with a thin basal subiculum, superficial, globose to subglobose, not collapsing or laterally pinched to slightly cupulate upon drying, white to pale yellow, sienna, dull orange, orange-yellow or brownish-orange, KOH-, LA-. *Ascomatal apex* faintly or acutely papillate, flat, usually discoid; disk formed of intertwined hyphae that often develop into triangular fasciculate hairs forming an apical crown, rarely apex discoidal without or with short, sinuous hairs. *Peridium* of single stratum or sometimes three strata. *Asci* 6–8-spored, unitunicate, clavate to widely fusiform, evanescent, apex rounded, without an apical ring. *Ascospores* irregularly biseriate or multiseriate to fasciculate, clavate to fusiform to long fusiform, 1- to multi-septate or muriform, straight to slightly curved, guttulate, hyaline, smooth to striate- or spinulose-walled, sometimes strongly cyanophilous. **Asexual morph:** Acremonium-like. *Conidiophores* originate from somatic hyphae, monophialidic, mononematous, straight, with one basal septum, hyaline, smooth-walled. *Conidia* solitary or aggregate at the tip of phialide, ellipsoidal to cylindrical, aseptate, with or without a visible abscission scar, guttulate, hyaline, smooth-walled. *Microsclerotia* rarely formed, often ellipsoidal to cylindrical oblong or occasionally globose, orange to brownish orange or brick red, KOH-.

Type genus: ***Ijuhya*** Starbäck

Notes: Taxonomic placement of the genus *ljuhya* was debated for decades. *ljuhya* was initially accepted in Gymnoascaceae and was reassigned to Sphaeriaceae by Müller and von Arx (1973) and, later placed in Hypocreaceae (Rogerson, 1970). Rossman et al. (1999) accepted *Ijuhya* in Bionectriaceae. In the analysis undertaken by Voglmayr and Jaklitsch (2019) *Ijuhya* and *Kallichroma* clustered together and formed a basal clade in Bionectriaceae, which indicates the weak relationship of these two genera to the family Bionectriaceae. In our phylogenetic analysis *ljuhya* and *Kallichroma* formed a distinct clade from the Bionectriaceae and sister to the clade representing Flammocladiellaceae

(Figure 2.1). The phylogenetic relationship between *Ijuhya* and *Kallichroma* was strongly supported in our analysis (93% MLBT; Figure 2.1). Therefore, we introduce new family Ijuhyaceae to accommodate *Ijuhya* and *Kallichroma*. Species of *Ijuhya* occur in both terrestrial or marine habitats while *Kallichroma* occurs in marine habitats (Kohlmeyer & Kohlmeyer, 1993; Rossman et al., 1999; Abdel-Wahab et al., 2016).

Ecological and economic significance of Ijuhyaceae

Species of *Ijuhya* and *Kallichroma* are generally wood-inhabiting saprobic fungi in marine and terrestrial environments, and involved in nutrient cycling (Dighton, 1995; Hyde & Lee, 1995; Arrigo, 2005). *Ijuhya vitellina*, which produces chaetoglobosin with nematicidal and nematode-inhibiting activities, were studied for using against cereal cyst nematode *Heterodera filipjevi* (Ashrafi et al., 2017).

Genera included in Ijuhyaceae (*taxonomic notes provided)

Ijuhya Starbäck*

= *Peristomialis* (W. Phillips) Boud.

Kallichroma Kohlm. & Volkm.-Kohlm.*

Ijuhya Starbäck, Bih. K. svenska VetenskAkad. Handl., Afd. 3 25(no. 1): 30 (1899)

= *Peristomialis* (W. Phillips) Boud., Hist. Class. Discom. Eur. (Paris): 116 (1907)

Index Fungorum number: IF2482, Facesoffungi number: FoF10917

Saprobic on wood and herbaceous debris, occurring on fresh plant material, sometimes *fungicolous* or *parasitic* on nematodes, in terrestrial or marine habitats. **Sexual morph:** *Ascomata* perithecial, solitary or in groups, astromatic, with a thin basal subiculum or sometimes stromatic, superficial, sometimes arranged in rows of 2–8, superficial or initially immersed and later become erumpent, globose, depressed subglobose or subglobose to ellipsoidal, not collapsing or laterally pinched to slightly cupulate upon drying, epapillate or papillate hyaline, white to pale yellow, sienna, dull orange to orange, orange-yellow, reddish-orange or brownish-orange, KOH-/+ discoloured, LA-. *Ostiolar canal* lined with periphyses. *Ascomatal apex* faintly or acutely papillate, faintly clypeate or in other species flat, usually discoid; disk formed of

intertwined hyphae that often develop into triangular fasciculate hairs forming an apical crown. *Peridium* of 1, 2 or 3-strata. *Hamathecium* composed of septate, branched, filamented apical paraphyses, merging with periphyses, evanescent. *Asci* 3–8-spored, unitunicate, persistent or semi-persistent, subcylindrical, obclavate clavate or widely fusiform, evanescent, apex rounded, without an apical ring. *Ascospores* uni- or bi-seriate, irregularly biseriate or multiseriate to fasciculate, ellipsoidal or clavate to fusiform to long fusiform, 0–1-to multi-septate or muriform, straight to slightly curved, hyaline or apricot colour, smooth to striate- or spinulose-walled, sometimes strongly cyanophilous, sometimes with an evanescent mucilaginous sheath. **Asexual morph:** Acremonium-like. *Conidiophores* originate from somatic hyphae, monophialidic, mononematous, straight, with one basal septum, hyaline, smooth-walled. *Conidia* solitary or aggregate at the tip of phialide, ellipsoidal to cylindrical, aseptate, with or without a visible abscission scar, guttulate, hyaline, smooth-walled. *Microsclerotia* rarely formed, often ellipsoidal to cylindrical oblong or occasionally globose, orange to brownish orange or brick red, KOH- (Adapted from Rossman et al., 1999).

Known distribution: Worldwide distribution. Belgium (Lechat & Fournier, 2017a), China (Zhuang et al., 2007), Hong Kong (Fröhlich & Hyde, 2000), French Guiana (Lechat et al., 2015; Lechat & Fournier, 2017a), France, Turkey (Ashrafi et al., 2017; Lechat & Fournier, 2017a, 2019c), Germany (Lechat & Baral, 2008), Spain (Lechat & Fournier, 2019c), Chile, Brazil, Colombia, UK, France, India, Java, Indonesia, Panama, Venezuela (Rossman, 1983; Samuels, 1976b; Rossman et al., 1999), New Zealand (Whitton et al., 2012b).

Notes: Starbäck (1899) established the genus *Ijuhya* for *I. vitrea*. *Ijuhya* species are mainly saprobic, growing on wood and herbaceous debris. *Ijuhya* species were also isolated from fresh plant material, ascomata of pyrenomycetous fungi (Rossman et al., 1999; Lechat & Courtecuisse, 2010; Lechat & Hairaud, 2012) and few are parasitic on nematodes such as *Heterodera filipjevi*, a cereal cyst nematode (Ashrafi et al., 2017). The genus is characterized by white to pale coloured ascomata, with an apical crown of fasciculate hairs and, ascomata lack KOH or lactic acid reactions. *Ijuhya vitellina* is the only species in the genus associated with nematodes (Ashrafi et al., 2017). *Ijuhya vitellina* varies from other *Ijuhya* species by brightly coloured, orange to reddish microsclerotia, which are new to the genus (Ashrafi et al., 2017). Nannfeldt (1936) believed *Ijuhya* and

Peristomialis as taxonomic synonyms. After observing type specimens, Samuels (1976) recognized *Ijuhya vitrea* and *Peristomialis berkeleyi* are the same fungus. However, Samuels (1976) considered *Ijuhya* and *Peristomialis* to be synonyms of *Nectria*. Rossman et al. (1999) resurrected the genus *Ijuhya* (in Bionectriaceae) and retained *Ijuhya peristomialis* as the type. We consider *Peristomialis* as a synonymy of *Ijuhya* following previous studies. Ashrafi et al. (2017) provided DNA sequences for *Ijuhya peristomialis* (CBS 569.76 = G.J.S. 73–314) and demonstrated *Ijuhya* is distinct from *Nectria*. In the current phylogenetic analysis, *Ijuhya* species clustered with *Kallichroma* species with strong statistical support (Figure 2.1).

Type species: ***Ijuhya peristomialis*** (Berk. & Broome) Rossman & Samuels, in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 34 (1999)

Basionym: *Peziza peristomialis* Berk. & Broome, Ann. Mag. nat. Hist., Ser. 3 18: 126 (1866)

= *Ijuhya vitrea* Starbäck, Bih. K. svenska VetenskAkad. Handl., Afd. 3 25(no. 1): 30 (1899)

= *Nectria peristomialis* (Berk. & Broome) Samuels, N.Z. Jl Bot. 14(3): 251 (1976)

= *Peristomialis berkeleyi* Boud., Hist. Class. Discom. Eur. (Paris): 116 (1907)

Index Fungorum number: IF459474, *Facesoffungi number*: FoF10918, Figure 2.35, 2.36

On culms of bamboo. **Sexual morph:** *Ascomata* 250–350 µm diam., perithecial, solitary or consists of groups of 2–7, superficial, astromatic or on a sparse white hyphal subiculum, globose or depressed subglobose to subglobose, nonpapillate, with a flattened faintly sunken apex, intertwined hyphae often develop into triangular fasciculate hyaline hairs forming a stellate apical disc, not collapsing upon drying, white to pale yellow, becoming darker when dry, KOH-, ostiolate. *Ostiolar canal* lined with hyaline, un-branched, septate periphyses narrowing towards the apex. *Peridium* 30–50 µm thick, of three strata: outer stratum 10–20 µm thick, composed of prosenchymatous cells; central stratum 15–20 µm thick, composed of elongate cells; inner stratum 10–15 µm thick, composed of thin walled, elongate cells. *Paraphyses* not seen. *Asci* 60–100 × 10–15 µm, 8-spored, unitunicate, clavate, with a short pedicel, apex rounded, simple, without an apical ring. ***Ascospores*** 30–50 × 4–7 µm, irregularly bi-seriate to pluri-seriate, 1–5-

septate, fusiform to long fusiform, with rounded ends, usually curved, hyaline, coarsely striate. **Asexual morph:** Hyphomycetous, acremonium-like. *Colony* white, velvety. *Mycelium* aerial, composed of hyaline, branched, smooth hyphae. *Conidiophores* arising from hyphae, up to 50 µm high, 1.5–2.5 µm wide at the base, 1–1.5 µm at the apex, cylindrical, unbranched or branched, tapering at the apex, straight to flexuous, solitary, hyaline, smooth-walled. *Conidiogenous cells* terminal, monophialidic, cylindrical, apex with inconspicuous collarets, hyaline, smooth-walled. *Conidia* 5–6 × 1–2 µm ($\bar{x}$ = 5.3 × 1.6 µm, n = 20), solitary, aseptate, ellipsoid to cylindrical, ends rounded, aseptate, abscission scare not visible, hyaline, smooth-walled. **Sexual morph**: not observed.

Material examined: BRAZIL, Rio Grande do Sul, on culms of bamboo, 7 April 1983, Malme 340, S, F 10202, **holotype** of *Ijuhya vitrea*; NEW ZEALAND, Rodney County, Atuanui State Forest, isolated from *Cyathea dealbata*, 17 November 1973, Samuels PDD 32567 = IMI 208155 as *Nectria peristomialis*.

Kallichroma Kohlm. & Volkm.-Kohlm., Mycol. Res. 97(6): 759 (1993)

Basionym: *Hydronectria tethys* Kohlm. & E. Kohlm. 1965

Index Fungorum number: IF22429, Facesoffungi number: FoF10919

Saprobic on wood in marine habitats. *Ascomata* perithecial, sometimes stromatic, solitary or occur in small groups, mostly arranged in rows of 2–8, gregarious or frequently confluent, globose, depressed subglobose or subglobose to ellipsoidal, not collapsing when dry, initially immersed, erumpent, epapillate or papillate, faintly clypeate around the ostiolar region, papillae protruding above the substrate, hyaline, orange-yellowish or orange to reddish-orange, ostiolate, KOH+ discoloured. *Ostiolar canal* lined with periphyses embedded in a gelatinous matrix. *Peridium* 1, 2 or 3-strata, hyaline or yellow to apricot colour. *Hamathecium* composed of septate, branched, filamented apical paraphyses, merging with periphyses, evanescent. *Asci* 3–8-spored, unitunicate, subcylindrical to clavate or obclavate, short pedicellate, persistent or semi-persistent, thin-walled, apex thick-walled, without an apical ring.

Note (a) Herbarium material with label. (b, c) Appearance of ascomata on the host substrate. (d, e) Vertical sections of ascomata (e with fasciculate hairs). (f) Vertical section of peridium. (g–i) Asci. k–n Ascospores. Scale bars: b = 100 µm, c = 200 µm, d, e = 100 µm, f = 50 µm, g–i = 20 µm, k–n = 10 µm.

Figure 2.35 *Ijuhya peristomialis* (F 10202, holotype of *Ijuhya vitrea*)

Note (a) Herbarium packet. (b) Dried culture. (c) Close-up of colony. (d–h) Hyphae and conidiophores. (i, j) Conidia. Scale bars: d–h = 50 μm, i, j = 5 μm.

Figure 2.36 *Ijuhya peristomialis* (IMI 208155)

Ascospores uni- or bi-seriate, ellipsoidal or clavate to fusiform, 0–1-septate, not or slightly constricted at the septum, with median or submedian septum, hyaline or apricot colour, thick-walled, smooth-or rough-walled, sometimes longitudinally striate, without or with an evanescent mucilaginous sheath, often oozed out through the ostiolar canal to form a cirrhus. **Asexual morph:** Undetermined (Adapted from Kohlmeyer & Kohlmeyer, 1993; Rossman et al., 1999; Abdel-Wahab, et al. 2016).

Known distribution: Bermuda, Bahamas, Belize, Mexico, Tobago, USA, India, Malaysia, Seychelles, Thailand, Australia, Brunei, Fiji, French Polynesia (Kohlmeyer & Kohlmeyer, 1993), Saudi Arabia (Abdel-Wahab et al., 2016)

Notes: Kohlmeyer and Kohlmeyer (1993) established *Kallichroma* to accommodate two marine species, which were hitherto described in the genus *Hydronectria*. Later Abdel-Wahab et al. (2016) introduced another two species to the genus. Species of this genus are found on decayed wood in marine habitats (Kohlmeyer & Kohlmeyer, 1993; Abdel-Wahab et al., 2016).

Type species: ***Kallichroma tethys*** (Kohlm. & E. Kohlm.) Kohlm. & Volkm.-Kohlm. (1993)

Basionym: *Hydronectria tethys* Kohlm. & E. Kohlm., Nova Hedwigia 9: 95 (1965)

Index Fungorum number: IF359766, Facesoffungi number: FoF10920, Figure 2.37

Saprobic on wood in marine habitats. **Sexual morph:** *Ascomata* 280–380 µm high × 330–400 µm diam. perithecial, astromatic, solitary or occur in small groups, mostly arranged in rows, immersed or erumpent in the substrate, mostly arranged in rows, unilocular, frequently confluent, subglobose to ellipsoidal, not collapsing when dry, epapillate, with a clypeus around the ostiolar region, orange to reddish-orange, discoloured in 3% KOH, ostiolate. *Ostiolar canal* lined with periphyses embedded in a gelatinous matrix. *Peridium* 20–70 µm wide, wider at sides and around the ostiole, of 3-strata, outer stratum composed of hyaline, polygonal cells with large lumina; central stratum of hyaline, thick-walled, cells with small lumina; inner stratum of hyaline, thick-walled, compressed cells of *textura angularis*. *Hamathecium* composed of septate, branched, thread-like, 2 µm wide apical paraphyses, merging with periphyses. *Asci* 90–100 µm × 14–20 µm, 8-spored, unitunicate, subcylindrical, narrower towards the apex, short pedicellate, persistent, thin-walled, apex thick-walled, without an apical ring. *Ascospores* 16–25 µm × 8–14 µm, uni- to bi-seriate, ellipsoidal, 1-septate, not or slightly constricted at the septum, upper half comparatively larger, straight, hyaline, with ridge like longitudinal striations, thick-walled. **Asexual morph:** Undetermined.

Material examined: USA, Florida, Miami, Key Biscayne, on driftwood, 27. December 1963, Kohlmeyer No. 1709d, B 700017006, **holotype**.

Note (a) Specimen label. (b) Herbarium material. (c, d) Immersed or erumpent ascoma in the substrate. (e) Section through ascoma. (f) Section through ostiolar region. (g) Peridium. (h) Paraphyses. (i–k) Immature and mature asci. (l) Germinating ascospores mounted in 3% KOH. (m–p) Ascospores. (o, p: mounted in 3% KOH). Scale bars: d = 500 µm, e, f = 100 µm, g–l = 50 µm, m–p = 20 µm.

Figure 2.37 *Kallichroma tethys* (B 700017006, holotype)

2.3.6 Nectriaceae Tul. & C. Tul.

The name *Nectria* was initially introduced by Fries (1825) as one of the four sections of the genus *Hypocrea*, suborder Sphaerini, order Sphaeriacei. Fries (1825) divided *Hypocrea* into four sections: *Cordyceps*, *Hypocrea*, *Hypomyces* and *Nectria*. De Notaris (1844) believed these four sections should be distinct genera. *Nectria* was raised to genus level in the order Sphaeriacei by Fries (1849), on the basis of the diagnosis "Peritheciis liberis, membranaceis (neque corticatis nec pruina velatis) flaccidis, laete coloratis, papilla pallida, nucleo fluxiti pallido guttae 1, floccorum alborum instar expulsae, asci 8-sporis sporisque pellucidis". Nectriaceae was established based on *Nectria* by Tulasne and Tulasne (1865). Nectriaceae has been treated differently by many authors (detailed under Hypocreales Lindau in current paper). Seaver (1909a) recognised Nectriaceae and Hypocreaceae as different taxonomic groups based on stromatal variations. Seaver (1909a) defined Nectriaceae as fungi with "perithecia entirely free on the substratum (occasionally subepidermal), or seated on a fleshy or tubercular stroma, but when the latter is present, perithecia always superficial, usually in cespitose clusters; stroma often obscured at maturity by the perithecia and occasionally becoming obsolete in aged specimens, but in such cases, its presence is indicated by the densely cespitose clusters of perithecia".

Rossman et al. (1999) accepted Nectriceae as a distinct family, which was defined on the basis of stromatal, ascomatal and ascospore characters. They revised Nectriaceae and placed 20 genera in the family, namely: *Albonectria*, *Allonectella*, *Calonectria*, *Calonectria*, *Corallomycetella*, *Cosmospora*, *Gibberella*, *Haematonectria*, *Lanatonectria*, *Leuconectria*, *Nectria*, *Neocosmospora*, *Neonectria*, *Ophionectria*, *Pleogibberella*, *Pseudonectria*, *Rubrinectria*, *Stalagmites*, *Viridispora* and *Xenonectriella*. Lumbsch and Huhndorf (2010) accepted 26 genera in Nectriaceae. Lombard et al. (2015) provided a well-defined generic outline for Nectriaceae providing and analyzing DNA sequence data for most of the genera. Furthermore, they accepted 47 genera and introduced six genera in Nectriaceae (ie. *Aquanectria*, *Bisifusarium*, *Coccinonectria*, *Paracremonium*, *Rectifusarium* and *Xenoacremonium*). Lombard et al. (2015) did not treat or excluded some genera, which were previously accepted in Nectriaceae due to lack of sequence data and living cultures. Those taxa are *Bacillispora*, *Peziotrichum*, *Pleogibberella*, *Pleurocolla*, *Pseudocosmospora* and *Stalagmites*, due to lack of molecular data and living

cultures. Rossman et al. (2013) linked asexual and sexual morphic genera and proposed the protection of some generic names in the Nectriaceae. *Penicillifer* over *Viridispora*, *Sarcopodium* over *Actinostilbe* and *Lanatonectria*, and *Xenocylindrocladium* over *Xenocalonectria* were conserved by Lombard et al. (2015).

Maharachchikumbura et al. (2016) recorded 65 genera in the family. After Lombard et al. (2015) several new genera were added to the family: eg. *Corinectria*, *Cosmosporella*, *Murinectria*, *Neothyronectria*, *Pandanaceomyces*, *Pleiocarpon*, *Pseudoachroiostachys*, *Varicosporellopsis*, *Xenoleptographium*. Recently, three new genera *Cinnamomeonectria*, *Macronectria* and *Tumenectria* have been placed in Nectriaceae by Salgado-Salazar et al. (2016). A recent study by Savary et al. (2021) introduced *Longinectria*. Crous et al. (2021) added three fusarioid genera *Luteonectria*, *Nothofusarium* and *Scolecofusarium* to the family. *Neothyronectria* was synonymised with *Thyronectria* based on morphological and phylogenetic data by Voglmayr et al. (2022). Based on phylogenetic analysis and following Flakus et al. (2019) we accept *Globonectria*, which was previously placed in Bionectriaceae, in Nectriaceae. *Murinectria* was excluded from Nectriaceae. Furthermore, *Sulcatistroma* was suppressed over *Thyronectria* and a new combination for *Sulcatistroma nolinae* is proposed as *Thyronectria nolinae*. Currently we accept 77 genera in the family.

Nectriaceae is characterized by yellow, orange, red to purple uniloculate ascomata, reacting in KOH and lactic acid (LA) with phialidic asexual morphs; ascospores not disarticulating, globose, ellipsoid to long-fusiform (never truly filiform) (Rossman et al., 1999; Lombard et al., 2015).

Ecological and economic significance of Nectriaceae

Members of Nectriaceae such as *Albonectria*, *Calonectria*, Cylindrocladiella, *Dactylonectria*, *Ilyonectria*, *Fusarium* and *Neocosmospora* are important plant pathogens of economically important plants all over the world (Jayawardena et al., 2019a, b; Aiello et al., 2020). *Albonectria* species are plant pathogenic fungi causing fruit rot, canker disease, dieback disease and gall disease of economically important plants (Serrato-Diaz et al., 2011; Lee et al., 2017; Nhung et al., 2018; Vicente et al., 2012;). *Neocosmospora* species are pathogens that cause avocado trunk cankers (Guarnaccia et al., 2018) and, crown rot and stem canker of Pistachio rootstocks (Crespo et al., 2019), potato stem rot (Riaz et al., 2020), root rot of peanut (Fuhlbohm et al., 2007) and cane blight of red

raspberry (Guarnaccia et al., 2022). *Calonectria* is reported to produce leaf blight, root rot, and wilt of *Metrosideros* spp. (Alfenas, Pereira, Ferreira et al., 2013), Eucalyptus leaf blight (Chen et al., 2011), root rot of avocado (Dann et al., 2012) and leaf blight and cutting rot of forest tree in Brazil (Alfenas, Pereira, Jorge et al., 2013). *Fusarium* species are important plant pathogens and mycotoxin producers and opportunistic human and animal pathogens (Kistler, 1997; Antonissen et al., 2014; Ma et al., 2013; Adikaram & Yakandawala, 2020). *Fusarium oxysporum* affects many important trees and crops worldwide, causing wilt diseases (Ibrahim et al., 2021). Mycotoxins produce by *Fusarium* species cause mortalities of insects such as termites, mealworms, flour beetles, maize borers and blow flies (Teetor-Barsch & Roberts, 1983; Chehri, 2017). Ingestion of *Fusarium* mycotoxins through food and feed may impair intestinal health, immune function and/or pathogen fitness of humans and animals (Antonissen et al., 2014). Several Nectriaceae species fungi used widely in industrial, medicinal and commercial applications for their therapeutic enzymes, biodegraders and biocontrol agents (Abdel-Azeem et al., 2019; Peitl et al., 2020; Ibrahim et al., 2021; Cleveland et al., 2021; Parmar et al., 2021). *Fusarium* species are used for the synthesis of different metal nanoparticles that are useful in biotechnological, medicinal, pharmaceutical and industrial fields (Abdel-Azeem et al., 2019; Cleveland et al., 2021; Ibrahim et al., 2021). *Nectria galligena*, *Volutella minima*, non-pathogenic *Fusarium* species are currently employed in biocontrol studies (Corke & Hunter, 1979; Kaur et al., 2011; Peitl et al., 2020). Saprobic species of Nectriaceae are involved in nutrient cycling (Dighton, 1995).

Nectriaceae Tul. & C. Tul. [as 'Nectriei'], Select. fung. carpol. (Paris) 3: 3 (1865)

Index Fungorum number: IF81059, Facesoffungi number: FoF01396

Endophytic, corticolous, foliicolous, saprobic or pathogenic on plant hosts, fungicolous, some are entomogenous, rarely bryophilous or lichenicolous, a few species are human and animal pathogens; some are isolated from soil, water and air; in terrestrial and aquatic habitats. *Stromata* when present sparse to well-developed, superficial on host or on immersed to erumpent. **Sexual morph:** *Ascomata* perithecial, stromatic or astromatic, solitary or aggregated in groups, globose to subglobose, ovoid, elongate-ovoid, obpyriform, obovoid or pyriform, white, red, dark red, reddish-brown, orange, orange-red, orange-brown, yellow, pale yellow, brown, greyish yellow-green, dark bluish, bluish purple, bluish black or black, KOH +/-, surface smooth to papillate, striate, warted,

verrucose, scaly or hairy, with or without setae, ostiolar region sometimes papillate, ostiole periphysate. *Paraphyses* present or absent. *Asci* 2–8-spored, unitunicate, clavate to narrowly clavate, cylindrical or ellipsoidal, with pointed or pedicellate base, with or without apical ring; rarely budding in the ascus to produce ascoconidia. *Ascospores* uniseriate to biseriate or overlappingfusiform, ellipsoidal, oblong, long-fusiform, biconic, pyriform, reniform or allantoid, aseptate to multi-septate or muriform, constricted at the septum or not, hyaline to yellow, yellow-brown, golden-brown, pale-brown or green, smooth-walled, spinulose, verruculose or striate. **Asexual morph:** Generally, hyphomycetous, less commonly coelomycetous. *Conidiomata* synnematous, sporodochial or pycnidial. *Conidiophores* branched or unbranched, penicillate, verticillate. *Conidiogenous cells* monophialidic to polyphialidic, ampulliform to lageniform, cylindrical, elongate-ampulliform or subcylindrical, hyaline, smooth-walled. *Conidia* globose, ovate, ellipsoidal, cylindrical to subcylindrical, fusiform, long-fusiform, filiform, allantoid or falcate, straight to slightly or strongly curved, hyaline, aseptate to multi-septate, constricted at septum or not, with or without evident abscission scars, sometimes guttulate, smooth-walled. *Chlamydospores* present or absent (Adapted from Maharachchikumbura et al., 2016).

Type genus: ***Nectria*** (Fr.) Fr.

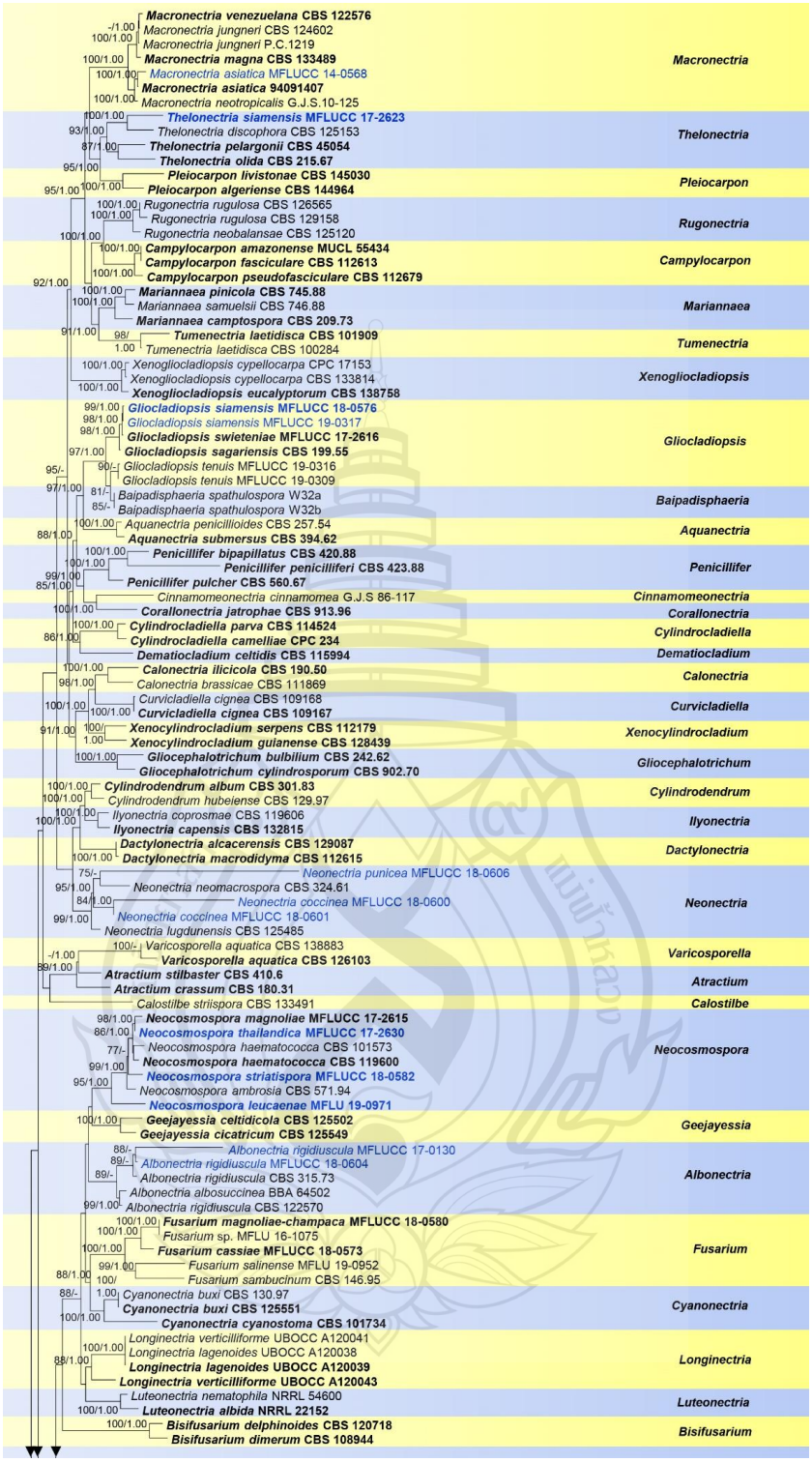


Figure 2.38 Phylogram generated from maximum likelihood analysis based on combined ACT, CDMA, HIS3, ITS, LSU, RPB1, RPB2, TEF1 and TUB2 sequence data of Nectriaceae taxa

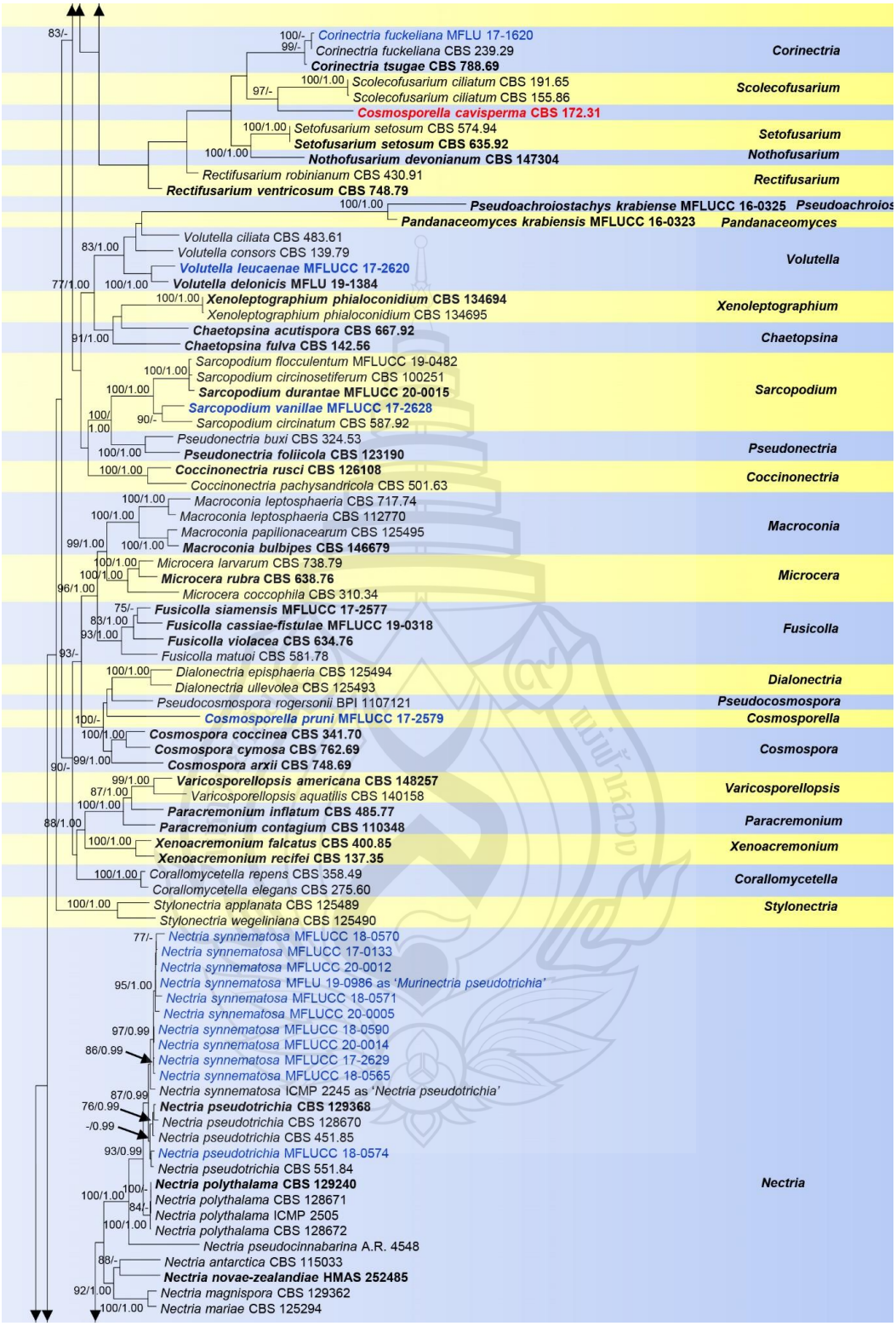
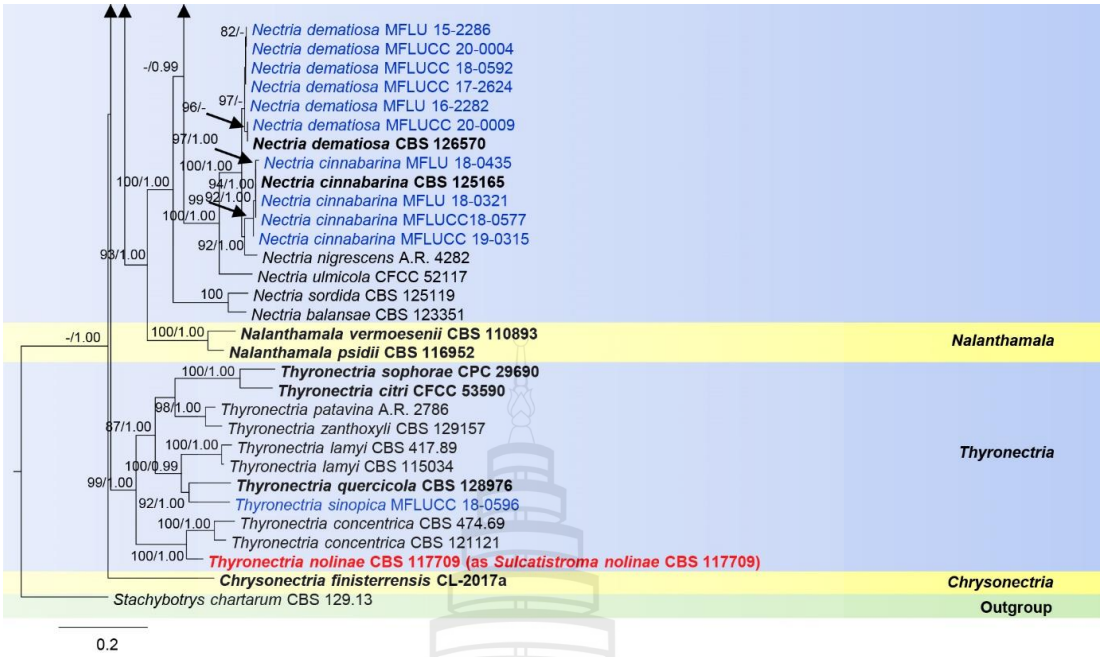


Figure 2.38 (continued)



Note Two hundred thirteen strains are included in the combined analyses, which comprised 8540 characters (ACT: 830, CDMA: 1004, HIS3:1195, ITS: 542, LSU: 797, RPB1: 670, RPB2: 1740, TEF1: 1133, TUB2: 629), including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to *Stachybotrys chartarum* CBS 129.13. Ex-type strains are in bold. The newly generated sequences are indicated in blue. The scale bar indicates 0.2 nucleotide changes per site.

Figure 2.38 (continued)

Genera included in Nectriaceae (* taxonomic notes provided)

Albonectria Rossman & Samuels*

Allonectella Petr.

Aphanocladium W. Gams

Aquanectria L. Lombard & Crous*

Atractium Link

Baipadisphaeria Pinruan

Bisifusarium L. Lombard, Crous & W. Gams

Calonectria De Not.

Calostilbe Sacc. & Syd.

Campylocarpon Halleen, Schroers & Crous

Chaetonectrioides Matsush.

Chaetopsina Rambelli*

Chrysonectria Lechat & J. Fourn.*

Cinnamomeonectria Salgado & P. Chaverri*

Coccinonectria Lombard & Crous

Corallomycetella Henn.*

Corallonectria C. Herrera & P. Chaverri

Corinectria C. González & P. Chaverri*

Cosmospora Rabenh.

Cosmosporella S.K. Huang, R. Jeewon & K.D. Hyde*

Curvicladiella Decock & Crous*

Cyanochyta Höhn.

Cyanonectria Samuels & Chaverri

Cyanophomella Höhn.

Cylindrocladiella Boesew.

Cylindrodendrum Bonord.

Dacryoma Samuels

Dactylonectria L. Lombard & Crous

Dematiocladium Allegr., Aramb., Cazau & Crous

Fusarium Link*

Fusicolla Bonord*

Geejayessia Schroers, Gräfenhan & Seifert*

Gliocephalotrichum J.J. Ellis & Hesselt.

Gliocladiopsis S.B. Saksena*

Globonectria Etayo*

Ilyonectria P. Chaverri & C. Salgado

Longinectria O. Savary, M. Coton, E. Coton & J.L. Jany*

Luteonectria Sand.-Den., L. Lombard, Schroers & Rossman*

Macroconia (Wollenw.) Gräfenhan, Seifert & Schroers*

Macronectria Salgado & P. Chaverri*

Mariannaea G. Arnaud ex Samson

Microcera Desm.*

Nalanthamala Subram.

Nectria (Fr.) Fr.*

Neocosmospora E.F. Sm.*

Neonectria Wollenw.*

Nothofusarium Crous, Sand.-Den. & L. Lombard*

Ophionectria Sacc.*

Pandanaceomyces Tibpromma & K.D. Hyde*

Paracremonium L. Lombard & Crous

Payosphaeria W.F. Leong*

Penicillifer Emden*

Persiciospora P.F. Cannon & D. Hawksw.

Pleiocarpon L. Lombard & D. Aiello*

Pleogibberella Sacc.*

Pleurocolla Petr.

Pseudoachroiostachys Tibpromma & K.D. Hyde*

Pseudocosmospora C. Herrera & P. Chaverri

Pseudonectria Seaver

Rectifusarium L. Lombard, Crous & W. Gams*

Rugonectria P. Chaverri & Samuels

Sarcopodium Ehrenb.*

Scolecofusarium L. Lombard, Sand.-Den. & Crous*

Setofusarium (Nirenberg & Samuels) Crous & Sand.-Den.*

Stylonectria Höhn.*

Thelonectria P. Chaverri & C.G. Salgado*

= *Neothyronectria* Crous & Thangavel*

Thyronectria Sacc.*

= *Allantonectria* Earle

= *Neothyronectria* Crous & Thangavel

= *Pleonectria* Sacc.

= *Sulcatistroma* A.W. Ramaley*

= *Thyronectroidea*

Tumenectria Salgado & Rossman*

Varicosporella Lechat & J. Fourn.*

Varicosporellopsis Lechat & J. Fourn.*

Vesicladiella Crous & M.J. Wingf.*

Volutella Tode*

Xenoacremonium Lombard & Crous

Xenocylindrocladium Decock, Hennebert & Crous

Xenogliocladiopsis Crous & W.B. Kendr.

Xenoleptographium Marinc., T.A. Duong, Z.W. de Beer & M.J. Wingf.*

Xenonectriella Weese*

Albonectria Rossman & Samuels, in Rossman et al., Stud. Mycol. 42: 105 (1999)

Index Fungorum number: IF27953, Facesoffungi number: FoF10934

Saprobic or *pathogenic* on dicotyledonous and monocotyledonous plant parts. **Sexual morph:** *Ascomata* perithecial, solitary to gregarious, superficial on a stroma, globose to subglobose to ellipsoidal or ovoid to obovoid, not collapsing upon drying, white to pale yellow to pale ochraceous, KOH-, surface strongly ornamented with warts, with a small pointed papilla or nonpapillate. *Stromata* sparse to well-developed. *Asci* 4–8-spored, narrowly clavate or broadly clavate to ellipsoidal, without an apical ring. *Ascospores* obliquely uniseriate or biseriate, ellipsoidal to long-ellipsoidal, 3- to multi-septate, not or slightly constricted at the septum, hyaline to yellow-brown, smooth-walled to striate. **Asexual morph:** *Conidiomata* fusarium-like, hyphomycetous. *Conidiophores* mononematous or sporodochial. *Aerial conidiophores* irregularly branched or unbranched, producing terminal or lateral phialides. *Aerial phialides* monophialidic, cylindrical to subcylindrical, periclinal thickening not visible or absent, smooth-, thin-walled, giving rise to two types of conidia. *Aerial microconidia* ovoid to obovoid, oblong or ellipsoid, 0–1- septate, hyaline, smooth-walled, flattened basal papilla present or lacking, formed in dry chains or wet heads. *Aerial macroconidia* falcate, multi-septate, with a curved, blunt to pointed apical cell and a foot-shaped basal cell, or distinctly beaked at both ends. *Sporodochia* cream colour to yellow. *Conidiophores* densely

packed, branched, verticillate, having a short, smooth- and thin-walled stipe. *Sporodochial conidiogenous cells* monophialidic, arrange in terminal whorls of 2–4, cylindrical to subulate, smooth- and thin-walled, collarette reduced or flared. *Sporodochial macroconidia* falcate, 5–9-septate, moderately curved to straight, thick-walled, consisting of a blunt to hooked apical cell and distinct well-developed foot-shaped basal cell. *Chlamydospores* absent. (Adapted from Rossman et al., 1999; Crous et al., 2021).

Known distribution: Taiwan (Guu et al., 2007), Sri Lanka, Jamaica, New Zealand, Puerto Rico, Ecuador, Venezuela, Brazil, Colombia (Rossman et al., 1999), Thailand (This study).

Notes: Rossman et al. (1999) established *Albonectria* for species having white to pale yellow, strongly warted ascomata and producing *Fusarium* asexual morphs.

Type species: ***Albonectria rigidiuscula*** (Berk. & Broome) Rossman & Samuels, in Rossman et al., Stud. Mycol. 42: 105 (1999)

Basionym: *Nectria rigidiuscula* Berk. & Broome, J. Linn. Soc., Bot. 14(no. 74): 116 (1873) [1875]

= *Calonectria sulcata* Starbäck, Bih. K. svenska VetenskAkad. Handl., Afd. 3 25(no. 1): 29 (1899)

= *Calonectria rigidiuscula* (Berk. & Broome) Sacc., Michelia 1(no. 3): 313 (1878)

= *Fusarium decemcellulare* Brick, Jber. Vereinig. Angew. Bot. 6: 227 (1908)

For other synonyms see Index Fungorum.

Index Fungorum number: IF460215, Facesoffungi number: FoF10935, Figure 2.39

Saprobic on *Chromolaena odorata* and *Mangifera indica*. **Sexual morph:** *Ascomata* 180–310 µm high × 170–260 µm wide, perithecial, solitary or gregarious, in groups up to 15, usually on a well-developed stroma, globose to subglobose, not collapsing or slightly laterally pinched when dry, pale yellow to white, with a small pointed papilla, ostiolate, KOH-, surface prominently warted. *Ascomatal warts* up to 20–75 µm high, large, composed of hyaline to yellow cells 2.5–11 diam. *Stromata* up to 400 µm tall, immersed in the host epidermis, well-developed, composed of hyaline pseudoparenchymatous cells forming *textura angularis*, KOH-. *Ostiolar canal* lined with

hyaline periphyses. *Peridium* 10–35 µm thick between the warts, up to 25–110 µm thick at the warts, of 3 strata: outer stratum including warts 34–87 µm thick, composed of hyaline to yellow, thick-walled cells forming *textura angularis* to *textura globulosa*; middle stratum 10–18 µm, composed of hyaline, thick-walled, elongate cells forming *textura angularis*; inner stratum 15–24 µm, of hyaline, thin-walled cells forming *textura angularis*. *Apical paraphyses* moniliform, hyaline. *Asci* 80–105 µm × 11–15 µm ($\bar{x}$ = 93 × 13.1 µm), 2–4-spored, narrowly clavate to long ellipsoidal, apex simple. ***Ascospores*** 21–32 µm × 6.8–8.8 µm ($\bar{x}$ = 25.8 × 8.8 µm), uniseriate, obliquely uniseriate to biseriate, ellipsoidal to long-ellipsoidal, with rounded ends, inequilateral or symmetric, 3-septate, constricted or not constricted at septa, slightly curved or straight, multi-guttulate, hyaline to yellowish-brown, smooth-walled, without appendages or mucilaginous sheath. **Asexual morph:** see Rossman et al. (1999) and Booth (1971).

Culture characteristics: Ascospores germinating on PDA within 24 hrs at 25°C. Colony on MEA reaching 45 mm diam. within 14 days at 25°C; above white with orange brown ring at the center and near to the edge, circular, flat, edge filamentous, surface smooth, dense, cottony, with sparse aerial mycelium, reverse orange brown with a white ring at the edge.

Material examined: THAILAND, Chiang Mai Province, on a dead stem of *Chromolaena odorata* (Asteraceae), 02 February 2017, R. H. Perera, BN01 (MFLU 18-2728), living culture MFLUCC 17-0130; *Ibid*., Chiang Mai Province, Mae Rim District, on dead twigs of *Mangifera indica* (Anacardiaceae),18 September 2017, R. H. Perera, Rim03 (MFLU 19-0965), living culture MFLUCC 18-0604; USA, North Carolina, Jackson Co., Nantahala Natl. Forest, Bull Pen Rd. to Chattooga River, Ellicott Rock Trail from Fowler Creek, on bark of recently dead *Fagus* sp., 28 Sept 1989, G. J. Samuels, C. T. Rogerson, R. C. Harris, W. R. Buck, Det. G. J. Samuels, S, No. 336 = F10220 (**holotype of *Calonectria sulcata***).

GenBank numbers: MFLUCC 17-0130: LSU: ON352625, ITS: ON361567, RPB1: ON364458; MFLUCC 18-0604: LSU: ON352626, ITS: ON361568, RPB1: ON364459, RPB2: ON364490, TEF1: ON364466.

Notes: Rossman et al. (1999) introduced *Albonectria* for the saprobic or pathogenic species *Albonectria rigidiuscula*. *Calonectria sulcata* was considered a synonym of *A. rigidiuscula* by many authors (Rossman et al., 1999; Lombard et al., 2015;

Crous et al., 2021). We located the holotype specimen of *Calonectria sulcata* (F10220) for this study. In 1979, A. Rossman annotated that there are frutting bodies of another fungus *Nectria rigidiuscula* (current name *Albonectria rigidiuscula*) on the same substrate. We had the same observation and found the true fruitting bodies of *Calonectria sulcata* in the holotype specimen. Here we provide illustrations of *Albonectria rigidiuscula* collected from Thailand (MFLU 19-0965) (Figure 2.36). The fungal morphology and measurements we report here matches the original description of *Calonectria sulcata* by Starbäck (1899) and descriptions of the *Albonectria rigidiuscula* provided by Rossman et al. (1999). *Fusarium* species with dark purple old ascomata were found closer to *Albonectria rigidiuscula* ascomata on MFLU 18-2728 and MFLU 17-0130 specimens.

Aquanectria L. Lombard & Crous, in Lombard et al., Stud. Mycol. 80: 207 (2015)

Index Fungorum number: IF810949, Facesoffungi number: FoF10936

On submerged plant debris in aquatic habitats. **Sexual morph:** *Ascomata* perithecial, superficial, solitary or aggregated in groups, ovate to subglobose, collapsing laterally upon drying, brown-orange to orange-red, ostiolate. *Ostioles* papillate. *Asci* 8-spored, cylindrical to clavate. *Ascospores* ellipsoid to fusiform, 1-septate, with a slight constriction at the septum, hyaline. **Asexual morph:** *Conidiomata* hyphomycetous. *Conidiophores* erect, solitary, septate, branched, hyaline, with verticillate penicillus, bearing 1–4 phialides. *Conidiogenous cells* phialidic, cylindrical, with an evident periclinal thickening, collarette not flared, usually tubular. *Conidia* filiform, curved to variously sigmoid, 0–1-septate, hyaline, smooth-walled. *Chlamydospores* intercalary, guttulate, pale to dark brown, agglutinating to produce sclerotia (Adapted from Ingold, 1944; Lombard et al., 2015).

Note (a) Herbarium material. (b–d) Appearance of ascomata on host substrate (d ascomata reconstituted with water). (e) Transverse section of stroma and ascomata in 3% KOH. (f) Transverse section of ascoma. (g) Face view of the peridium. (h) Transverse section of peridium with warts. (i, j) Asci with paraphyses. (k) Ascus. (l–s) Ascospores. (t) Germinating ascospore. (u, v) Colony on MEA. Scale bars: b = 1 mm, c = 200 µm, d = 500 µm e–h = 200 µm, i–k = 50 µm, l–t = 20 µm.

Figure 2.39 *Albonectria rigidiuscula* (a–d, g–t: MFLU 19-0965; e, f, u, v: MFLU 18-2728)

Known distribution: China (Huang et al., 2018), USA, Jamaica (Lombard et al., 2015), Ecuador, French Guiana, Singapore (Gordillo & Decock, 2019).

Notes: Based on multigene analysis, Lombard et al. (2015) described the new aquatic genus *Aquanectria* for *Flagellospora penicillioides* and *Heliscus submersus* (Ranzoni, 1956; Hudson, 1961). Later Huang et al. (2018) and Gordillo and Decock (2019) added another five species to the genus. *Aquanectria* species are morphologically closer to *Gliocladiopsis* species but distinct by longer, straight to sigmoid conidia.

Type species*:* ***Aquanectria penicillioides*** (Ingold) L. Lombard & Crous, in Lombard et al., Stud. Mycol. 80: 207 (2015)

Basionym: *Flagellospora penicillioides* Ingold, Trans. Br. mycol. Soc. 27(1-2): 44 (1944)

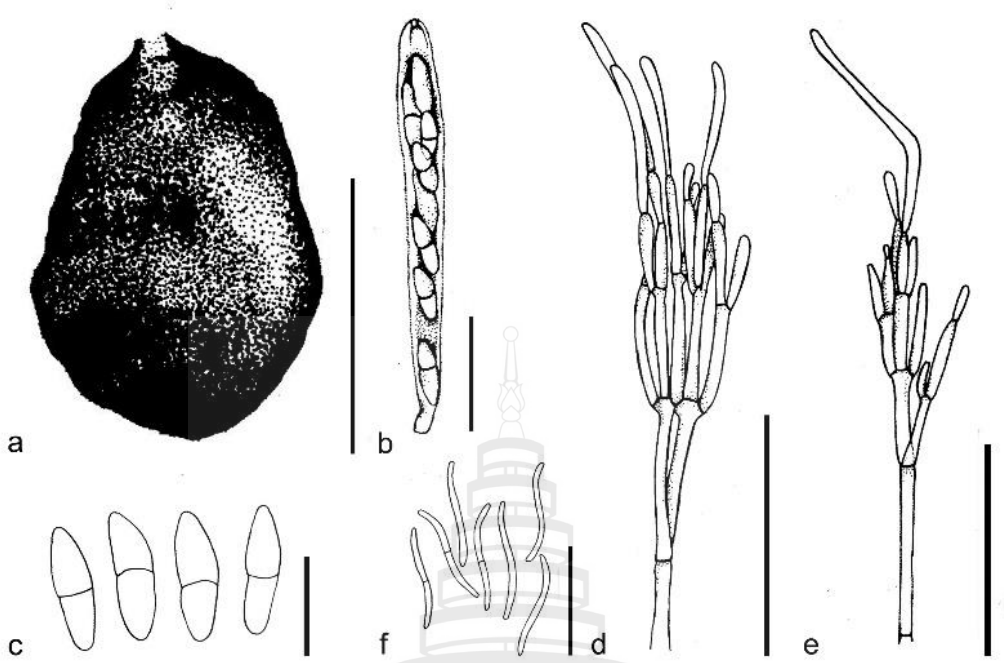
= *Nectria penicillioides* Ranzoni, Am. J. Bot. 43: 17 (1956)

Index Fungorum number: IF810950, Facesoffungi number: FoF05440, Figure 2.40

Descriptions: see Ranzoni (1956) and Ingold (1944)

Material examined: USA, California, isolated from decaying, submerged leaves of *Acer* sp., culture on PDA, 19 June 1956, Ranzoni F.Z., IMI 63372 (i), (ii). There are no fruiting structures.

Notes: We were unable to locate the type material of *Flagellospora penicillioides*. The specimens we located (IMI 63372 (i), (ii)) were authentic materials deposited by F. Z. Ranzoni. However, there were no fruiting structures remaining on the substrate for the study.



Note (a) Ascoma. (b) Ascus. (c) Ascospores. (d, e) Upper part of the conidiophores with phialids and conidia. (f) Conidia. Scale bars: a = 50 µm, b, c = 20 µm, d–f = 50 µm.

Figure 2.40 *Aquanectria penicillioides* (a–d: redrawn from Ranzoni, 1956; e, f: redrawn from Ingold, 1944)

Chaetopsina Rambelli, Atti Accad. Sci. Ist. Bologna, Cl. Sci. Fis. Rendiconti 3: 5 (1956)

= *Chaetopsinectria* J. Luo & W.Y. Zhuang, Mycologia 102(4): 979 (2010)

Index Fungorum number: IF7584, Facesoffungi number: FoF10937

On leaves, bark, dead palm leaves or stromata of ascomycetes. **Sexual morph:** *Ascomata* perithecial, solitary, scattered or clustered in groups, sometimes associated with conidiophores of their asexual morph, astromatic, superficial, subglobose to obpyriform, apex acute or broadly obtuse, collapsing or not collapsing when dry, dark orange or red, KOH+ dark red or purple, LA yellow, ostiolate, surface smooth. *Ostiolar canal* periphysate. *Paraphyses* moniliform. *Asci* 4–6–8-spored, unitunicate, clavate, with or without an apical ring. *Ascospores* ellipsoid to fusiform or narrowly fusiform, 1-septate,

constricted or not constricted at septum, hyaline, smooth-walled to striate or spinulose, rarely with cyanophilous tips. **Asexual morph:** Hyphomycetous. *Conidiophores* sparse or abundant, macronematous, mononematous, erect, setiform or rarely not setiform, septate, tapering gradually towards acutely rounded apex, usually flexuous, yellow-brown to dark or pale reddish brown or brownish orange, KOH+ red-brown, fertile in mid region or apical or along the length of the main axis, usually unbranched or branched at tip or, rarely divergent, horizontal, sterile branches born in a whorl at or beneath the mid-point, base bulbous, thick-walled, verruculose. *Fertile region* consisting conidiogenous cells. *Conidiogenous cells* phialidic, ampulliform to lageniform, doliiform, cylindrical to subcylindrical, mono- to polyphialidic, terminal or lateral, irregularly branched, densely aggregated, hyaline or sometimes pale brown, smooth-walled. *Conidiation* enteroblastic without progression or holoblastic and irregularly sympodial. *Conidia* solitary, sub-cylindrical or fusiform or ellipsoid, sometimes catenate, straight or slightly curved, aseptate or very rarely 1-septate, usually bluntly rounded at apex and base, rarely with visible abscission scar, guttulate or eguttulate, hyaline, smooth-walled (Adapted from Kirk & Sutton, 1985; Lombard et al., 2015; Lechat & Fournier, 2019d, 2020a).

Known distribution: *Chaetopsina fulva*: cosmopolitan. Other species: tropical and neotropical areas (Lechat & Fournier, 2019d, 2020a).

Type species: ***Chaetopsina fulva*** Rambelli, i, Atti Accad. Sci. Ist. Bologna, Cl. Sci. Fis. Rendiconti 3: 5 (1956)

= *Nectria chaetopsinae* Samuels, Mycotaxon 22: 18. 1985.

= *Cosmospora chaetopsinae* (Samuels) Rossman & Samuels, Stud. Mycol. 42: 119. 1999.

= *Chaetopsinectria chaetopsinae* (Samuels) J. Luo & W.Y. Zhuang, Mycologia 102: 979. 2010.

Index Fungorum number: IF294735, Facesoffungi number: FoF10938, Figure 2.41

On *Cedrus deodara*. **Sexual morph:** Undetermined. **Asexual morph:** Hyphomycetous. *Conidiophores* 180–300 long × 7.5–10 µm wide, sparse, scattered, setiform, unbranched, septate, acute and tapered to the apex, bulbous at base, orange-brown, basal cell less pigmented at the base, KOH+ red-brown, thick-, smooth-walled. *Fertile region* in just below the middle of the main axis or higher, occasionally terminal,

consisting conidiogenous cells. *Conidiogenous cells* 6–10.5 long × 3.4–4.3 µm wide ($\bar{x}$ = 8.3 × 3.6 µm), phialidic, ampulliform to lageniform, irregularly branched, periclinal thickening visible, with minute collarettes, hyaline, thick-, smooth-walled. *Conidia* 9.9–12.3 × 1.1–1.6 µm ($\bar{x}$ = 10.8 × 1.4 µm), solitary, cylindrical, aseptate, straight, apex bluntly rounded, attenuated at base with an abscission scar, hyaline, thin-, smooth-walled.

Material examined: ITALY, on *Cedrus deodara*, A. Rambelli, IMI 62199, **holotype**.

Note (a) Herbarium material label. (b) Herbarium material. (c) Conidiophore on the substrate. (d, e) Conidiophore with conidiogenous cells. (f) Base of a conidiophore. (g) Conidia. Scale bars: c = 100 µm, e, f = 50 µm, g = 20 µm.

Figure 2.41 *Chaetopsina fulva* (IMI 62199, holotype)

Notes: Rambelli (1956) introduced a setiform dematiaceous hyphomycetes genus *Chaetopsina* based on *Chaetopsina fulva*. Luo and Zhuang (2010a) introduced *Chaetopsinectria* for *Chaetopsinectria chaetopsinae* and another three species that were

previously placed in *Cosmospora* with *Chaetopsina* asexual morphs. Later, *Chaetopsinectria* was religated to synonymy under the older name *Chaetopsina* by Lombard et al. (2015).

Chrysonectria Lechat & J. Fourn., in Lechat, Fournier & Priou, Ascomycete.org 10(4): 122 (2018)

Index Fungorum number: IF826765, Facesoffungi number: FoF10939

Corticolous, on bark of *Quercus robur*. **Sexual morph:** *Ascomata* perithecial, gregarious, astromatic, superficial, easily removed from substratum, partially immersed in a subiculum, globose to subglobose, apex papillate, not collapsing upon drying, pale orange, KOH+ upper third turning partially red, LA+ yellow, overlain by golden yellow hyphal elements except ostiolar region. *Peridium* 25–35 µm thick, of two strata. *Subiculum* made of thin-walled, septate hyphae proliferating upwards to cover ascomatal surface, golden yellow, KOH+ dark orange. *Asci* 8-spored, evanescent, cylindrical to fusiform, apically truncate, apex with a refractive apical ring. *Ascospores* 12–15 × 3–4 µm, irregularly biseriate, subfusiform to narrowly clavate, rounded at ends, equally 1-septate, 2–4 guttulate, hyaline, smooth-walled. **Asexual morph:** Acremonium-like. *Conidiophores* born on smooth hyphae, abandant, usually simple or sometimes branched, yellow. *Conidiogenous cells* subulate, collarette unflared. *Conidia* 2.5–4 × 2.5– 3 µm, subglobose to widely ellipsoidal, aseptate, symmetric or asymmetric, abscission scar not visible, hyaline to pale yellowish, smooth-walled, held masses (Adapted from Lechat, Fournier et al., 2018).

Known distribution: France (Lechat, Fournier et al., 2018)

Notes: Lechat, Fournier et al. (2018) introduced the monotypic genus *Chrysonectria* for *C. finisterrensis*. *Chrysonectria* is unified by phenotypic characters such as KOH+, LA+ pale orange ascomata, overlain by golden yellow hyphal elements and forming acremonium-like asexual morph (Lechat, Fournier et al., 2018). *Chrysonectria* has been placed in Nectriaceae based on LSU analysis and morphology. The genus resembles Nectriaceae in having soft textures, brightly coloured perithecia change colour in 3% KOH and LA (Lechat, Fournier et al., 2018).

Type species: ***Chrysonectria finisterrensis*** Lechat, J. Fourn. & Priou, Ascomycete.org 10(4): 122 (2018)

Index Fungorum number: IF826766, Facesoffungi number: FoF10940

Descriptions and illustrations: see Lechat, Fournier et al. (2018)

Cinnamomeonectria Salgado & P. Chaverri, in Salgado-Salazar, Rossman & Chaverri, Fungal Diversity 80: 451 (2016)

Index Fungorum number: IF816465, Facesoffungi number: FoF10941

On woody substrates of recently dead or decaying plants. **Sexual morph:** *Ascomata* (270–)350–550(600) μm, perithecial, often forming on bark cracks, superficial on an erumpent, white hyphal stroma, solitary to cespitose in groups of 4 or more, superficial, globose, apapillate, not collapsing when dry, ochreous to umber, with ostiolar area darker, chestnut, KOH-, LA yellow, surface highly warted. Warts forming cells circular to angular, easily dislodged. *Peridium* of three intergrading strata. *Asci* 90–100 × 16–25 μm, 8-spored, clavate, apex simple. *Ascospores* 22–38 × 8–12 μm, ellipsoid to fusiform, 1-septate, hyaline, slightly constricted at septum, hyaline, smooth-walled, surrounded by a wrinkled ochreous sheath. **Asexual morph:** *Conidiomata* cylindrocarpon-like. *Phialides* borne apically on irregularly branching clusters of cells or directly from hyphae, cylindrical or slightly swollen in the middle, periclinal thickening evident, with a collarette. *Microconidia* absent. *Macroconidia* cylindrical or slightly fusiform, curved, with more sharply curved ends, 3-septate. *Chlamydospores* globose, light brown when formed in culture, form singly or in chains (Adapted from Salgado-Salazar et al., 2016).

Known distribution: Tropical: French Guiana, Guyana, northern Brazil (Salgado-Salazar et al., 2016).

Notes: *Cinnamomeonectria* was introduced to accommodate *Nectria cinnamomea* (Salgado-Salazar et al., 2016). The genus is characterized by typical cinnamon coloured perithecia and cylindrocarpon-like asexual morph producing 3-septate macroconidia (Salgado-Salazar et al., 2016). *Cinnamomeonectria* clades within Nectriaceae closer to *Corallonectria* in the current phylogenetic analysis (Figure 2.38).

Type species: ***Cinnamomeonectria cinnamomea*** (Brayford & Samuels) Salgado & P. Chaverri, in Salgado-Salazar, Rossman & Chaverri, Fungal Diversity 80: 452 (2016)

Basionym: *Nectria cinnamomea* Brayford & Samuels, Mycologia 85(4): 617 (1993)

Index Fungorum number: IF816466, Facesoffungi number: FoF10942

Descriptions and illustrations: see Salgado-Salazar et al. (2016)

Corallomycetella Henn., Hedwigia 43(4): 245 (1904)

Index Fungorum number: IF1237, Facesoffungi number: FoF10943

Saprobic on woody plant material, including monocotyledons, sometimes isolated from soil. **Sexual morph:** *Ascomata* perithecial, solitary or gregarious, associated with rhizomorphs or synnemata, obpyriform, ostiolate, surface slightly scruffy, smooth around the ostiole, orange-red to red, KOH+ purple. *Peridium* cells *textura angularis* in vertical section, *textura globose* to *textura angular* in face veiw. *Asci* 8-spored, clavate to cylindrical, with an apical ring. *Ascospores* uniseriate or apically biseriate, ellipsoidal, 1-septate, constricted at the septum, hyaline to yellow-brown, finely striate. **Asexual morph:** *Conidiomata* rhizostilbella-like, synnematous. *Synnemata* solitary or gregarious, in clusters of 2–5, occur laterally or as terminal elongations of the rhizomorphs or directly from the substrate, cylindric-capitate, subulate-capitate, cylindrical, slender to robust, straight to curved to sinuous, unbranched or branched, hirsute, pale luteous to luteous, KOH+ red to purple. *Conidiophores* unbranched, or once simple monochasial or monoverticillate; sometimes forming simple, unbranched, acremonium-like conidiophores *in vitro*. *Conidiogenous cells* phialidic, cylindrical, terminal, collarettes not flared, periclinal thickening visible. *Conidia* ellipsoidal, ovoidal with a truncate base, aseptate, hyaline, smooth-walled. *Conidial masses* subglobose, white to yellow. *Marginal hyphae of synnemata* echinulate to verrucose, septate, with clavate terminal cells, covering the whole surface of stipe, pale luteous, KOH+ bright red. (Adapted from Rossman et al., 1999; Herrera et al., 2013; Lombard et al., 2015).

Known distribution: China, India, Indonesia (Herrera et al., 2013); Brazil, Colombia, Costa Rica, French Guiana, Germany, Nicaragua, Panama, Sri Lanka, Surinam, Venezuela (Rossman et al., 1999).

Notes: Hennings (1904b) introduced *Corallomycetella* based on *C. heinsenii* as the type. However, *Corallomycetella heinsenii* was religated to synonymy of *Corallomycetella repens* on the basis of morphological similarity (Rossman et al., 1999). *Corallomycetella repens* was originally based on *Sphaerostilbe repens* Berk. & Broome Currently there are two species in *Corallomycetella* (Rossman et al., 1999; Herrera et al., 2013). *Corallomycetella* species are somewhat similar to *Corallonectria*. However, *Corallomycetella* form rhizostilbella-like asexual morphs while *Corallonectria* has fusarium-like (Herrera et al., 2013).

Type species: ***Corallomycetella repens*** (Berk. & Broome) Rossman & Samuels, Studies in Mycology 42: 113 (1999)

Basionym: *Sphaerostilbe repens* Berk. & Broome, J. Linn. Soc., Bot. 14(no. 74): 114 (1873) [1875]

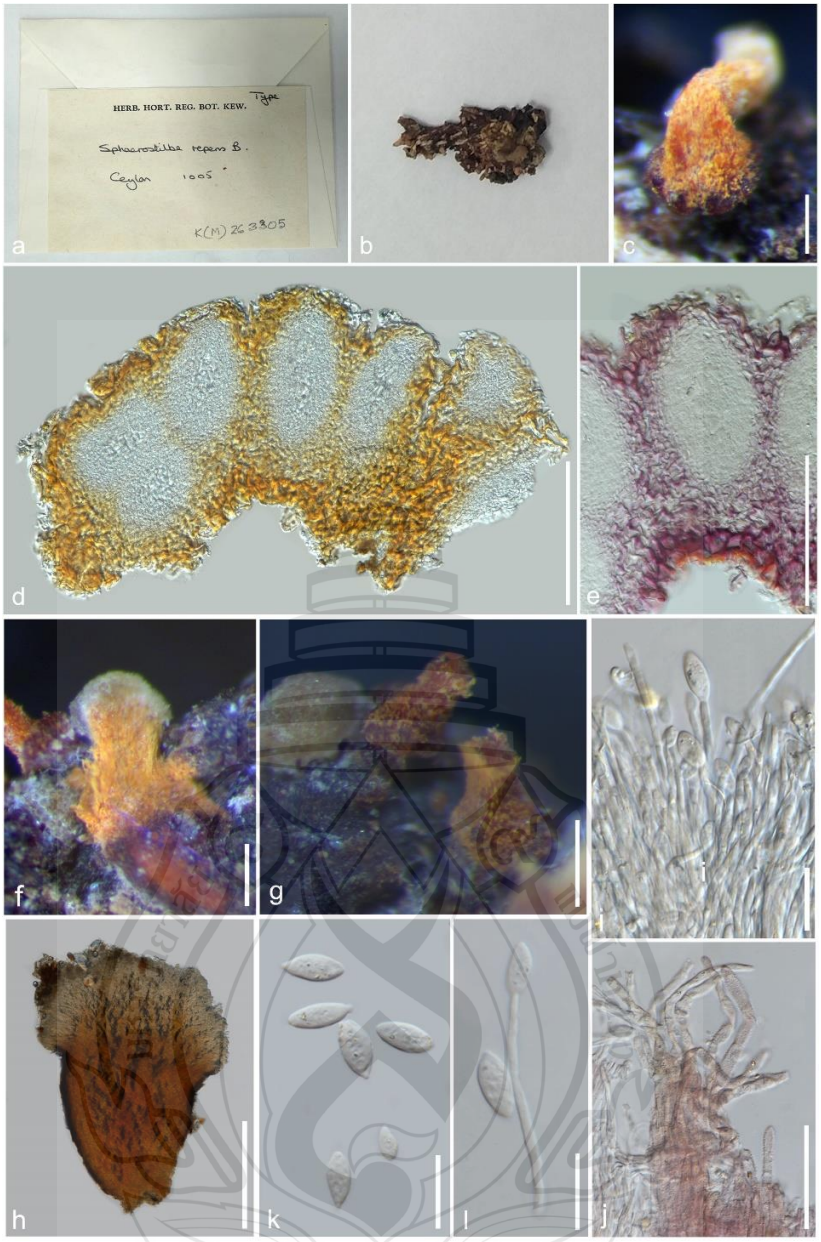
= *Corallomycetella heinsenii* (Henn.) Henn. [as 'heinesii'], Hedwigia 43(4): 245 (1904)

= *Corallomyces heinsenii* Henn., Bot. Jb. 23: 538 (1897)

Index Fungorum number: IF460217, Facesoffungi number: FoF10944, Figure 2.42

On decaying wood. **Sexual morph:** *Ascomata* 300–650 µm high × 250–450 µm, associated with rhizomorphs or synnemata, arranged in small clusters, obpyriform, orange red to red, KOH+ purple, papillate, ostiolate. *Peridium* 50–70 µm thick in vertical section, of single stratum made of orange red cells forming *textura angularis*, becoming compressed and thinner inwardly; *textura globulosa* to *textura angularis* in face veiw. *Asci* 185–220 µm × 8–9 µm, 8-spored, clavate to cylindrical, with an apical ring. *Ascospores* 14–21 µm × 5–9 µm uniseriate or apically biseriate, ellipsoidal, 1-septate, constricted at the septum, hyaline to yellow-brown, finely striate. **Asexual morph**: *Conidiomata* rhizostilbella-like, synnematous. *Synnemata* 250–8000 µm long × 75–375 µm diam., solitary, gregarious, densely crowded or in small clusters of 2–5, occur laterally or as terminal extensions of the rhizomorphs or directly from the substrate, cylindric-capitate, subulate-capitate, slender or robust, straight or curved, unbranched, orange to reddish brown, KOH+ purple. *Conidiophores* 80–200 µm long, 1.5–2.3 µm wide with rounded tips, unbranched, or once simple monochasial or monoverticillate. *Conidiogenous cells* 34–60 × (1.5–)2–3 µm, phyalidic, long, cylindrical, terminal, lateral and terminal, or in terminal whorls of 3, collarettes not flared, periclinal thickenings evident. *Conidia* (9–)12–20 × (3.5–)5–9 µm, white to pale yellow in mass, ellipsoid, ovoid, fusiform-ellipsoid, or oblong-ellipsoid, straight, often with a truncate base, hilum visible. *Marginal hyphae* septate, terminal cells clavate, covering the whole surface of the stipe, pale reddish brown, KOH+ purple to bright red, surface echinulate to verrucose. (Adapted from Rossman et al., 1999; Herrera et al., 2013).

Material examined: SRI LANKA (as Ceylon), Peradeniya, on decaying wood of *Artocarpus integrifolia*, August, Herb. Berkeley 1005, K(M) 263305, **holotype**.



Note (a) Herbarium material label. (b) Herbarium material. (c) Ascomata associated with a synnema. (d, e) Vertical section of immature ascomata (e in 3% KOH). f, g Synnema on the host. (h) Synnema mounted in water. (i) Conidiophores with conidia in 3% KOH. (j) Marginal hyphae in 3% KOH. (k, l) Conidia in 3% KOH (i with a conidiogenous cell). Scale bars: c = 200 µm, d, e = 100 µm, f–g = 200 µm, i = 20 µm, j = 50 µm, k, l = 20 µm.

Figure 2.42 *Corallomycetella repens* (K(M) 263305, holotype)

Notes: We found only immature ascomata associated with synnemata in specimen K(M) 263305.

Corinectria C. González & P. Chaverri, Mycol. Progr. 16(11-12): 1021 (2017)

Index Fungorum number: IF822856, Facesoffungi number: FoF10945

Saprobic, *hemibiotrophic*, *pathogenic* on bark of conifers. **Sexual morph:** *Ascomata* 200–400 μm diam., perithecial, gregarious in numbers of 200–300, stromatic, globose to subglobose, darker around ostiolar area, not collapsing upon drying, initially orange and red, become dark-red when mature, KOH+ black, yellow in lactic acid. *Stromats* erumpent through bark. *Peridium* up to 60 μm wide; outer stratum comprising of a palisade of oblong cylindrical cells, cells perpendicular to locule in face veiw. *Asci* 8-spored, cylindrical. *Ascospores* 1-septate, ellipsoidal, constricted or not at septum, guttulate, hyaline, smooth-walled. **Asexual morph:** *Conidiophores* from cultures simple or sparsely branched, producing microconidia or sporodochia (in the natural substrate), producing cylindrocarpon-like macroconidia. *Microconidia* aseptate, hyaline, formed in wet droplets. *Macroconidia* in white or pale-yellow masses, cylindrical, (3–)5–7-septate, typically 7-septate when mature, straight or somewhat curved, ends pointed or rounded, hyaline. *Chlamydospores* absent (Adapted from González & Chaverri, 2017).

Known distribution: Northern and Southern Hemispheres (González & Chaverri, 2017), Southeast Asia (Thailand) (this study).

Notes: González and Chaverri (2017) found thet the *Neonectria constricta*, *N. fuckeliana* and *N. tsugae* clade was distant from the *Neonectria sensu stricto* clade. Therefore, González and Chaverri (2017) established *Corinectria* to accommodate those taxa based on multigene phylogeny morphological differences and biology. Besides, *Corinectria* resembles *Nectria mammoidea*-group, which was described by Booth (1959) on the basis of perithecial wall anatomy (Chaverri et al., 2011). *Corinectria* species are restricted to coniferous hosts so far, and some pathogenic species are causing cankers (González & Chaverri, 2017).

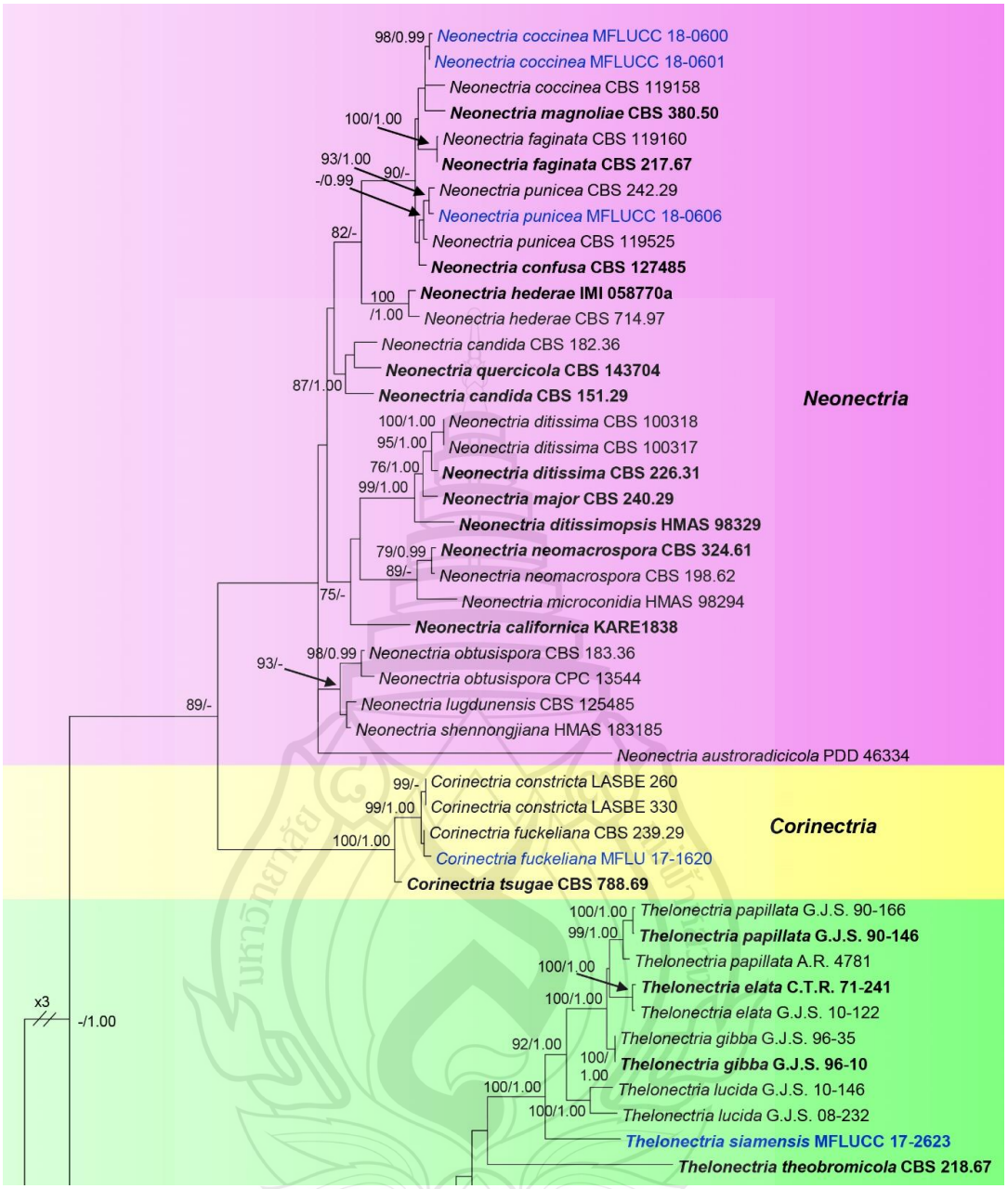
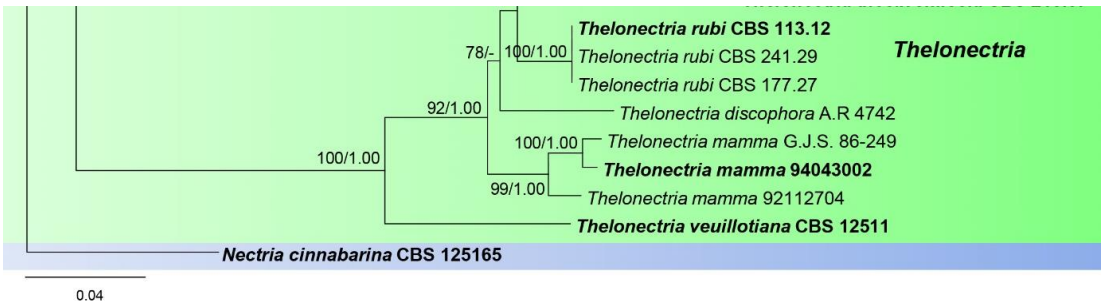


Figure 2.43 Phylogram generated from maximum likelihood analysis based on combined ITS, LSU, TUB2 and TEF1 sequence data of *Corinectria*, *Neonectria* and *Thelonectria* taxa



Note Fifty-four strains are included in the combined analyses, which comprised 3052 characters (ITS: 536, LSU: 810, TUB2: 634, TEF1: 1072), including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to *Thelonectria veuillotiana* CBS 12511. Ex-type strains are in bold. The newly generated sequences are indicated in blue. The scale bar indicates 0.04 nucleotide changes per site.

Figure 2.43 (continued)

Type species: ***Corinectria fuckeliana*** (C. Booth) C. González & P. Chaverri, Mycol. Progr. 16(11-12): 1023 (2017)

Basionym: *Nectria fuckeliana* C. Booth, Mycol. Pap. 73: 56 (1959)

= *Neonectria fuckeliana* (C. Booth) Castl. & Rossman, Can. J. Bot. 84 (9): 1428 (2006)

Index Fungorum number: IF822858, Facesoffungi number: FoF10946, Figure 2.44, 45

Saprobic, *Hemibiotrophic* or pathogenic (causing cankers), on bark of coniferous hosts. **Sexual morph:** *Ascomata* 255–400 μm ($\bar{x}$ = 312 μm) diam., perithecial, solitary or gregarious in numbers of 2–100, stromatic, broadly ellipsoid to globose, ostiolate, slightly papillate, not collapsing upon drying, surface smooth, shiny, initially orange and red, dark-red when mature, KOH+ purple. *Stromata* 1–2 mm diam., discrete, erumpent through bark. *Peridium* 50–85 μm thick, of three strata, outer stratum of elongate, thick-walled, pigmented cells arranged radially, 25–45 μm thick; middle stratum of elongate, thick-walled, hyaline to pigmented cells, 12–20 μm thick; inner stratum composed of several layers of angular, thin-walled, hyaline cells. *Paraphyses* present. *Asci* 90–120 ×

5.7–8.2 μm ($\bar{x}$ = 105 × 7 μm), 8-spored, unitunicate, cylindrical, apex rounded, with a J- apical ring. *Ascospores* (8.8–)11–15.3 × 4.4–6.2 μm ($\bar{x}$ = 13 × 5 μm), uniseriate to obliquely uniseriate or rarely biseriate, not overlapping, broadly fusiform to ellipsoidal, 1-septate, not constricted or sometimes slightly constricted at the septum, guttulate, hyaline, slightly verrucose when mature. **Asexual morph:** See Booth (1959).

Material examined: UKRAINE, Ivano-Frankivsk Region, Carpathian National Nature Park, Verkhovyna District, foot of the Pozhizhevs'ka Mountain, vicinities of High-altitude experimental station of the Institute of Ecology and Carpathians NAS of Ukraine, on recently dead, corticated branches still attached to the tree of *Picea abies* (L.) H. Karst. (Pinaceae), 07 August 2017, leg. det. A. Akulov, CWU (Myc) AS6493, MFLU 17-1620.

GenBank numbers: LSU: ON352627, ITS: ON361569

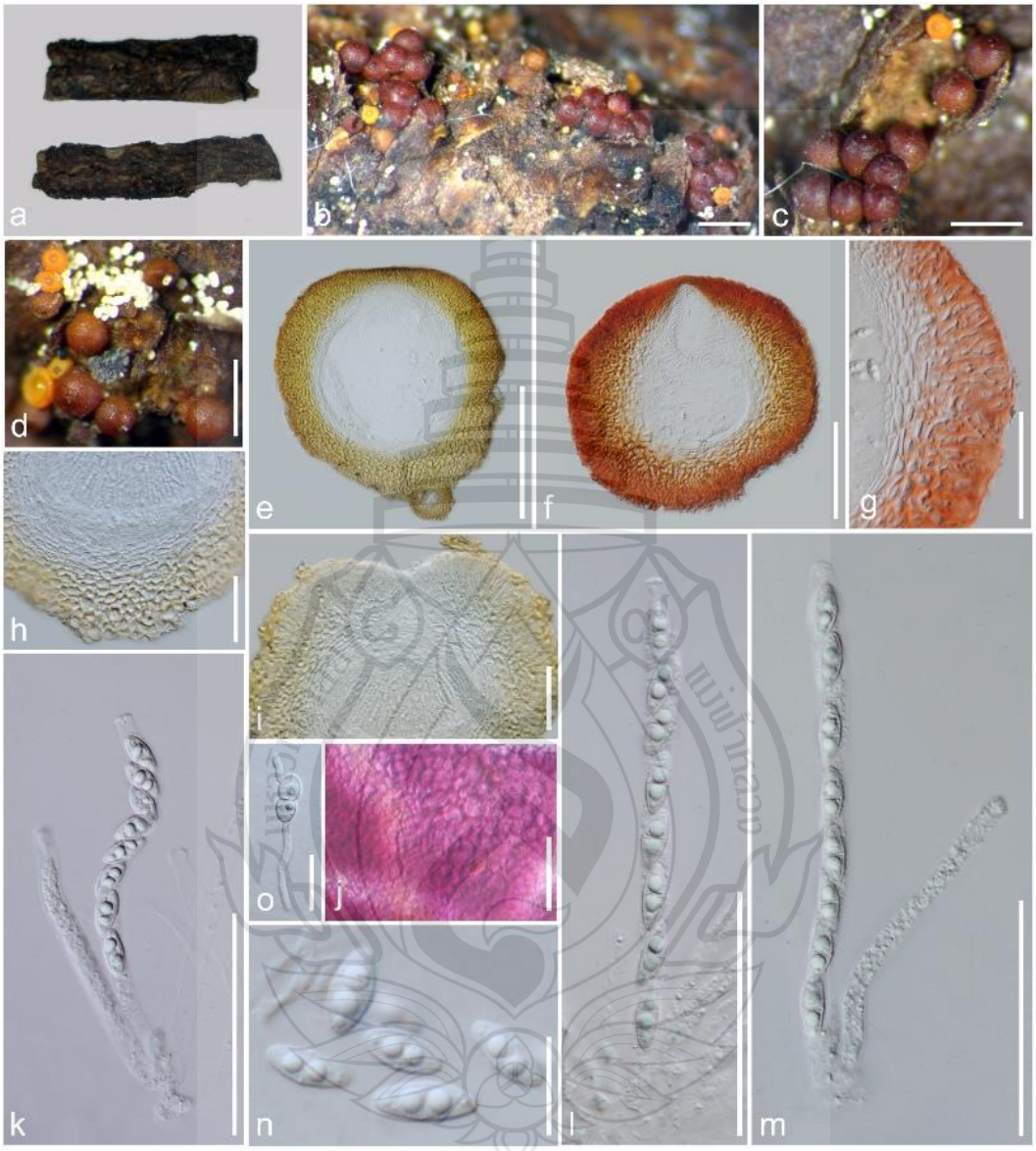
Notes: González and Chaverri (2017) proposed a new combination *Corinectria fuckeliana* for *Neonectria fuckeliana*. The asexual morph is redrawn based on Booth (1959).

Cosmosporella S.K. Huang, R. Jeewon & K.D. Hyde, in Huang et al., Cryptog. Mycol. 39(2): 179 (2018)

Index Fungorum number: IF554371, Facesoffungi number: FoF10947

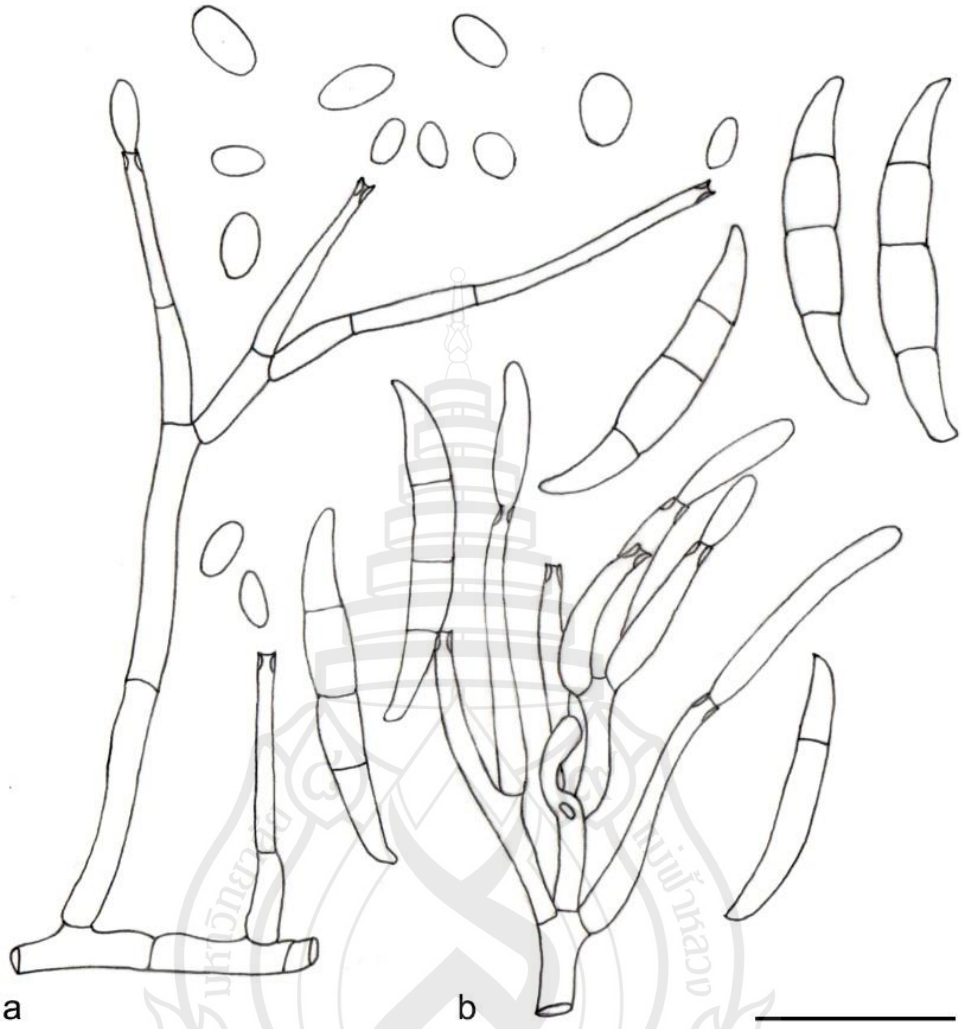
Saprobic on dead wood. **Sexual morph:** *Ascomata* perithecial, solitary to gregarious, superficial on host or on immersed to erumpent stroma, ovoid, globose to obpyriform or pyriform, collapsing laterally when dry, orange red, red to pale yellow, KOH+ reddish to purple (darker around ostiole), with a central ostiole. *Ostiolar canal* lined with hyaline periphyses. *Peridium* membranous, made of hyaline or orange or hyaline cells forming *textura angularis*. *Paraphyses* moniliform, hyaline. *Asci* 8-spored, unitunicate, cylindrical to slightly clavate, apex rounded, with an evanescent wall. *Ascospores* ellipsoidal to ovoid, 0- or 1-septate, hyaline to pale brown. **Asexual morph:** *Conidiomata* hyphomycetous. *Conidiophores* fusarium-like or acremonium-like, mononematous, septate, hyaline, forming lateral phialides on somatic hyphae, or with one or two levels of monochasial branching, or irregularly branched. *Conidiogenous cells* monophialidic, cylindrical, producing two types of conidia. *Microconidia* ellipsoidal to obovoid, 0–1-septate, hyaline. *Macroconidia* falcate, straight to curved, 1–3-septate, apical cell blunt to hooked; basal cell poorly to well-developed, foot-shaped. *Chlamydospores* lacking (Adapted from Huang et al., 2018; Crous et al., 2021).

Known distribution: France, New Zealand, China (Huang et al., 2018), Czech Republic, Norway (Crous et al., 2021)



Note (a) Herbarium material. (b–d) Appearance of ascomata on host substrate. (e, f) Transverse sections of ascomata. (g, h) Transverse sections of the peridium. (i) Transverse section of the ostiole. (j) Peridium in 3% KOH. (k–m) Asci. (n) Ascospores. (o) Germinating ascospore. Scale bars: b–d = 500 µm, e, f = 200 µm, g–m = 50 µm, n = 10 µm, o = 20 µm.

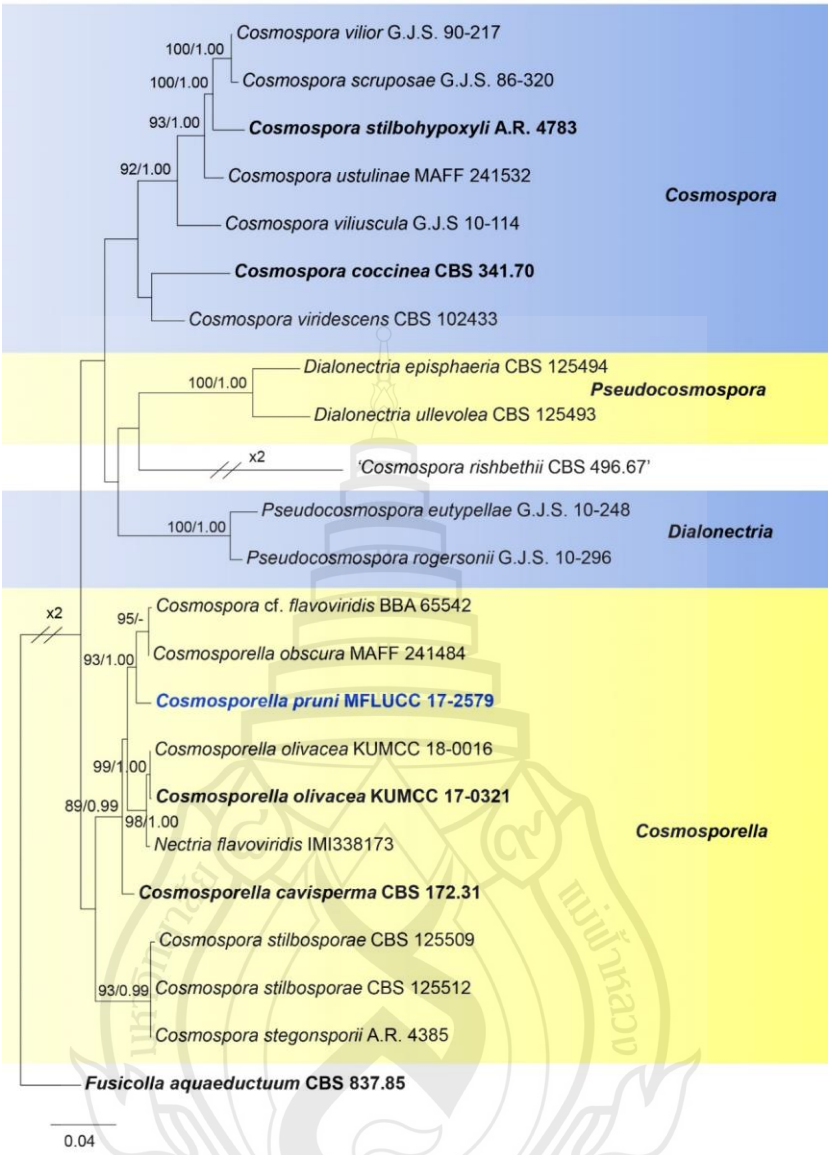
Figure 2.44 *Corinectria fuckeliana* (MFLU 17-1620)



Note (a) Microcnidiophores and microconidia. (b) Macrconidiophores and macroconidia. Scale bars: a, b = 20 µm.

Figure 2.45 *Corinectria fuckeliana* (Redrawn from Booth, 1959)

Notes: Huang et al. (2018) established *Cosmosporella* for *Cosmosporella olivacea* and *Cosmosporella obscura*. Those taxa were previously placed in *Cosmospora* (Rossman et al., 1999). Currently, there are three species in the genus including *Cosmosporella cavisperm* (Huang et al., 2018; Crous et al., 2021).



Note Twenty-two strains are included in the combined analyses, which comprised 3559 characters (ITS: 578, LSU: 792, TUB2: 642, RPB1: 691, RPB2: 856), including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to *Fusicolla aquaeductuum* CBS 837.85. Ex-type strains are in bold. The newly generated sequences are indicated in blue. The scale bar indicates 0.04 nucleotide changes per site.

Figure 2.46 Phylogram generated from maximum likelihood analysis based on combined ITS, LSU, TUB2, RPB1 and RPB2 sequence data of selected Nectriaceae taxa

Type species: ***Cosmosporella olivacea*** S.K. Huang et al., Cryptog. Mycol. 39(2): 181 (2018)

Index Fungorum number: IF554373, Facesoffungi number: FoF10948

Descriptions and illustrations: see Huang et al. (2018)

Cosmosporella pruni R.H. Perera, E.B.G. Jones & K.D. Hyde, *sp. nov*.

Index Fungorum number: IF559634, Facesoffungi number: FoF10949, Figure 2.47

Etymology: Name refers to the host genus *Prunus* from which it was collected.

Saprobic on *Prunus avium*. **Sexual morph**: *Ascomata* 185–270 × 150–230 μm ($\bar{x}$ = 222 × 193 μm, n = 6), perithecial, solitary to gregarious, superficial, oval to globose or pyriform, slightly papillate, collapsing laterally when dry, orange-red, KOH+ reddish to purple (darker around ostiole), surface shiny. *Ostioles* periphysate, ostiolar canal lined with hyaline periphyses. *Peridium* 25–80 μm thick., membranous, composed of two strata, cells becoming less pigmented towards the centrum: outer stratum made of 3–7 layers of globose to angular, dark orange, thick-walled cells, elongated around the ostiole; inner stratum made of 2–4 layers of hyaline, flattened, angular, thin-walled cells. *Apical paraphyses* up to 16 μm wide, moniliform, hyaline. *Asci* 63–100 × 6.3–9.5 μm ($\bar{x}$ = 86 × 8 μm, n = 25), 8-spored, unitunicate, cylindrical or sometimes narrowly clavate, apex truncate, apical ring J-. *Ascospores* 7.1–13.5 × 4.2–5.6 μm ($\bar{x}$ = 10.3 × 4.9 μm, n = 55), obliquely uniseriate, ellipsoid to oval, 1-septate, rounded at ends, slightly constricted at septum when mature, bi-guttulate or with several small guttules, hyaline, pale brown when mature, thick-, smooth-walled. **Asexual morph:** Undetermined.

Culture characteristics: Ascospores germinating on PDA within 24 hrs at 25°C. Colony on MEA becoming 3 cm diam. within 14 days at 25°C, circular, umbonate, filamentous, above yellow-green to olive-green, reverse greenish-brown to brown.

Material examined: ITALY, Forlì-Cesena Province, Fiumicello di Premilcuore, on fallen dead branch of *Prunus avium* (Rosaceae), 21 April 2017, Erio Camporesi, IT3322 (MFLU 17-0974, **holotype**), **ex-type** living culture MFLUCC 17-2579.

GenBank numbers: LSU: ON352628, ITS: ON361570, RPB1: ON364460, RPB2: ON364492, TEF1: ON364467, TUB2: ON364480.

Notes: *Cosmosporella pruni* clusters with *C. obscura* (MAFF 241484) and *Cosmospora* cf. *flavoviridis* (BBA 65542) in the phylogenetic tree, with high statistical

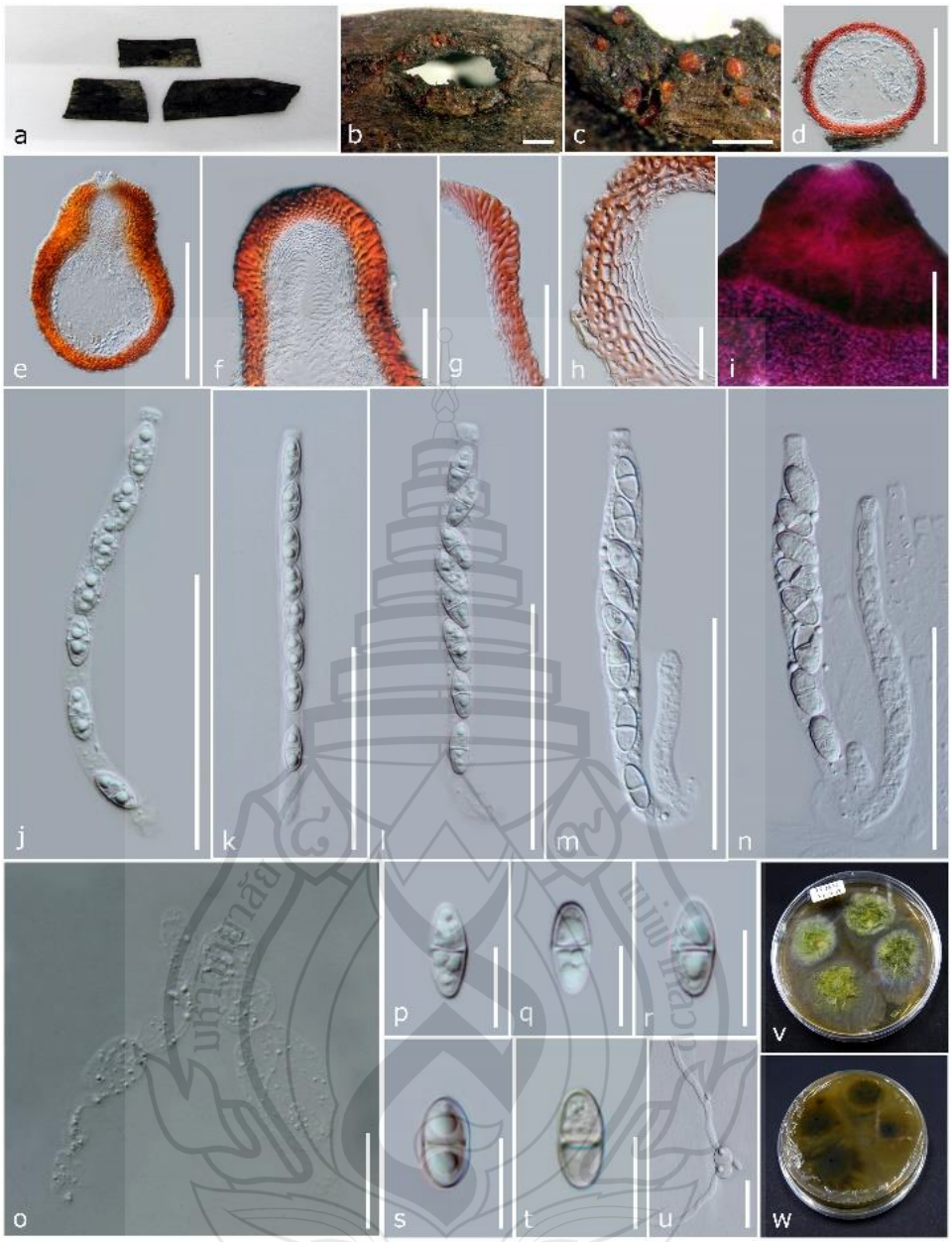
support (93% MLBT, 100% BYPP; Figure 2.46). Our collection (MFLU 17-0974) is typical of the genus *Cosmosporella* in having orange-red perithecia, cylindrical to narrowly clavate asci and pale brown, 1-septate ascospores (Crous et al., 2021). *Cosmosporella pruni* can be distinguished from *C. obscura* by orange-red ascomata changing colour in 3% KOH and, smooth-walled ascospores, while the latter species has pale yellow, KOH-negative ascomata and verrucose ascospores (Rossman et al., 1999). *Cosmosporella pruni* and *C. obscura* (MAFF 241484) showed 1 different nucleotide in the ITS region (0.2%, 0 gaps), 4 in LSU sequences (3.8%, 0 gaps), 13 in TUB2 sequences (2.4%, 0 gaps), and 17 in RPB1 sequences (2.5%, 2 gaps). *Cosmosporella pruni* differs from *Cosmosporella olivacea* having ascomata that changed colour in 3% KOH and smooth-walled, smaller ascospores, while latter species has KOH-negative ascomata and larger (7.1–13.5 × 4.2–5.6 μm vs 10–15 × 4–7 μm), verrucose ascospores (Huang. et al., 2018). We, therefore, introduce *Cosmosporella pruni* as a new species.

Curvicladiella Decock & Crous, Stud. Mycol. 55: 225 (2006)

Index Fungorum number: IF500866, Facesoffungi number: FoF10950

On decaying angiospermous leaves and seeds. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* hyphomycetous; sporodochial or synnematal, with conidiophores and sterile stipe extensions. *Conidiophores* numerous, penicillate; main axis thick-walled, smooth to finely verruculose, septate, medium to light brown, arising from a stroma of brown, thick-walled chlamydospores. *Conidiophore branches* sub-cylindrical, straight to slightly curved, hyaline, smooth-walled. *Sterile stipe extensions* apically 1(–2) septate, with one basal septum, nonvesiculate; apical cell strongly curved, tapering toward a bluntly rounded acute apex, light brown, thick-walled, verruculose. *Conidiogenous cells* phialidic, doliiform to reniform or sub-cylindrical, periclinal thickening minute, with an inconspicuous flared collarette, hyaline, smooth-walled. *Conidia* cylindrical, 1-septate, abscission scar not visible, occur in hyaline slimy heads. *Chlamydospores* intercalary, globose to elongate ellipsoidal, usually aggregating to form microsclerotia. (Adapted from Decock & Crous, 1998).

Known distribution. French Guiana (Decock & Crous, 1998), China (Lian-chai et al., 2022)



Note (a) Herbarium material. (b, c) Ascomata on host substrate. (d, e) Transverse sections of ascomata. (f) Transverse section of ostiole. (g) Elongated peridium cells around the ostiole in a transverse section. (h) Transverse section of peridium. (i) Ascoma in 3% KOH. (j–n) Asci. (o) Paraphyses. (p–t) Ascospores. (u) Germinating ascospore. (v, w) Colony on MEA. Scale bars: b = 1 mm, c = 500 µm, d, e = 200 µm, f, g = 50 µm, h = 20 µm, i = 100 µm, j–n = 50 µm, o = 20 µm, p–u = 10 µm.

Figure 2.47 *Cosmosporella pruni* (MFLU 17-0974, holotype)

Notes: The generic name *Curvicladium* Decock and Crous was invalidly published by Decock and Crous (1998), as it was already taken by a moss genus *Curvicladium* Enroth (1993). Hence, Crous et al. (2006) proposed *Curvicladiella* nom. nov for *Curvicladium*.

Type species: ***Curvicladiella cignea*** (Decock & Crous) Decock & Crous, in Crous et al., Stud. Mycol. 55: 225 (2006)

Basionym: *Curvicladium cigneum* Decock & Crous, Mycologia 90(2): 277 (1998)

Index Fungorum number: IF500867, *Facesoffungi number*: FoF10951, Figure 2.48

On decaying leaf of an angiosperm. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* hyphomycetous; sporodochial or synnematal. *Conidiophores* 50–100 µm long × 3–5 µm wide, numerous, penicillate; main axis thick-walled, smooth to finely verruculose, 2–5-septate, medium to light brown, arising from a stroma of brown, thick-walled chlamydospores. *Conidiophore branches* sub-cylindrical, 0(-1)-septate, straight to slightly curved, hyaline, smooth-walled; primary branches 15–30 × 4–5.5 ($\bar{x}$ = 24 × 4.6 µm), each producing 1–4 secondary branches; secondary branches 8–20 × 3.6–5 ($\bar{x}$ = 13.2 × 4.4 µm), each producing 1–3 tertiary branches; tertiary branches (4.3–)10–15 × 3–4 ($\bar{x}$ = 12.4 × 3.6 µm). *Sterile stipe extensions* 100–200 µm long, 1–4 per conidiogenous apparatus, apically 1(–2) septate, basally 1-septate, nonvesiculate; apical cell strongly curved, tapering toward a bluntly rounded acute apex, light brown, thick-walled, verruculose. *Conidiogenous cells* 6.3–18 × 2.7–5 µm ($\bar{x}$ = 11.7 × 3.7 µm), phialidic, doliiform to reniform or sub-cylindrical, periclinal thickening minute, with an inconspicuous flared collarette, hyaline, smooth-walled. *Conidia* 30–36 × 2.7–3.3 µm ($\bar{x}$ = 32.9 × 2.9 µm), cylindrical, 1-septate, abscission scar not visible, hyaline, smooth-walled, occur in hyaline slimy heads. *Chlamydospores* 8–20 µm long × 6–12 µm wide, globose to elongate ellipsoidal, medium brown to brown, thick-walled, usually aggregating to form microsclerotia.

Material examined: Dry culture derived from the holotype, 23 July 2014, MUCL 40269.

Cylindrodendrum Bonord., Handb. Allgem. mykol. (Stuttgart): 98 (1851)

Index Fungorum number: IF7873, Facesoffungi number: FoF10952

On plant parts including fruits and roots, sometimes on insect pupae. Sexual morph: Undetermined. Asexual morph: *Conidiophores* initially as lateral phialides on somatic hyphae, sometimes verticillate, hyaline. *Conidiogenus cells* monophialidic, elongate doliiform to reniform to obpyriform, with the terminal part frequently having a swollen tip, with a minute periclinal thickening, collarette inconspicuous. *Conidia* cylindrical, rounded at both ends, straight, 0–3-septate, abscission scars visible (Adapted from Lombard et al., 2015).

Known distribution: Canada, China, France (Lombard et al., 2014), UK (Petch, 1944), Spain (Agustí-Brisach et al., 2016)

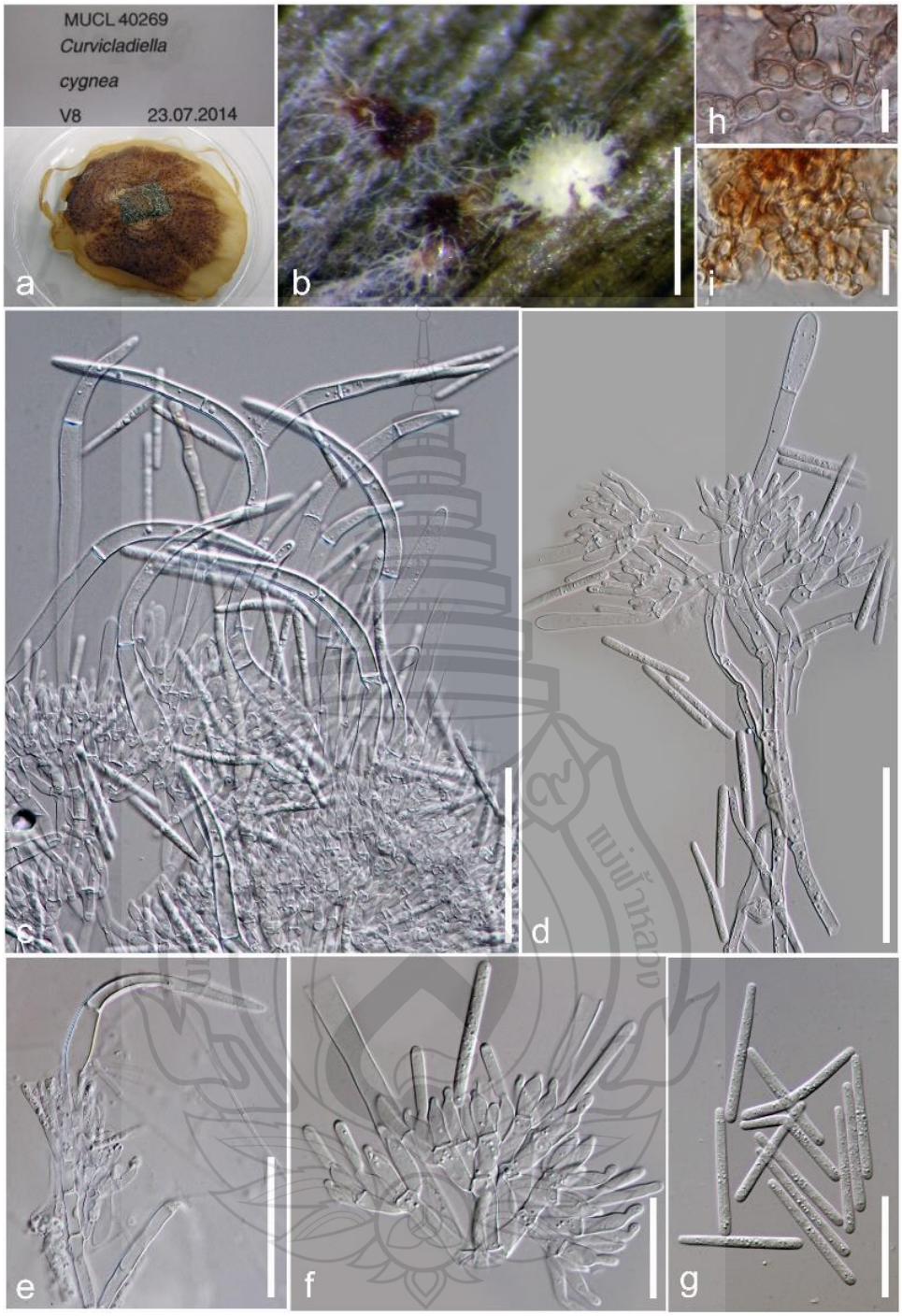
Notes: In the phylogenetic analysis by Lombard et al. (2015) *Cylindrodendrum* showed phylogenetic affinities to *Dactylonectria*, but in our study it formed a monophyletic clade sister to *Dactylonectria* and *Ilyonectria* (Figure 2.41).

Type species*:* ***Cylindrodendrum album*** Bonord., Handb. Allgem. mykol. (Stuttgart): 48 (1851)

Index Fungorum number: IF174041, Facesoffungi number: FoF10953, Figure 2.49

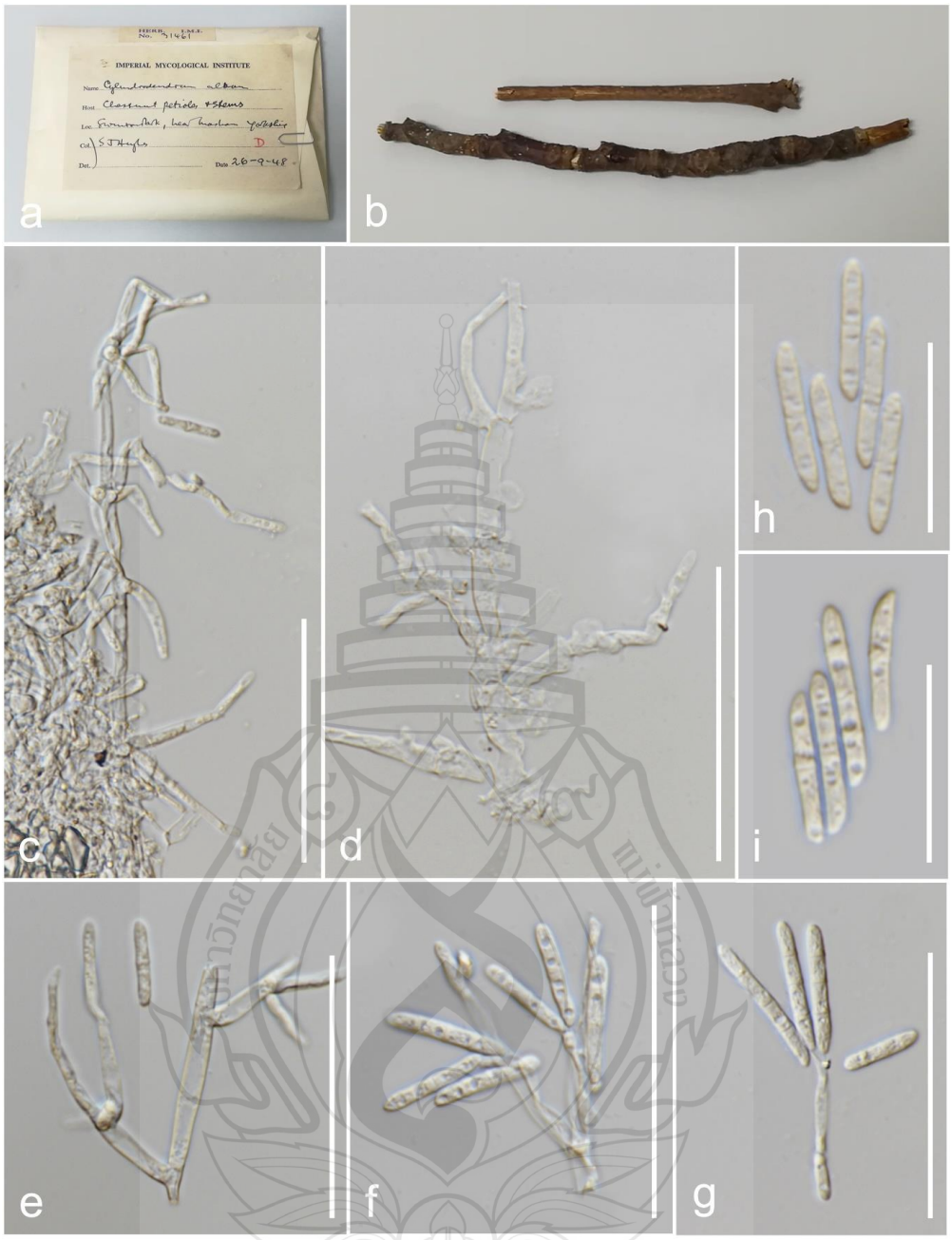
On petioles and stems of *Castanea sativa*. **Sexual morph:** Undetermined. **Asexual morph:** Hyphomycetous. *Colonies* white, scattered. *Mycelium* superficial, comprising hyaline, septate, smooth hyphae. *Conidiophores* hyaline, branched, sometimes verticillate, septate. *Conidiogenous cells* 12–30 µm high, 2.5–4 µm wide at the base, 1–2 µm wide at the apex, monophialidic, lageniform, integrated, lateral or terminal, occurring singly, in pairs, or in whorls of 2–3, cylindrical or subcylindrical, tapering towards the apex, straight or slightly curved, hyaline, smooth-walled. *Conidia* 14–24 µm × 2–3.5 µm ($\bar{x}$ = 18.4 × 3 µm, n = 35), cylindrical, rounded at both ends, 0–3-septate, very slightly constricted at the septum, hilum slightly laterally displaced, apex with minute periclinal thickening, collarets inconspicuous, straight, hyaline, smooth-walled.

Material examined: UK, Yorkshire, on petioles and stems of *Castanea sativa*, 26 September 1948, S. J. Hughes, IMI 31461.



Note (a) Herbarium material with label. (b) Sporulation on V8. (c) Stipe extensions. d Conidiophore with immature stipe extensions. (e) Conidiophore with a mature stipe extension. (f) Phialides with conidia. (g) Conidia. (h) Chlamydospores. i Stroma cells. Scale bars: b = 500 µm, c, d = 20 µm, e, f = 10 µm, g–i = 20 µm.

Figure 2.48 *Curvicladiella cignea* (MUCL 40269)



Note (a) Herbarium packet. (b) Herbarium material. (c–g) Conidiophores and conidiogenous cells. (h, i) Conidia. Scale bars: c–g = 50 µm, h, i = 20 µm.

Figure 2.49 *Cylindrodendrum album* (IMI 31461)

Fusarium Link, Mag. Gesell. naturf. Freunde, Berlin 3(1-2): 10 (1809)

= *Gibberella* Sacc. [as 'Giberella'], Michelia 1(no. 1): 43 (1877)

Index Fungorum number: IF8284, Facesoffungi number: FoF00149

Saprobic or *pathogenic* on herbaceous and woody plant substrates, some are animal pathogens, also isolated from soil, water, insects, dairy products, and human tissue. **Sexual morph:** Ascomata perithecial, usually gregarious, astromatic or on a thin stroma erumpent through the epidermis, superficial, subglobose to globose to broadly pyriform, apapillate, not collapsing upon drying, bluish purple to black, KOH+ dark purple, pigment dissolving in LA, surface slightly rugose to tuberculate, lacking hairs or appendages. *Peridium* of two strata: outer stratum of thick-walled, pigmented cells forming a *textura angularis* or *textura globulosa*; inner stratum of elongate, hyaline, thin-walled cells, becoming thinner towards the centrum. *Asci* 8-spored, unitunicate, clavate, with or without an apical ring. *Ascospores* biseriate to pluriseriate, ellipsoidal to cylindrical, 1–3- septate, not or slightly constricted at the septa, hyaline to pale yellow-brown, smooth-walled. **Asexual morph:** *Conidiomata* hyphomycetous. *Conidiophores* mononematous (aerial conidiophores) or forming sporodochia; aerial conidiophores, if consistenly formed, unbranched, sympodial or irregularly branched, producing terminal or lateral phialides, often reduced to single phialides. *Conidiogenous cells* mono- or polyphialidic, subulate to subcylindrical, sometimes proliferating percurrently, periclinal thickening inconspicuous or absent, smooth- and thin-walled. *Aerial conidia* hyaline, smooth- and thin-walled, of three types: microconidia ellipsoidal to fusoid to ovoid to obovoid to reniform to allantoid to clavate to napiform to pyriform to limoniform, 0–5-septate, held in false heads or chains on the phialides; mesoconidia (producing in some species or species complexes) falcate, slender with no significant curvature to curved with parallel walls, 1–5-septate, tapering towards both ends, with a pointed to blunt apical cell and obtuse to flattened basal cell; macroconidia, typically occur on sporodochia, falcate, slightly to strongly curved dorsiventrally, 1-septate to multi-septate, with a curved, long and tapering, pointed, blunt, hooked or elongated apical cell and obtuse, poorly developed, well-developed, to elongate, foot-shaped basal cell. *Sporodochia* cream to pale tan to orange to saffron to blue. *Sporodochial conidiophores* verticillately branched, densely packed, comprising of short, smooth- and thin-walled stipes producing an apical whorl of 2–4 monophialides. *Sporodochial conidiogenous cells* phialidic, subulate to

subcylindrical, with reduced or flared collarette, smooth- and thin-walled. *Sporodochial (macro)conidia* falcate, smooth- and thin-walled, distinctly curved to curved with parallel walls to unequally curved, tapering to both ends, with pointed, blunt, papillate, hooked, or elongate apical cell and obtuse, poorly developed, well-developed, to elongate, foot-shaped basal cell. *Chlamydospores* present or absent, terminal or intercalary, solitary or in pairs or forming chains or aggregating to form microsclerotia, when present globose to subglobose to ovoid to obovoid, hyaline to subhyaline, smooth-walled to slightly verrucose (Adapted from Crous et al., 2021).

Known distribution: Worldwide (Rossman et al., 1999; Booth, 1971)

Notes: *Fusarium* was segregated into seven genera, and species in *Fusarium solani* species complex (FSSC) were transferred to *Neocosmospora* by Lombard et al. (2015). However, assigning taxa of FSSC to *Neocosmospora* has been opposed by some authors (Geiser et al., 2020; O'Donnell et al., 2020). Geiser et al. (2020) performed phylogenomic calculations of a 55.1 kb, 19- protein-coding gene dataset to assess the monophyly of *Fusarium* which supported the broad *Fusarium* concept. Nonetheless, Crous et al. (2021) revisited the fusarioid taxa in Nectriaceae based on detailed morphological characterization along with multi-locus phylogeny and, secondary metabolites data. They accepted 27 fusarioid genera including three new genera in Nectriaceae (Crous et al., 2021). The multi-gene analysis in this study supports the findings of Crous et al. (2021) (Figure 1.38).

Type species: ***Fusarium sambucinum*** Fuckel, Jb. nassau. Ver. Naturk. 23-24: 167 (1870) [1869-70]

= *Fusarium roseum* Link, Mag. Gesell. naturf. Freunde, Berlin 3(1-2): 10 (1809)

Index Fungorum number: IF 161187, Facesoffungi number: FoF03129, Figure 2.50

On dead branches of *Sambucus nigra*. **Sexual morph:** See Rossman et al. (1999) **Asexual morph:** *Mycelium* white. *Conidiomata* sporodochial, appearing as pale tan to orange masses on the host surface. *Conidiophores* 19–35 µm long × 3.2–4 µm (n = 8) wide, hyaline, verticillately branched and densely packed, comprising short, smooth- and thin-walled stipes, whorl of 2–4 monophialides bearing at the apex. *Conidiogenous cells* 11–18.5 × 3.1–4.8 (n = 15) µm, phialidic, cylindrical, periclinal thickening evident, with inconspicuous collarette, hyaline, smooth- and thin-walled. *Conidia* 12–34 × 3.6–5.1 µm

(n = 20), (0–)1–3-septate, not constricted at the septum, sub-fusiform, tapering to both ends, tip cell more or less hooked, with a pedicellate foot-cell, hyaline, thin-, smooth- and thin-walled.

Material examined: GERMANY, Hessen, on dead branches of *Sambucus nigra*, Fuckel K.W.G., Fungi Rhen. Exs. 211, G00266369, **lectotype**.

Notes: *Fusarium sambucinum* was originally described by Fuckel (1863). The genus *Fusarium* was established by Link (1809) based on the single species *Fusarium roseum*. Gams et al. (1997) proposed to conserve the best-known and well typified name *Fusarium sambucinum* over *Fusarium roseum* and several other synonyms.

Fusicolla Bonord., Handb. Allgem. mykol. (Stuttgart): 150 (1851)

Index Fungorum number: IF8294, Facesoffungi number: FoF10954

Saprobic, associated with soil, soil plant matter, woody substrates including seed pods, slime flux of trees, occasionally *fungicolous* on stromata of other fungi, isolated from flowing water. **Sexual morph:** *Ascomata* 100–200 μm high, perithecial, fully or partially immersed in stroma, scattered to gregarious, or arrange in small groups, globose to pyriform, papilla short acute or disk-like, surface smooth, yellow, pale buff to orange, KOH-. *Ostioles* periphysate. *Stromata* erumpent, slimy, pale orange, composed of sheet of hyphae over the substrate. *Asci* 8-spored, unitunicate, cylindrical to narrowly clavate, with an apical ring, J-. *Ascospores* uniseriate, 1-septate, hyaline to pale brown, smooth or becoming slightly verrucose. **Asexual morph:** *Conidiomata* fusarium-like. *Conidiophores* initially occurring as lateral phialides on somatic hyphae, sometimes monochasial, verticillate or penicillate, hyaline. *Conidiogenous cells* phialidic, monophialidic, cylindrical to subulate, hyaline. *Microconidia* lacking or very rare, ellipsoidal to allantoid, aseptate, hyaline, form two types of conidia. *Macroconidia* falcate, mostly 1–3-septate or 3–5-septate or sometimes up to 10- septate, straight to curved, tapering towards the ends, hyaline, apical cell often hooked with a pointed tip, basal cell slightly pedicellate. *Chlamydospores* absent or present, globose, occur singly, arrange in pairs or chains, sometimes in macroconidia (adapted Gräfenhan et al., 2011 and Lombard et al., 2015).

Note (a) Herbarium material label. (b) Herbarium material. (c) Conidiomata on the host. (d–f) Conidiophores with conidia. (g–m) Conidia. Scale bars: c = 500 µm, d = 50 µm, e, f = 20 µm, g–m = 10 µm.

Figure 2.50 *Fusarium sambucinum* (G00266369, lectotype)

Known distribution: Worldwide (Gräfenhan et al., 2011; Jones et al., 2020; Dayarathne et al., 2020; Perera et al., 2020)

Notes: *Fusicolla* was treated as a synonym of *Fusarium* (Wollenweber, 1916). Gräfenhan et al. (2011) reinstated the genus designating a lectotype for the type species

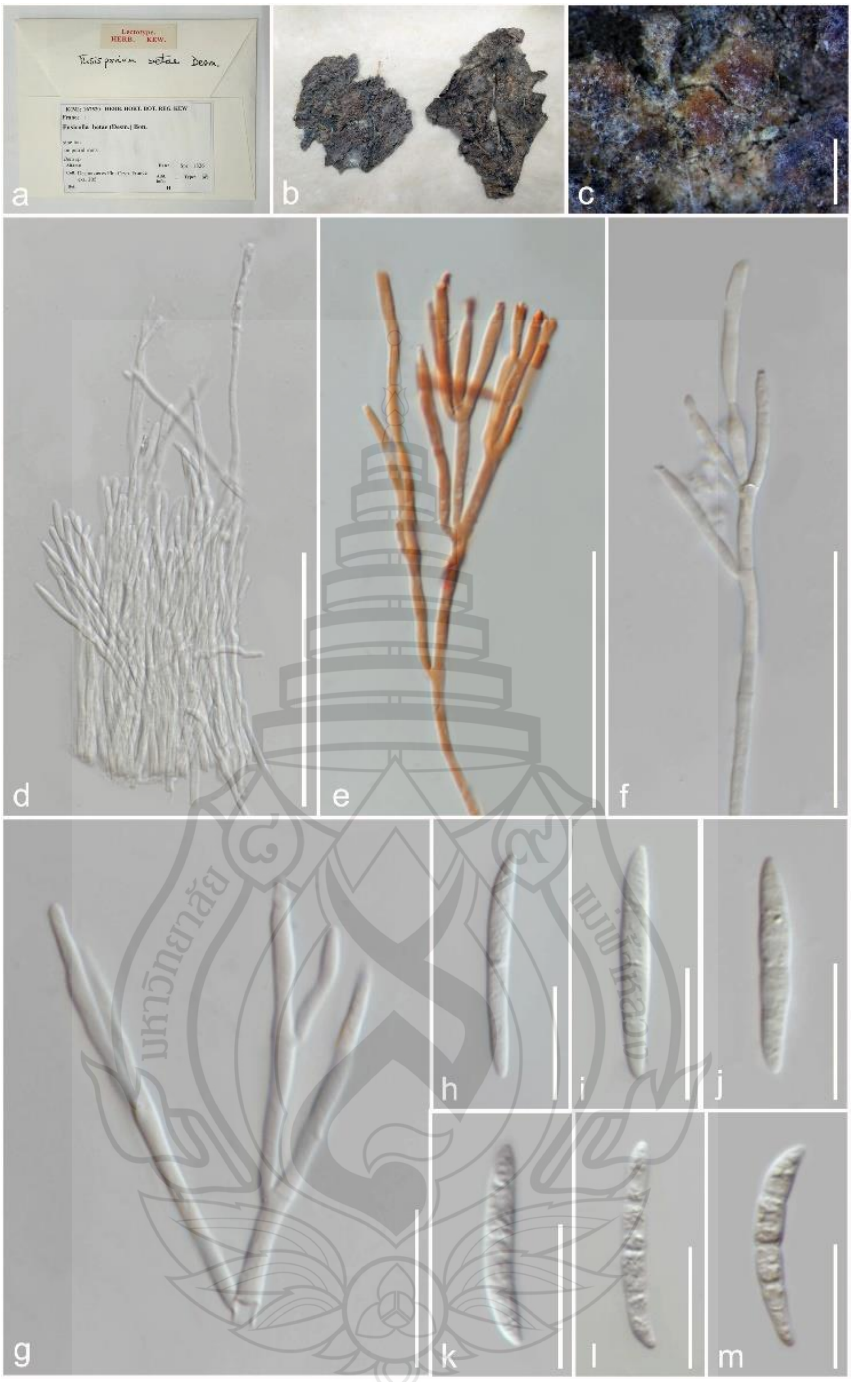
Fusicolla betae. *Fusicolla* can be distinguished from *Fusarium* from their *y*ellow to orange, perithecia, while dark blue to black perithecia are produced in *Fusarium* (Crous et al., 2021).

Type species: ***Fusicolla betae*** Bonord., Handb. Allgem. mykol. (Stuttgart): 150 (1851)

Index Fungorum number: IF192559, Facesoffungi number: FoF10955, Figure 2.51

On tuber of *Beta vulgaris*. **Sexual morph:** Undetermined. **Asexual morph**: Colonies on the host appearing as brownish orange, irregularly or irregularly rounded patches with yellowish or white margins. *Conidiomata* fusarium-like, hyphomycetous, sporodochial. *Sporodochia* brownish orange. *Conidiophores* up to 220 µm tall, 2.4–3.5 µm wide, densely packed, straight or curved, stipes branched, monochasial, verticillate or penicillate, hyaline, smooth-walled, bearing apical whorls of 1–3 phialides. *Conidiogenous cells* 9–41 × 2–4 µm, lateral or terminal, monophialidic, cylindrical to subulate, slightly tapering toward the apex, with a visible periclinal thickening, collarettes inconspicuous, hyaline, thin- and smooth-walled. *Microconidia* absent. *Macroconidia* 30–37 × 3.5–5.2 µm, falcate, 1–3-septate, straight or slightly to clearly curved, slightly tapering toward each end, apical cell often hooked with a more or less pointed tip, basal cell slightly pedicellate, hyaline, thin- and smooth-walled. Chlamydospores absent.

Material examined: FRANCE, on tuber of *Beta vulgaris*, spring 1826, Desmazières, K(M) 167520, **lectotype**.



Note (a) Herbarium material label. (b) Herbarium material. (c) Sporodochium on the host. (d–g) Conidiophores with conidiogenous cells. (h–m) Conidia. Scale bars: c = 1 mm, d = 100 µm, e, f = 50 µm, g–m = 20 µm.

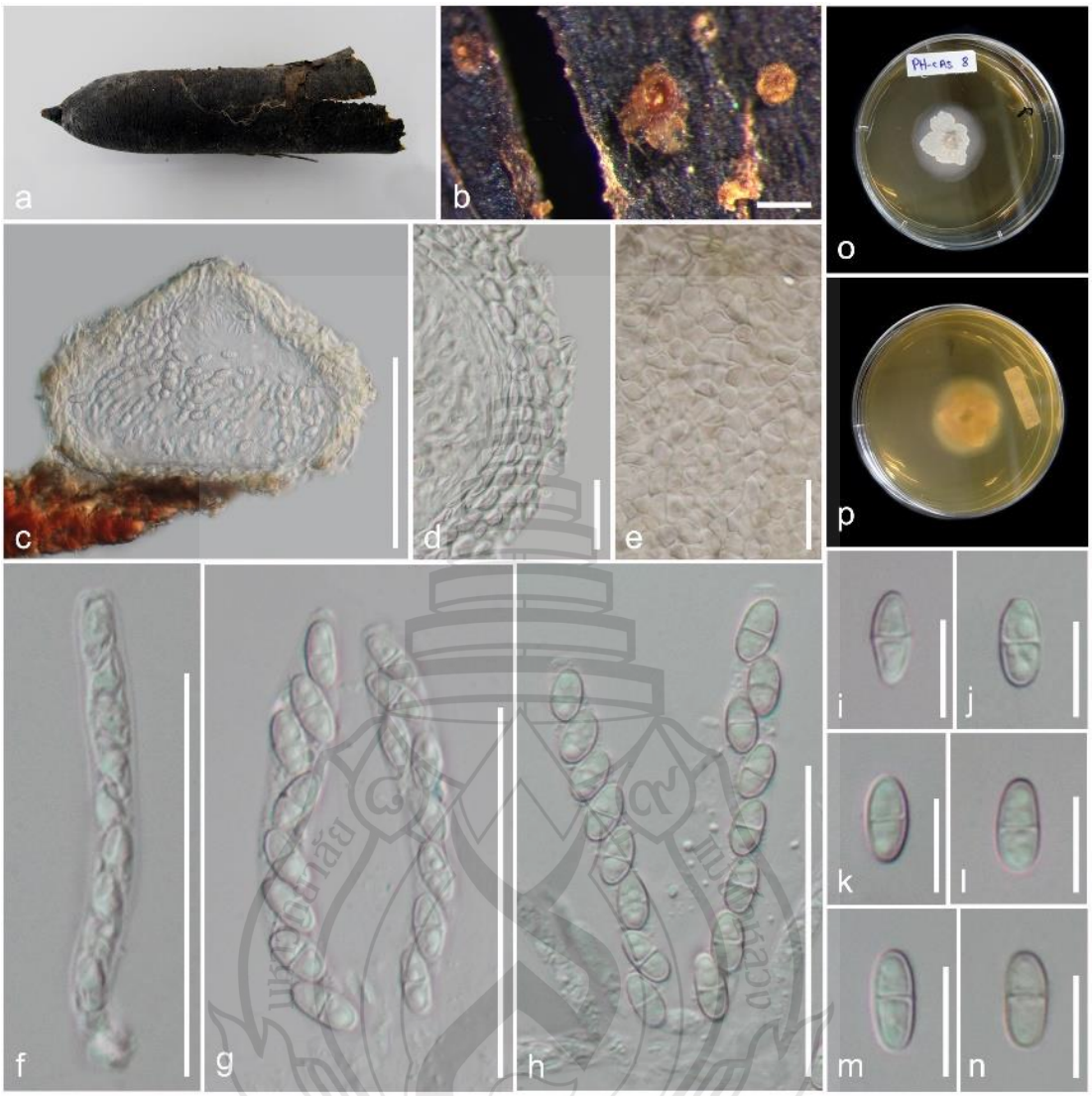
Figure 2.51 *Fusicolla betae* (K(M) 167520, lectotype)

Fusicolla cassiae-fistulae R.H. Perera, E.B.G. Jones & K.D. Hyde, in Perera et al., Mycosphere 11(1): 2146 (2020)

Index Fungorum number: IF556858, Facesoffungi number: FoF07760, Figure 2.52

Saprobic on decaying wood and seed pods of *Cassia fistula*. **Sexual morph:** *Ascomata* 130–180 µm diam., perithecial, seated on an erumpent stroma, scattered or in small groups of 3–8, globose to pyriform, sometimes collapsing upon drying, yellow, pale yellow to pale orange, KOH-, surface smooth. *Ostioles* lined with periphyses, with a broadly conical, rounded ostiolar neck. *Peridium* cells forming a *textura angularis* to *textura globulosa* in face view, 15–30 µm wide in vertical section, two strata: outer stratum composed of 3–4 layers of hyaline to pale brown, thick-walled cells of *textura angularis* to *textura globulosa*; inner stratum composed of 2–3 layers of hyaline cells of *textura angularis*. *Asci* 54–65 × 5.8–8 µm ($\bar{x}$ = 57 × 6.5 µm, n = 20), 8-spored, unitunicate, cylindrical to narrowly clavate, short pedicellate, apex flat, apical ring J-, lying without paraphyses. *Ascospores* 7–10.5 × 3.5–4 µm ($\bar{x}$ = 8.6 × 3.7 µm, n = 30), uniseriate, 1-septate, not constricted at the septum, ellipsoidal, rounded at ends, equilateral or inequilateral, guttulate, hyaline to very pale brown, thick-walled, smooth and slightly verrucose. **Asexual morph:** Undetermined.

Material examined: THAILAND, Phayao Province, on decaying seed pods of *Cassia fistula* (Fabaceae), 4 August 2017, R.H. Perera, PH-CAS 08 (MFLU 18-2753, **holotype**).



Note (a) Herbarium material. (b) Ascomata on host. (c) Vertical section of ascomata. (d) Vertical section of peridium. (e) Face view of peridium. (g–h) Asci. (i–n) Ascospores. (o, p) Colony on PDA. Scale bars: b = 200 µm, c = 100 µm, d, e = 20 µm, f–h = 50 µm, i–n = 10 µm.

Figure 2.52 *Fusicolla cassiae-fistulae* (MFLU 18-2753, holotype)

Geejayessia Schroers, Gräfenhan & Seifert, in Schroers, Gräfenhan, Nirenberg & Seifert, Stud. Mycol. 68: 124 (2011)

Index Fungorum number: IF519479, Facesoffungi number: FoF10956

On dead or decaying plant parts, mainly on branches or twigs. *Stromata* erumpent, of densely arranged hyphae, byssoid or densely prosenchymatous, giving rise to ascomata or sporodochia. **Sexual morph:** *Ascomata* perithecial, seated on or with base partly immersed in stroma, solitary or cespitose in groups of five or more, pyriform, subglobose to globose or broadly ellipsoidal, with a short neck, collapsing laterally when dry, pale orange, brownish to reddish orange, surface smooth, rarely smooth to warted, pale orange, brownish to reddish orange, bright red or black, KOH+ dark purple red, LA+, (black ascomata hardly reacting with KOH and LA). *Peridium* of 1 or 2 strata. *Paraphyses* moniliform. *Asci* (4–6–7–)8-spored, cylindrical, subcylindrical or clavate, apex broadly rounded or flattened, with or without a minute refractive ring. *Ascospores* obliquely uniseriate or biseriate above and uniseriate below, broadly ellipsoidal or ellipsoidal, 1-septate, slightly constricted at the septum, hyaline to pale brown or yellowish brown, smooth-walled or verruculose when mature. **Asexual morph:** *Conidiomata* fusarium-like. *Conidiophores* simple or sporodochial. *Conideogenous cells* monophialidic, polyphialidic. *Microconidia* usually absent, when present clavate or oblong ellipsoidal, aseptate, straight or gently curved, rounded at both ends or acute at the base, hyaline. *Macroconidia* formed in white to pale yellow slimy masses, gently curved, with a pedicellate foot cell, and more or less inequilaterally fusoid, hooked apical cell. *Chlamydospores* absent (Adapted from Schroers et al., 2011; Lombard et al., 2015).

Known distribution: China (Zeng & Zhuang, 2018), North America (Canada), New Zealand, Slovenia, Europe (Belgium, France, Germany, Italy, Spain, UK) (Lechat & Fournier, 2017b, 2021; Schroers et al., 2011).

Notes: Schroers et al. (2011) established *Geejayessia* to accommodate *Nectria cicatricum* and three other species previously treated in *Nectria* and/or *Cosmospora* and further added one new species. The existence of *Geejayessia* was questioned by Geiser et al. (2013) due to *Geejayessia* species nesting within the *Fusarium* clade in their phylogenetic analysis. Furthermore, the fusarium-like asexual morphs produced by *Geejayessia* species also supported their findings. However, the species concept of *Geejayessia* was accepted by subsequent authors (Lombard et al., 2015; Lechat & Fournier, 2017b, 2021; Zeng & Zhuang, 2018). Here we identify *Geejayessia* as a distinct genus, which clades distant to *Fusarium* and is sister to the *Neocosmospora* clade in present phylogenetic analysis (Figure 2.38).

Type species: ***Geejayessia cicatricum*** (Berk.) Schroers, in Schroers et al., Stud. Mycol. 68: 124 (2011)

Basionym: *Sphaeria sanguinea* var. *cicatricum* Berk., Mag. Zool. Bot. 1: 48 (1837)

= *Nectria cicatricum* (Berk.) Tul. & C. Tul., Select. fung. carpol. (Paris) 3: 77 (1865)

Index Fungorum number: IF519481, Facesoffungi number: FoF10957, Figure 2.53

Saprobic on decaying twigs. **Sexual morph**: *Stromata* erumpent through the host substrate, composed of hyaline prosenchymatous cells. *Ascomata* 160–220 µm high, 170–250 µm diam., aggregated in small to large numbers, superficial to slightly immersed in stromata, perithecial, broadly ellipsoidal or broadly ampulliform with a short neck, bright red, KOH+ deep violet, ostiolar area concolourous. *Peridium* comprising two strata in vertical section, outer stratum 20–27.5 µm wide, composed 3–5- layers of thick-walled, orange cells of *textura angularis* to *textura epidermoidea*; inner stratum 7–9.5 µm wide, made up of thin-walled, compressed, hyaline cells. *Asci* cylindrical to clavate, hyaline, *Ascospores* broadly ellipsoidal to ellipsoidal, equally 1-swptate, slightly constricted at septum, verruculose, hyaline or pale brown (Ascospores morphology adapted from Schroers et al., 2011) **Asexual morph:** See Schroers et al. (2011).

Material examined: Sine loco, on stems of ?*Buxus sempervirens*, ex herb. M.J. Berkeley, K(M) 160064, **isotype of *Sphaeria sanguinea* var. *cicatricum***.

Notes: Ascomata in herbarium specimen K(M) 160064 are immature and we did not observe ascospores there. Geiser et al. (2013) considered *Geejayessia cicatricum* as a synonymy of *Fusarium cicatricum* based on their phylogenetic analysis. However, our study showed that *Geejayessia cicatricum* is distatnt from *Fusarium* species and groups with *Geejayessia celtidicola* (Figure 2.38).

Note (a) Herbarium packet. (b) Herbarium material. (c) Ascomata on host. (d–f) Vertical sections of ascomata. (g) Vertical section of peridium in 3% KOH. (h) Face view of peridium. (i) Immature asci. Scale bars: d = 200 µm, e = 100 µm, f = 20 µm.

Figure 2.53 *Geejayessia cicatricum* (K(M) 160064, isotype of *Sphaeria sanguinea* var. *cicatricum*)

Geejayessia zealandica (Cooke) Schroers, in Schroers, Gräfenhan, Nirenberg & Seifert, Stud. Mycol. 68: 133 (2011)

Basionym: *Nectria zealandica* Cooke, Grevillea 8(no. 46): 65 (1879)

≡ *Cosmospora zealandica* (Cooke) Samuels & Nirenberg, in Nirenberg & Samuels, Can. J. Bot. 78(11): 1483 (2000)

= *Cucurbitaria zelandica* (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3(3): 462 (1898)

= *Fusarium zealandicum* Nirenberg & Samuels, Can. J. Bot. 78(11): 1483 (2000)

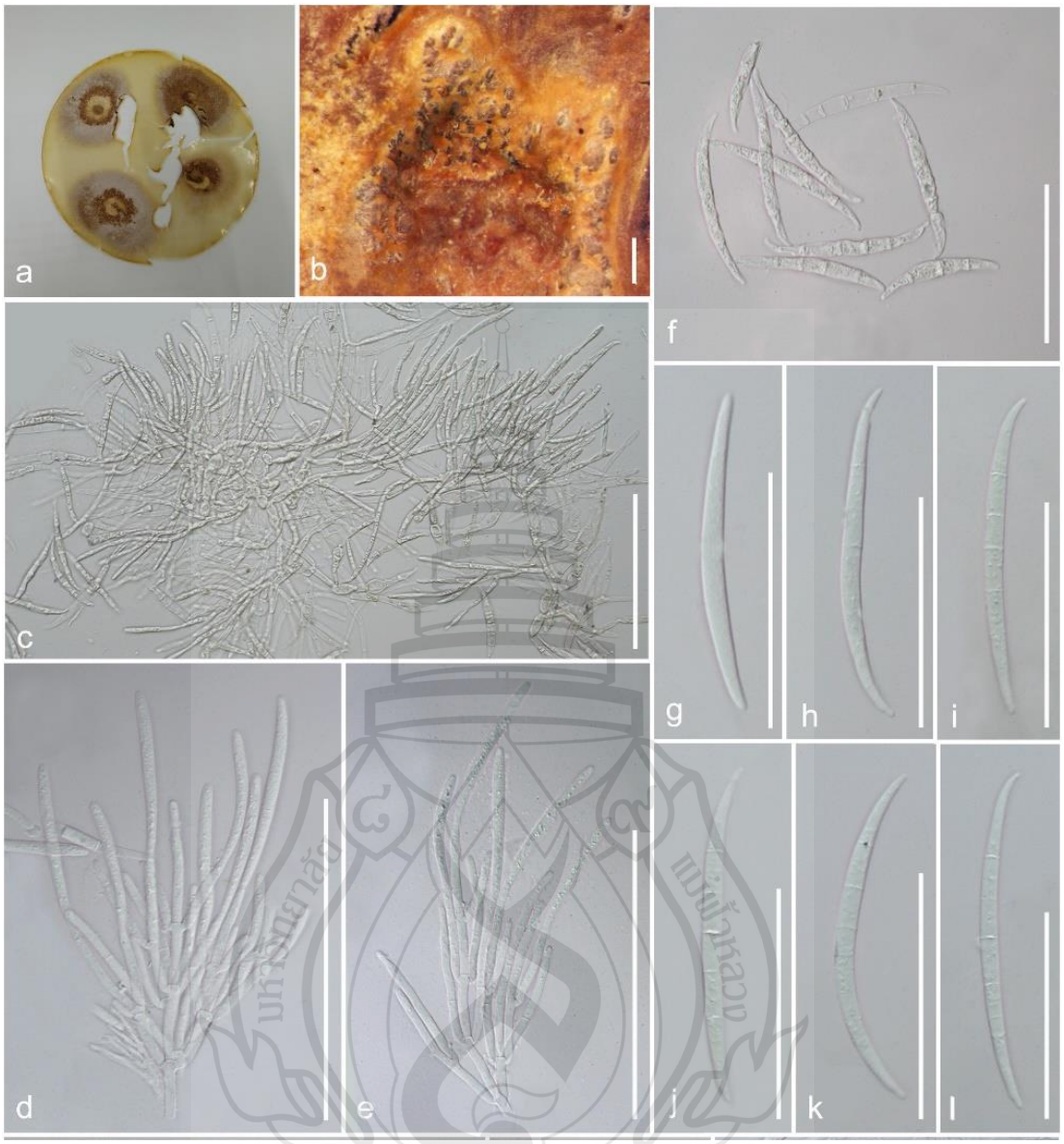
Index Fungorum number: IF519484, Facesoffungi number: FoF10958, Figures 2.54, 2.55

On *Hoheria populnea*. **Sexual morph:** *Ascomata* 200–250 µm diam., perithecial, cespitose in groups up to 50, stromatic, superficial or with base slightly immersed in a stroma, globose, slightly papillate, not collapsing upon drying, sometimes becoming slightly umbilicate, orange red to red, KOH+ dark red, surface smooth, scaly or warted. *Ostiolar canal* periphysate. *Peridium* 40–70 µm wide, composed of two strata: outer stratum 25–55 µm wide, merged with the surrounding stroma, outer stratum 25–50 µm wide, composed of globose to elliptic, pigmented, thick-walled cells, outermost cell layer of scales or warts; inner stratum 10–16 µm wide, composed of compressed, flattened, hyaline, thin-walled cells; cells angular to globose in surface view. *Apical paraphyses* catenate, septate, hyaline, smooth-walled. *Asci* 90–108 × 7.7–12 µm ($\bar{x}$ = 100 × 9.5 µm), 8-spored, unitunicate, cylindrical to narrowly clavate, apex simple, without an apical ring. *Ascospores* 11–15.3 × 4.6–7 µm ($\bar{x}$ = 13.3 × 5.5 µm), biseriate above and uniseriate below, ellipsoidal to broadly ellipspoidal or fusiform, 1-septate, septum median or slightly sub-median, initially hyaline, pale brown when mature, verruculose. **Asexual morph on PDA:** colony surface off-white to roseous. *Conidiomata* hyphomycetous *Conidiophores* monophialidic, branching trichotomous or sometimes dichotomous, hyaline, smooth-walled. *Conidiogenous cells* 20–48 × 2.6–3.6 µm ($\bar{x}$ = 28 × 3.2 µm), phialidic, cylindrical, slightly narrowing towards the apex, periclinal thickening visible, collarets inconspicuous, hyaline, smooth-walled. *Macroconidia* 40–80 × 3.5–4.6 µm ($\bar{x}$ = 68.6 × 4 µm), off-white to reddish in mass, (0–)3–5-septate, curved or straight, tip slightly more strongly curved, tip cell tapered to subacute, basal cell pedicellate, hyaline, smooth-walled. *Microconidia* absent. *Chlamydospores* lacking.

Material examined: NEW ZEALAND, North Island, Auckland, Waitemata City, Waitakere Ranges, Cascades, on bark of *Hoheria populnea*, 3 June 1983, J.M. Dingley & A.Y. Rossman, PDD 46436, **holotype**.

Note (a, b) Herbarium material label. (c) Herbarium material. (d) Ascomata on the host. (e) Vertical section of conidiomata. (f) Peridium in face view (in 3% KOH). (g) Vertical section of ascoma. (h) Vertical section of peridium. (i) Catenophyses. (j–m) Asci (k with catenophyses). n–s Ascospores. Scale bars: d = 500 µm, e = 200 µm, f = 20 µm, g–m = 50 µm, n–s = 10 µm.

Figure 2.54 *Geejayessia zealandica* (PDD 46436, holotype, sexual morph)



Note (a) Colonies on PDA. (b) Conidiomata on PDA. (c–e) Conidiophores with conidia (d, e in 3% KOH). (f–l) Macroconidia (g–l in 3% KOH). Scale bars: b = 500 µm, c–e = 100 µm, f–l = 50 µm.

Figure 2.55 *Geejayessia zealandica* (PDD 46436, holotype**,** asexual morph)

Notes: The holotype material of *Geejayessia zealandica* designated by Schroers et al. (2011) was studied. *Nectria zealandica* was transferred to *Cosmospora* as *Cosmospora zealandica* by Nirenberg and Samuels (2000) and later to new genus *Geejayessia* by Schroers et al. (2011).

Gliocladiopsis S.B. Saksena, Mycologia 46: 662 (1954)

Index Fungorum number: IF8341, Facesoffungi number: FoF10959

Associated with plant litter in soil or roots of diseased plants, sometimes isolated from submerged wood in freshwater habitats. **Sexual morph:** *Ascomata* perithecial, superficial, densely gregarious, held on a thin basal stroma, obovoid to broadly obpyriform, collapsing laterally when dry, red-brown with a dark red stromatic base, KOH+ dark red, surface warted. *Asci* unitunicate, 8-spored, cylindrical, sessile, apex flattened, with a refractive apical ring. *Ascospores* uniseriate, overlapping, ellipsoidal, 1-septate, hyaline, smooth. **Asexual morph:** *Conidiomata* sporodochial, comprising of numerous aggregated penicillate conidiophores, or reduced to distinct penicillate or subverticillate conidiophores. *Conidiophores* monomorphic, penicillate, consisting of a stipe and a penicillate arrangement of fertile branches, rarely dimorphic, penicillate and subverticillate. *Stipe extensions* septate, hyaline, smooth-walled. *Conidiogenous apparatus* with several series of aseptate or 1-septate branches, each terminal branch bearing 2–6(–7) conidiogenous cells. *Conidiogenous cells* phialidic, doliiform to cymbiform to cylindrical, aseptate, periclinal thickening minute, with an inconspicuous collarette, hyaline. *Conidia* cylindrical, rounded at both ends, (0–)1-septate, straight to curved, usually with a flattened base, without a visible abscission scar, born in fascicles by colourless slime (Adapted from Saksena, 1954; Lombard et al., 2015).

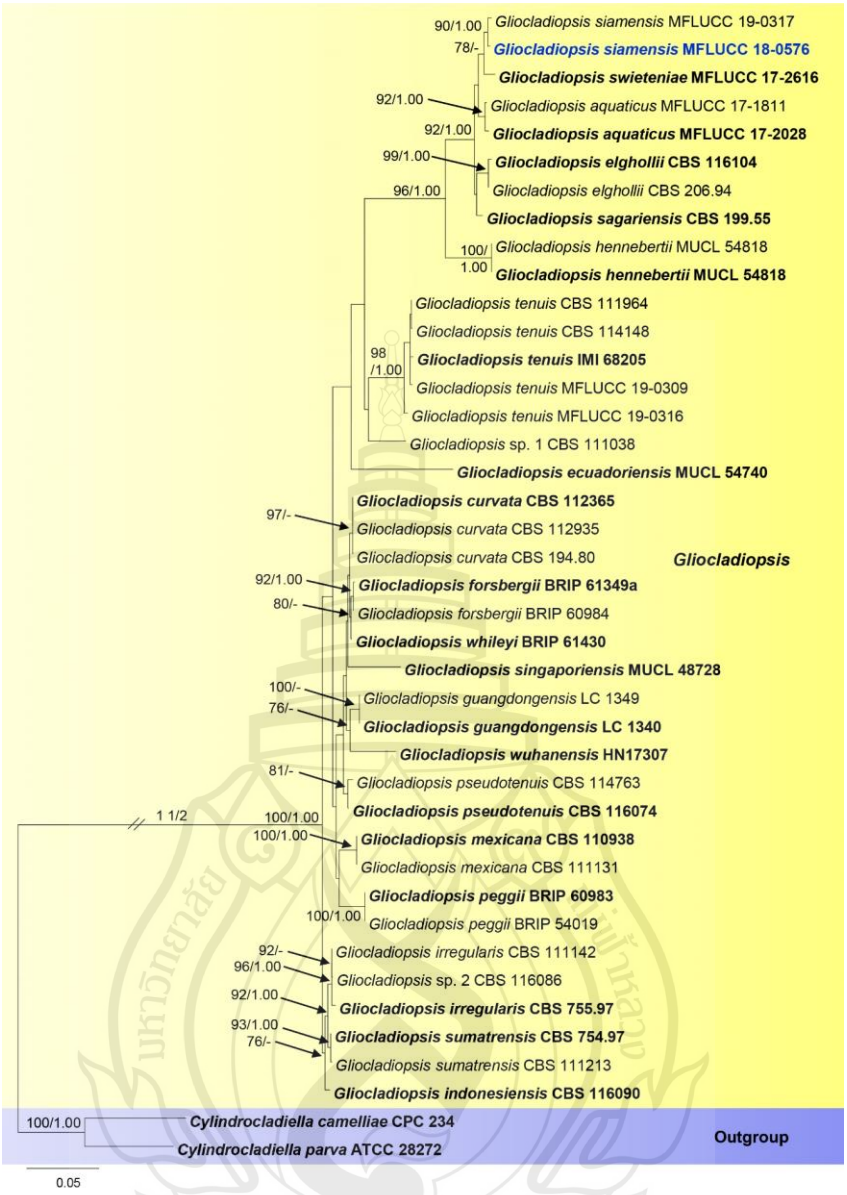
Known distribution: Worldwide (Saksena, 1954; Crous & Wingfield, 1993; Lombard & Crous, 2012)

Notes: Saksena (1954) introduced the genus *Gliocladiopsis* based on *G. sagariensis* and placed it in Moniliaceae. Considering morphological resemblance, some authors treated *Gliocladiopsis* as a synonymy of *Cylindrocladium* (Subramanian, 1971; Barron, 1968). Later, Crous and Wingfield (1993) resurrected the genus *Gliocladiopsis*, and Lombard & Crous (2012) accepted *Gliocladiopsis* in Nectriaceae based on multi-gene phylogeny.

Type species: ***Gliocladiopsis sagariensis*** S.B. Saksena, Mycologia 46: 662 (1954)

Index Fungorum number: IF297822, Facesoffungi number: FoF10960

Descriptions and illustrations: see Saksena (1954)



Note Forty-one strains are included in the combined analyses, which comprised 1667 characters (ITS: 538, TUB2: 624, HIS3: 505), including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to *Cylindrocladiella camelliae* (CPC 234) and *C. parva* (ATCC 28272). Ex-type strains are in bold. The newly generated sequences are indicated in blue. The scale bar indicates 0.05 nucleotide changes per site.

Figure 2.56 Phylogram generated from maximum likelihood analysis based on combined ITS, TUB2 and HIS3 sequence data of *Gliocladiopsis* taxa

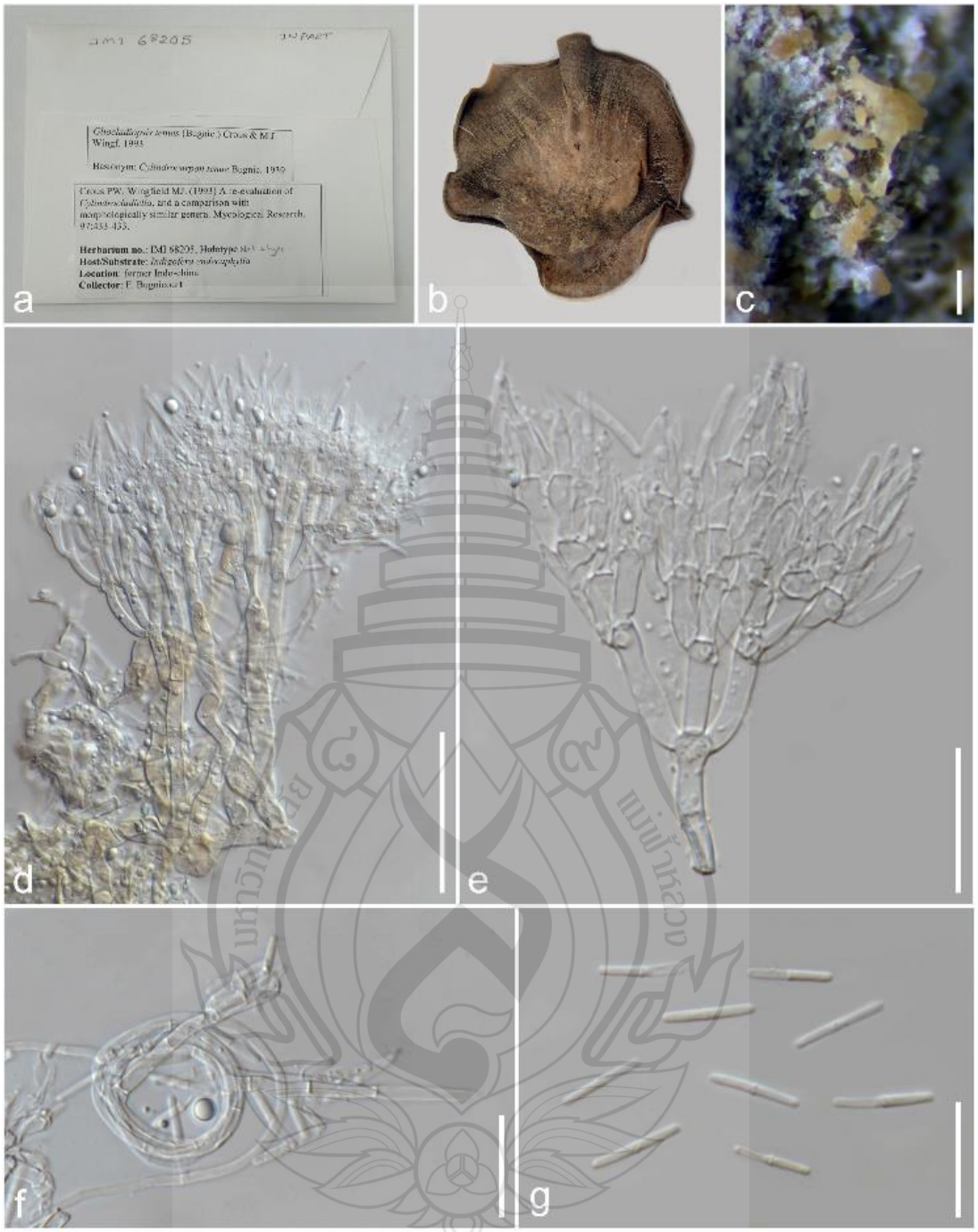
Gliocladiopsis tenuis (Bugnic.) Crous & M.J. Wingf., Mycol. Res. 97(4): 446 (1993)

Basionym: *Cylindrocarpon tenue* Bugnic., Encyclop. Mycol. (Paris) 11: 178 (1939)

Index Fungorum number: IF359449, Facesoffungi number: FoF06876, Figure 2.57

On *Indigofera endecaphylla*. **Sexual morph**: Undetermined. **Asexual morph**: in culture, appearing as yellowish-brown masses on the substrate. *Mycelium* up to 2 μm wide, septate, hyaline. *Conidiophores* 140–180 × 5.8–7.5 μm, penicillate, septate, hyaline to pigmented, smooth-walled, without sterile stipe extensions and terminal vesicles. *Conidiogenous apparatus* with several series of hyaline branches: primary branches 9–21 × 3–4.2 μm, aseptate or rarely 1-septate; secondary branches 10–16 × 2.5–3.7 μm, aseptate; tertiary branches 9–13.8 × 2–3.2 μm, quaternary branches rare to absent, 9.4–12 × 2–2.7 μm, aseptate; usually central axis of conidiophore terminating in a fertile, extended phialide. *Conidiogenous cells* 12–22 × 2–2.3 μm, phialidic, doliiform to cymbiform to cylindrical, arranged in terminal whorls of up to 7 per branch, sometimes with minute collarettes, central phialide frequently extending above the rest. *Conidia* 14.5–19 × 1.3–2 μm, 1-septate, cylindrical, with rounded ends, straight, hyaline, smooth-walled, without appendages. *Chlamydospores* extensive, in clearly delimited, mostly unbranched chains, pale yellow to golden brown.

Material examined: FORMER INDO-CHINA, on *Indigofera endecaphylla*, F. Bugnicourt, IMI 68205, **holotype**. THAILAND, Chiang Rai Province, Mae Fah Luang University, on decaying fruit of a palm tree, 18 August 2017, R.H. Perera CR-F 12, MFLU 19-0956.



Note (a) Herbarium material label (b) Herbarium material. (c) Sporodochia in culture. (d, e) Conidiophores with conidiogenous cells. (f) Mycelium curled into a circle. (g) Conidia. Scale bars: c = 200 µm, d = 50 µm, e–g = 20 µm.

Figure 2.57 *Gliocladiopsis tenuis* (IMI 68205, holotype)

Gliocladiopsis siamensis R.H. Perera, E.B.G. Jones & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF559635, Facesoffungi number: FoF10961, Figure 2.58

Etymology: Name refers to the type locality, 'Siam' earlier name of Thailand.

Saprobic on decaying plant stem. *Mycelium* 1.8–7.3 μm wide, branched, septate, hyaline to orange-brown, smooth-walled. **Sexual morph:** Undetermined. **Asexual morph on PDA:** Hyphomycetous. *Conidiomata* initially appearing as white masses, becoming yellowish white to orange-brown with age. *Conidiophores* 85–150 μm, penicillate; stipes of conidiogenous apparatus 25–36 × 3.4–8.8 μm, brown, aseptate or 1-septate, smooth-walled; lacking sterile stipe extensions and terminal vesicles. *Conidiogenous apparatus* with several series of hyaline to orange-brown: primary branches 16–32 × 2–7 μm, cylindrical to clavate, aseptate or 1-septate, smooth-walled; secondary branches 9.4–27 × 2–4.5 μm, cylindrical, aseptate, hyaline, smooth-walled; tertiary branches 8–22.5 × 1.8–3.3 μm, cylindrical, aseptate, hyaline, smooth-walled; quaternary branches 8.8–15.7 × 1.5–2.5 μm, cylindrical or sometimes calvate, aseptate, hyaline, smooth-walled; quinary branches very rare or absent, aseptate, calvate or cylindrical, hyaline, smooth-walled. *Phialides* (5.6–)7–19 × 1.4–3.6(–4.7) μm, doliiform to cymbiform to cylindrical, arranged in terminal whorls of 2–6 per branch, with periclinal thickening and minute collarettes. *Conidia* 16–21 × 1.5–2 μm ($\overline{x}$ = 18.3 × 1.8 μm, n = 50), cylindrical, with rounded ends, straight, 1-septate, lacking a visible abscission scar, hyaline, smooth-walled.

Culture characteristics: Conidia germinating on PDA within 8 hours. Colonies growing on PDA reaching 45 mm within 2 weeks at 25°C, circular, with effuse surface, edge entire, aerial mycelium dense, above and reverse initially yellowish white, becoming sayal brown to sepia with age.

Material examined: THAILAND, Phyao Province, on a decaying stem of a woody plant, 04 August 2017, R.H. Perera, PH04 (MFLU 18-2743, **holotype**); **ex-type** living culture MFLUCC 18-0576. *Ibid*., on decaying seed pods of *Cassia fistula* (Fabaceae), 4 August 2017, R.H. Perera, PH-CAS 04 (MFLU 18-2750), living culture MFLUCC 19-0317).

GenBank numbers: MFLUCC 18-0576: LSU: ON352629, HIS3: ON364457, ITS: ON361571, TUB2: ON364481.

Notes: In the phylogenetic analysis our new isolate clustered with ex-type of *Gliocladiopsis swieteniae* (MFLUCC 17-2616) with moderate statistical support (78% MLBT; Figure 2.56). *Gliocladiopsis siamensis* and *G. swieteniae* also share similar morphology in having sayal brown colonies on PDA, yellowish sporodochia and similar conidiophore size (Perera et al., 2020). However, *G. siamensis* differs from *G. swieteniae* in having larger conidia (16–21 vs 14.4–17.9 μm) (Perera et al., 2020). *Gliocladiopsis siamensis* (MFLUCC 18-0576) and *G. swieteniae* (MFLUCC 17-2616) showed 5 nucleotides differences (1%, 2 gaps) in the ITS region, 1 different nucleotide (0.02%, 0 gaps) in the TUB2 region and, 8 different nucleotides (1.8%, 1 gap) in the HIS3 region. Based on morphological and molecular evidence we introduce our collection as a new species *G. siamensis*. Furthermore, due to lack of enough DNA data the strain previously identified as *Gliocladiopsis aquaticus* isolate MFLUCC 17-2033 (Perera et al., 2020) is identified here as *Gliocladiopsis siamensis* (Figure 2.56).

Globonectria Etayo, Biblthca Lichenol. 84: 46 (2002)

Index Fungorum number: IF28686, Facesoffungi number: FoF10962

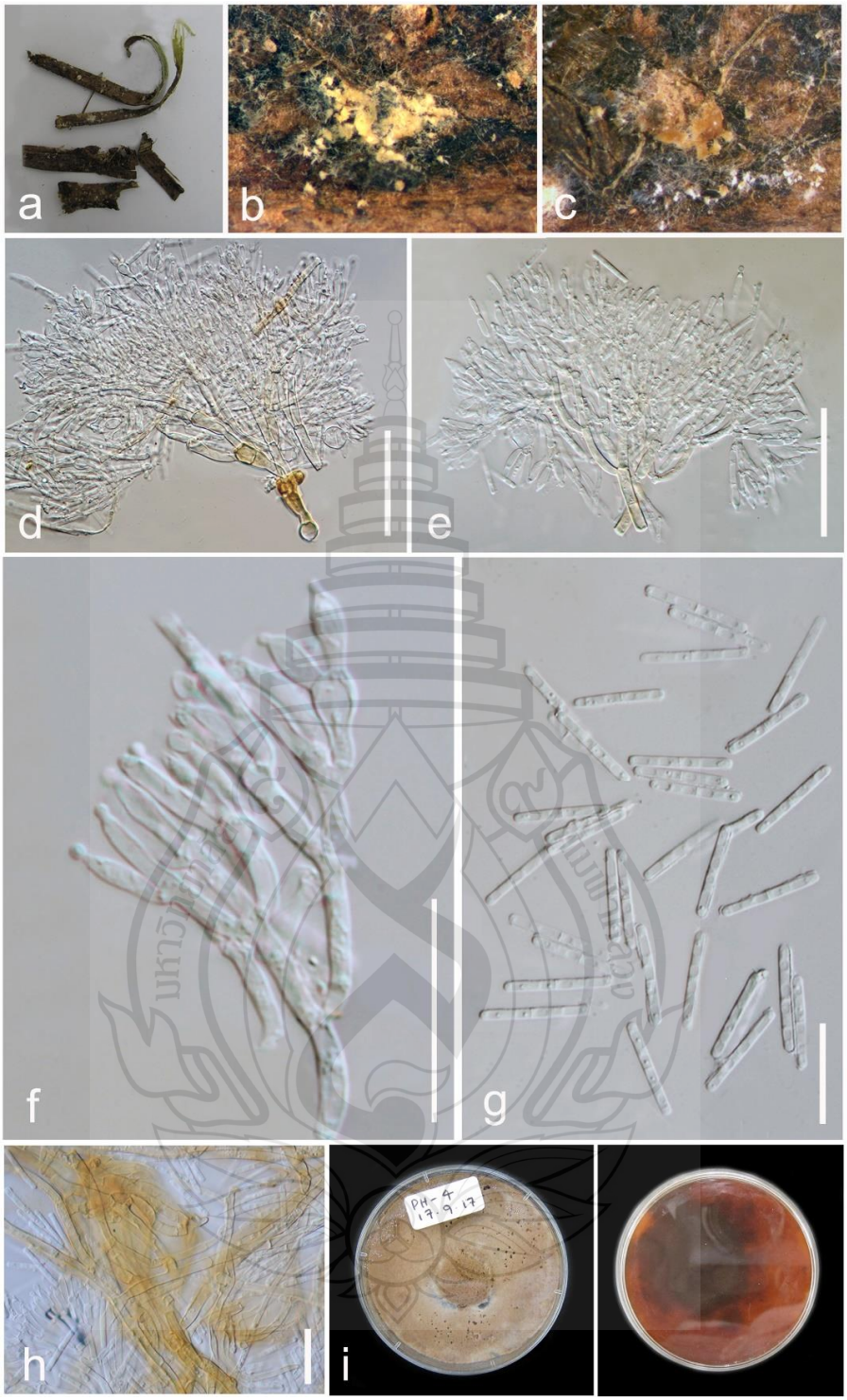
Known distribution: Colombia (Etayo 2002), Bolivia (Flakus et al., 2019)

Notes: *Globonectria* is a lichenicolous genus epiphytic on *Lobariella crenulata* and *L. pallida* (Etayo, 2002; Flakus et al., 2019), and morphogically closer to *Pronectria* species (Etayo, 2002). However, the genus was previously accepted in Bionectriaceae (Etayo, 2002; Maharachchikumbura et al., 2015, 2016; Wijayawardene et al., 2020, 2022). Flakus et al. (2019) showed that *Globonectria cochensis* nested within Nectriaceae in their phylogenetic analyses. However, the phylogenetic placement of *Globonectria* within Nectriaceae is statistically not well-supported. Single gene and combined gene analysis in our study also confirmed the placement of *Globonectria* in Nectriaceae (Figure 2.1).

Type species: ***Globonectria cochensis*** Etayo, Biblthca Lichenol. 84: 47 (2002)

Index Fungorum number: IF372531, Facesoffungi number: FoF10963

Descriptions and illustrations: see Etayo (2002) and Flakus et al. (2019)



Note (a) Herbarium material. (b, c) Sporodochia on host substrate. (d–f) Conidiophores with conidiogenous cells and conidia. (g) Mycelium on PDA. (h) Conidia. (i, j) Colony on PDA. Scale bars: d–f = 50 µm, g, h = 20 µm.

Figure 2.58 *Gliocladiopsis siamensis* (MFLU 18-2743, holotype)

Longinectria O. Savary, M. Coton, E. Coton & J.L. Jany, in Savary et al., Index Fungorum 504: 1 (2021)

Index Fungorum number: IF559340, Facesoffungi number: FoF10964

Isolated from European cheese. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiophores* are variable-length phialides, sometimes extremely long (153–237 µm), lateral, sometimes verticillate, hyaline. *Macroconidia* 0–3 septate, straight to slightly curved, apical cell blunt to papillate, basal cell often notched, hyaline. *Microconidia* ovoid, ellipsoid to allantoid, 0–1 septate, hyaline. *Chlamydospores* lacking to abundant, globose, single, in pairs or chains, intercalary or terminal (Adapted from Savary et al. 2021).

Known distribution: France (Savary et al., 2021)

Notes: *Longinectria* is a recently recognized genus for two fungi isolated from Swiss and Italian cheese samples (Savary et al., 2021). *Longinectria* currently accommodates two species (Savary et al., 2021). However, this genus was not considered as a valiedly published as it was not indicated that the type culture is preserved in a metabolically inactive state in the original paper.

Type species: ***Longinectria lagenoides*** O. Savary, M. Coton, E. Coton & J.L. Jany, in Savary et al., Index Fungorum 504: 1 (2021)

Index Fungorum number: IF559341, Facesoffungi number: FoF10965

Descriptions and illustrations: see Savary et al. (2021)

Luteonectria Sand.-Den., L. Lombard, Schroers & Rossman, in Crous et al., Stud. Mycol. 98(no. 100116): 59 (2021)

Index Fungorum number: IF838664, Facesoffungi number: FoF10966

Associated with bark of woody stems. **Sexual morph:** Stromata well-developed, composed of pseudoparenchymatous cells. *Ascomata* perithecial, gregarious, seated on a stroma, globose to pyriform, with a broadly rounded and papillate apical region, offwhite to pale luteous, becoming ochraceous when dry, KOH-, LA-, surface covered with loose, white hyphae, smooth and thin-walled, short setae-like hairs sometimes emerging from perithecial wall. *Asci* 8-spored, clavate with a simple apex. *Ascospores* overlapping irregularly uniseriate to biseriate, fusiform with rounded ends, 3-septate, somewhat constricted at septum, hyaline, becoming pale yellow-brown, smooth-walled to finely striate. **Asexual morph:** *Conidiophores* mononematous, septate, irregularly branched,

bearing terminal phialides. *Conidiogenous cells* monophialidic, cylindrical to subcylindrical, periclinal thickening inconspicuous to absent, smooth- and thin-walled. *Macroconidia* fusoid, 1–7-septate, curved, with a wide, blunt apical cell and a poorly- to well-developed, foot-shaped basal cell, hyaline. *Micro- and mesoconidia* absent. *Chlamydospores* absent. (Adapted from Rossman, 1983; Crous et al., 2021).

Known distribution: Jamaica (Rossman, 1983; Crous et al., 2021)

Notes: Crous et al. (2021) erected *Luteonectria* to accommodate *Nectria albida* and *Fusarium nematophilum*. However, phylogenetically the genus has a close relationship to Nectriaceae (Crous et al., 2021). *Luteonectria* formed a clade sister to *Longinectria* within Nectriaceae in our phylogenetic analysis (Figure 2.38).

Type species: ***Luteonectria albida*** (Rossman) Sand.-Den. & L. Lombard, in Crous et al., Stud. Mycol. 98(no. 100116): 60 (2021)

Basionym: *Nectria albida* Rossman, Mycol. Pap. 150: 79 (1983)

Index Fungorum number: IF838665, Facesoffungi number: FoF10967

Descriptions and illustrations: see Rossman (1983)

Macroconia (Wollenw.) Gräfenhan, Seifert & Schroers, in Gräfenhan, Schroers, Nirenberg & Seifert, Stud. Mycol. 68: 101 (2011)

Index Fungorum number: IF519441, Facesoffungi number: FoF10968

Fungicolous on stromata of other ascomycetes growing on herbaceous plants or deciduous trees. **Sexual morph:** *Stromata* inconspicous or absent. *Ascomata* 100–250 μm high, perithecial, solitary, subglobose, with a small papilla or nonpapillate, become cupulate upon drying, orange to carmine red, KOH+ dark red to violet, sometimes hyphal hairs arising from the ascomatal surface. *Asci* 8-spored, unitunicate, cylindrical to narrowly clavate, apex simple. *Ascospores* uniseriate or partially biseriate, 1-septate, yellowish, smooth-walled or becoming striate when mature. **Asexual morph:** *Conidiophores* initially occurring as lateral phialides on somatic hyphae, become monochasial to verticillate, hyaline. *Conidiogenous cells* monophialidic, cylindrical to subulate, hyaline. *Microconidia* absent or sparse, when present ellipsoidal to allantoid, hyaline. *Macroconidia* subcylindrical to curved, 3–7(–14)-septate, apical cell conical or hooked, basal cell poorly to well-developed, footshaped, hyaline. *Chlamydospores* absent or rare, globose, single, held in pairs or chains in hyphae (Adapted from Gräfenhan et al., 2011).

Notes: Gräfenhan et al. (2011) established *Macroconia* based on *Nectria leptosphaeriae* and four other taxa, which were hitherto treated in *Cosmospora*, *Fusarium* and *Nectria*. *Macroconia* is phylogenetically closely related to *Fusicolla* and entomogenous group *Microcera* (present study Figure 2.38; Lombard et al., 2015).

Type species: ***Macroconia leptosphaeriae*** (Niessl) Gräfenhan & Schroers, in Gräfenhan et al., Stud. Mycol. 68: 102 (2011)

Basionym: *Nectria leptosphaeriae* Niessl, in Krieger, Fung. Saxon. Exsicc., Pilze Sachsen's 4: no. 165 (1886)

Index Fungorum number: IF519442, Facesoffungi number: FoF10969, Figure 2.59

Fungicolous, on ascomata of *Leptosphaeria doliolum*. **Sexual morph**: *Stroma* inconspicous. *Ascomata* 210–275 × 185–220 µm, perithecial, superficial, solitary, subglobose, ostiolate, with a small apical papilla, collapsing laterally when dry, orange to carmine red, KOH+ violet. *Ostiolar canal* filled with hyaline, filiform periphyses. *Peridium* 40–50 µm wide, composed of orange to hyaline, thick-walled cells of *textura globulosa* to *textura angularis*, cells around the ostiole elongated. *Asci* 90–146 × 10–15.5 µm ($\bar{x}$ = 112.5–11.8 µm), 8-spored, unitunicate, cylindrical to narrowly clavate, short pedicellate, apical ring J-. *Ascospores* 15–21 × 4.7–6.2 µm ($\bar{x}$ = 17.6 × 5.5 µm), uniseriate to partially biseriate, ellipsoid or fusiform-ellipsoid, straight or slightly curved,1-septate, slightly constricted at septa, 2–4-guttulate, hyaline to pale yellowish, smooth-walled. **Asexual morph**: Wollenweber (1926).

Material examined: GERMANY, Saxony, Königstein Fortress, church yard, on *Leptosphaeria doliolum* on stems of *Urtica dioica*, 1885 September, W. Krieger, Krieger's Fungi saxonici 165, K(M) 165805, **lectotype**.

Note (a) Herbarium material label. (b) Herbarium material. (c) Ascomata on host. d, e Section of ascomata (e in 5% KOH). f Periphyses in 5% KOH. g, h Asci. i–n Ascospores. Scale bars: c = 500 µm, d, e = 200 µm, f–h = 50 µm, i–n = 10 µm.

Figure 2.59 *Macroconia leptosphaeriae* (K(M) 165805, lectotype)

Macronectria Salgado & P. Chaverri, in Salgado-Salazar, Rossman & Chaverri, Fungal Diversity 80: 448 (2016)

Index Fungorum number: IF816457, Facesoffungi number: FoF10970

Saprobic on decaying woody substrates and other plant organic matter. **Sexual morph:** *Mycelium* visible or not visible on host. *Ascomata* (370–)400–520(600) μm, perithecial, gregarious in groups of many, superficial on an erumpent stroma, subglobose to pyriform, sometimes elongated and flask-shaped, not collapsing when dry, constricted below apex to form a broad or small papilla μm, peach to orange, ochreous to umber, with papilla same colour as perithecium, chestnut, KOH+ red, LA yellow, surface smooth. *Peridium* up to 50 μm, of two intergrading strata, outer stratum of intertwined hyphae with cells slightly elliptical, inner stratum of flattened fusoids cells. *Asci* 55–100 × 12–30 μm, 8-spored, clavate, apex simple. *Ascospores* 20–35 × 8–11 μm, ellipsoid to fusiform, 1-septate, slightly constricted a septum, hyaline, same colour when young, striate, sometimes surrounded by a narrow sheath. **Asexual morph:** *Conidiomata* cylindrocarpon-like, hyphomycetous. *Conidiogenous cells* borne apically on irregularly branching clusters of cells or directly from hyphae, phialidic, cylindrical or slightly swollen, periclinal thickening evident, with collarette. *Microconidia* absent or present, globose to oval, with abscission scar. *Macroconidia* cylindrical or fusiform with rounded ends, 3–8- septate. *Chlamydospores* not produced in cultures (Adapted from Salgado-Salazar et al., 2016).

Known distribution: Brazil, Costa Rica, French Guiana, Guatemala, Japan, Taiwan, Venezuela (Salgado-Salazar et al., 2016)

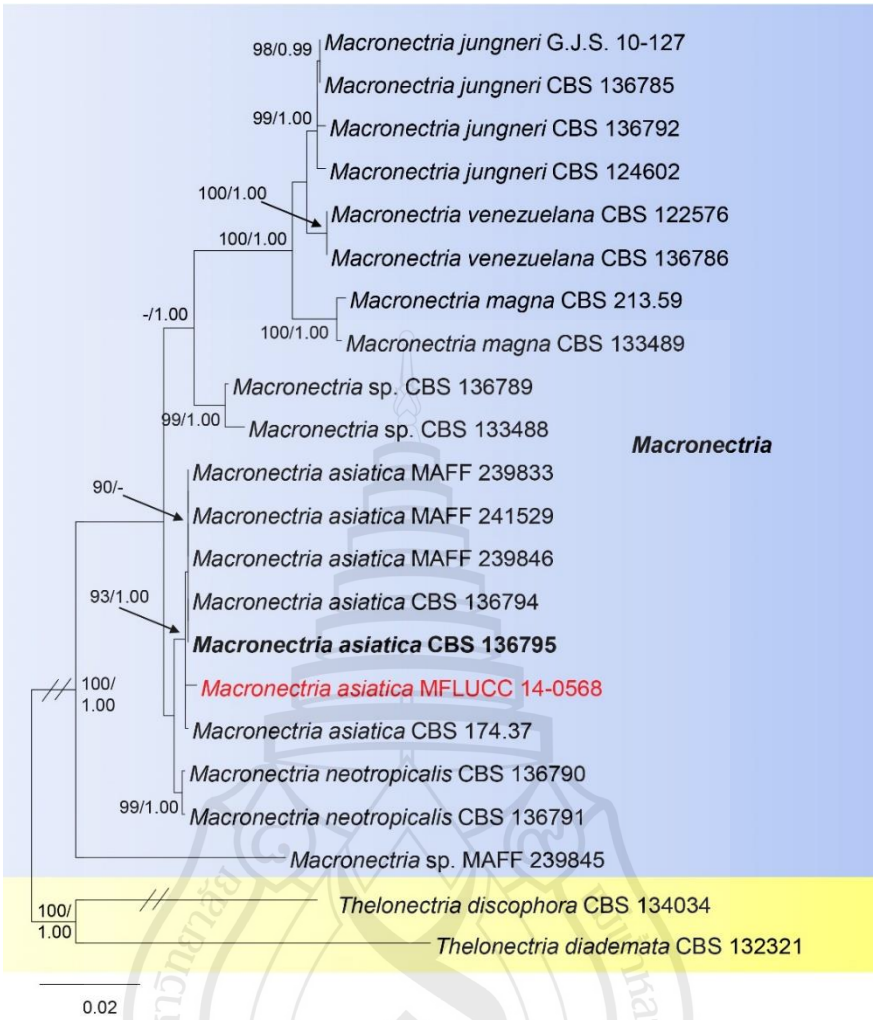
Notes: Salgado-Salazar et al. (2016) introduced *Macronectria* to accommodate five saprobic taxa that have cylindrocarpon-like asexual morphs. *Macroconidia* show phylogenetic affinities to *Pleiocarpon* and *Thelonectria* (Figure 2.38). *Macroconidia* is characterized by pyriform and elongated perithecia with a broad, knobby papilla and produces 5–8-septate larger macroconidia up to 110 μm in length.

Type species: ***Macronectria jungneri*** (Henn.) Salgado & P. Chaverri, in Salgado-Salazar, Rossman & Chaverri, Fungal Diversity 80: 448 (2016)

Basionym: *Nectria jungneri* Henn., Bot. Jb. 22: 75 (1895)

Index Fungorum number: IF816458, Facesoffungi number: FoF07763

Descriptions and illustrations: see Salgado-Salazar et al. (2016).



Note Twenty-two strains are included in the combined analyses, which comprised 1818 characters (ITS: 485, LSU: 826, TUB2: 507), including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to *Thelonectria diademata* CBS 132321 and *Thelonectria discophora* CBS 134034. Ex-type strains are in bold. Taxonomic novelties are indicated in red. The scale bar indicates 0.02 nucleotide changes per site.

Figure 2.60 Phylogram generated from maximum likelihood analysis based on combined ITS, LSU, and TUB2 sequence data of selected *Macronectria* taxa

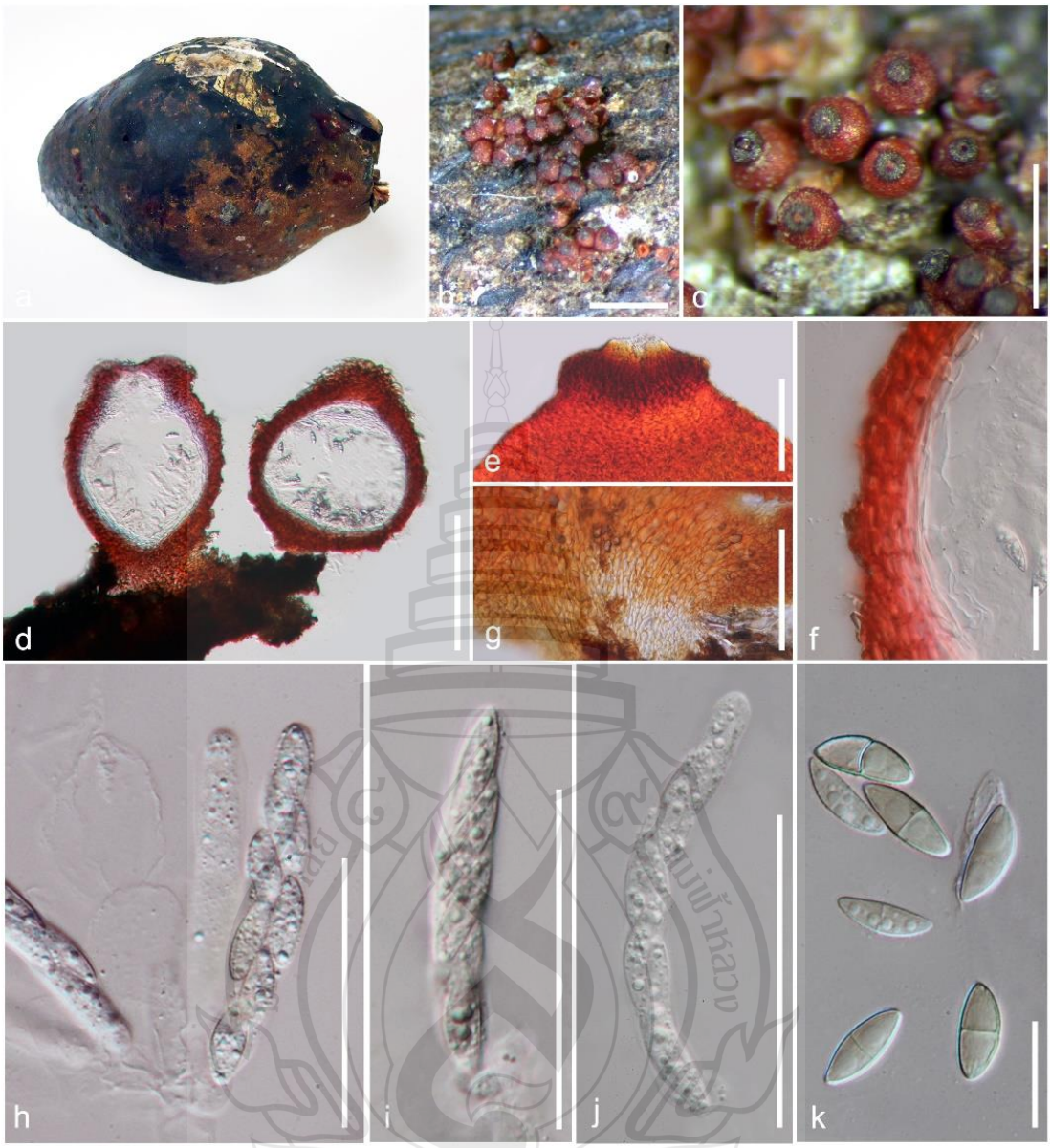
Macronectria asiatica Salgado & Guu, in Salgado-Salazar, Rossman & Chaverri, Fungal Diversity 80: 448 (2016)

Index Fungorum number: IF816459, Facesoffungi number: FoF10972, Figure 2.61

Saprobic on decaying fruits of *Swietenia*. **Sexual morph:** *Ascomata* 300–358 μm diam (n = 10), perithecial, gregarious in groups of several, seated on an erumpent stroma, subglobose to pyriform, sometimes elongated and flask-shaped, ostiole papillate, constricted below apex, not collapsing apon drying, orange to sienna, become dark black red when aged, with ostiolar area darker, KOH+ red, surface smooth, shiny. *Peridium* 20–40 μm, of two strata; outer stratum made of intertwined hyphae with cells slightly elliptical, inner stratum of flattened fusoids cells. *Apical paraphyses* moniliform, hyaline. *Asci* 66–100 × 8.6–17 μm ($\bar{x}$ = 78 × 14 μm, n = 20), 8-spored, unitunicate, clavate, thin-walled, short pedicellate, apex simple. *Hamathecium* of hyaline, septate, apical paraphyses. *Ascospores* 18–21.5 × 5.8–8.2 μm ($\bar{x}$ = 20 × 7 μm, n = 35), bi-seriate, fusiform, sometimes inequilateral, 1-septate, not constricted at septum, guttulate, hyaline, pale yellow when mature, striate. **Asexual morph:** Salgado-Salazar et al. (2016).

Material examined: THAILAND, Chiang Rai Province, Mae Fah Luang University garden, on decaying fruits of *Swietenia mahagoni* (Meliaceae), 4 August 2014, R.H. Perera, RHP09 (MFLU 16-1050), living culture MFLUCC 14-0568.

Notes: We re-examined the herbarium material of '*Macronectria jungneri*' (MFLU 16-1050) and noted MFLU 16-1050 is morphologically closer to *M. asiatica* (Salgado-Salazar et al., 2016). Isolate MFLUCC 14-0568 and ex-type of *M. asiatica* (CBS 136795) showed 1 nucleotide difference (0.2%, no gaps) in the ITS region and 15 nucleotide differences (3%, 12 gaps) in the TUB2 region, while their LSU sequences were identical. Isolate MFLUCC 14-0568 and *M. asiatica* strain (CBS 136794) showed 3 nucleotide differences (0.6%, no gaps) in the TUB2 region, while their ITS and LSU sequences were identical. Based on sequence data, multigene analysis and morphology, we identify collection MFLU 16-1050 as *M. asiatica* (Figure 2.60).



Note (a) Herbarium material. (b, c) Ascomata on host. (d) Vertical section of ascomata. (e) Ostiole in side view. (f) Vertical section of peridium. (g) Cells of stromata tissue. (h) Asci and apical paraphyses. (i, j) Asci. (k) Ascospores (in Melzer reagent). Scale bars: b = 1 mm, c = 500 µm, d = 200 µm, e = 50 µm, f = 20 µm, g–j = 50 µm, k = 20 µm.

Figure 2.61 *Macronectria asiatica* (MFLU 16-1050)

Microcera Desm., Annls Sci. Nat., Bot., sér. 3 10: 359 (1848)

Index Fungorum number: IF8920, Facesoffungi number: FoF10973

Entomogenous, mostly parasitic on scale insects, sometimes reported on aphids, adelgids and, also isolated as saprobes from plant matter or soil. **Sexual morph:** *Stroma* and/or byssus covering host surface. *Ascomata* perithecial, solitary or gregarious, globose, bluntly papillate, collapsing or pinched upon drying, orange to dark red, KOH+ dark red or violet, surface finely roughened. *Asci* 8-spored, cylindrical to narrowly clavate, with an apical ring. *Ascospores* uniseriate, hyaline to pale yellow-brown, 1(–3)-septate, smooth-walled or tuberculate when mature. **Asexual morph:** *Conidiomata* fusarium-like, synnematous or sporodochial. *Conidiophores* first occurring as lateral phialides on somatic hyphae, becoming monochasial, verticillate to penicillate, hyaline, develop into sporodochia or synnemata. *Conidiogenous cells* monophialidic, cylindrical to subulate to subclavate, hyaline. *Macroconidia* subcylindrical, curved, (0–)3–5(–12)-septate, hyaline, apical cell often slightly or conspicuously hooked, basal cell papillate to well-developed, foot-shaped, pale, orange, pink or bright red in mass (Adapted from Gräfenhan et al. 2011; Crous et al. 2021).

Known distribution: Worldwide (Booth, 1971; Rossman, 1983; Gräfenhan et al., 2011)

Notes: Wollenweber & Reinking (1935) transferred *Microcera* species to *Fusarium* and, this classification was followed by subsequent authors (Booth, 1971; Gerlach & Nirenberg, 1982; Nelson et al., 1983; Snyder & Hansen, 1945; Leslie et al., 2006.). Gräfenhan et al. (2011) revived the genus based on phylogenetic analysis which confirmed the generic concept of *Microcera*. In current phylogenetic analysis, *Microcera* cladded within Nectriaceae with close phylogenetic affinities to *Macroconia* (Figure 1.38).

Type species: ***Microcera coccophila*** Desm., Annls Sci. Nat., Bot., sér. 3 10: 359 (1848)

Index Fungorum number: IF249367, Facesoffungi number: FoF10974, Figure 2.62

On bark of *Salix* and *Fraxinus* spp. **Sexual morph:** see Petch (1921). **Asexual morph**: *Conidiomata* fusarium-like, synnematous, flame-like, discrete, pale orange to orange red, originating from a stroma. *Conidiophores* up to 300 µm tall × 2.6–4 µm wide, monochasial, verticillate, septate, hyaline, smooth-walled. *Conidiogenous cells* 9.7–48 × 2.3–4.8 µm, monophialidic, cylindrical to subulate to subclavate, periclinal thickening visible, with inconspicuous to slightly conspicuous collarettes, hyaline, smooth-walled.

Microconidia absent. *Macroconidia* 45–115 × 3.4–5.4 µm, subcylindrical, (0–)3–12 septate, slightly or moderately curved, not or inconspicuously constricted at the septa, apical cell usually inconspicuously or conspicuously hooked, basal cell slightly to conspicuously pedicellate, hyaline, smooth-walled, pale orange in mass.

Material examined: FRANCE, Normandy, near Caen, on bark of young living trees of *Salix* and *Fraxinus* spp., February 1847, M. Roberge, K (M) 165807, **lectotype**.

Note (a) Herbarium material label. (b) Herbarium material. (c) Flame-like synnemata emerging from the stroma. (d–f) Conidiophores and conidiogenous cells. (g–m) Conidia. Scale bars: c = 500 µm, d, e = 50 µm, f = 20, g–m = 50 µm.

Figure 2.62 *Microcera coccophila* (K (M) 165807, lectotype)

Nectria (Fr.) Fr., Summa veg. Scand., Sectio Post. (Stockholm): 387 (1849)

Index Fungorum number: IF3431, Facesoffungi number: FoF02122

Saprobic on decaying wood and occurring as pathogens of trees, rarely *bryophilous*. **Sexual morph:** *Stromata* erumpent. *Ascomata* perithecial, seated on or slightly or completely immersed in a stroma, aggregated in groups, globose to subglobose, red to bay to sienna, KOH+ turning bright red, blood red to purple, surface smooth to warted. *Asci* 8-spored, unitunicate, clavate to narrowly clavate or cylindrical, apical ring inconspicuous. *Ascospores* up to 4-septate, ellipsoidal, oblong, fusiform, pyriform or allantoid, with rounded ends, straight to slightly curved, hyaline, smooth-walled or spinulose. **Asexual morph:** *Conidiophores* pycnidial, sporodochial, lateral phialidic pegs or acropleurogenous. *Microconidia* ellipsoid to fusoid or sometimes curved, aseptate, hyaline. *Macroconidia* 0–1- septate, ellipsoidal, oblong, cylindrical to allantoid or subglobose to ellipsoidal, straight to slightly curved, rounded at ends, hyaline, smooth-walled. *Chlamydospores* occasional (Adapted from Lombard et al., 2015; Maharachchikumbura et al., 2016).

Type species: ***Nectria cinnabarina*** (Tode) Fr., Summa veg. Scand., Section Post. (Stockholm): 388 (1849)

Basionym: *Sphaeria cinnabarina* Tode, Fung. mecklenb. sel. (Lüneburg) 2: 9 (1791)

For other synonyms see Index Fungorum.

Index Fungorum number: IF249710, Facesoffungi number: FoF10975, Figures 2.63, 2.64

Associated with dead plant parts. **Sexual morph:** *Stromata* up to 2 mm high, well-developed, erumpent through host epidermis, composed of pseudoparenchymatous cells forming *textura angularis* to *textura* prismatica, light yellow to bay, KOH+ dark red, surface roughened with concolourous warts, sometimes smooth. *Ascomata* 280–370 µm high × 250–370 µm wide, perithecial, superficial on stroma, solitary or aggregated in large numbers, subglobose to globose, sometimes cupulate when dry, apapillate, red to reddish brown, apical region darer, KOH+ dark red. *Peridium* cells forming *textura globulosa* or *textura angularis* in face view; up to 56 µm thick in vertical section, of two distinct strata: outer statum µm 38–50 µm thick, intergrading with stroma, composes of elongated, reddish brown cells forming *textura angularis* or *textura globulosa*, inner

statum 15–22 µm thick, composed of elongated, hyaline, thin-walled cells forming *textura prismatica*. *Paraphyses* absent. *Asci* 83–100 × 8–10.6 µm ($\bar{x}$ = 92 × 8.9 µm; n = 20), 8-spored, unitunicate, cylindrical to narrowly clavate, apical ring inconspicuous, J-. *Ascospores* 14–18 × 4–5.8 µm ($\bar{x}$ = 16.2 × 5.2 µm; n = 35), uniseriate to biseriate, (0–)1-septate, ellipsoidal to fusiform, straight or somewhat curved, hyaline, smooth-walled. **Asexual morph:** *Stromata* well-developed, erumpent through epidermis, pale yellow to orange. *Conidiomata* sporodochial. *Sporodochia* superficial on stroma, sometimes associated with ascomata, scattered, solitary or in groups of 2–4, cerebriform or tubercularoid, stipitate, pustulate, discoid or cylindric-capitate, white to whitish yellow, sometimes orange, smooth. *Stipe* up to 490 mm wide, white to whitish red, rarely darker, cells forming *textura angularis*. *Conidiophores* arising from hymenium, monoverticillate or rarely bi-verticillate, septate, straight or curved, hyaline, smooth-walled. *Conidiogenous cells* 3–10 µm long, 1.5–2 µm wide, monophialidic, occurring below each septum, or terminal, without collarettes, hyaline, smooth-walled. *Conidia* 4.9–7.2 × 1.5–3 µm ($\bar{x}$ = 6.2 × 2.3 µm; n = 50), narrowly ellipsoidal to cylindrical, aseptate, straight or slightly curved, hyaline, smooth-walled.

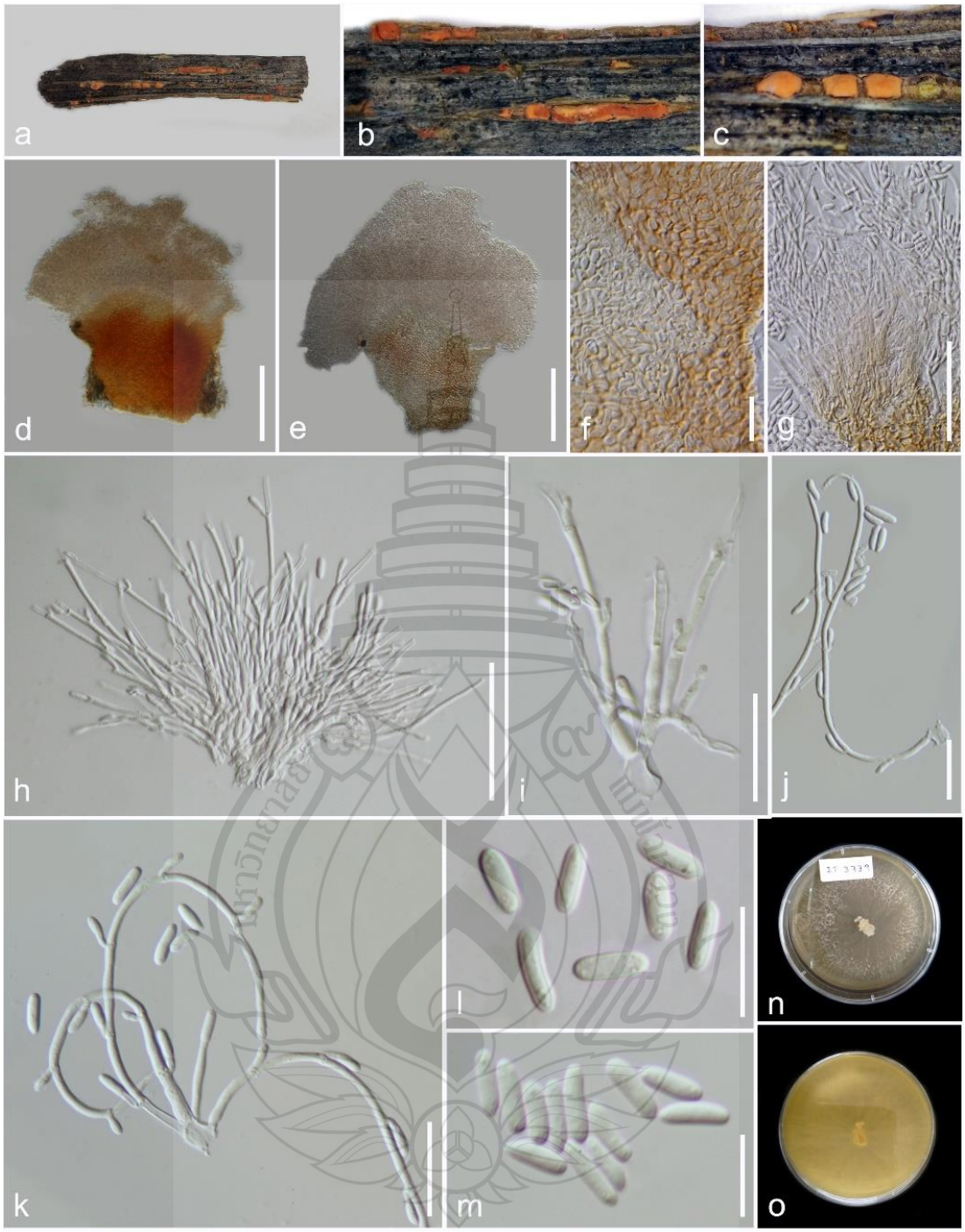
Culture characteristics: Colony on PDA reaching 45–70 mm diam. at 25℃ after 7 days. Colony circular, somewhat cottony with aerial mycelium, radial or sometimes wavy, white to whitish yellow, reverse white to slightly whitish yellow.

Material examined: FRANCE, Villiers en Bois, on dead twigs of *Aesculus* sp., 13 February 2008, C. Lechat, (CLL7152), BPI 879981, **epitype**. ITALY, Forlì-Cesena Province, Corniolo-Santa Sofia, on fallen dead branch of *Acer campestre* (Sapindaceae), 28 March 2017, Erio Camporesi, IT3300, MFLU 17-0870, living culture MFLUCC18-0577; *Ibid*., Ravenna Province, near Brisighella, on fallen dead branch of *Vitis vinifera* (Vitaceae), 18 February 2018, Erio Camporesi, IT3739, MFLU 18-0742, living culture MFLUCC 19-0315. RUSSIA, Rostov Region, Shakhty City District, Alexandrovsky Park, on dying twigs of *Aesculus hippocastanm* L. (Sapindaceae), 23 October 2017, Timur S. Bulgakov, T2149, MFLU 18-0321; *Ibid*., on dead twigs of *Robinia pseudoacacia* L. (Fabaceae), 26 October 2017, Timur S. Bulgakov, T2274, MFLU 18-0435.

GenBank numbers: MFLUCC18-0577: LSU: ON352630, ITS: ON361572; MFLUCC 19-0315: LSU: ON352631, ITS: ON361573, SSU: ON357986, RPB2: ON364491, TEF1: ON364468, TUB2: ON364482. MFLU 18-0321: LSU: ON352632, ITS: ON361574, TEF1: ON364469, TUB2: ON364483; MFLU 18-0435: LSU: ON352633, ITS: ON361575, RPB1: ON364461, TEF1: ON364470, TUB2: ON364484.

Note (a) Herbarium label. (b) Herbarium material. (c) Ascomata on host substrate. (d) Ascomata and long stipitate sporodochia on host substrate. (e) Transverse section through ascoma. (f) Transverse section through peridium. (g–h) Asci (j Ascus in Melzer's reagent). (k) Ascospores. Scale bars: c, d = 2 mm, e = 200 µm, f–j = 50 µm, k = 20 µm.

Figure 2.63 *Nectria cinnabarina* (BPI 879981, epitype)



Note (a) Herbarium material. (b, c) Appearance of conidiomata on the host substrate. (d, e) Vertical section through sporodochia. (f) Stromata cells. (g–k) Conidiophores and conidia. (l, m) Conidia. (n, o) Colony on MEA. Scale bars: d, e = 200 µm, f=20 µm, g, h = 50 µm, i–k = 20 µm, l, m= 10 µm.

Figure 2.64 *Nectria cinnabarina* (MFLU 18-0742)

Nectria dematiosa (Schwein.) Berk., N. Amer. Fung.: no. 154 (1873)

Index Fungorum number: IF144029, Facesoffungi number: FoF07461, Figures. 2.64, 2.66

On dead plant parts. **Sexual morph:** *Stromata* up to 280 mm high, well-developed, erumpent through epidermis, composed of pseudoparenchymatous, cells forming *textura angularis* to *textura prismatica*, orange to bay to darker red, KOH+ dark red. *Ascomata* 250–380 μm high × 250–375 μm diam., perithecial, superficial on stroma, solitary or caespitose up to 20, subglobose to globose, sometimes cupulate when dry, apapillate, red to reddish brown, apical region darker, KOH+ dark red, surface rough with concolourous warts. *Peridium* cells forming *textura globulosa* or *textura angularis* in face view; 35–56 μm thick in vertical section, of two strata: outer stratum 23–40 μm thick, intergrading with stroma, composed of pigmented cells forming *textura globulosa* or *textura angularis*; inner stratum 10–18 mm thick, composed of elongated, thin-walled, hyaline cells forming *textura prismatica*. *Asci* 75–96 × 9.3–11 μm ($\bar{x}$ = 86 × 10.1 μm; n = 25), 8-spored, unitunicate, cylindrical to narrowly clavate, apical ring inconspicuous, J-. *Ascospores* 13.7–21.5 × 4.2–5.7 μm ($\bar{x}$ = 16.5 × 4.8 μm; n = 45) biseriate above, uniseriate below, ellipsoidal to fusiform or long fusiform, straight or slightly curved, (0–)1-septate, not constricted at septum, hyaline, smooth-walled. **Asexual morph on MEA:** *Conidiomata* 40–100 × 2.4–5.8 μm sporodochial, white to whitish yellow. *Conidiophores* verticillately branched, septate, hyaline, smooth-walled. *Conidiogenous cells* 3.3–20 μm long, 1.8–3.8 μm wide at base ($\bar{x}$ = 11.4 × 2.6 μm; n = 35), monophialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, with a visible periclinal thickening, collarette inconspicuous, hyaline, smooth-walled. *Conidia* 2–19.4 × 1.8–2.5 μm ($\bar{x}$ = 5.5 × 2.2 μm; n = 50) formed abundantly on slimy heads, ellipsoidal, oblong to cylindrical, aseptate, straight or slightly curved with round at both ends, hyaline, smooth-walled. *Chlamydospores* not produced.

Culture characteristics: Colony on PDA reaching 70 mm diam. at 25°C after 7 days. Colony circular, surface slightly cottony with aerial mycelium, radial or sometimes wavy, white to whitish yellow, reverse white to slightly whitish yellow, sporulated after 3 weeks.

Material examined: ITALY, Forlì-Cesena Province, Passo la Calla - Santa Sofia, on fallen dead branch of *Fagus sylvatica* (Fagaceae), 18 June 2017, Erio Camporesi,

IT1594, MFLU 15-2286; *Ibid*., near Campigna-Santa Sofia, on dead aerial branch of *Pyrus communis* (Rosaceae), 7 September 2017, Erio Camporesi, IT3481, MFLU 17-1638, living culture MFLUCC 20-0004; *Ibid*., on fallen dead branch of *Acer pseudoplatanus* (Sapindaceae), 5 July 2017, Erio Camporesi, IT3406, MFLU 17-1276, living culture MFLUCC 18-0592; *Ibid*., 9 October 2017, Erio Camporesi, IT3406a, MFLU 17-1445, living culture MFLUCC 17-2624; *Ibid*., near Fiumicello di Premilcuore, on fallen dead branch of *Alnus cordata* (Betulaceae), 29 July 2016, Erio Camporesi, IT3049, MFLU 16-2282; *Ibid*., near Verghereto, on dead aerial branch of *Laburnum anagyroides* (Fabaceae), 29 May 2017, Erio Camporesi, IT3357, MFLU 17-1068, living culture MFLUCC 20-0009.

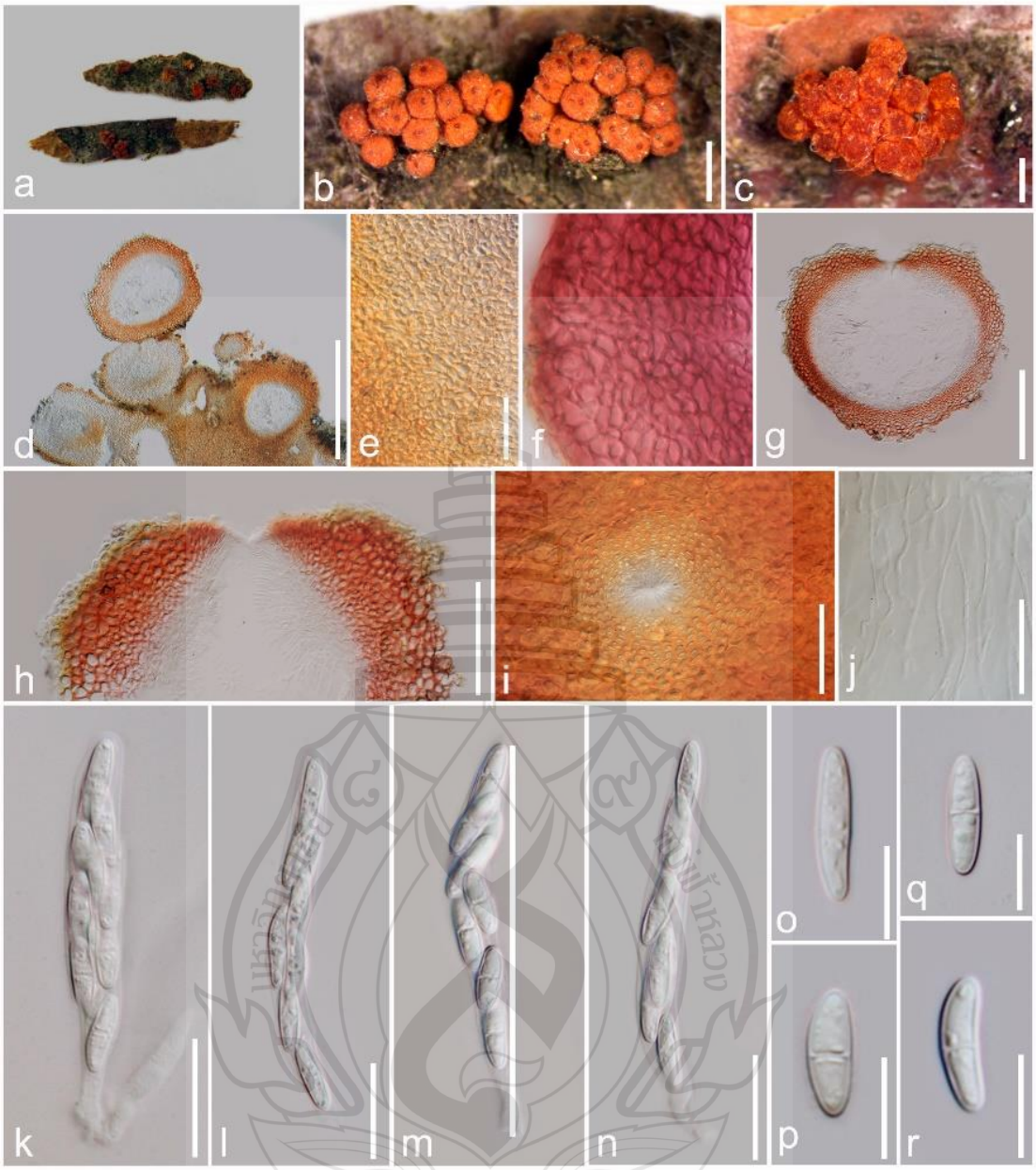
GenBank numbers: MFLU 15-2286: CAM: ON364456, LSU: ON352634, ITS: ON361576, TUB2: ON364485; MFLUCC 20-0004: ITS: ON361577, TEF1: ON364471; TUB2: ON364486; MFLUCC 18-0592: ITS: ON361578, TUB2: ON364487; MFLUCC 17-2624: ITS: ON361579, TUB2: ON364488; MFLU 16-2282: ITS: ON361580, TUB2: ON364489; MFLUCC 20-0009: LSU: ON352635; ITS: ON361581.

Nectria pseudotrichia Berk. & M.A. Curtis, J. Acad. nat. Sci. Philad., N.S. 2(6): 289 (1854) [1853]

For synonyms see Index Fungorum.

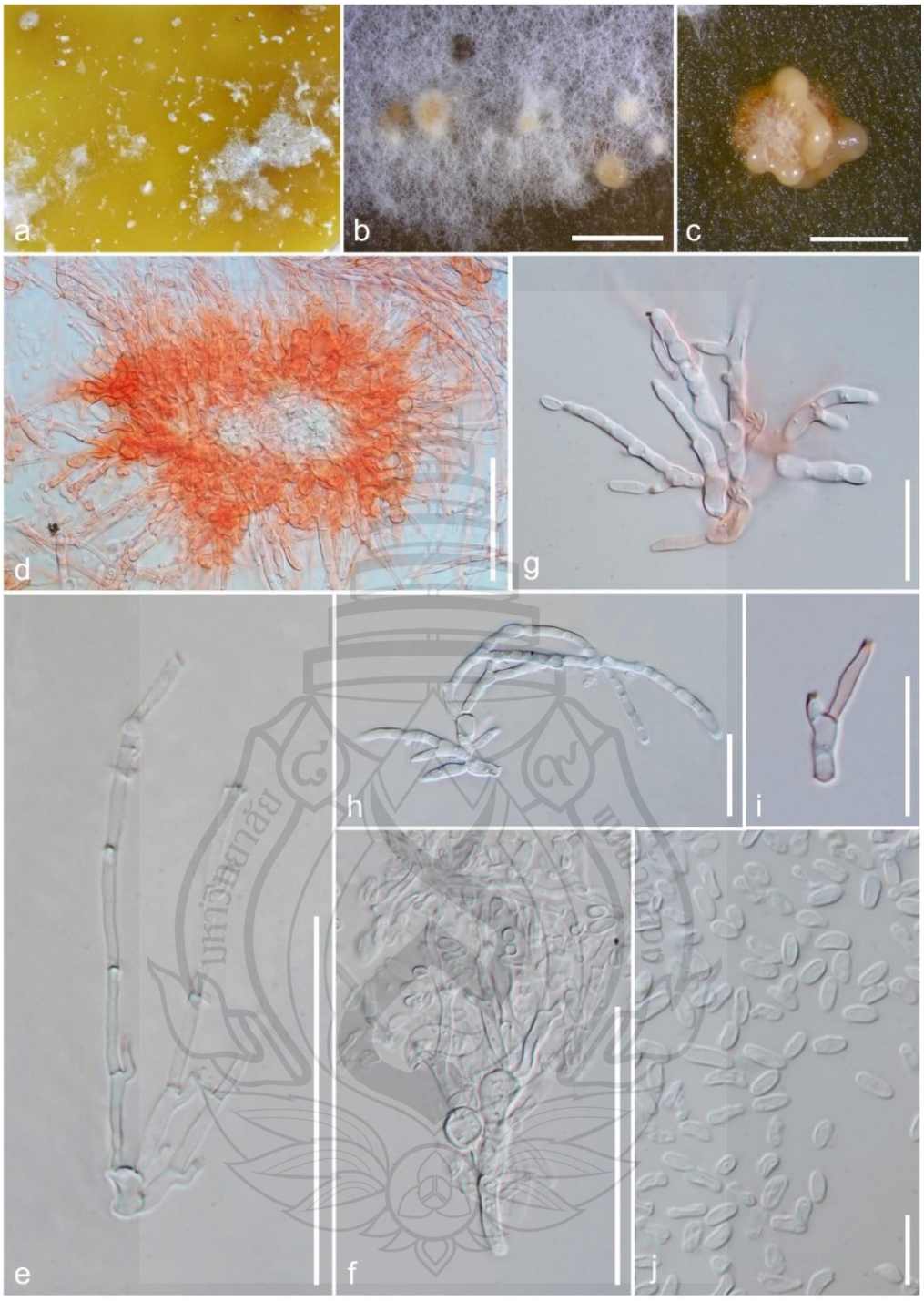
Index Fungorum number: IF206961, Facesoffungi number: FoF01990, Figure 2.67

Associated with woody substrates. **Sexual morph:** see Hirooka et al. (2012). **Asexual morph:** *Synnemata* 780–2600 μm high × 70–170 μm wide, erumpent through host epidermis, crowded to caespitose, cylindrical-capitate, subulate-capitate, or claviform, erect or nodding, unbranched or up to 3 branches at base, medium to slender, distinctly hispid at base to mid-level, stipe red-brown at base, KOH+ blood-red. *Hyphae on stipe* 3.4–6.2 μm wide, external hyphae pigmented, becoming less pigmented toward apex, KOH+; internal hyphae hyaline, KOH–. *Ornamental cells* 7–15.6 μm long, 2–3.7 μm wide, cylindrical, straight, curved, sinuous or sometimes twisted, usually unbranched, sometimes dichotomously branched, aseptate or up to 3-septate, terminal hyphae with bluntly rounded tips, distributed evenly or concentrated near base or apex of the stipe. *Conidiophores* bearing long sterile hyphae and phialides, branching monoverticillate or biverticillate, whorls compact or diffuse. *Sterile hyphae* 68–124 × 1.6–1.9 μm, acicular,



Note (a) Herbarium material. (b, c) Ascomata on host substrate (c moist with water). (d, g) Vertical section of ascomata. (e) Cells of stroma. (f) Surface view of peridium. (h) Vertical section of ostiole. (i) Upper view of ostiole. (j) Paraphyses. (k–n) Asci. (o–r) Ascospores. Scale bars: b, c = 500 µm, d = 200 µm, e = 50 µm, g = 200 µm, h = 100 µm, i, j = 50 µm, k–n = 20 µm, o–r = 10 µm.

Figure 2.65 *Nectria dematiosa* (MFLU 15-2286)



Note (a–c) Conidiomata on MEA. (d–i) Conidiophores and conidiogenous cells. (d, g, i in Congo red). (j) Conidia on MEA. Scale bars: b = 2 mm, c = 1 mm, d–f =50 µm, g–i = 20 µm, j = 10 µm.

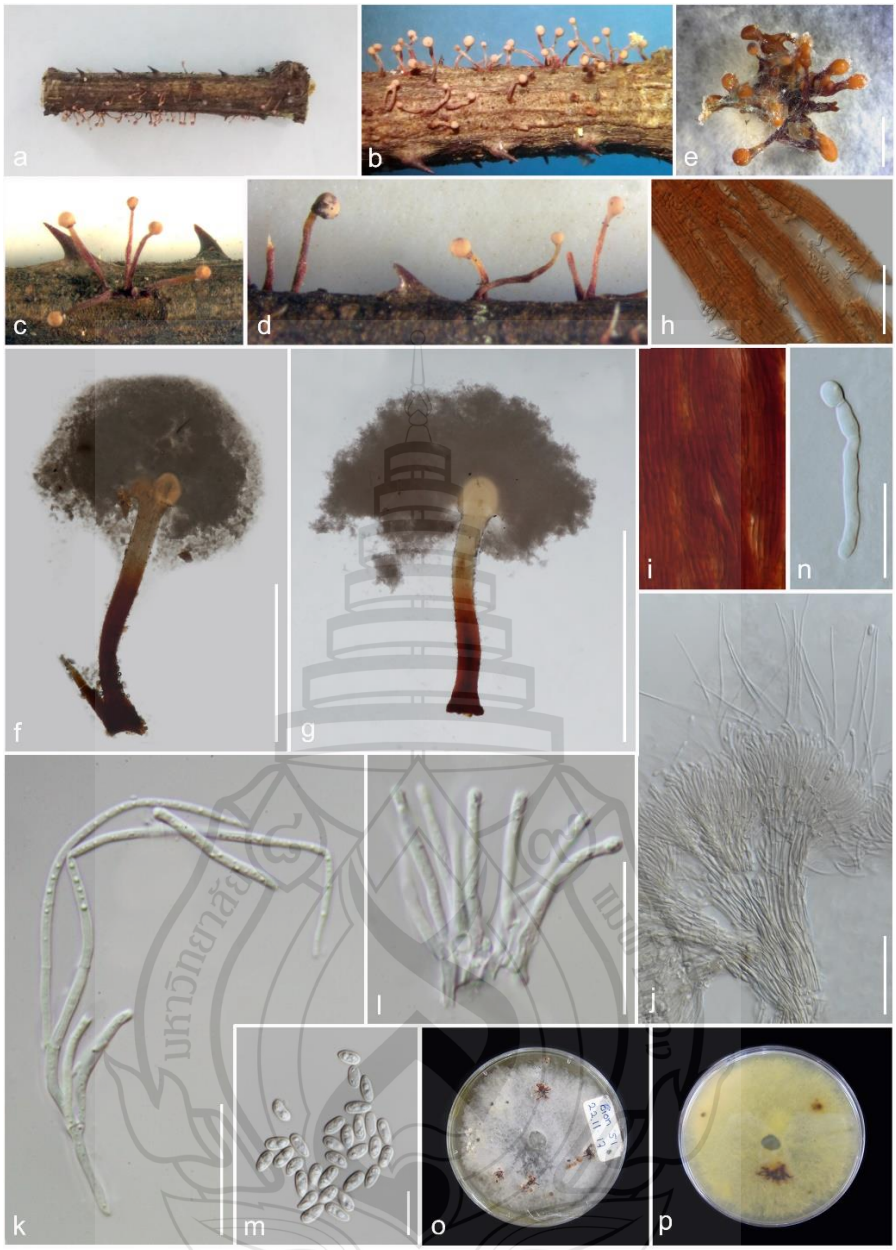
Figure 2.66 *Nectria dematiosa* (MFLU 17-1276, asexual morph on MEA)

curved or straight, unbranched or dichotomously branched, septate, arising from hyphae often in groups of 1–3 from conidiophores together with phialides. *Conidiogeonus cells* 18–25 × 1.3–2.1 μm, enteroblastic, monophialidic, cylindrical to subulate, straight or curved, in terminal whorls of 2–5 together with sterile hyphae or lateral and terminal without sterile hyphae, with a visible periclinal thickening, collarette not visible, hyaline, smooth walled. *Conidia* 4.5–6.8 × 2.3–3.2 μm ($\bar{x}$ = 5.7 × 2.6 μm; n = 35), ellipsoidal, obovate or oblong, sometimes somewhat curved, aseptate, guttulate, with a centrally located or slightly laterally displaced hilum, hyaline, smooth-walled. *Conidial masses* 130–400 μm wide, globose or hemispherical, whitish yellow when fresh, become sienna when dry.

Culture characteristics: Colonies on PDA reaching 55 mm diam. within 7 days at 25 °C. Colony circular, surface cottony with aerial mycelium orange, becoming yellowish brown, reverse orange to yellowish brown. Conidiomata produced after 3 months.

Material examined: THAILAND, Chiang Rai Province, Wiang Pa Pao District (lat.19.32975, long. 99.45048, alt. 661 m), on fallen dead twig of an unidentified plant, 9 November 2017, R. H. Perera, Bion51, MFLU 18-2715, living culture MFLUCC 18-0574).

GenBank numbers: LSU: ON352641, TEF1: ON364477.



Note (a) Herbarium material. (b–d) Synnemata on host substrate. (e) Synnemata on MEA. (f, g) Synnemata. (h) Hyphae on stipe and ornamental cells. (i) Hyphae on stipe in 3% KOH. (j, k) Conideophores, sterile hyphae and conidiogenous cells. (l) Conidiogenous cells. (m) Conidia. (n) Germinating conidium. (o, p) Colony on MEA. Scale bars: e = 2 mm, f, g = 1 mm, h, j = 50 µm, k, l = 20 µm, m = 10 µm, n = 20 µm.

Figure 2.67 *Nectria pseudotrichia* (MFLU 18-2715)

Nectria synnematosa R.H. Perera, Maharachch., E.B.G. Jones & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF559642, Facesoffungi number: FoF10976, Figures 2.68, 2.69

Etymology: Refers to the synnematous conidiomata.

Associated with woody substrates. **Sexual morph:** *Ascomata* and synnemata occurring on same or distinct stroma. *Mycelium* not visible around ascomata and on host. *Stromata* up to 500 mm high, well-developed, erumpent through epidermis, orange to bay, KOH+ dark purple, composed of pseudoparenchymatous, cells of *textura angularis* to *textura prismatica*. *Ascomata* 275–400 μm high × 275–521 μm diam., superficial on stromata, caespitose or solitary, globose, papillate, cupulate upon drying, red, with darker apical region, KOH+ dark purple, surface smooth or roughened with concolourous warts. *Peridium* cells forming *textura globulosa* or *textura angularis* in face view; 49–96 μm thick in vertical section, of three strata: outer stratum 22–53 μm thick, comprising pigmented cells forming *textura globulosa* or *textura angularis*, intergrading with stroma; middle stratum 7–25 μm thick, cells pigmented, containing brown to red-brown pigment droplets, forming *textura globulosa*; inner stratum 8–22 μm thick, of elongated, thin-walled, hyaline cells, forming *textura prismatica* , intergrading with stroma. *Asci* 57–102 × 14–29 μm ($\bar{x}$ = 81 × 22.3 μm; n = 40), 2–8-spored, unitunicate, clavate, with inconspicuous ring at apex, J-. *Ascospores* 18–38 × 8.3–17.4 μm, ($\bar{x}$ = 26.7–11.7 μm; n = 55), biseriate above, uniseriate below, muriform, with 3–7(–9) transverse septa and 1–2 longitudinal septa, constricted at each septum, ellipsoidal to fusiform, straight, occasionally slightly curved, hyaline, smooth-walled. **Asexual morph:** *Synnemata* 900–2980 μm high × 126–240 μm wide, erumpent through host epidermis, crowded to caespitose, associated with ascomata or not, cylindrical-capitate, subulate-capitate, or claviform, erect or nodding, unbranched or rarely up to 3 branches at base, medium to slender, distinctly hispid at base to mid-level, stipe red-brown at base, KOH+ blood-red. *Hyphae on stipe* 4–9 μm wide, external hyphae pigmented, becoming less pigmented toward apex, KOH+; internal hyphae hyaline, KOH–. *Ornamental cells* 4.3–12 μm long, 2.1–4.3 μm wide, cylindrical, straight, curved, sinuous or sometimes twisted, usually unbranched, sometimes dichotomously branched, aseptate or up to 3-septate, terminal hyphae with bluntly rounded tips, distributed evenly or concentrated near base or apex of

the stipe. *Conidiophores* bearing long sterile hyphae and phialides, branching monoverticillate or biverticillate, whorls compact or diffuse. *Sterile hyphae* 52–100 × 1.3–2 μm, acicular, curved or straight, unbranched or dichotomously branched, septate, arising from hyphae often in groups of 1–3 from conidiophores together with phialides. *Conidiogeonus cells* 12–30 × 1.5–2.2 μm, enteroblastic, monophialidic, cylindrical to subulate, straight or curved, in terminal whorls of 2–5 together with sterile hyphae or lateral and terminal without sterile hyphae, with a visible periclinal thickening, collarette not visible, hyaline, smooth walled. *Conidia* 4.2–7.2 × 2.5–3.3 μm ($\bar{x}$ = 5.7 × 2.8 μm; n = 65), ellipsoidal, obovate or oblong, sometimes somewhat curved, aseptate, guttulate, with a centrally located or slightly laterally displaced hilum, hyaline, smooth-walled. *Conidial masses* 110–335 μm wide, globose or hemispherical, whitish yellow when fresh, become sienna when dry.

Culture characteristics: Colonies on PDA reaching 45 mm diam. within 7 days at 25 ℃. Colony circular, surface cottony with aerial mycelium, white to yellowish, reverse orange to yellowish.

Material examined: THAILAND, Chiang Mai Province, on fallen dead twigs of Dicotyledon plant, 1 September 2017, R. Brahamanage, CM-04, MFLU 19-0963, living culture MFLUCC 18-0570; *Ibid*., on fallen dead twigs of *Dimocarpus longan* (Sapindaceae), 1 September 2017, R. H. Perera, CM-05, MFLU 19-0964, living culture MFLUCC 20-0012; *Ibid*., Phyao Province, Phachang Noi Pong District (lat. 19.3807881, long. 100.4050678), on fallen dead stem of *Gliricidia sepium* (Fabaceae), 9 November 2017, R. H. Perera, Bion07, MFLU 18-2701, living culture MFLUCC 20-0005; *Ibid*., Phyao Province, Phachang Noi Pong District, on dead stem of unidentified vein, 9 November 2017, R. H. Perera, Bion18, MFLU 18-2710, living culture MFLUCC 17-2629; *Ibid*., on dead stem of *Chromolaena odorata* (Siam weed) (Asteraceae), 9 November 2017, R. H. Perera, Bion19, MFLU 18-2711, living culture MFLUCC 20-0014. *Ibid*., Chiang Mai Province, on fallen dead branch of Dicotyledon plant, 2 February 2017, R. H. Perera, BN07, MFLU 18-2732, **holotype**, **ex-type** living culture MFLUCC 17-0133; *Ibid*., Lampang Province, on aerial dead stem of *Bauhinia racemosa* (Fabaceae), 18 August 2017, R. H. Perera, Lamp11a, MFLU 18-2762, living culture MFLUCC 18-0571; *Ibid*., Chiang Mai Province, Mae Rim District, on aerial dead twigs of *Muntingia calabura* (Muntingiaceae), R. H. Perera, 18 September 2017, Rim06,

MFLU 19-0968, living culture MFLUCC 18-0565; *Ibid*., on fallen dead stems of Dicotyledon plant, 18 September 2017, R. H. Perera, Rim14, MFLU 19-0974, living culture MFLUCC 18-0590. *Ibid*., Chiang Mai Province, on decaying seed pods of *Delonix regia* (Fabaceae), 1 September 2016, R.H. Perera, S-16 (MFLU 19-0986).

GenBank numbers: MFLUCC 18-0570: LSU: ON352636, ITS: ON361582, TEF1: ON364472; MFLUCC 20-0012: LSU: ON352637, ITS: ON361583, TEF1: ON364473; MFLUCC 20-0005: LSU: ON352638, TEF1: ON364474; MFLUCC 17-2629: LSU: ON352639, ITS: ON361584, RPB1: ON364462, TEF1: ON364475; MFLUCC 20-0014: LSU: ON352640, ITS: ON361585, RPB1: ON364463, TEF1: ON364476; MFLUCC 17-0133: LSU: ON352642; ITS: ON361586, RPB1: ON364464, TEF1: ON364478; MFLUCC 18-0571: LSU: ON352643; ITS: ON361587; MFLUCC 18-0565: LSU: ON352644, ITS: ON361588, RPB1: ON364465, TEF1: ON364479; MFLUCC 18-0590: ITS: ON427124, RPB2: ON453875, TEF1: ON453876.

Notes: *Nectria synnematosa* strains formed a monophyletic group sister to the *N. pseudotrichia* clade with moderate statistical support (87% MLBT; 0.99 BYPP; Figure 2.38). The ex-type of *Nectria synnematosa* (MFLUCC 17-0133) and ex-epitype of *N. pseudotrichia* (CBS 129368) showed 18 nucleotide differences (3.4%, 9 gaps) in the ITS region which indicates that they are distinct taxa (Jeewon & Hyde, 2016). Ex-type of *Nectria synnematosa* (MFLUCC 17-0133) and *N. pseudotrichia* strain (CBS 128670) showed 17 nucleotide differences (3.7%, 8 gaps) in the ITS region, 11 nucleotide differences (1.4%, 1 gap) in the LSU region, 47 nucleotide differences (5.7%, 3 gaps) in the TEF1 region and 15 nucleotide differences (2.4%, no gaps) in the RPB1 region. *Nectria synnematosa* resembles *N. pseudotrichia*, from which it differs by having larger ascospores (18–38 × 8.3–17.4 μm vs. 21–28.8 × 7.5–11.4 μm) (Hirooka et al., 2012). Hirooka et al. (2010) observed six subclades within *Nectria pseudotrichia* that are strongly interconnected with geography, but it was difficult to distinguish them morphologically (Hirooka et al., 2010, 2012). We also observed the cryptic nature of *Nectria pseudotrichia* in our study. However, in considering phylogenetic analysis, nucleotide differences in ITS, LSU, TEF1 and RPB1 regions and morphological variations we identified new species *Nectria synnematosa*.

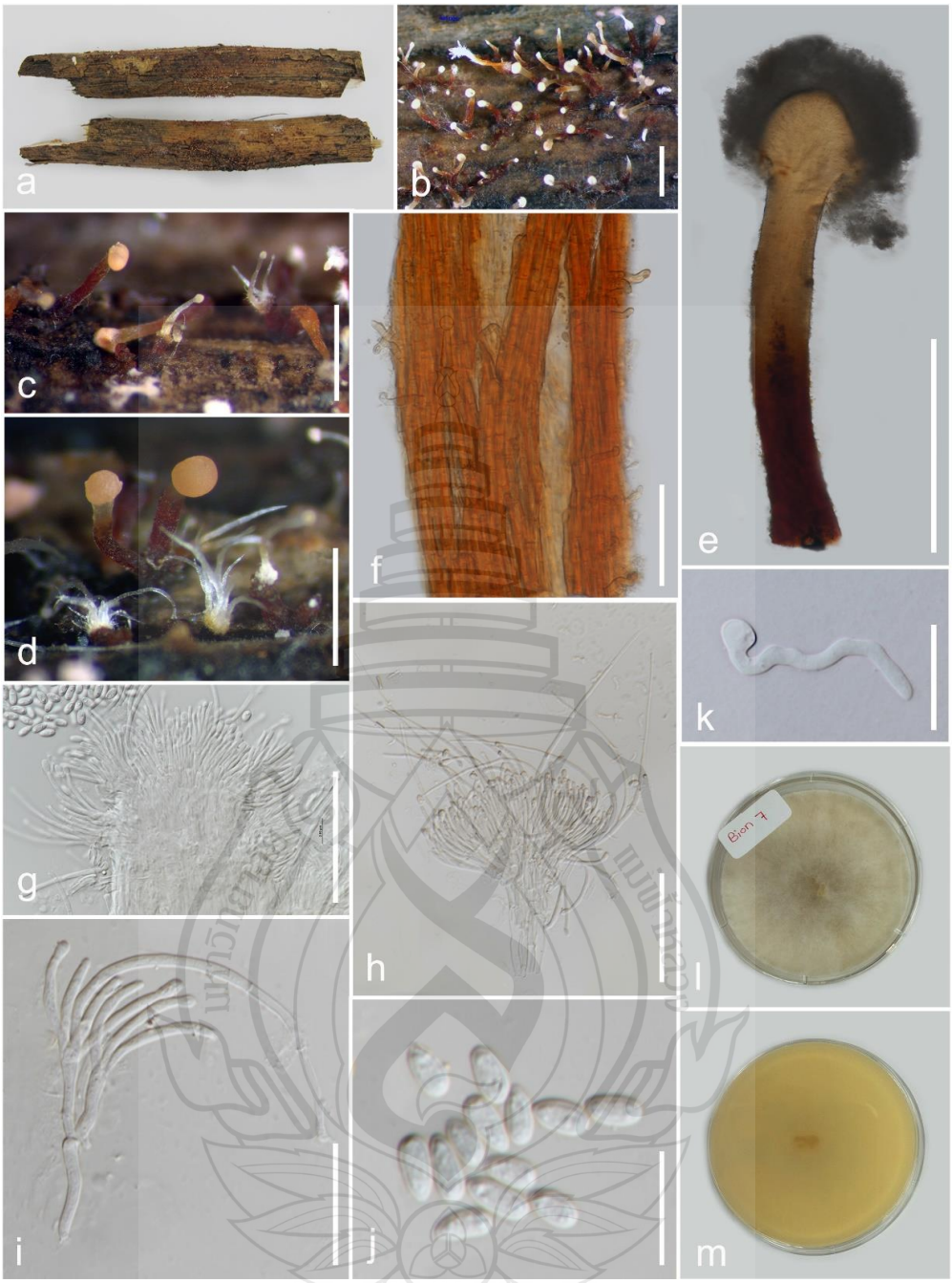
Neocosmospora E.F. Sm., U.S.D.A. Div. Veg. Pathol. Bull. 17: 45 (1899)

Index Fungorum number: IF3447, Facesoffungi number: FoF10977

Saprobic, some plant pathogenic, on herbaceous substrates, isolated from soil and nematodes; in terrestrial and marine environments. **Sexual morph:** *Ascomata* perithecial, solitary or gregarious, astromatic or seated on a reduced basal stroma, superficial, globose to pyriform, papillate or with short ostiolar neck, not collapsing upon drying, orange-brown to bright red, KOH+ darkening or becoming purple, surface usually tuberculate, rarely smooth-walled, lacking hairs or appendages. *Peridium* of two strata: outer stratum of thick-walled, pigmented cells forming a *textura angularis*; inner stratum of elongate, hyaline, thin-walled cells, becoming thinner towards the centrum. *Asci* 8-spored, unitunicate, saccate, clavate to cylindrical, apex simple, rounded or flattened. *Ascospores* uniseriate to irregularly biseriate, globose to ellipsoidal, with or without slightly truncate ends, generally 1-septate, initially hyaline, becoming yellow golden-brown at maturity, thick-walled, longitudinally striate; ascospores in some species 0-septate, cerebriform or spinulose. **Asexual morph:** *Conidiophores* mononematous (aerial) or grouped on sporodochia, or somewhat erect, loosely branched sporodochial pustules. *Aerial conidiophores* simple, sparsely to highly branched. *Aerial conidiogenous cells* monophialidic, elongate subulate to subcylindrical. *Aerial conidia* hyaline, smooth- and thick-walled, of two types. *Aerial microconidia* subglobose, ellipsoidal to somewhat clavate, 0–2(–4)-septate, held in false heads on phialides. *Aerial macroconidia* falcate, slightly to strongly curved dorsiventrally, 1-septate to multi-septate, with blunt to hooked to slightly pointed apical cell and papillate to well-developed foot-shaped basal cell. *Sporodochia* cream, pale luteous, light green, olivaceous, bluish, hazel to greyish sepia. *Sporodochial conidiophores* verticillately or sympodially branched or sparingly branched and densely packed, consisting of short, smooth- and thin-walled, stipes bearing apical whorl of 2–4 monophialides. *Sporodochial conidiogenous cells* monophialidic, doliiform, short subcylindrical to subulate, periclinal thickening and collarettes inconspicuous or absent, smooth- and thin-walled. *Sporodochial macroconidia* falcate, straight or curved

Note (a) Herbarium material. (b, c) Ascomata and synnemata on host substrate. (d) Vertical section of stroma with ascoma. (e–g) Vertical sections of ascomata (e in 3% KOH). (h–o) Asci. p Germinating ascospore. (q–v) Ascospores. (w, x) Colony on PDA. Scale bars: d = 500 µm, e–g = 200 µm, h–o = 50 µm, p–v = 20 µm.

Figure 2.68 *Nectria synnematosa* (MFLU 18-2732, holotype)



Note (a) Herbrium material. (b–d) Synnemata on host substrate. (e) Synnema mounted with with. (f) Closeup of the stipe. (g–i) Conidiophores and phialides. (j) Conidia. (k) Germinating conidium. (l, m) Colony of PDA. Scale bars: b–d = 1 mm, e = 500 µm, f–h = 50 µm, i = 20 µm, j = 10 µm, k = 20 µm.

Figure 2.69 *Nectria synnematosa* (a–f, h–k: MFLU 18-2701, g: MFLU 18-2732, holotype)

with parallel walls to unequally curved, in some species clavate and asymmetrical, tapering towards both ends, with a pointed to blunt to hooked apical cell and papillate to well-developed foot-shaped basal cell, smooth- and thick-walled. *Chlamydospores* globose to subglobose to ovoid to obovoid, hyaline to pale golden brown, smooth-walled to slightly verrucose, terminal or intercalary, solitary or in pairs or forming chains or aggregating in some species to form buff, olive aeruginous or bluish microsclerotia. (Adapted from Rossman et al., 1999; Crous et al., 2021).

Known distribution: Worldwide (Rossman et al., 1999)

Type species: ***Neocosmospora vasinfecta*** E.F. Sm., Bull. U.S. Department of Agriculture 17: 45 (1899)

Index Fungorum number: IF241907, Facesoffungi number: FoF10978

Discriptions and illustrations: Sandoval-Denis et al. (2019)

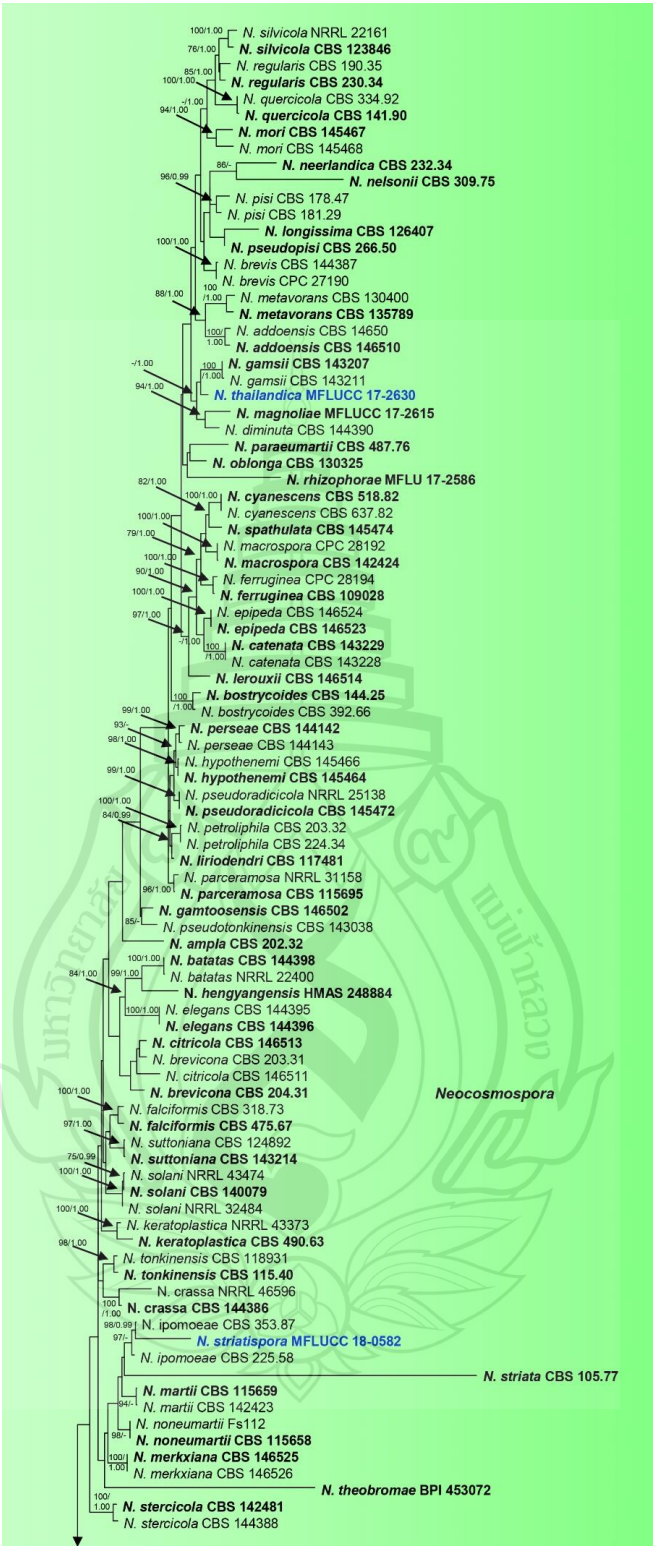
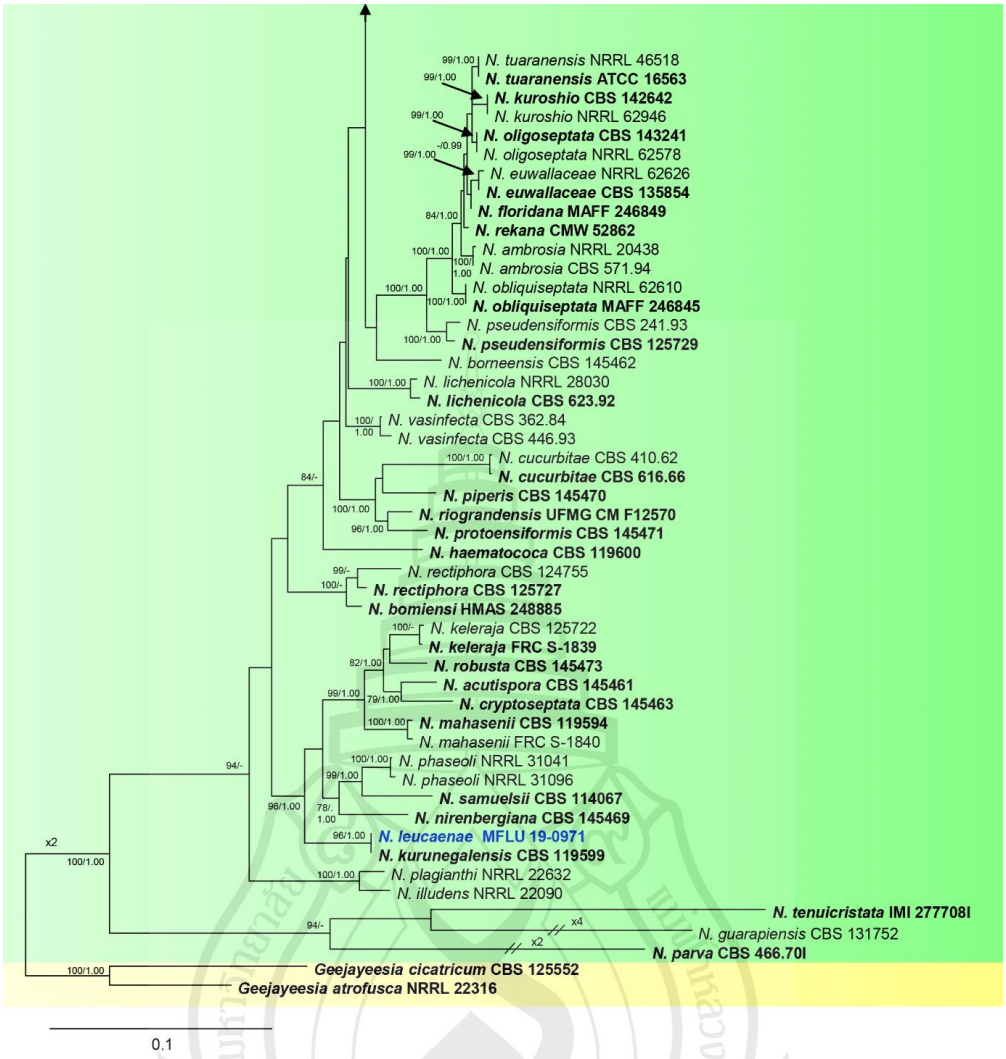


Figure 2.70 Phylogram generated from maximum likelihood analysis based on combined ITS, LSU, TUB2, and TEF1 sequence data of selected *Neocosmospora* taxa



Note One hundred forty-one strains are included in the combined analyses, which comprised 3597 characters (ITS: 480, LSU: 812, TUB2: 686, TEF1: 1619), including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to *Geejayeesia atrofusca* NRRL 22316 and *Geejayeesia cicatricum* CBS 125552. Ex-type strains are in bold. The newly generated sequences are indicated in blue. The scale bar indicates 0.1 nucleotide changes per site.

Figure 2.70 (continued)

Neocosmospora striatispora R.H. Perera, Maharachch., E.B.G. Jones & K.D. Hyde, ***sp. nov.***

Etymology: Name refers to striate ascospores.

Index Fungorum number: IF559636, Facesoffungi number: FoF10979, Figure 2.71

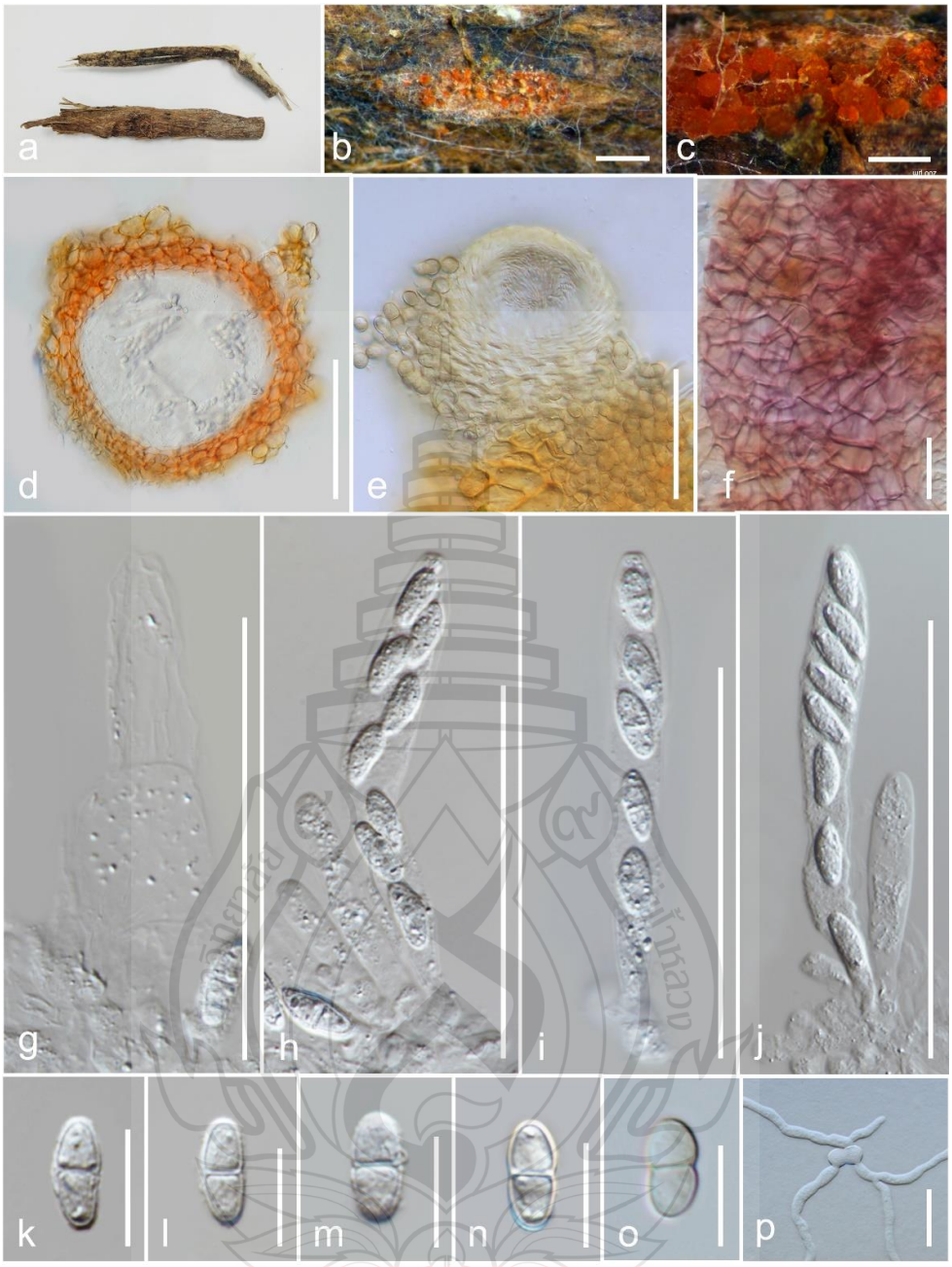
Associated with a dicotyledonous plant stem. **Sexual morph:** *Ascomata* 180–200 μm diam., perithecial, astromatic, superficial, gregarious, globose to pyriform, orange, KOH+ reddish purple, surface coarsely warted, glabrous. *Peridium* cells pigmented, forming *textura angularis* in face view; invertical section composed of thick-walled, orange cells of *textura angularis*. *Paraphyses* moniliform, hyaline, thin-walled. *Asci* 75–105 × 9.5–13.6 μm ($\bar{x}$ =89 × 11.2 μm, n = 142), 8-spored, unitunicate, subcylindrical to clavate, apex flat to rarely rounded, apex thickened, J-. *Ascospores* 8.5–12.5 × 3.9–6.2 μm ($\bar{x}$ = 10.6 × 5 μm, n = 20), uniseriate, obliquely uniseriate or irregularly biseriate at apex of the asci, broadly ellipsoidal to ellipsoidal, 1-septate, often constricted at septum, hyaline, becoming pale yellow-brown to golden yellow when mature, thick-walled, longitudinally finely striate. **Asexual morph:** Undetermined.

Culture characteristics: Ascospores germinating on PDA within 14 hours. Colonies growing on PDA, reaching up to 27 mm within 7 days at 28°C, surface effused, smooth, margin entire, aerial mycelium rare, initially white, becoming rosy pink, reverse rosy pink.

Material examined: THAILAND: Mae Rim District, Chiang Mai Province, on a dicotyledonous plant stem, 18 September 2017, R. H. Perera, Rim14a (MFLU 19-0975, **holotype**), **ex-type** living culture MFLUCC 18-0582.

GenBank numbers: ITS: ON775553, TEF1: ON892545, TUB2: ON892552

Notes: Our new isolate (MFLUCC 18-0582) clustered with *Neocosmospora ipomoeae* isolates CBS 353.87 and CBS 225.58 with high statistical support (Figure 2.70). DNA sequences of type material of *N. ipomoeae* is lacking. Ascospore measurements of the *N. striatispora* are similar to *N. ipomoeae* (Sandoval-Denis et al., 2019). However, the new collection has longer asci (75–105 μm vs. 67.5–80.5 μm) and orange ascomata, while *N. ipomoeae* has shorter asci and orange to dark-red ascomata (Sandoval-Denis et al., 2019). We also compared the ITS and TEF1 sequences. The new isolate MFLUCC 18-0582 and *N. ipomoeae* isolate (CBS 353.87) showed 7 different nucleotides in the ITS region (1.6%, 0 gaps) and 18 in TEF1 sequences (2.8%, 1 gap).



Note (a) Herbarium material. (b, c) Ascomata on host substrate. (d) Vertical section of ascoma. (e) Upper view of ostiolar canel. (f) Surfave view of peridium cells in 3% KOH. (g–j) Asci. (k–o) Ascospores. (p) Germinating ascospore. Scale bars: b = 1 mm, c = 500 µm, d = 100 µm, e = 50 µm, f = 10 µm, g–j = 50 µm, k–o = 10, p= 20 µm.

Figure 2.71 *Neocosmospora striatispora* (MFLU 19-0975, holotype)

Based on morphological data and differences in ITS and TEF1 sequences we introduce *N. striatispora* as a new species.

Neocosmospora leucaenae R.H. Perera, Maharachch. & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF519847, Facesoffungi number: FoF10980 Figure 2.72

Etymology: Name refers to the host genus *Leucaena* from which it was collected.

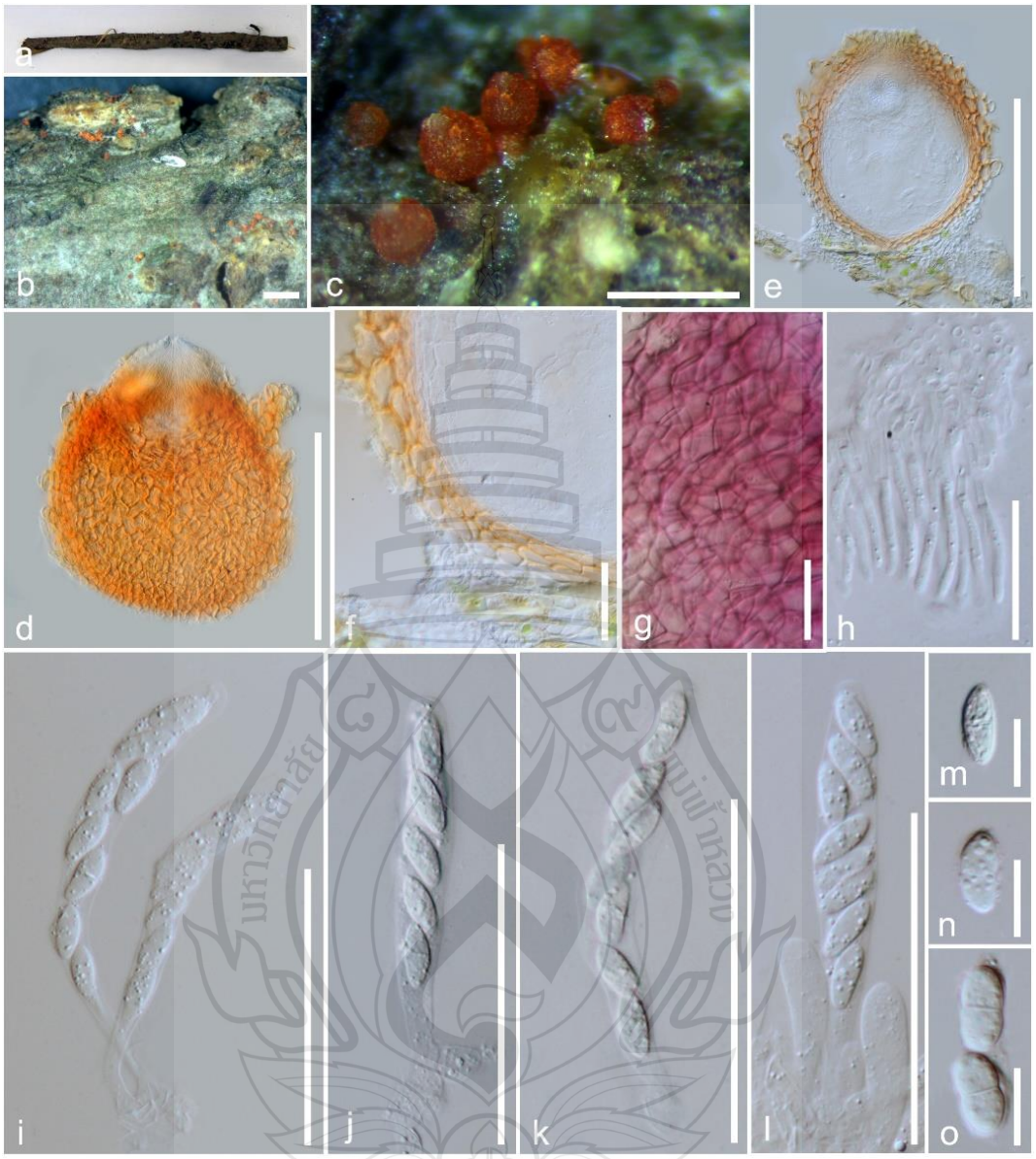
Saprobic on *Leucaena leucocephala*. **Sexual morph:** *Ascomata* 185–280 mm high, 180–240 µm wide, perithecial, superficial on a basal stroma, gregarious, globose to broadly pyriform, collapsing by lateral pinching when dry, red-orange, KOH+ purple. *Ostiolar canal* lined with filiform, hyaline periphyses rounded at the apex. *Peridium* 25–55 µm thick in vertical section, composed of two strata, outer stratum 15–40 µm thick including warts, of thick-walled, pigmented cells, globose in outline, becoming elongate towards the centrum; inner stratum 6–13 µm thick, composed of thin-walled, elongate, hyaline cells. *Asci* 45–88 × 7.5–11 µm (65.5 × 8.7 µm; n =20), 8-spored, unitunicate, clavate to cylindric clavate, apex flattened, simple. *Ascospores* 10.5–13.6 × 4–6.1 µm (11.4 × 4.9 µm; n =45), bi- to multi-seriate, uni-seriate toward the base, broadly ellipsoidal, 1-septate, hyaline, slightly constricted at the septum, smooth-walled, without appendages. **Asexual morph:** Nalim et al. (2011).

Material examined: THAILAND, Chiang Mai Province, Mae Rim District, on fallen dead stem bark of *Leucaena leucocephala* (Fabaceae), 18 September 2017, R. H. Perera, Rim10, MFLU 19-0971, **holotype**.

GenBank nubers: LSU: ON787616

Notes: Since we could not maintain the living cultures DNA was extracted directly from the fruiting bodies. The new collection (MFLU 19-0971) clades sister to ex-type of *N. kurunegalensis* (CBS 119599), which was isolated from Sri Lanka (Nalim et al., 2011) (Figure 2.70). Ascomatal morphology and asci measurements of new collection are similar to the latter of holotype of *N. kurunegalensis*. However, MFLU 19-0971 has smaller ascospores (10.5–13.6 × 4–6.1 µm vs. 13.2–15 × 6.2–7.5 µm), which are not striate, when compared to *N. kurunegalensis* (Nalim et al., 2011). Furthermore, Nalim et al. (2011) mentioned that ascomata turned to red in 3% KOH, while our colletion having ascomata turned purple in 3% KOH. We noted that LSU sequences of our collection and

N. kurunegalensis (CBS 119599) are identical. Nonetheless, we identified our collection (MFLU 19-0971) as a new species *N. leucaenae* based on morphological data.



Note (a) Herbarium material. (b, c) Ascomata on the host. (d) Transverse section of ascoma. (e) Ascoma mounted in water. (f) Transverse section of the peridium. g Face view of peridium cells. (h) Periphyses. (i–l) Asci. (m–o) Ascospores. Scale bars: b = 1 mm, c = 500 µm, d, e = 200 µm, f–h = 20 µm, i–l = 50 µm, m–o = 10 µm.

Figure 2.72 *Neocosmospora leucaenae* (MFLU 19-0971, holotype)

Neocosmospora thailandica R.H. Perera, E.B.G. Jones & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF559637, Facesoffungi number: FoF10981, Figure 2.73

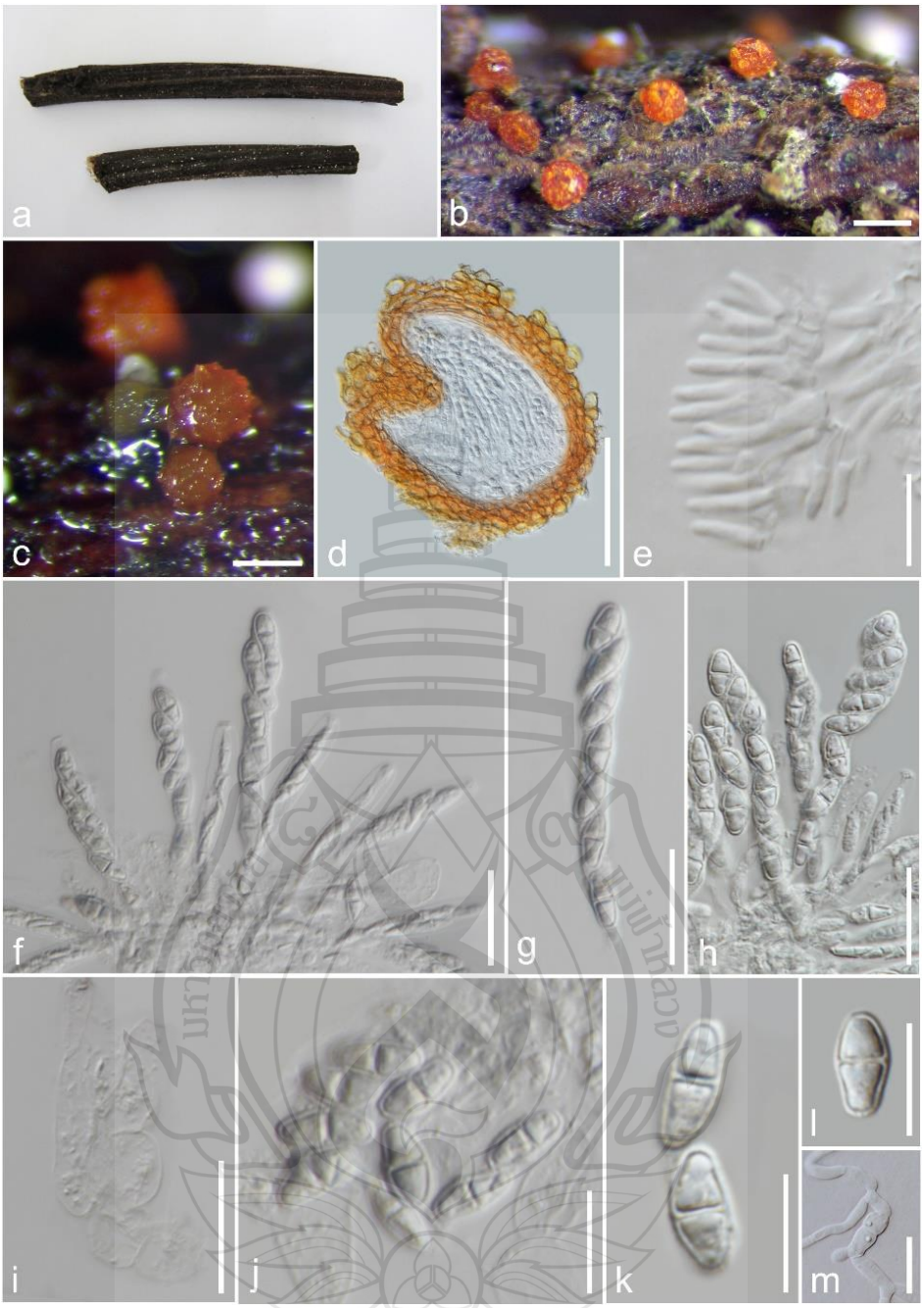
Etymology: Name refers to the type locality Thailand.

Saprobic on plant stems. **Sexual morph:** *Ascomata* 160–220 μm diam., perithecial, solitary or in small groups of 2–3, globose to pyriform, superficial, orange to brown-red, KOH+ reddish purple, surface coarsely warted, glabrous. *Peridium* cells pigmented, forming *textura angularis* in face view; 23–40 μm thick in vertical section, of two strata, outer stratum 20–37 μm thick including warts, of thick-walled, pigmented cells, globose in outline, becoming elongate towards the centrum; inner stratum 4–7 μm thick, composed of thin-walled, elongate, hyaline cells. *Paraphyses Asci* 57–70 × 6.6–9 μm ($\bar{x}$ = 63 × 7.7 μm; n = 20), 8-spored, unitunicate, clavate, short pedicellate, with a broad and somewhat flattened apex, apical ring J-. *Ascospores* 8.6–11 × 3.7–5.2 μm ($\bar{x}$ = 9.2–4.5 μm; n = 50), obliquely uniseriate or irregularly biseriate, ellipsoid to sub-fusiform, 1-septate, not constricted at the septum, hyaline, pale yellow-brown when aged, thick-walled, longitudinally finely striate, without appendages. **Asexual morph:** Undetermined.

Material examined: THAILAND, Phyao Province, Phachang Noi Pong District, on dead stem of unidentified vein, 9 November 2017, R. H. Perera, Bion20 (MFLU 18-2712, **holotype**), **ex-type** living culture MFLUCC 17-2630.

GenBank nubers: LSU: ON787612, ITS: ON787624, TEF1: ON892546

Notes: Our new collection (MFLU 19-0971) clades sister to ex-type of *N. gamsii* (CBS 143207) and *N. gamsii* (CBS 143211) with low bootstrap support (Figure 2.70). *Neocosmospora thailandica* and the ex-type of *N. gamsii* isolate (CBS 143207) showed 2 different nucleotides in the ITS region (0.4%, 1 gap), 24 in TEF1 sequences (3.6%, 14 gap) and LSU sequences were identical. Compared to *Neocosmospora gamsii, N thailandica* differs in smaller asci (57–70 vs. 72–87.5μm), and ascospores (8.6–11 × 3.7–5.2 μm vs. 10.5–11.5 × 5–6.5 μm) that are not constricted (Sandoval-Denis & Crous, 2018). We therefore introduce *N. thailandica* as a new species.



Note (a) Herbarium material. (b, c) Ascomata on the host. (d) Transverse section of ascoma. (e) Periphyses. (f–h) Asci. (i) Paraphyses. (j–l) Ascospores. (m) Germinating ascospore. Scale bars: b, c = 200 µm, d = 50 µm, e = 10 µm, f–i = 10 µm, j–l = 10 µm, m = 20 µm.

Figure 2.73 *Neocosmospora thailandica* (MFLU 18-2712, holotype)

Neonectria Wollenw., Annls mycol. 15(1/2): 52 (1917)

= *Cylindrocarpon* Wollenw., Phytopathology 3: 225. 1913

Index Fungorum number: IF3469, Facesoffungi number: FoF10982

On woody substrates. **Sexual morph:** *Ascomata* perithecial, solitary or in groups, superficial, seated on an erumpent stroma, subglobose to broadly obpyriform, with a blunt to acute apex, rarely papillate, red, KOH+ dark red, LA+, not collapsing upon drying, surface smooth to slightly rugulose, without hairs or appendages. *Peridium* of two strata: outer stratum composed of thick-walled, pigmented cells forming a *textura epidermoidea*; inner stratum of elongate, hyaline, thin-walled cells, becoming thinner toward the centrum. *Asci* cylindrical, 8-spored, without an apical ring, uniseriate. *Ascospores* ellipsoidal to fusoid, 1-septate, hyaline, smooth or finely spinulose. **Asexual morph:** *Sporodochia* not producing. *Conidiophores* mononematous, unbranched or irregularly branched, septate, hyaline, bearing in 1–3 phialides at the apex or reduced to lateral phialides. *Conidiogenous cells* monophialidic, cylindrical, tapering towards the apex, periclinal thickening inconspicuous, with inconspicuous collarettes. *Microconidia* abundant, ellipsoidal to obovoid, aseptate, hyaline, sometimes producing false heads on phialides. *Macroconidia* cylindrical, 3–7(–9)-septate, usually straight, with rounded ends. *Chlamydospores* terminal or intercalary, solitary or in pairs or occurring in chains, globose to subglobose, hyaline to subhyaline, smooth-walled to slightly verrucose. (Adapted from Chaverri et al., 2011; Crous et al., 2021).

Known distribution: Cosmopolitan (Chaverri et al., 2011)

Notes: *Neonectria* has been linked to the asexual morph genus *Cylindrocarpon* with the link being established based on multigene phylogeny (Brayford et al., 2004; Chaverri et al., 2011). *Neonectria sensu lato* and cylindrocarpon-like taxa were assigned to four genera: *Rugonectria*, *Thelonectria*, *Ilyonectria* and *Campylocarpon* by Chaverri et al. (2011). Macroconidia of *Neonectria* are characterized by 3–7(–9) septa, typically 5-septate (González & Chaverri, 2017).

Type species: ***Neonectria candida*** (Ehrenb.) Rossman, L. Lombard & Crous, in Lombard, van der Merwe, Groenewald & Crous, Stud. Mycol. 80: 217 (2015)

= *Neonectria ramulariae* Wollenw., Annls mycol. 15(1/2): 52 (1917)

See Index Fungorum for other synonyms.

Index Fungorum number: IF234524, *Facesoffungi number*: FoF10983

Neonectria punicea (J.C. Schmidt) Castl. & Rossman, in Castlebury, Rossman & Hyten, Can. J. Bot. 84(9): 1425 (2006)

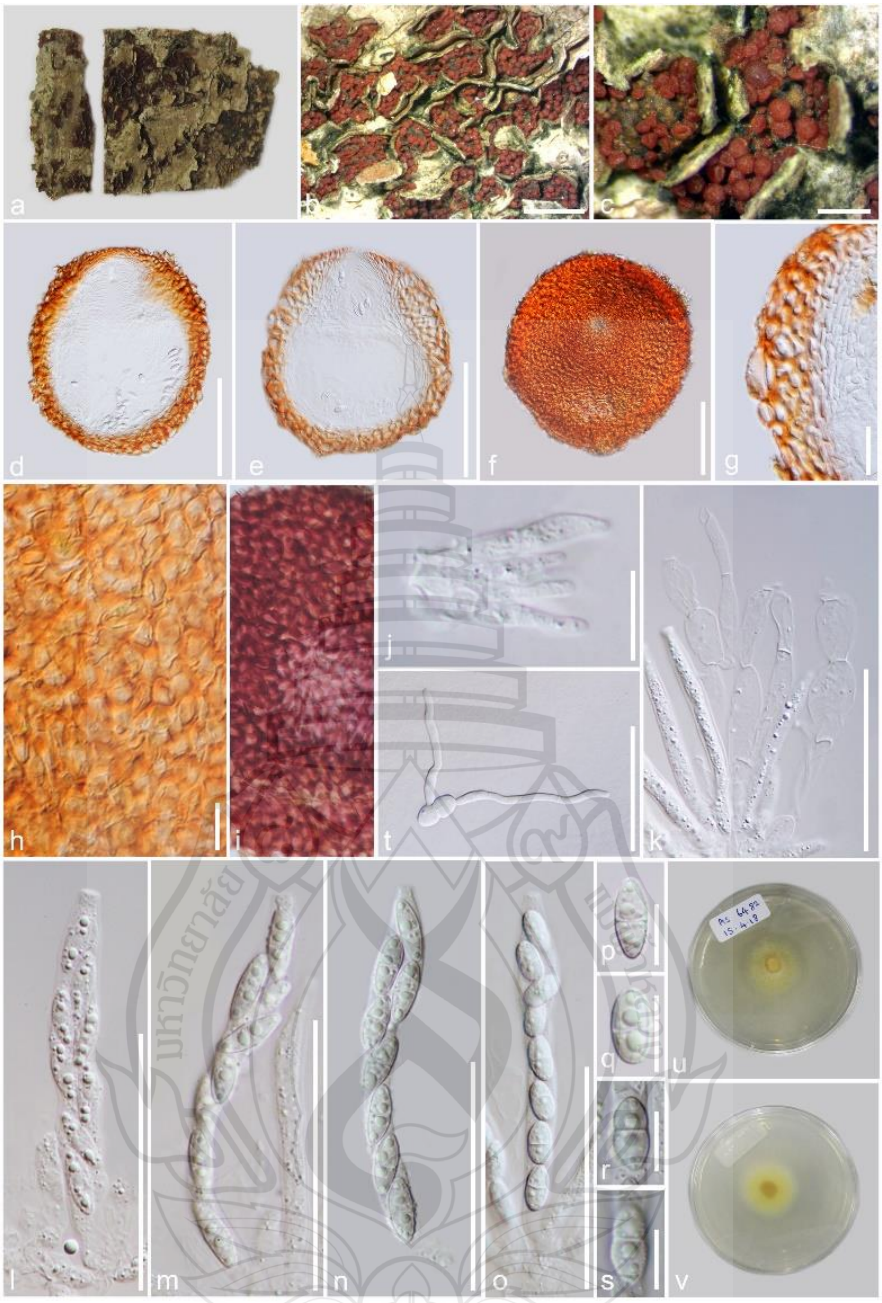
Index Fungorum number: IF501100, Facesoffungi number: FoF10984, Figure 2.74

Associated with branches of *Acer pseudoplatanus*. **Sexual morph:** *Stromata* well-developed, erumpent through epidermis, scarlet to bay, KOH+ dark red, composed of pseudoparenchymatous cells forming *textura angularis* to *textura prismatica*, intergrading with peridium. *Ascomata* 180–340 μm high and 160–300 μm diam., perithecial, superficial on stroma, solitary or caespitose of several, subglobose to pyriform, often cupulate upon drying, apapillate or slightly papillate, red to sienna, KOH+ purple, surface smooth to rough. *Ostiolar canal* lined with periphyses. *Peridium* cells forming *textura globulosa* or *textura angularis* in face view; 44–40 μm thick in vertical section, of two strata: outer stratum 30–33 μm thick, intergrading with stroma, composed, pigmented cells forming *textura globulosa* or *textura angularis*; inner stratum 5–14 μm thick, composed of elongated, thin-walled, hyaline cells forming *textura prismatica*. *Apical paraphyses* moniliform, hyaline, thin-walled. *Asci* 70–96 × 6.5–10.6 μm ($\bar{x}$ = 82.3 × 9 μm; n = 20), 8-spored, unitunicate, cylindrical to narrowly clavate, short-pedicellate, apical ring J-. *Ascospores* 9.5–14.5 × 4.6–6.5 μm ($\bar{x}$ = 12.8 × 5.1 μm; n = 40), uniseriate, occasionally obliquely biseriate near apex, ellipsoidal to fusiform, sometimes long fusiform, 1-septate, with narrowly rounded ends, straight or slightly curved, 2, 4-guttulate, hyaline, finely spinulose. **Asexual morph:** see Hirooka et al. (2013).

Culture characteristics: Ascospores germinated on PDA within 12 hours. Colonies growing on PDA, reaching up to 40 mm within 7 days at 28°C, radial, surface cottony, aerial mycelium abundant, sometimes wavy, white to pale ochraceous, reverse similar colour.

Material examined: UKRAINE, Transcarpathian Region, Rakhiv District, Carpathian Biosphere Reserve (Chornogora branch), vicinities of Lviv National University Biological station, on slope of the Menchul Kvasivsky mountain, on fallen skeletal branches of *Acer pseudoplatanus* L. (Sapindaceae), 9 August 2017, Leg. A. Akulov, CWU (Myc) AS6482 (MFLU 17-1618), living culture: MFLUCC 18-0606.

GenBank numbers: LSU: ON787618, ITS: ON787625, TEF1: ON892547, TUB2: ON892553.



Note (a) Herbarium material. (b, c) Ascomata on the host. (d, e) Transverse section of ascomata. (f) Ascoma mounted in water. (g) Transverse section of peridium. (h, i) Face view of peridium (i in 3% KOH). (j) Periphyses. (k) Asci and paraphyses. (l–o) Asci. (p–s) Ascospores. (t) Germinating ascospore. (u, v) Colony on MEA. Scale bars: b = 2 mm, c = 500 µm, d–f = 100 µm, g, h = 20 µm, j = 10 µm, k–o = 50 µm, p–s = 10 µm, t = 50 µm.

Figure 2.74 *Neonectria punicea* (MFLU 17-1618)

Neonectria coccinea (Pers.) Rossman & Samuels, in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 158 (1999)

Index Fungorum number: IF460455, Facesoffungi number: FoF10985, Figures. 2.75, 2.76

On *Fagus sylvatica*. **Sexual morph:** *Stromata* up to 275 μm high, well-developed, erumpent through epidermis, composed of pseudoparenchymatous cells *forming textura angularis* to *textura prismatica*, intergrading with ascomatal wall, red to bay, KOH+ dark red. *Ascomata* 200–350 μm high and 150–350 μm diam., perithecial, superficial on stroma, solitary or caespitose up to large numbers on a stroma, subglobose to pyriform, often cupulate upon drying or collapsing by lateral pinching, papillate, red to sienna, apical region sometimes slightly darker, KOH+ purple, surface smooth to rough. *Peridium* surface cells forming *textura globulosa* or *textura angularis* in face view, 16–50 μm thick in vertical section, of two strata: outer stratum 20–39 μm thick, intergrading with stroma, composed of pigmented cells forming *textura globulosa* or *textura angularis*; inner stratum 6–18 μm thick, composed of elongated, thin-walled, hyaline cells forming textura prismatica. *Asci* 56–100 × 8.5–12.2 μm ($\bar{x}$ = 82.9–11.1 μm; n=20), 8-spored, unitunicate, cylindrical to narrowly clavate, stipitate, apical ring J-. *Ascospores* 10.2–18 × 4.5–6.7 μm ($\bar{x}$ = 15.1 × 5.3; n=35), obliquely uniseriate, sometimes obliquely biseriate near apex, ellipsoidal to fusiform, with narrowly rounded ends, straight or slightly curved, 1 septate, not constricted at the septum, hyaline, finely spinulose. **Asexual morph:** *Conidiomata* sporodochial, occur on stroma, yellow-brown to bay. *Stromata* erumpent through the host epidermis, composed of lightly to darkly pigmented pseudoparenchymatous cells forming *textura angularis* to *textura primatica*. *Conidiophores* 40–150 μm high, 2.5–5 μm wide, unbranched or 1 to 2-level verticillately branched, densely packed, septate, hyaline, smooth-walled, each branch producing an apical monophialide. *Conidiogenous cells* 5–40 μm long, 1.5–3 μm wide at base, monophialidic, cylindrical and slightly tapering toward tip or narrowly flask-shaped, without periclinal thickening, collarettes visible, hyaline, smooth-walled. *Conidia* 5–100 × 2.5–6.4 μm ($\bar{x}$ = 68 × 4.3 μm; n = 37), ellipsoidal, oblong to long cylindrical, straight or slightly curved with round at both ends, 0–7-septate, not constricted at septa, hyaline, smooth-walled.

Culture characteristics: Ascospores germinated on PDA at 25°C within 24 hrs. Colony on PDA reaching 40 mm diam. at 25°C. Colony circular, surface cottony with aerial mycelium, white to yellowish white, reverse yellow to ochraceous.

Material examined: UKRAINE, Ivano-Frankivs'k Region, Kosiv District, National Nature Park "Hutsulshchyna" (Carpathians), vicinities of Sheshory village, mixed forest in the Korov'yak stow, on fallen skeletal branches of *Fagus sylvatica* L. (Fagaceae), 04 August 2017, Leg. A. Akulov, CWU (Myc) AS6469 (MFLU 17-1614); living culture MFLUCC 18-0600; *Ibid*., CWU (Myc) AS6470 (MFLU 17-1615); living culture MFLUCC 18-0601.

GenBank nubers: MFLUCC 18-0600: LSU: ON787619, ITS: ON787626, TEF1: ON892548, TUB2: ON892554; MFLUCC 18-0601: ITS: ON787627, TEF1: ON892549, TUB2: ON892555

Note (a) Herbarium material. (b, c) Ascomata on host substrate. (d, e) Vertical sections of ascomata. (f) Vertical section of peridium. (g, h) Face view of peridium (h in 3% KOH). (i–k) Asci. (l–p) Ascospores. (q) Germinating ascospores. (r, s) Colony on PDA. Scale bars: b = 2mm, c = 1 mm, d, e = 200 µm, f = 50 µm, i–k = 50 µm, l–p = 10 µm, q = 20 µm.

Figure 2.75 *Neonectria coccinea* (MFLU 17-1614)

Note (a) Herbarium material. (b, c) Conidiomata on the host. (d) Transverse section of conidiomata. (e) Cells of stromata tissue. (f, g) Conidiophores and conidia. (h–k) Conidia. (l) Germinating conidium. (m, n) Colony on MEA. Scale bars: b = 1 mm, c = 500 µm, d–l = 50 µm.

Figure 2.76 *Neonectria coccinea* (MFLU 17-1615)

Nothofusarium Crous, Sand.-Den. & L. Lombard, in Crous et al., Stud. Mycol. 98(no. 100116): 71 (2021)

Index Fungorum number: IF838674, Facesoffungi number: FoF10986

Associated with dead cladodes of *Ruscus aculeatus*. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiophores* mononematous (aerial conidiophores) or sporodochial. *Aerial conidiophores* simple, unbranched or irregularly branched, sometimes reduced to single lateral phialides or phialidic pegs on the hyphae. *Conidiogenous cells* monophialidic, cylindrical, tapering towards apex, with periclinal thickening inconspicuous or absent, smooth- and thin-walled, occur singly. *Microconidia* absent. *Aerial macroconidia* falcate, 1–5(–6)-septate, curved to lunate, with a blunt apical cell and often obtuse, poorly- to well-developed foot-shaped basal cell, thick-walled. *Sporodochia* white, pale luteous to pale citrine. *Sporodochial conidiophores* irregularly and verticillately branched, consisting of short, smooth- and thin to thick-walled stipes bearing apical whorls of mono- and polyphialides. *Sporodochial conidiogenous cells* monophialidic and polyphialidic, doliiform, subulate to subcylindrical, apex with reduced collarette, smooth- and thin-walled. *Sporodochial macroconidia* similar to aerial macroconidia. *Chlamydospores* subglobose to ellipsoidal, solitary or arrange in chains (Adapted from Crous et al., 2021).

Type species: ***Nothofusarium devonianum*** L. Lombard, Crous & Sand.-Den., in Crous et al., Stud. Mycol. 98(no. 100116): 72 (2021)

Index Fungorum number: IF838675, Facesoffungi number: FoF10987

Descriptions and illustrations: see Crous et al. (2021)

Ophionectria Sacc., Michelia 1(no. 3): 323 (1878)

= *Antipodium* Piroz., Can. J. Bot. 52(5): 1143 (1974)

Index Fungorum number: IF3608, Facesoffungi number: FoF10988

On decaying woody substrates or other plant debris. **Sexual morph:** *Subiculum* if present white to bright yellow, composed of thick-walled, minutely warted septate hyphae, each cell swollen at one end. *Ascomata* perithecial, solitary or aggregated in groups, superficial on substrate or sometimes seated on a subiculum, ovoid to elongate-ovoid to cylindrical, often truncate at the apex, red-orange to scarlet, KOH+ dark red to bay, surface covered with warts, ascomata often naked towards the apex. *Ascomatal warts* conspicuous, concolorous, composed of loosely compacted, irregularly globose,

pigmented cells. *Apical paraphyses* early evanescent. *Asci* 8-spored, unitunicate, clavate, without an apical ring. *Ascospores* long-fusiform, often slightly bent, vermiform, multi-septate, the proximal end slightly inflated and bluntly rounded, the distal end tapering and narrowly rounded, thick-walled, hyaline, with faint longitudinal striations or smooth. **Asexual morph:** *Conidiophores* arise laterally from hyphae, septate, unbranched, erect, straight, thin-walled, hyaline tapering toward the apex, bearing a single phialide at the apex. *Conidiogenous cells* phialidic, cylindrical. *Conidia* fusiform, (2–)3–5(–6)-septate, with the two middle cells larger than the end cells, not constricted at the septa, or broadly ellipsoidal to ovoid and slightly constricted at the median septum, initially hyaline turning olive-yellow with age (Adapted from Rossman, 1977; Rossman et al., 1999; Lombard et al., 2015).

Known distribution: Worldwide

Notes: Saccardo (1878a) introduced *Ophionectria* to accommodate *Nectria* species with very long spores. Rogerson (1970) seperated *Calonectria* from *Ophionectria* based on ascospore length-width ratio (less or greater than 20: 1). However, ascospore length-width ratios do not separate these two genera properly (Rossman, 1977). Rossman (1977) suggested to use perithecial wall structure to differentiate *Ophionectria* and *Calonectria*. Lombard et al. (2015) proposed to protect older and widely used generic name *Ophionectria* over generic name *Antipodium*, which was followed by Rossman et al. (2016).

Type species: ***Ophionectria trichospora*** (Berk. & Broome) Sacc., Michelia 1(no. 3): 323 (1878)

Basionym: *Nectria trichospora* Berk. & Broome, J. Linn. Soc., Bot. 14(no. 74): 115 (1873) [1875]

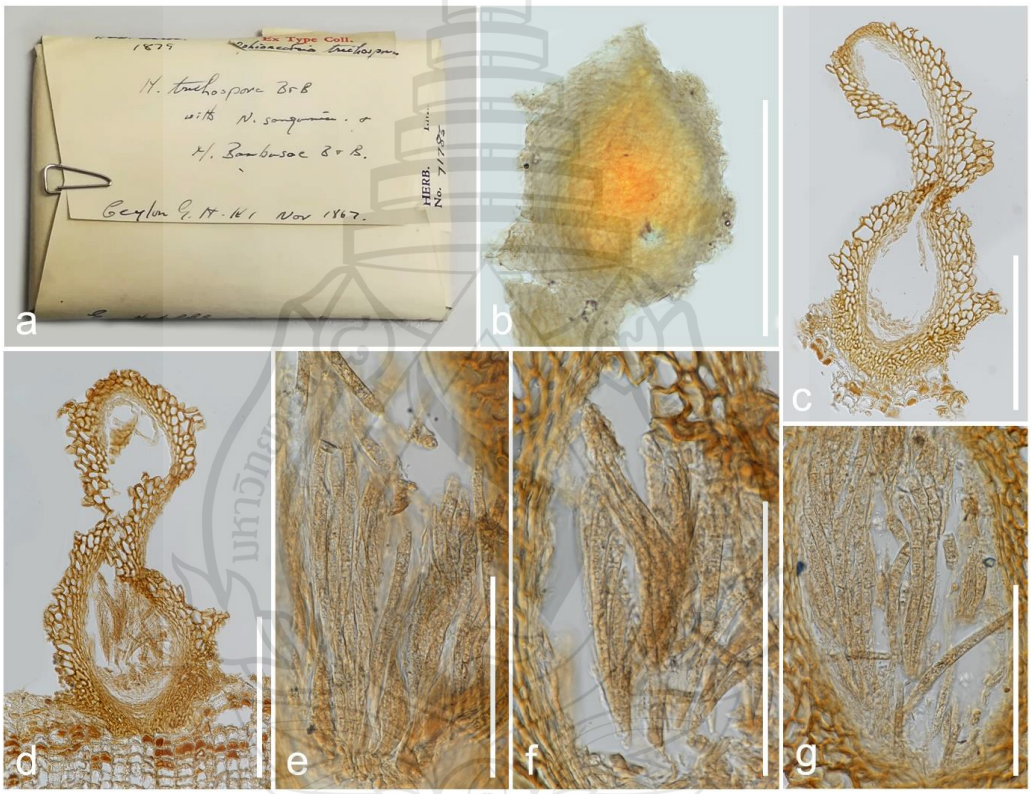
For synonyms see Index Fungorum.

Index Fungorum number: IF185626, Facesoffungi number: FoF10989, Figure 2.77

Associated with *Nectria* species. **Sexual morph**: *Ascomata* 400–480 µm high × 175–250 µm diam. ($\bar{x}$ = 450 × 215 µm, n = 6), seated on a subiculum made up of thick-walled orange, septate hyphae; ovoid to cylindrical, orange, with rounded to truncate apex, ostiolate, surface warted. *Ostioles* 55–60 µm wide, periphysate. *Peridium* comprising two strata; outer stratum 30–75µm thick including warts, 3–5-layered,

composed of large, thick-walled, uneven, orange cells (10–25 µm diam.) forming a *textura globulosa*; inner stratum 9–10.5 µm thick, made up of thin-walled, elongated, hyaline cells. *Asci* 60–160 × 17–25 µm ($\bar{x}$ = 109.3 × 19.6 µm, n = 4), clavate. *Ascospores* 70–125 × 5–7.5 µm ($\bar{x}$ = 98.7 × 6.3 µm, n = 3), parallel, long-fusiform, twisted around each other, usually bent, septate, sub-hyaline to pale orange. **Asexual morph**: see Rossman (1977); Rossman et al. (1999).

Material examined: SRI LANKA (as Ceylon), associated with *Nectria sanguinea* & *N. bambusae*, November 1867, IMI 71785 (slides) (**Holotype of *Nectria trichospora***)



Note (a) Herbarium packet. (b) Squash mount of an ascoma. (c, d) Vertical sections of ascomata. (e–g) Asci and ascospores. Scale bars: b =500 µm, c, d = 200 µm, e–g =100 µm.

Figure 2.77 *Ophionectria trichospora* (IMI 71785, holotype of *Nectria trichospora*)

Pandanaceomyces Tibpromma & K.D. Hyde, in Tibpromma et al., Fungal Divers. 92: 107 (2018)

Index Fungorum number: IF554537, Facesoffungi number: FoF04544

Saprobic on dead or decaying leaves and wood of *Pandanus* sp. in terrestrial habitats. **Sexual morph:** *Ascomata* solitary, scattered to gregarious, superficial or semi-immersed with a flat base, oval, unilocular, yellow-orange, dull, papillate, ostiolate. *Peridium* of single stratum, composed of several layers of thin-walled cells forming *textura prismatica*. *Paraphyses* cellular, branched or unbranched, guttulate, septate. *Asci* 6–8-spored, unitunicate, cylindrical to cylindrical-clavate, pedicel furcated, with a J+ or J- apical ring. *Ascospores* fusiform, curved towards both ends, 1-septate, not constricted at septum, hyaline to subhyaline, guttulate or aguttulate, with or without mucoid sheath. **Asexual morph:** Undetermined (Adapted from Tibpromma et al., 2018).

Known distribution: Thailand (Tibpromma et al., 2018)

Notes: Tibpromma et al. (2018) established the monotypic genus Pandanaceomyces. No asexual morph is recorded. The genus resembles Nectriaceae by light to bright coloured, soft-textured perithecia (Tibpromma et al., 2018). In current study *Pandanaceomyces* grouped within Nectriaceae with closer phylogenetic affinities to *Pseudoachroiostachys* (Figure 2.1).

Type species: ***Pandanaceomyces krabiensis*** Tibpromma & K.D. Hyde, in Tibpromma et al., Fungal Divers. 92: 107 (2018)

Index Fungorum number: IF554538, Facesoffungi number: FoF04545

Descriptions and illustrations: see Tibpromma et al. (2018)

Payosphaeria W.F. Leong, in Leong et al., Bot. Mar. 33: 511 (1990)

Index Fungorum number: IF25521, Facesoffungi number: FoF10992

Lignicolous, on submerged mangrove wood blocks and driftwood. **Sexual morph:** *Ascomata* perithecial, solitary to gregarious, superficial, globose to pyriform, papillate, membranous, hyaline, subhyaline to yellowish brown, ostiolate. *Ostioles* lack periphyses. *Ascomatal neck* cylindrical, hyaline, stout. *Peridium* of single stratum, up to 8 µm thick, composed of thin-walled, elongate cells. *Paraphyses* not abundant, branched, septate, hyaline. *Asci* 8-spored, unitunicate, long-cylindrical, short pedicellate, persistent, thin-walled, developing at the base of the ascomata. *Ascospores* uniseriate, round to oval, aseptate, guttuale, hyaline, thin-, smooth-walled, without appendages or gelatinous sheath. **Asexual morph:** Undetermined.

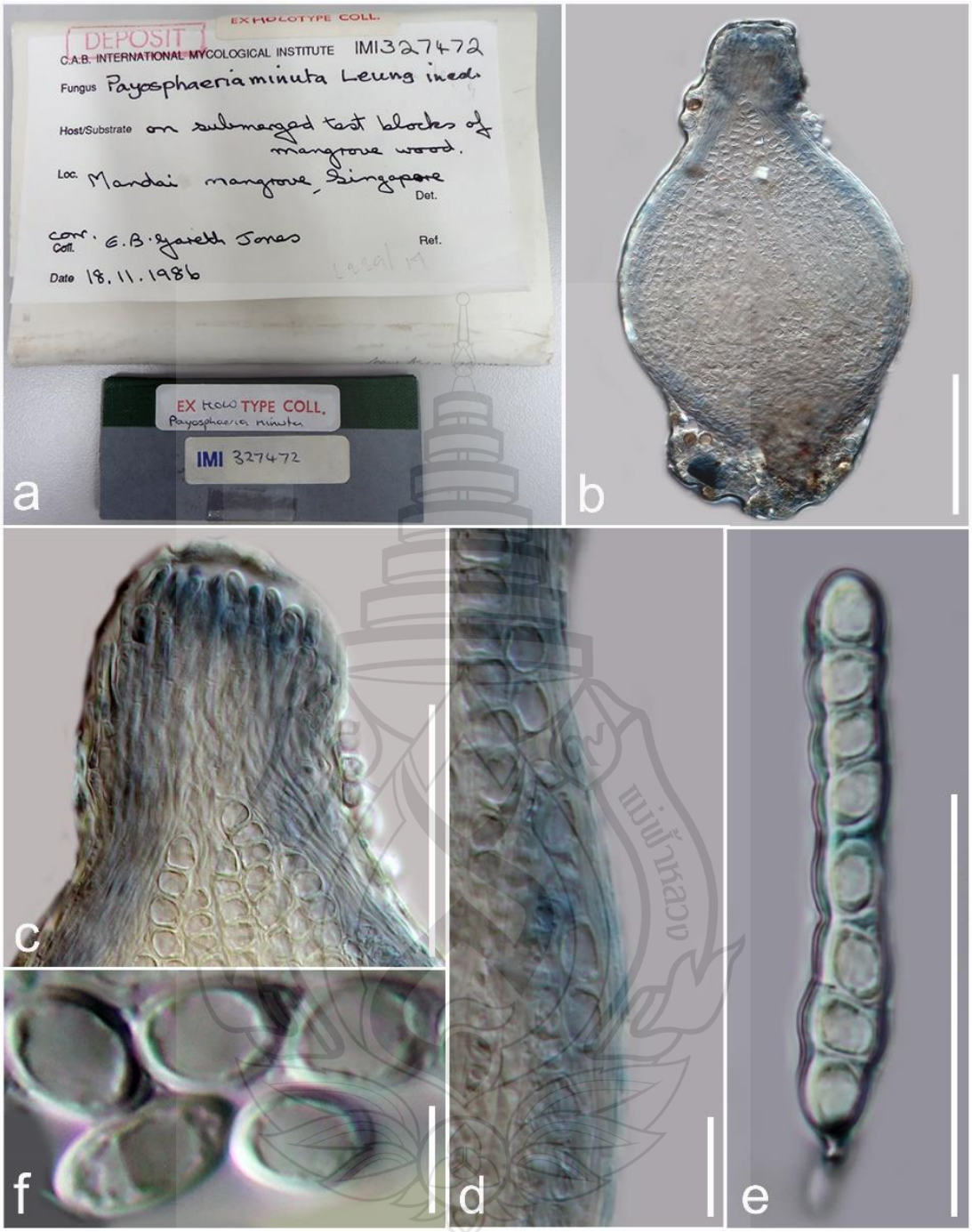
Notes: Leong (1990) erected this monospecific genus for lignicolous taxon *Payosphaeria minuta*, without assigning it to any order. *Payosphaeria minuta* usually associated with submerged mangrove wood (*Avicennia alba*, *A. lanata* and *Rhizophora apiculata*) and, driftwood (Leong, 1990). No sequence data are available. We could not observe the 3% KOH reaction of ascomata, as we received permanent slides of herbarium material.

Type species: ***Payosphaeria minuta*** H.Y.M. Leung, in Leong, Tan, Hyde & Jones, Bot. Mar. 33: 511 (1990)

Index Fungorum number: IF126891, Facesoffungi number: FoF10993, Figure 2.78

On submerged mangrove wood. **Sexual morph:** *Ascomata* 127–155 × 73–95 µm, perithecial, globose to pyriform, hyaline, ostiolate, lacking periphyses. *Ostiolar neck* cylindrical, hyaline to subhyaline. *Peridium* of single stratum, up to 8 µm thick, composed of thin-walled, elongate, hyaline cells. *Paraphyses* not observed. *Asci* 50–65 × 5–7 µm diam., 8-spored, unitunicate, long-cylindrical, apex rounded, short pedicellate, persistent, without an apical ring. *Ascospores* 7–9.5 × 4.5–6 µm, uniseriate, aseptate, round to oval, guttuale, hyaline, thin-, smooth-walled, without appendages or gelatinous sheath. **Asexual morph:** Undetermined.

Material examined: SINGAPORE, Mandai Mangrove, on submerged test blocks of mangrove wood, E. B Gareth Jones, 1986 November 18, IMI 327472, **holotype** (slides).



Note (a) Herbarium material with label. (b, c) Transverse section through ascoma. (d) Transverse section of peridium. (e) Ascus. (f) Ascospores. Scale bars: b, c = 50 µm, d = 20 µm, e = 50, f = 5 µm.

Figure 2.78 *Payosphaeria minuta* (IMI 327472, holotype)

Penicillifer Emden, Acta bot. neerl. 17: 54 (1968)

= *Viridispora* Samuels & Rossman, Stud. Mycol. 42: 166 (1999)

Index Fungorum number: IF9256, Facesoffungi number: FoF10994

On decaying woody substrates, sometimes isolated from plant roots and soil. **Sexual morph:** *Ascomata* astromatic, superficial on the substrate, solitary, globose to pyriform, red, orange-brown, tan, or brown, KOH-/+ red, surface coarsely warted or glabrous. *Asci* clavate, with a simple apex. *Ascospores* 1-septate, green or pale yellow to yellowish green, smooth-walled. **Asexual morph:** *Conidiophores* erect, solitary, septate, unbranched and monophialidic, or with a biverticillate penicillus, hyaline. *Conidiogenous cells* phialidic, cylindrical, tip with periclinal thickening, with a usually tubular not flared collarette. *Conidia* cylindrical to somewhat naviculate, with blunt papilla at one or both ends, 1-septate, hyaline, smooth-walled (Adapted from Rossman et al., 1999; Lombard et al., 2015).

Known distribution: Worldwide (Van Emden, 1968; Samuels, 1989; Rossman et al., 1999)

Notes: *Penicillifer* was introduced by Van Emden (1968) to accommodate a hyphomycetous species *P. pulcher* isolated from soil. Lombard et al. (2015) proposed to protect the widely used older name *Penicillifer* over *Viridispora*, which was followed by Rossman et al. (2016).

Type species: ***Penicillifer pulcher*** Emden, Acta bot. neerl. 17: 54 (1968)

Index Fungorum number: IF335703, Facesoffungi number: FoF10995

Descriptions and illustrations: see Van Emden (1968)

Penicillifer macrosporus Samuels, Mycologia 81(3): 349 (1989)

Basionym: *Nectria penicilliferi* Samuels, Mycologia 81(3): 349 (1989)

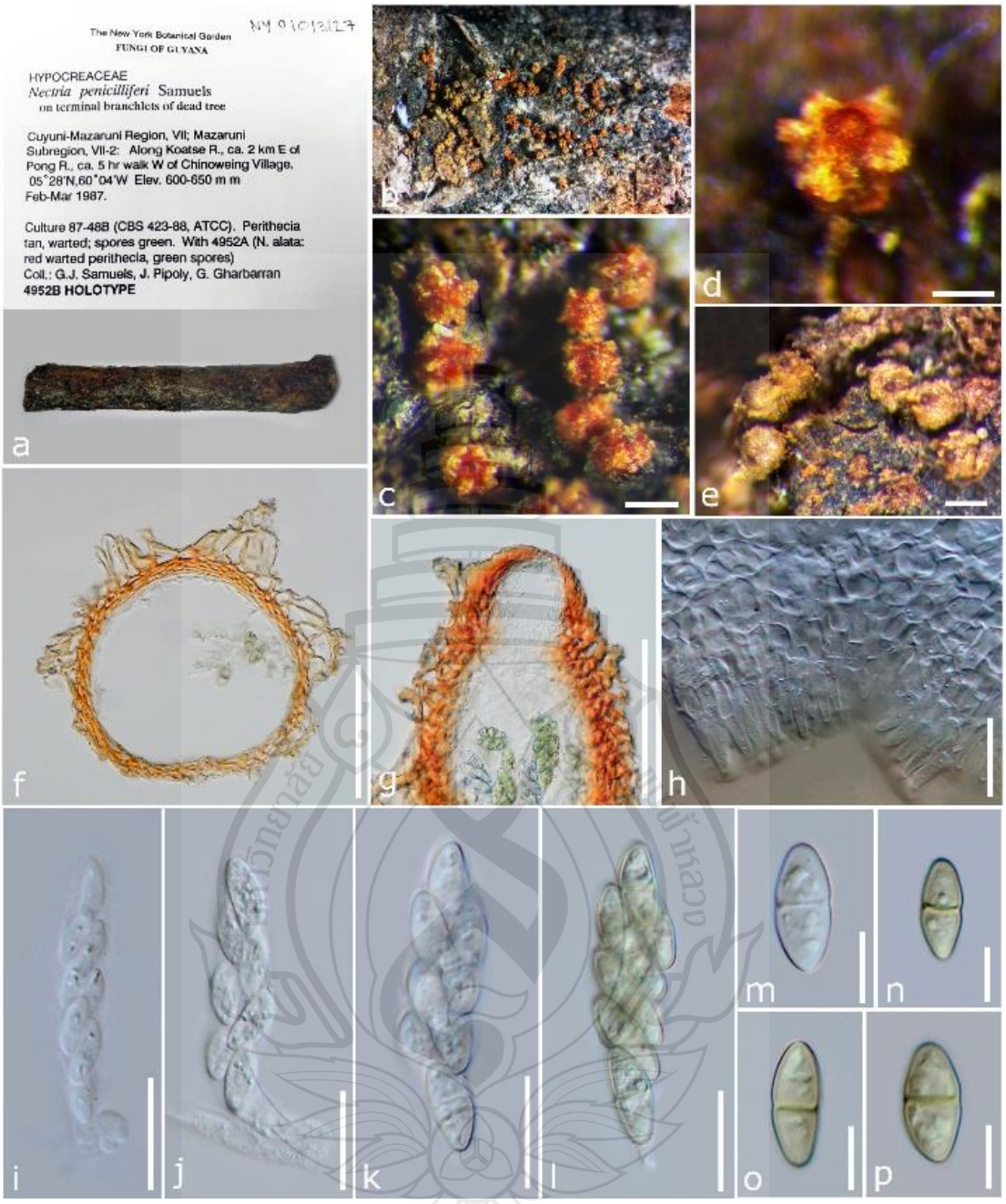
= *Viridispora penicilliferi* (Samuels) Samuels & Rossman, in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 166 (1999)

Index Fungorum number: IF136170, Facesoffungi number: FoF10996, Figures. 2.79, 2.80

Associated with plant parts. **Sexual morph:** *Ascomata* 168–220 µm diam., astromatic, perithecial, superficial, tightly attached to the substrate, solitary to gregarious, globose to pyriform, apapillate or minutely papillate, not collapsing when dry, tan to red

or orange-brown, ostiolar area darker red brown, KOH-, surface warted. *Warts* up to 62 µm high, mostly occur around perithecial apex thus giving the perithecium a coronate characteristic, concolorous with the peridium, cells of warts larger than surface cells of peridium. *Ostiolar canal* lined with hyaline, un-branched, septate periphyses tapering towards the apex. *Peridium* cells circular to angular in face view; up to 75 µm thick including warts in vertical section, comprises of two intergrading strata in vertical section, outer stratum including warts 70 µm thick, cells orange, globose in outline, elongate toward the inside, thick-walled; inner stratum 12 µm thick, composed of hyaline, thick-walled, elongate cells; cells around the perithecial apex vertically elongated. *Paraphyses* absent. *Asci* 56–72 µm × 9–12 µm, 8-spored, unitunicate, clavate, short pedicellate, apex simple. *Ascospores* 17.2–22 × 6.8–9.1 µm ($\bar{x}$ = 19.1 × 7.5 µm; n = 25), bi- to pluriseriate, completely filling each ascus, ellipsoidal to sub-fusiform, 1-septate, somewhat constricted at the septum, straight, guttulate, hyaline or pale green, smooth-walled. **Asexual morph on PDA:** Hyphomycetous. *Conidiophores* arising from the culture, erect, solitary, macronematous, or with a bi- or tri-verticillate penicillus, branched, septate, pale brown to brown, smooth-walled, each branch bearing whorls of 1–3 terminal or lateral phialides. *Conidiogenous cells* 21–27 × 6–8.6 µm, monophialidic, clavate, with evident periclinal thickening, collarette tubular or slightly flared, hyaline to pale brown, abscission scar not visible, smooth-walled. ***Conidia*** 14–32 × 3.6–7.6 µm ($\bar{x}$ = 26.9 × 5.9 µm; n = 25), cylindrical to slightly naviculate, rarely clavate, (0–)1-septate, with blunt papilla at one or both ends, hyaline, smooth-walled.

Material examined: GUYANA, Cuyuni-Maxaruni Region, VII-2: Along Koatse R., ca. 2 km E of Pong R., ca. 5 hr walk W of Chinoweing village, 05°28’N, 60°04’W Elev. 600–650 m, on terminal branchlets of dead tree, February-March 1987, G.J. Samuels 4952B, J. Pipoly, G. Gharbarran, NY 01013127, **holotype**. Culture on PDA, NY 01013128 (asexual morph).



Note (a) Herbarium material with the label. (b–e) Appearance of ascomata on the host substrate. (f) Section through ascoma. (g) Ostiole. (h) Periphyses. (i–l) Immature and mature asci. (m–p) Ascospores. Scale bars: c = 200 µm, d = 100 µm, e = 200 µm, f, g = 100 µm, h–l = 20 µm, m–p = 10 µm.

Figure 2.79 *Penicillifer macrosporus* (NY 01013127, holotype, sexual morph)

Note (a) Dried culture on PDA, with the label. (b, c) Asexual morph. (d–f) Conidiophores with conidiogenous cells and conidia. (g–j) Conidia. Scale bars: c = 200 µm, d, e = 50 µm**,** f = 100 µm, g–j = 20 µm.

Figure 2.80 *Penicillifer macrosporus* (NY 01013128, asexual morph)

Pleiocarpon L. Lombard & D. Aiello, in Aiello et al., IMA Fungus 8(1): 73 (2017)

Index Fungorum number: IF820028, Facesoffungi number: FoF10997

Plant pathogenic, some are lichenicolous. **Sexual morph:** *Ascomata* perithecial, solitary or gregarious, astromatic, superficial, tightly attached to the substrate, widely obpyriform to subglobose, not collapsing or laterally pinched upon drying, reddish orange to dark red, KOH+ purple, LA+ yellow, surface rugose. *Ascomatal apex* discoid, flattened, somewhat constricted beneath the disc. *Peridium* composed of two intergrading strata. *Asci* 8-spored, short-stipitate, cylindrical to narrowly clavate, apex with a thin slightly refractive disc. *Ascospores* obliquely uniseriate or biseriate above and uniseriate below, ellipsoidal, 1-septate, not to somewhat constricted at septum, hyaline, echinulate. **Asexual morph:** *Conidiophores* simple or branched, or aggregated to form sporodochia; simple conidiophores arising laterally or terminally from aerial hyphae, solitary to loosely aggregated, unbranched or sparsely branched, septate, producing up to three conidiogenous cells. *Conidiogenous cells* monophialidic, cylindrical, tapering slightly to the apex. *Microconidia* abundant, aseptate, ellipsoid to ovoid or subcylindrical, straight to slightly curved, with or without a clearly laterally displaced hilum, hyaline, smooth-walled. *Macroconidia* cylindrical to subcylindrical, straight to curved, 1−6-septate, apex or apical cell typically slightly bent to one side and minutely beaked, base with sometimes visible, centrally located or laterally displaced hilum, hyaline, smooth-walled. *Chlamydospores* absent or abundant, when present occur singly or in chains, globose to subglobose, hyaline or pale brown or brown (Adapted from Aiello et al. 2017).

Known distribution: Italy (Aiello et al., 2017, 2020), Algeria (Aigoun-Mouhous et al., 2019), French Guiana (Lechat & Fournier, 2019b), Sri Lanka (Marin-Felix et al., 2019)

Notes: Aiello et al. (2017) introduced *Pleiocarpon* for *P. strelitziae*, a cylindrocarpon-like species causing basal rot of *Strelitzia reginae*. Later another three species were added to the genus including one lichenicolous fungus (Aigoun-Mouhous et al., 2019; Lechat & Fournier, 2019b; Marin-Felix et al., 2019). Lechat and Fournier (2019b) described the sexual morph of the genus. In the current study *Pleiocarpon* showed close phylogenetic affinities to *Thelonectria* (Figure 2.38).

Type species: ***Pleiocarpon strelitziae*** L. Lombard & D. Aiello, in Aiello, Polizzi, Crous & Lombard, IMA Fungus 8(1): 73 (2017)

Index Fungorum number: IF820029, Facesoffungi number: FoF10998

Descriptions and illustrations: see Aiello et al. (2017)

Pleogibberella Sacc. ex Berl. & Voglino, in Saccardo, Syll. fung., Addit. I-IV (Abellini): 217 (1886)

Index Fungorum number: IF4211, Facesoffungi number: FoF10999

On dead plant parts. **Sexual morph**: *Stromata* well-developed, dark purple, becoming black when dry; composed of pigmented, pseudoparenchymatous cells. *Ascomata* superficial, aggregated on the stroma, globose to pyriform, sometimes collapsing laterally when dry, dark purple, KOH+ black, red-orange in LA, surface scurfy. *Asci* 2–3 or 8-spored, clavate, globose-ovate. *Ascospores* broadly-ellipsoid, muriform, hyaline, smooth-walled. **Asexual morph**: Undetermined (Adapted from Rossman et al., 1999).

Known distribution: Australia (Hansford, 1957), Brazil (Rehm, 1898), India (Berlese & Voglino, 1886; Rossman et al., 1999)

Notes: *Pleogibberella* species are associated with plant material, including leaves, fruits and dead branches (Hansford, 1957; Rossman et al., 1999; Rehm, 1898). Only the sexual morph is recorded. No DNA sequence data or living cultures are available (Lombard et al., 2015). Dark coloured ascomata of *Pleogibberella* are similar to some *Fusarium* species, while stromatal morphology and peridium characters resemble to *Nectria sensu stricto* (Rossman et al., 1999).

Type species: ***Pleogibberella calami*** (Cooke) Berl. & Voglino [as '*calamia*'], in Saccardo, Syll. fung., Addit. I-IV (Abellini): 217 (1886)

Basionym: *Gibberella calami* Cooke, Grevillea 13(no. 65): 8 (1884)

Index Fungorum number: IF143288, Facesoffungi number: FoF11000, Figure 2.81

On fruits of *Calamus fasciculatus*. **Sexual morph**: *Stromata* up to 1 mm thick, covering all over the fruit surface, well-developed, dark purple to black, consisting of dark purple, thick-walled, pseudoparenchymatous cells forming *textura angularis*. *Ascomata* 340–390 µm high × 250–390 µm diam. ($\bar{x}$ = 370 × 335 µm), perithecial, aggregated, seated on the stroma, globose to pyriform, rarely collapsing laterally upon

drying, apapillate, with a flattened apex, dark purple, KOH+ black, surface shiny, smooth, faintly cracked, scurfy, or scaly. *Ostiolar canal* lined with filiform, hyaline periphyses rounded at the apex. *Peridium* 50–100 µm thick, of two strata: outer strata 50–85 µm thick, composed of pigmented, thick-walled cells of *textura globulosa* to *textura angularis*, intergrading with the stroma; inner strata 10–16 µm thick, of elongated, compressed, hyaline, thin-walled cells; cells globose to angular in surface view. *Cells around the ostiole* elongated, pigmented, thin-walled, slightly swollen at the apex. *Asci* 85–122 × 12–24 µm ($\bar{x}$ = 94 × 17 µm), 2(–3)-spored, unitunicate, evanescent, clavate, thin-walled, apex simple. *Ascospores* 20–47 × 10–23 µm ($\bar{x}$ = 36 × 17 µm), broadly ellipsoid, initially 1-septate, becoming muriform, with 2–3 transverse and 1–2 partially transverse septa, 1-longitudinal septum, and 1–2 diagonal septa in the apical cells, guttulate, hyaline, yellow when mature, smooth-walled. **Asexual morph**: Undetermined.

Material examined: INDIA, Andhra Pradesh, Vizagapatnam, on fruits of *Calamus fasciculatus*, September 1884, M. C. Cooke, K(M) 35078, **holotype**.

Pseudoachroiostachys Tibpromma & K.D. Hyde, in Tibpromma et al., Fungal Divers. 92: 107 (2018)

Index Fungorum number: IF554547, Facesoffungi number: FoF04554

Saprobic on dead or decaying leaves of *Pandanus* sp. in terrestrial habitats. *Mycelium* superficial on the host, hyaline, rough, unbranched, septate, pale orange. **Sexual morph**: Undetermined. **Asexual morph** Hyphomycetous. *Conidiophores* macronematous, mononematous, unbranched, erect, straight, multi-septate, becoming thick-walled towards the base, hyaline and glassy. *Conidiogenous cells* terminal, phialidic, held in a whorl of 5–6, cylindrical, narrowing to a short neck, hyaline, smooth-walled. *Conidia* ovoid, aseptate, apex rounded, sometimes flattened in one side, smooth, hyaline to subhyaline, occur in slimy masses, with or without mucoid sheath (Adapted from Tibpromma et al., 2018).

Known distribution: Thailand (Tibpromma et al., 2018)

Note (a) Herbarium material label. (b) Herbarium material. (c) Ascomata on the host (d) Vertical section of ascoma. (e) Vertical section of ostiolar region. (f) Face view of peridium. (g–i) Asci. (j–o) Ascospores. Scale bars: c = 2 mm, d = 200 µm, e = 100 µm, f–i = 50 µm, j–o = 5 µm.

Figure 2.81 *Pleogibberella calami* (K(M) 35078, holotype)

Notes: Tibpromma et al. (2018) established the monospecific asexual genus *Pseudoachroiostachys* associated with *Pandanus* sp. *Pseudoachroiostachys* has similar conidiomata and colony morphology with *Achroiostachys aurantispora* in Stachybotriaceae (Hypocreales) (Lombard et al., 2016; Tibpromma et al., 2018). Current phylogenetic analysis confirmed the placement of *Pseudoachroiostachys* in Nectriaceae (Figure 2.1). *Pseudoachroiostachys* showed close phylogenetic affinities to *Pandanaceomyces* (Figure 1.38).

Type species: ***Pseudoachroiostachys krabiensis*** Tibpromma & K.D. Hyde [as '*krabiense*'], in Tibpromma et al., Fungal Divers. 92: 107 (2018)

Index Fungorum number: IF648198, Facesoffungi number: FoF04555

Descriptions and illustrations: see Tibpromma et al. (2018)

Rectifusarium L. Lombard, Crous & W. Gams, in Lombard, van der Merwe, Groenewald & Crous, Stud. Mycol. 80: 229 (2015)

Index Fungorum number: IF810252, Facesoffungi number: FoF10990

Associated with plant material including twigs and tubers, sometimes isolated from soil. **Sexual morph:** *Ascomata* perithecial, aggregated in groups, globose to subglobose, dark red, with a papillate ostiolar region, ringed by a short collar of hyphal tips, surface smooth. *Asci* 8- spored, clavate, apex rounded, with a containing J- apical ring. *Ascospores* ellipsoidal, 1-septate, constricted at the septum, light brown, verrucose. **Asexual morph:** *Conidiomata* hyphomycetous, not sporodochial. *Conidiophores* simple, mononematous, straight to flexuous, septate, unbranched or rarely branched, hyaline, terminating in a single phialide. *Conidiogenous cells* phialidic, cylindrical, tapering towards the apex, periclinal thickening visible, with flared collarettes. *Microconidia* rare, ellipsoidal to fusiform, 0–1-septate, hyaline. *Macroconidia* 3- septate, hyaline, ellipsoidal to fusiform, with both ends slightly curved, sometimes with a basal foot cell, apex acutely rounded. *Chlamydospores* occur laterally or terminally, globose to subglobose, hyaline (Adapted from Lombard et al., 2015).

Known distribution: Germany (Lombard et al., 2015)

Notes: Lombard et al. (2015) established *Rectifusarium* to accommodate the fusarium-like species previously treated as *F. ventricosum*. *Rectifusarium* is characterized by not possessing sporodochia.

Type species: ***Rectifusarium ventricosum*** (Appel & Wollenw.) L. Lombard & Crous, in Lombard, van der Merwe, Groenewald & Crous, Stud. Mycol. 80: 229 (2015)

Index Fungorum number: IF810253, Facesoffungi number: FoF10991, Figure 2.82

Isolated from soil. **Asexual morph:** Hyphomycetous. *Colonies* white, effuse, hairy or velvety. *Mycelium* superficial, comprising branched, septate, hyaline hyphae. *Conidiophores* 75–90 × 2–5 µm ($\bar{x}$ = 81.1 × 3.5 µm, n = 5), mononematous, originating laterally from hyphae, generally unbranched, sometimes branched at the apex, septate, simple, straight to flexuous. *Conidiogenous cells* 35–70 × 2–4 µm ($\bar{x}$ = 45.1 × 3.1 µm, n = 5), terminal, monophialidic, cylindrical, slightly tapering towards the apex, periclinal thickening visible, apex with minute collarettes, hyaline, smooth-walled. *Macroconidia* 19–30 × 4–6.5 µm ($\bar{x}$ = 23.1 × 5.3 µm, n = 25), 1–3-septate, fusiform to ellispoidal, straight or slightly curved, rounded at each ends or basal end of cells slightly flattened, hyaline, smooth-walled. *Chlamydospores* 8–9.5 × 7.5–9 µm ($\bar{x}$ = 8.7 × 8.5 µm, n = 5), arising terminally or laterally, hyaline to subhyaline, globose, thick-walled, verruculose, solitary or forming chains or developing directly from macroconidia. *Microconidia* not observed. **Sexual morph:** See Booth (1971).

Material examined: GERMANY, isolated from soil, 1958, K. Domsch, IMI 112498.

Note (a) Herbarium packet. (b) Dried culture herbarium. (c) Close-up of colony. (d, e) Hyphae, conidiophores and conidiogenous cells. (f, g) Macroconidia. (h) Macroconidia and chlamydospores developing from macroconidia. (i) Chlamydospore. Scale bars: c =2 mm, d = 100 µm, e–i = 20 µm.

Figure 2.82 *Rectifusarium ventricosum* (IMI 112498)

Sarcopodium Ehrenb., Sylv. mycol. berol. (Berlin): 23 (1818)

For synonyms see Index Fungorum (2022)

Index Fungorum number: IF9788, Facesoffungi number: FoF11003

On decaying or living woody and herbaceous substrates, sometimes on stromatic fungi. **Sexual morph:** *Ascomata* perithecial, solitary or in groups, superficial on a minute stroma, on an erumpent, previously conidial stroma, or at the base of a synnema, subglobose to broadly obpyriform, apapillate or minutely papillate, red, turning dark red in KOH, surface with hyaline to yellow hyphal hairs; hairs smooth, spinulose, hooked or straight, septate, thin-walled, arising from the surface of the ascomatal wall and forming around the ascomatal base, sometimes forming a tomentum on the ascomatal surface. *Asci* 8-spored, unitunicate, clavate to fusiform, apex simple or with a ring. *Ascospores* ellipsoid to fusiform, 1-septate, hyaline to pale yellow-brown, striate. **Asexual morph:** *Conidiomata* sporodochial, cupulate to synnematal, superficial. *Setae* simple, septate, rarely branched, straight or circinate, brown, walls smooth or verruculose. *Conidiophores* macronematous, irregularly, verticillately, or penicillately branched, hyaline, smooth-walled. *Conidiogenous cells* phialidic, cylindrical or doliiform to reniform, hyaline, smooth-walled. *Conidia* cylindrical to ellipsoid, straight, 0–1-septate, hyaline, aggregated in slimy masses (Adapted from Rossman et al., 1999, Lombard et al., 2015).

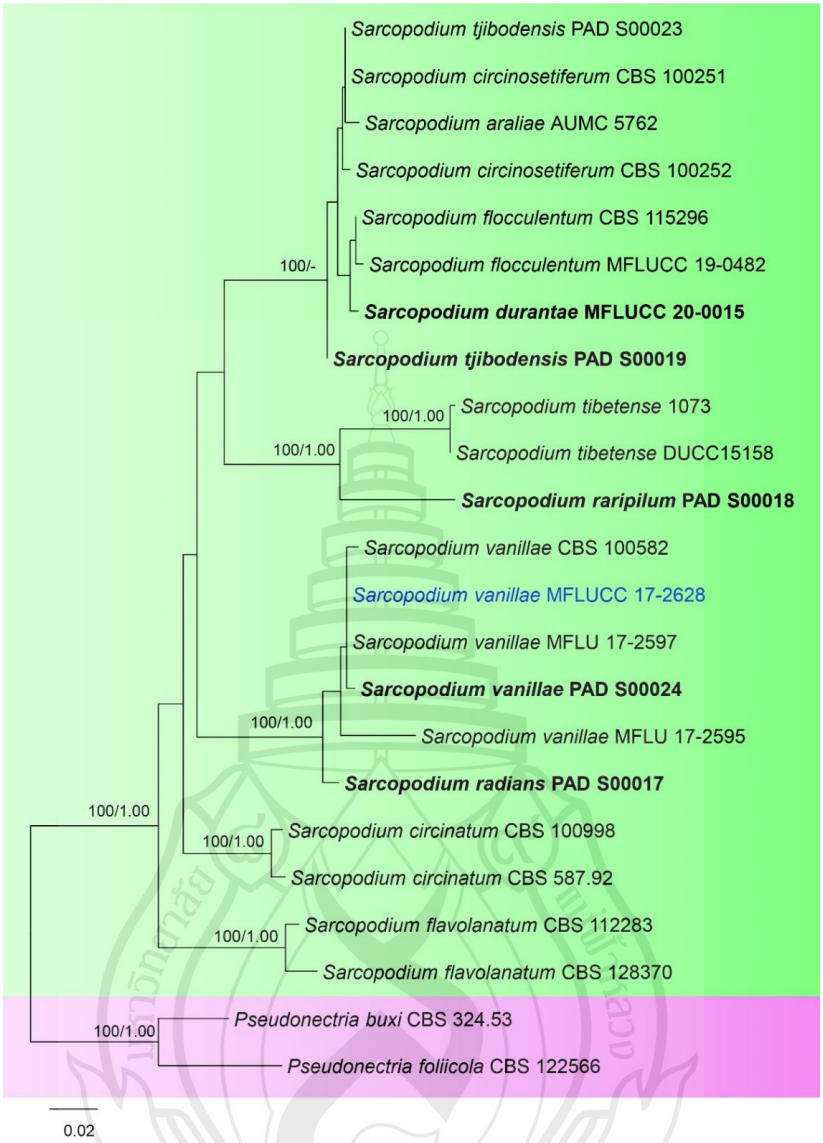
Known distribution: Tropical or subtropical areas (Rossman et al., 1999)

Notes: *Sarcopodium* was introduced for *S. circinatum* by Ehrenberg (1818). Sutton (1981) considered the generic names *Tricholeconium*, *Periolopsis*, *Actinostilbe*, *Kutilakesa* and *Kutilakesopsis* as synonyms of *Sarcopodium*. The sexual morph genus *Lanatonectria*, which was previously referred as *Nectria flavolanata*-group, has been transferred to *Sarcopodium* based on phylogenetic analyses (Lombard et al., 2015; Pennycook & Kirk, 2019). Rossman et al. (2016) also supported the placement of the *Actinostilbe* and the *Lanatonectria* under the oldest name *Sarcopodium*.

Type species: ***Sarcopodium circinatum*** Ehrenb., Sylv. mycol. berol. (Berlin): 23 (1818)

Index Fungorum number: IF235279, Facesoffungi number: FoF11004

Descriptions and illustrations: see Rossman et al. (1999).



Note Twenty-three strains are included in the combined analyses, which comprised 2103 characters (ITS: 561, LSU: 830, TUB2: 712), including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to *Pseudonectria buxi* (CBS 324.53) and *Pseudonectria foliicola* (CBS 122566). Ex-type strains are in bold. The newly generated sequences are indicated in blue. The scale bar indicates 0.02 nucleotide changes per site.

Figure 2.83 Phylogram generated from maximum likelihood analysis based on combined ITS, LSU and TUB2 sequence data of *Sarcopodium* taxa

Sarcopodium vanillae (Petch) B. Sutton, Trans. Br. mycol. Soc. 76(1): 99 (1981)

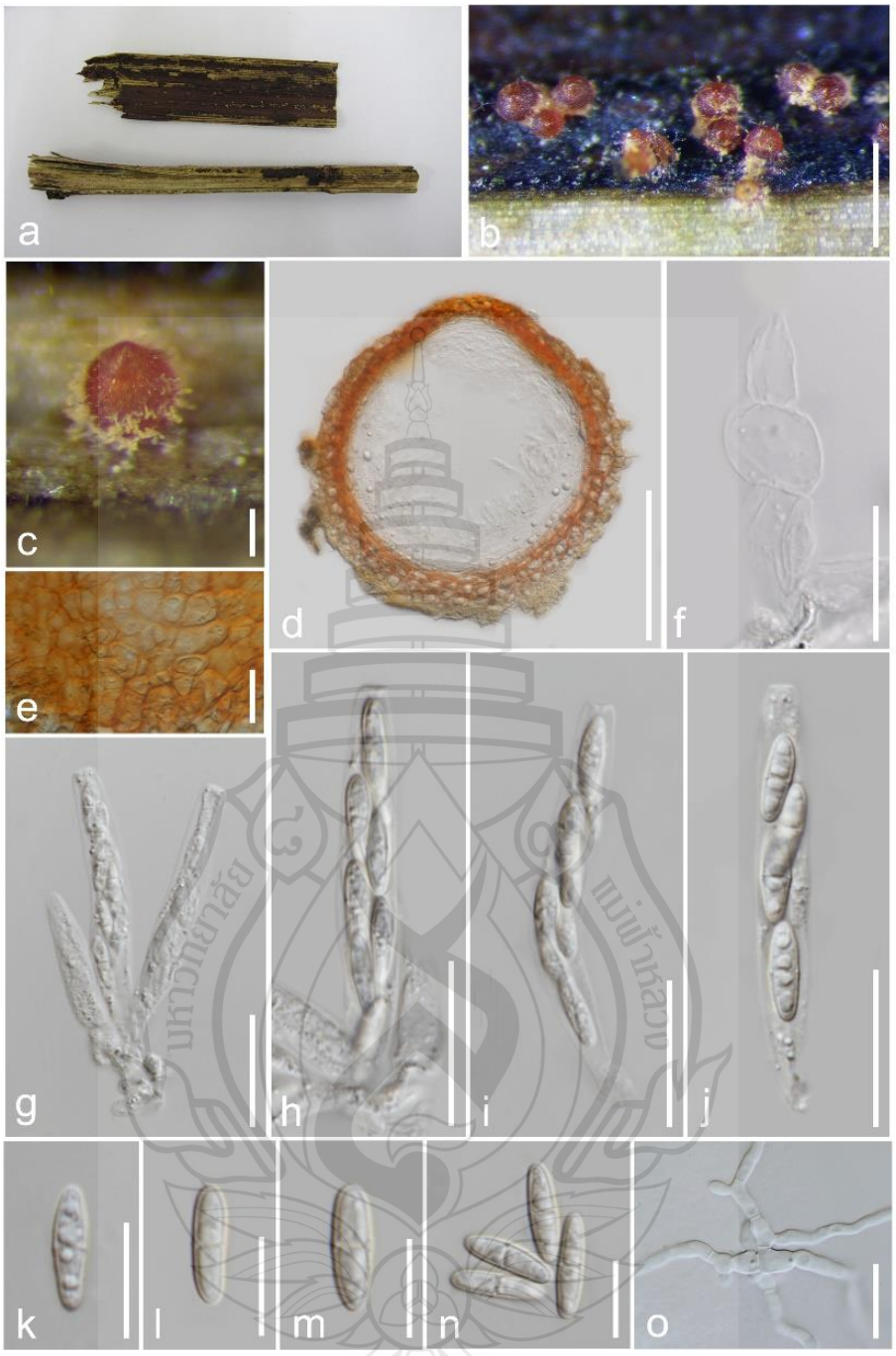
Index Fungorum number: IF112621, Facesoffungi number: FoF11005, Figure 2.84

Saprobic on stems of *Chromolaena odorata*. **Sexual morph**: *Ascomata* 180–250 µm high, 140–240 µm wide, perithecial, solitary or in groups, superficial on a minute stroma, subglobose to broadly obpyriform, not collapsing upon drying, surface shiny, dark red to reddish-orange, KOH+ purple, spinulose hyphal hairs arising from the surface of the ascomatal wall and forming around the ascomatal base, ostiolate, papillate. *Peridium* 15–50 µm, of 2-strata, outer strata composed of 3, 4 layers of reddish-orange colour cells of *textura angularis*, 4–11 µm wide; inner strata of compactly arranged, thin-walled, hyaline, flat cells, 14–30 µm wide. *Hamathecium* comprising hyaline, moniliform apical paraphyses up to 20 µm wide. *Asci* 44–77 × 5.4–7.8 µm ($\bar{x}$ = 54.7 × 6.5 µm), unitunicate, 4, 8-spored, cylindrical to fusiform, short pedicellate, with a J-apical ring. *Ascospores* 9.6–14.5 × 2.6–4 µm ($\bar{x}$ = 11.9 × 3.2 µm), bi-seriate, uni-seriate at the top and base, ellipsoid to fusiform, 1-septate, not constricted at the septum, multiguttulate, hyaline, striate. **Asexual morph**: Sutton (1981).

Material examined: THAILAND, Phyao Province, Phachang Noi Pong District, on a dead stem of *Chromolaena odorata*, 9 November 2017, R. H. Perera, Bion16, MFLU 18-2709, living culture MFLUCC 17-2628.

GenBank numbers: LSU: ON787620, ITS: ON787628

Notes: The asexual morph of *Sarcopodium vanillae* was isolated from different hosts and countries (Sutton, 1981; Lombard et al., 2015). Chaiwan et al. (2020) reported the sexual morph of *S. vanillae* on *Dracaena* sp. from Thailand. Ascomata, asci and ascospore morphology of our new collection is similar to *S. vanillae* (Chaiwan et al., 2020). Based on molecular and morphological data we identified our collection as sexual morph of *S. vanillae* and, *Chromolaena odorata* as a new host record for the species.



Note (a) Herbarium material. (b, c) Ascomata on host. (d) Vertical section of ascoma. (e) Surface view of the peridium. (f) Paraphysis. (j–j) Asci. (k–n) Ascospores. o Germinating ascospore. Scale bars: b = 500 µm, c, d = 100 µm, e = 20 µm, f–j = 50 µm, k–n = 10 µm, o = 20 µm.

Figure 2.84 *Sarcopodium vanillae* (MFLU 18-2709)

Scolecofusarium L. Lombard, Sand.-Den. & Crous, in Crous et al., Stud. Mycol. 98(no. 100116): 74 (2021)

Index Fungorum number: IF838676, Facesoffungi number: FoF11006

Associated with branch canker of *Fagus sylvatica*. **Sexual morph:** *Ascomata* perithecial, solitary or gregarious, partially immersed on a stroma, smooth- and thin-walled, globose to broadly pyriform, with a broad, discoid apical region, red, KOH+ darker red, LA+ yellow, surface lacking hairs and warts. *Peridium* of a single stratum, consisting of unevenly thickened cells of *textura epidermoidea*. *Asci* 8-spored, cylindrical, apex with an obscure refractive ring. *Ascospores* uniseriate, ellipsoidal to fusiform-ellipsoidal, 1- septate, not constricted at septum, yellow-brown, finely spinulose. **Asexual morph:** *Conidiophores* mononematous (aerial) or grouped on sporodochia. *Aerial conidiophores* unbranched to loosely irregularly branched, bearing terminal phialides. *Conidiogenous cells* monophialidic, subcylindrical, with visible periclinal thickening, collarette not flared, smooth- and thin-walled, producing only macroconidia. *Sporodochia* pink, orange to salmon coloured. *Sporodochial conidiophores* irregularly and verticillately branched, consisting of short, often swollen, smooth- and thin-walled stipes; stipes bearing single terminal monophialides or apical whorls of 2–3 monophialides. *Sporodochial conidiogenous cells* monophialidic, cylindrical to subcylindrical, with periclinal thickening visible, smooth- and thin-walled. *Macroconidia* subcylindrical, (0–)3–7(–10)- septate, straight or slightly curved, with blunt apical cell and obtuse to poorly developed, foot-shaped basal cell, occur in pink to salmon slimy masses. *Microconidia* absent. *Chlamydospores* absent. (Adapted from Crous et al., 2021).

Known distribution: Germany (Crous et al., 2021)

Notes: The monotypic genus *Scolecofusarium* was introduced by Crous et al. (2021) to accommodate *Atractium ciliatum*. *Scolecofusarium* shows close phylogenetic affinities to *Cosmosporella* (Figure 2.38).

Type species: ***Scolecofusarium ciliatum*** (Alb. & Schwein.) L. Lombard, Sand.-Den. & Crous, in Crous et al., Stud. Mycol. 98(no. 100116): 74 (2021)

Basionym: *Atractium ciliatum* (Alb. & Schwein.) Link, Mag. Gesell. naturf. Freunde, Berlin 8: 32 (1816) [1815]

Index Fungorum number: IF838677, Facesoffungi number: FoF11007

Descriptions and illustrations: see Crous et al. (2021)

Setofusarium (Nirenberg & Samuels) Crous & Sand.-Den., in Crous et al., Stud. Mycol. 98(no. 100116): 75 (2021)

Index Fungorum number: IF838678, Facesoffungi number: FoF11008

Associated with tree bark. **Sexual morph:** *Stromata* well-developed, immersed, composed of pseudoparenchymatous to hyphal cells. *Ascomata* perithecial, solitary or gregarious on stroma, pyriform, apex flattened and apapillate, dark red, apical region darker red-coloured, KOH+ darker, LA+ yellow, scaly to warty and thick-walled, lacking hairs. *Peridium* of two strata: outer stratum of thick-walled, pigmented cells of *textura angularis* to *textura globulosa* at warts cells; inner stratum of elongate, hyaline, thin-walled cells, becoming thinner towards the centrum. *Asci* 8-spored, cylindrical to clavate, with rounded to flattened simple apex. *Ascospores* overlapping uniseriate to biseriate, ellipsoidal, 1-septate, not constricted at septum, pale yellow-brown, smooth-walled to finely striate. **Asexual morph:** Conidiophores mononematous (aerial) or grouped on sporodochia. *Aerial conidiophores* unbranched or rarely branched, bearing terminal phialides. *Conidiogenous cells* monophialidic, cylindrical to subcylindrical, with periclinal thickening inconspicuous to visible, smooth- and thin-walled, producing only macroconidia. *Sporodochia* grey, setose. *Sporodochial setae* arising between and around sporodochia, stiff, erect with acute tip, at first hyaline later becoming pale golden brown, thick-walled. *Sporodochial conidiophores* densely packed, irregularly and verticillately branched, consisting of short, often swollen, smooth- and thin-walled stipes bearing apical whorl of 2–3 monophialides or single, terminal monophialides. *Sporodochial conidiogenous cells* monophialidic, cylindrical to subcylindrical, with inconspicuous to visible periclinal thickening, smooth- and thin-walled. *Macroconidia* cylindrical, (0–)3–5(–7)-septate, gently curved, with a blunt apical cell and an obtuse to poorly developed foot-shaped basal cell, held in off-white or grey slimy masses. *Microconidia* absent. *Chlamydospores* absent. (Adapted from Crous et al., 2021).

Known distribution: French Guiana (Crous et al., 2021)

Notes: Crous et al. (2021) introduced this monotypic genus to include *Fusarium setosum*. In current studies *Setofusarium* showed close phylogenetic affinities to *Albonectria* (Figure 1.38). However, *Albonectria* is characterized by pale yellow to white perithecia while *Setofusarium* has dark red perithecia (Crous et al., 2021).

Type species: ***Setofusarium setosum*** (Nirenberg & Samuels) Crous & Sand.-Den., in Crous et al., Stud. Mycol. 98(no. 100116): 76 (2021)

Basionym: *Fusarium setosum* Nirenberg & Samuels, in Samuels & Nirenberg, Can. J. Bot. 67(11): 3372 (1989)

= *Nectria setofusarii* Samuels & Nirenberg [as 'setofusariae'], Can. J. Bot. 67(11): 3372 (1989)

Index Fungorum number: IF125908, Facesoffungi number: FoF11009

Descriptions and illustrations: see Samuels & Nirenberg (1989) and Crous et al. (2021)

Stylonectria Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 124: 52 (1915)

Index Fungorum number: IF5301, Facesoffungi number: FoF11010

Fungicolous, on stromata of ascomycetes. **Sexual morph:** *Ascomata* 150–350 μm high, perithecial, stromatic gregarious, arrange in groups up to 50 (–80), subglobose, pyriform, obpyriform to subcylindrical, having a rounded or broad, circular, flat disc on a venter-like neck, not collapsing or laterally collapsing upon drying, ostiolate, surface smooth or sometimes slightly roughened, usually shiny, pale yellow, orange-red, orange-brown, or pale to dark red, KOH+ dark red to purple, yellow in lactic acid. *Stromata* hyphal or subiculum-like, thin, whitish or yellow. *Peridium* composed of two strata. *Paraphyses* filamentous to narrowly moniliform. *Asci* 8-spored, unitunicate, cylindrical to clavate, short pedicellate, apex simple or, with a J- apical ring or a faint ring-like apical thickening. *Ascospores* uniseriate, biseriate or irregularly disposed, hyaline or yellow to pale brown, 1-septate, cylindrical to allantoid or ellipsoidal, guttulate, smooth-walled, tuberculate or faintly spinulose. **Asexual morph:** Hyphomycetous. *Conidiophores* initially formed mostly as unbranched phialides on somatic hyphae, sometimes loosely branched, occasionally forming small sporodochia. *Phialides* monophialidic, cylindrical to subcylindrical, often with a visible collarette, giving rise to two types of conidia. *Microconidia* sparse, allantoid to lunulate, curved, aseptate, produced in wet heads. *Macroconidia* orange in mass, subcylindrical or curved, falcate, 0–3-septate, apex narrower than base, apical cell blunt or hooked, basal cell not or scarcely pedicellate. (Adapted from Höhnel, 1915; Gräfenhan et al., 2011; Lombard et al., 2015).

Known distribution: Austria, Germany, UK, Switzerland (Gräfenhan et al., 2011), China (Zeng et al., 2020), France (Lechat et al., 2021)

Notes: *Stylonectria* species are considered as host-specific taxa (Gräfenhan et al., 2011). They are generally associated with the members of Diaporthales (*Hapalocystis bicaudata Melanconis spodiaea*, *Melogramma bulliardi*,) or other ascomycetes such as *Eutypella*, *Diplodia* species. Currently, *Stylonectria* is recognized with eight species (Gräfenhan et al., 2011; Zeng et al., 2020, Lechat et al., 2021).

Type species: ***Stylonectria applanata*** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 124: 52 (1915)

= *Nectria applanata* var. *succinea* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 124: 51 (1915)

Index Fungorum number: IF432049, Facesoffungi number: FoF11011, Figure 2.85

On stromata of *Melogramma bulliardii*. **Sexual morph:** *Ascomata* 150–270 µm high, 180–240 diam., perithecial, stromatic, gregarious, in groups of less than 20, subglobose or pyriform, apex with a broad and flat disc, laterally pinched upon drying, ostiolate, surface smooth, yellow to orangish. *Stroma* subiculum-like, thin, whitish or yellow. *Ostioles* periphysate. *Peridium* 40–56 µm thick near the ostiole, 25–40 µm thick below, consisting of two strata: inner strata composed of hyaline, thin-walled, compressed, elongate cells of *textura angularis*; outer strata of distinct, thick-walled, pigmented cells of *textura angularis* to *textura globulosa*. *Asci* 50–75 × 5–6.6 (n = 15) µm, 8-spored, unitunicate, cylindrical to clavate, short pedicellate, apex with a J- apical ring. *Ascospores* 7.5–11 × 3.2–4 (n = 30) µm, uniseriate or overlapping uniseriate, 1-septate, hyaline, multi-guttulate, smooth-walled, without appendages. **Asexual morph:** see Höhnel (1915).

Material examined: AUSTRIA, Niederösterreich, near Sonntagsberg, on stromata of *Melogramma bulliardii* on dead twigs of *Corylus avellana*, 7 August 1914, P. Strasser, FH 00286663, **lectotype**.

Note (a) Herbarium material label. (b) Herbarium material. (c, d) Ascomata on host stromata. (e) Vertical section of ascoma. (f) Vertical section of ostiolar region. (g) Vertical section of peridium. (h) Empty asci. (i–l) Asci. (m–p) Ascospores. Scale bars: c = 500 µm, d = 200 µm, e = 100 µm, f, g = 50 µm, h–i = 20 µm, m–p = 5 µm.

Figure 2.85 *Stylonectria applanata* (FH 00286663, lectotype)

Thelonectria P. Chaverri & Salgado, in Chaverri et al., Stud. Mycol. 68: 76 (2011)

Index Fungorum number: IF518567, Facesoffungi number: FoF11012

On bark of recently died, dying or diseased trees, sometimes on rotting roots; plant pathogenic, often causing small cankers. **Sexual morph**: *Ascomata* perithecial, solitary to gregarious, astromatic and superficial on the substrate or, seated on an immersed inconspicuous stroma, globose, subglobose, or pyriform to elongated, orange to red, with a prominently darkened papilla or darkly pigmented apex, surface smooth or rugulose, without hairs or appendages. *Peridium* of two strata: outer stratum of thick-walled, pigmented cells forming a *textura epidermoidea*; inner stratum of elongate, hyaline, thin-walled cells, becoming thinner towards the centrum. *Asci* 8-spored, cylindrical to narrowly clavate, with an apical ring. *Ascospores* uniseriate, ellipsoidal to fusoid, 1-septate, hyaline, becoming pigmented with age, smooth-walled or finely spinulose or striate. **Asexual morph:** *Conidiomata* cylindrocarpon-like. *Sporodochia* not formed. *Conidiophores* mononematous, septate, irregularly branched, hyaline, bearing 1–3 phialides at the apex or reduced to lateral phialides. *Conidiogenous cells* monophialidic, cylindrical or slightly swollen, tapering towards the apex, periclinal thickening evident, with a flared collarettes, usually forming macroconidia. *Microconidia* rare. *Macroconidia* subcylindrical to slightly fusoid, curved, broadest at upper third, (3–)5–7(–9)-septate, with rounded ends or flattened at the basal cell. *Chlamydospores* undetermined (Adapted from Chaverri et al., 2011; Crous et al., 2021).

Known distribution: Cosmopolitan, mostly in tropical and subtropical areas (Chaverri et al., 2011)

Notes: Chaverri et al. (2011) established the genus *Thelonectria* to include species in the former *Neonectria mammoidea*- and *Neonectria veuillotiana*-groups.

Type species: ***Thelonectria discophora*** (Mont.) P. Chaverri & Salgado, in Chaverri et al., Stud. Mycol. 68: 76 (2011)

Basionym: *Sphaeria discophora* Mont., Annls Sci. Nat., Bot., sér. 2 3: 353 (1835)

Index Fungorum number: IF518569, Facesoffungi number: FoF11013

Descriptions and illustrations: see Brayford et al. (2004)

Thelonectria siamensis R.H. Perera, Maharachch., & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF559638, Facesoffungi number: FoF11014, Figure 2.86

Etymology: Name refers to the type locality, 'Siam' earlier name of Thailand.

Saprobic on dead stem bark. **Sexual morph:** *Ascomata* 290–340 µm high, 290–380 µm wide, perithecial, solitary to gregarious, astromatic, superficial on the substrate, globose to subglobose, apex flat, apapillate, not collapsing when dry, orange to darker red, with a darkly pigmented apex, KOH+ darker, surface smooth to slightly rugulose, without hairs or appendages. *Peridium* 35–70 µm thick in vertical section, wider around the ostiole, of two strata: outer stratum 18–45 µm thick, composed of thick-walled, pigmented cells forming a *textura epidermoidea*; inner stratum 10–21 µm thick, composed of elongate, hyaline, thin-walled cells, becoming thinner towards the centrum. *Asci* 65–95 µm × 6.5–10 µm ($\bar{x}$ = 78.4 × 8.2 µm), 8-spored, cylindrical, sometimes narrowly clavate, short pedicellate, with a J- apical ring. *Ascospores* 9.8–14.7 µm × 3.8–6.5(–8) µm ($\bar{x}$ = 12.2 × 5.2 µm), uniseriate, ellipsoidal, 1-septate, not or slightly constricted at the septa, hyaline, becoming pigmented with age, usually 2, 4 large guttules or with several small guttules, thick-walled, finely spinulose. **Asexual morph:** Undetermined.

Culture characteristics: Ascospores germinated on PDA within 12 hrs at 28°C. Colony on MEA becoming 20 mm diam. after 14 days at 28°C. Colony circular, surface cottony, with aerial mycelium, initially yellowish white, darkening pale yellow to bay, reverse same colour, with a white margin.

Material examined: THAILAND, Chiang Mai Province, Mae Rim District, on a dead stem bark of undetermined plant, 18 September 2017, R.H. Perera, Rim30 (MFLU 18-2726, **holotype**); **ex-type** living culture MFLUCC 17-2623.

GenBank numbers: LSU: ON787621, ITS: ON787629, TUB2: ON892556.

Notes: Our new fungus clades with species in *Thelonectria lucida* species complex with robust statistical support (100% MLBT, 100% BYPP; Figure 2.43). *Thelonectria siamensis* can be distinguished from *T. lucida* in having smaller ascomata (290–380 vs. 430–480 µm) (Brayford et al., 2004). *Thelonectria siamensis* is distinct from other *T. gibba* in having smaller ascomata (290–380 vs. 410–520 µm) and ascospores (9.8–14.7 × 3.8–6.5 vs. 20.2– 24.4 × 9.4–11 µm) (Salgado-Salazar et al., 2016). *Thelonectria siamensis* is distinct from other *T.* elata in having smaller ascomata

Note (a) Herbarium material. (b, c) Ascomata on host (c rehydrated with water). (d) Vertical section of ascoma. (e) Vertical section of ostiolar region. (f) Vertical section of peridium. (g) Hyphae of the peridium. (h–j) Asci. (k) Apex of an ascus. (l) Ascospores. Scale bars: d = 200 µm, e, f = 50 µm, g = 20 µm, h–j = 50 µm, k, l = 20 µm.

Figure 2.86 *Thelonectria siamensis* (MFLU 18-2726, holotype)

(290–380 vs. 400–520 μm) and ascospores (19.2–22.4 × 8.4–10.5 μm) (Salgado-Salazar et al., 2016). *Thelonectria siamensis* differs from *T. lucida* in having smaller ascomata (290–380 vs. 420–520 μm) and ascospores (17.9–20.7 × 7.3–9.3 μm) (Salgado-Salazar et al., 2016).

Thyronectria Sacc., Grevillea 4(no. 29): 21 (1875)

= *Sulcatistroma* A.W. Ramaley, Mycotaxon 93: 140 (2005)

For other synonyms see Jaklisch & Voglmayr (2014).

Index Fungorum number: IF5469, Facesoffungi number: FoF07713

On dead corticated twigs or branches of woody plants and/or fungicolous. **Sexual morph:** *Stromata* immersed-erumpent from bark, containing uni- to multiple ascomata, scattered, aggregated in groups or compact and pulvinate; stromatic tissue soft, surrounding individual ascomata or formed as a hypostroma, pseudoparenchymatous or prosenchymatous or both, light coloured, KOH+/-, usually upper surface covered by KOH- yellow-green amorphous scurf. *Ascomata* perithecial, immersed in a stroma or superficial and typically densely aggregated on a hypostroma, usually globose to flask-shaped, often collapsed cupulate upon drying, with an obtuse apex often black with age. *Peridium* of 2–4 cell layers; outer layer(s) pigmented, subhyaline, yellow, orange, red or light brown in section, when dry yellow-orange, shades of red to brown or black, thickened around the ostiole; pseudoparenchymatous, KOH+/-. *Hamathecium* present as periphyses in the ostiole and as apical paraphyses, branched and anastomosing, descending from an apical cushion to the bases of asci, usually present at maturity, cylindrical or as submoniliform bands. *Asci* 8-spored, unitunicate, oblong or clavate, with undifferentiated apex. *Ascospores* uni or biseriate, ellipsoid, oblong, fusiform, globose, clavate or vermiform, 1- to several-septate or muriform, hyaline, yellowish, rosy, green or brown, with eusepta and/or distosepta becoming indistinct in KOH, smooth or striate-walled, sometimes budding in the ascus to produce oblong to allantoid, aseptate, hyaline, ascoconidia. **Asexual morph:** Pycnidial and/or effuse conidial masses forming on white mycelium and conidiophores. *Pycnidia* associated with perithecia on the same hypostroma or occurring separately, solitary or aggregated in groups, erumpent-superficial, subglobose to irregularly discoid to cupulate or elongate and erect, rosy, orange, red, violaceous brown to nearly black, KOH+/-. *Sterile hyphae* sometimes present inside the pycnidium. *Conidiophores* densely aggregated, simple, irregularly or

verticillately branched; conidia formed on minute pegs or cylindrical to subulate phialides, conidial formation enteroblastic; *in cultures* lageniform to ampulliform phialides formed on simple, unbranched or branched, sometimes verticillate conidiophores or formed in pycnidia on mostly lageniform to subulate phialides on densely aggregated, simple, asymmetrically or verticillately branched, often shrub- or fan-shaped conidiophores. *Conidia* oblong, ellipsoid or (sub)allantoid, aseptate or rarely 1- or 2-sepate, hyaline, smooth-walled (Adapted from Jaklisch & Voglmayr, 2014).

Known distribution: North and south temperate regions, subtropical regions of Asia, the Caribbean region, Central and South America (Crous, Wingfield, Burgess et al., 2016; Jaklisch & Voglmayr, 2014; Yang et al., 2019)

Notes: Jaklisch & Voglmayr (2014) re-instated the genus *Thyronectria* based on multigene phylogeny. *Mattirolia*, *Pleonectria* and *Thyronectroidea* were considered as synonyms of *Thyronectria* (Jaklisch & Voglmayr, 2014). *Thyronectria* species are characterized by ascomata containing long, more or less persistent, apical paraphyses and hyaline, rosy, green or dark brown and sometimes distoseptate ascospores (Jaklisch & Voglmayr, 2014).

Crous, Wingfield, Burgess et al. (2016) established the genus *Neothyronectria* to accommodate single pycnidial species *Neothyronectria sophorae*, and it was assigned in Hypocreales, *Incertae sedis* based on LSU phylogeny. Later Yang et al. (2019) introduced another species, which had sexual morph characters allied to *Allantonectria* and *Thyronectria*. *Neothyronectria* has been accepted in Nectriaceae based on multigene phylogeny (Yang et al., 2019) and this was followed by subsequent authors (Hyde et al., 2020; Wijayawardene et al., 2020, 2022). However, Voglmayr et al. (2022) synonymised *Neothyronectria* under *Thyronectria* based on phylogenetic analysis. The combined gene analysis here (Figure 2.38). also confirms that *Neothyronectria* belongs to *Thyronectria*.

Type species: ***Thyronectria rhodochlora*** (Mont.) Seeler, J. Arnold Arbor. 21: 455 (1940)

Basionym: *Sphaeria rhodochlora* Mont., Annls Sci. Nat., Bot., sér. 2 1: 307 (1834)

= *Thyronectria patavina* Sacc., Grevillea 4(no. 29): 21 (1875)

Index Fungorum number: IF291395, *Facesoffungi number*: FoF11015

Descriptions and Illustrations: see Jaklitsch & Voglmayr (2014)

Thyronectria sinopica (Fr.) Jaklitsch & Voglmayr, Persoonia 33: 206 (2014)

Basionym: *Sphaeria sinopica* Fr., Elench. fung. (Greifswald) 2: 81 (1828)

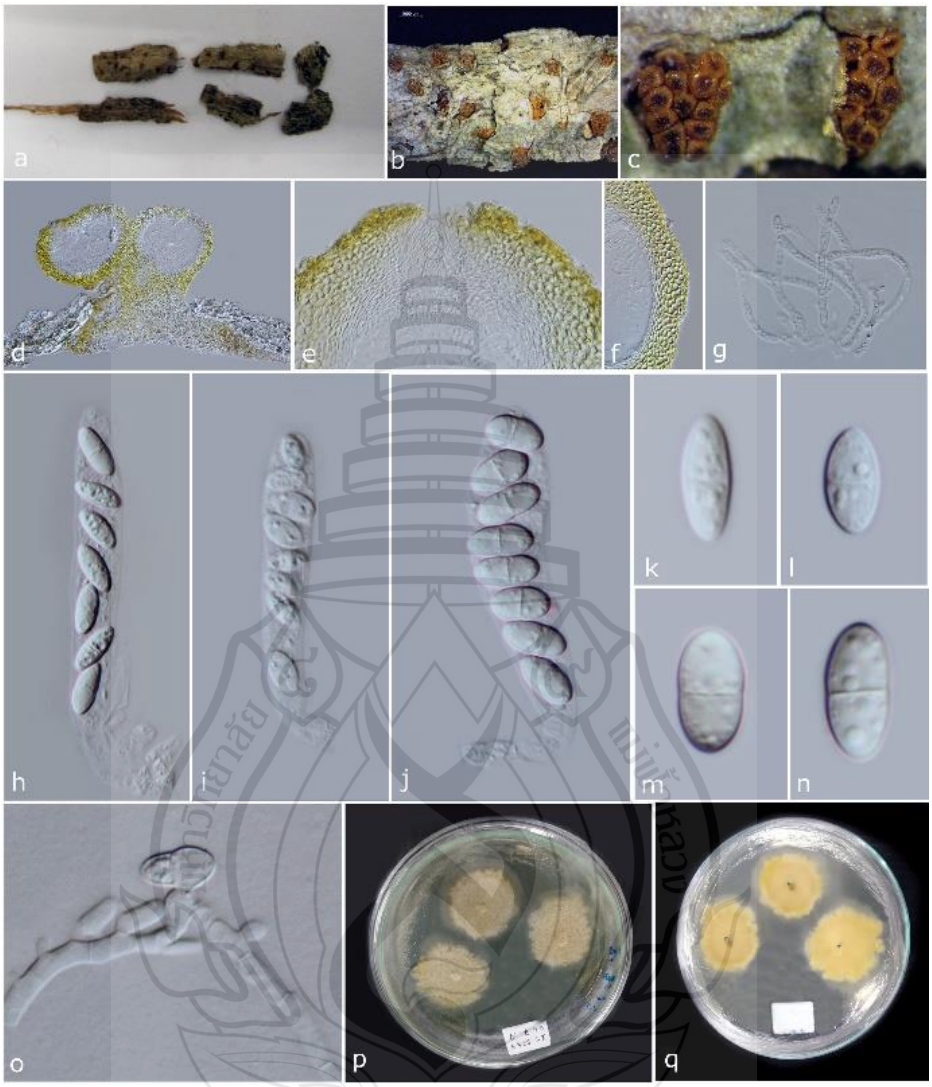
= *Pleonectria sinopica* (Fr.) Hirooka, Rossman & P. Chaverri, in Hirooka, Rossman, Samuels, Lechat & Chaverri, Stud. Mycol. 71: 165 (2012)

Index Fungorum number: IF808308, Facesoffungi number: FoF11016, Figures 2.87, 2.88

Saprobic on *Hedera felix*. **Sexual morph:** *Stromata* up to 1.4 mm high, well-developed, erumpent through host epidermis, bay, KOH+ dark red, composed of brown-yellow to hyaline pseudoparenchymatous cells forming *textura angularis*, intergrading with peridium cells. *Ascomata* 210–295 μm high × 210–355 μm diam., superficial on stromata, aggregated in groups of up to 40, subglobose to globose, apapillate, apically slightly cupulate upon drying, bay to scarlet with darker apical region, KOH+ dark red, surface smooth or scurfy, concolourous, sometimes minutely rugose, ostiolate. *Ostiolar canal* lined with periphyses. *Peridium* 42–65 μm thick, of two strata: outer stratum 26–51 μm thick, intergrading with stroma, composed of thick-walled, yellow cells forming *textura angularis*; inner stratum 6–23 μm thick, of elongate, thin-walled, flattened, hyaline cells forming *textura prismatica*; in surface cells forming *textura angularis.* *Paraphyses* 1.8–3.6 μm wide, filiform, septate, hyaline. *Asci* 55–85 × 7.3–14 μm ($\bar{x}$ = 68.1 × 10.1 μm, n = 15), (2, 4–)8-spored, narrowly clavate, unitunicate, with a J- inconspicuous apical ring. *Ascospores* 9.3–13.7 × 4.1–6 μm (10.7 × 4.8 μm, n = 30), uniseriate or sometimes biseriate ellipsoidal to fusiform, 1-septate, slightly constricted at septum, straight, hyaline, multi-guttulate, smooth-walled. **Asexual morph on PDA:** *Conidiomata* sporodochial, pale yellow to bay. *Conidiophores* up to 40–63 μm long, 3–4 μm wide at base., densely branched. *Conidiogenous cells* 3.4–11 μm long × 1.1–1.8 μm wide at the widest point, monophialidic, enteroblastic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle. *Conidia* 3.2–5.8 μm × 1.1–1.5 μm (4.6 × 1.3; n = 50), formed abundantly in slimy masses, oblong to allantoid, sometimes strongly curved, rounded at both ends, aseptate, hyaline, smooth-walled. *Chlamydospores* globose or cylindrical, hyaline to pigmented, smooth-walled, formed in long chains.

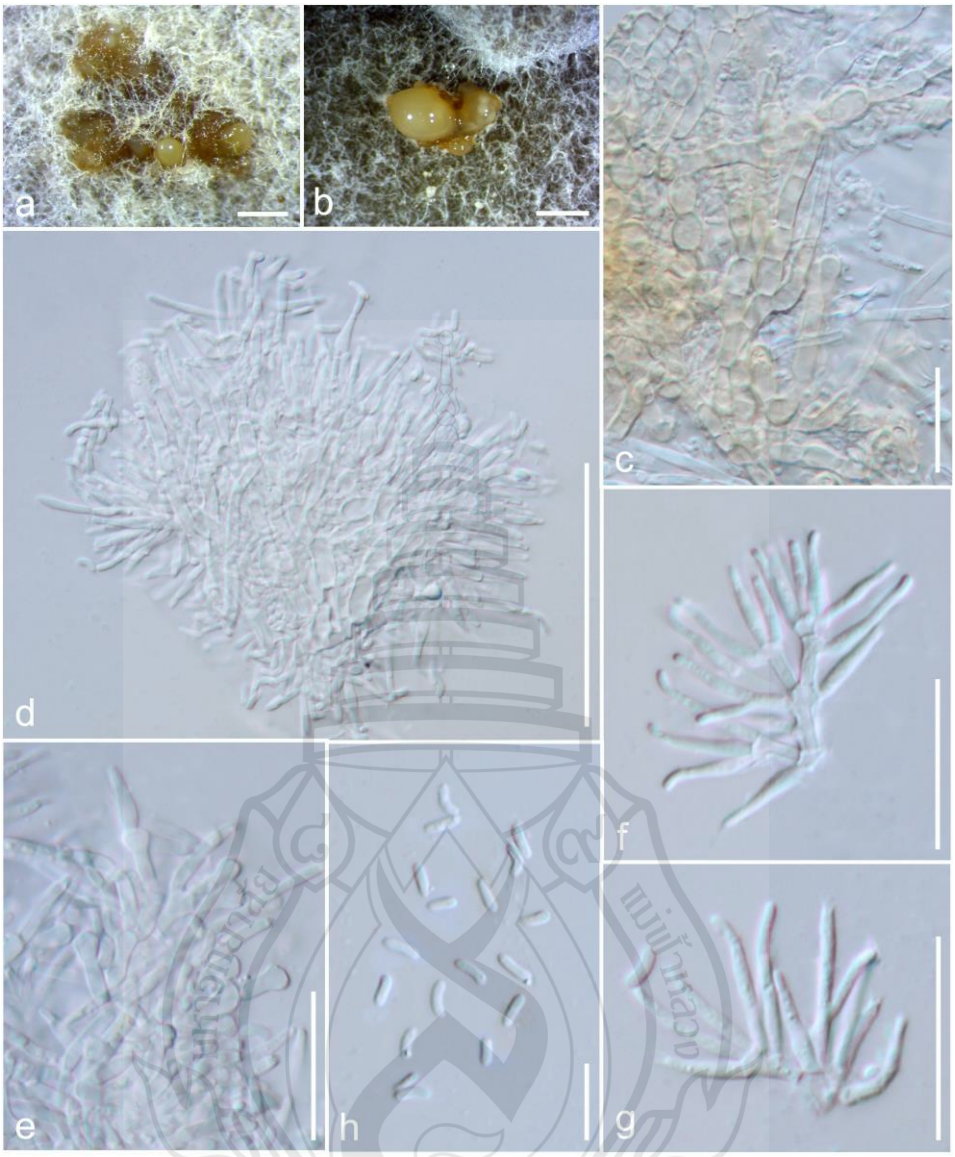
Culture characteristics: Ascospores germinating on PDA within 24 hrs at 25°C. Colony on MEA becoming 30 mm diam. within 7 days at 25°C, irregular, undulate,

raised, surface cottony with aerial mycelium, above and reverse whitish yellow, sporulating after 6 weeks.



Note (a) Herbarium material. (b, c) Ascomata on host. (d) Vertical section of stroma and ascomata. (e) Vertical section of ostiolar region. (f) Vertical section of peridium. (g) Paraphyses. (h–j) Asci. (k–n) Ascospores. (o) Germinating ascospore. (p, q) Colony on MEA. Scale bars: b = 2 mm, c = 500 µm, d = 200 µm, e–j = 50 µm, k–o = 10 µm.

Figure 2.87 *Thyronectria sinopica* (MFLU 17-0998)



Note (a, b) Conidiomata on MEA. (c) Chlamydospores. (d, e) Conidiophores and phialides. (f, g) Phialides and conidia. (h) Conidia. Scale bars: a = 500 µm, b = 1 mm, c = 20 µm, d = 50 µm, e–g = 20 µm, h = 10 µm.

Figure 2.88 *Thyronectria sinopica* (MFLU 17-0998)

Material examined: ITALY, Forlì-Cesena Province, Predappio, near Predappio Alta, on fallen dead branch of *Hedera felix* (Araliaceae), 5 May 2017, Erio Camporesi, IT3343 (MFLU 17-0998), living culture MFLUCC 18-0596.

GenBank nubers: ITS: ON787630, RPB1: ON892544, TEF1: ON892550, TUB2: ON892557

Thyronectria nolinae (A.W. Ramaley) R.H. Perera & K.D. Hyde, ***comb. nov.***

Basionym: *Sulcatistroma nolinae* A.W. Ramaley, Mycotaxon 93: 140 (2005)

Index Fungorum number: IF559632, Facesoffungi number: FoF11017

Notes: The monotypic genus *Sulcatistroma* was previously accepted in Calosphaeriales (Ramaley 2005; Wijayawardene et al. 2020) and later in Calosphaeriaceae (Lumbsch & Huhndorf, 2010; Maharachchikumbura et al., 2015, 2016). Based on ITS data Vu et al. (2019) revealed that *Sulcatistroma* is related to Nectriaceae. Huang et al. (2021) placed it in Hypocreales without assigning to a family and it was followed by Wijayawardene et al. (2022). In our study *Sulcatistroma* nested within Nectriaceae sister to *Thyronectria concentrica* isolates (CBS 474.69, CBS 121121) with high statistical support (100% MLBT; 1.00% BYPP). The morphology of the fungus is typical to *Thyronectria*; hence, we synonymise *Sulcatistroma* under *Thyronectria.*

Tumenectria Salgado & Rossman, in Salgado-Salazar, Rossman & Chaverri, Fungal Diversity 80: 451 (2016)

Basionym: *Nectria laetidisca* Rossman, Mycol. Pap. 150: 36 (1983)

Index Fungorum number: IF816463, Facesoffungi number: FoF11018

On wood and culms of bamboo. **Sexual morph:** *Ascomata* 370–580 × 300–415 μm, perithecial, solitary or gregarious arising from same point, astromatic, superficial, easily detached from substratum, papillate, globose, orange to scarlet, KOH+ red, LA yellow, surface smooth. *Peridium* of two strata. *Asci* 8-spored, unitunicate, narrowly clavate, apex simple. *Ascospores* fusiform with rounded ends, 3-septate, hyaline, smooth, regularly multi-seriate. **Asexual morph:** *Conidiomata* cylindrocarpon-like. *Phialides* borne apically on irregularly branching clusters of cells or directly from hyphae, cylindrical or slightly swollen, periclinal thickening evident, with a collarette. *Microconidia* absent. *Macroconidia* cylindrical to slightly fusiform, with rounded ends, 3–6-septate. *Chlamydospores* absent (Adapted from Salgado-Salazar et al., 2016).

Known distribution: Jamaica, Japan (Salgado-Salazar et al., 2016)

Notes: *Tumenectria* was introduced for a single species *Nectria laetidisca*, which has 3-septate phragmo-ascospores and cylindrocarpon-like asexual morphs (Salgado-

Salazar et al., 2016). *Tumenectria* resembles Nectriaceae by producing bright coloured perithecia and cylindrocarpon-like asexual morph. The genus showed close phylogenetic affinities to *Mariannaea* (Figure 2.38).

Type species: ***Tumenectria laetidisca*** (Rossman) Salgado & Rossman, in Salgado-Salazar, Rossman & Chaverri, Fungal Diversity 80: 451 (2016)

Basionym: *Nectria laetidisca* Rossman, Mycol. Pap. 150: 36 (1983)

Index Fungorum number: IF816464, Facesoffungi number: FoF11019

Descriptions and illustrations: see Salgado-Salazar et al. (2016)

Varicosporella Lechat & J. Fourn., Ascomycete.org 7(1): 2 (2015)

Index Fungorum number: IF810690, Facesoffungi number: FoF11020

On submerged wood of *Populus* sp. **Sexual morph:** *Ascomata* 340–390 μm high × 250–300 μm diam., astromatic, solitary, superficial with base slightly immersed in substratum, uniloculate, obpyriform, laterally collapsing upon drying, greyish yellow to pale orange, with a translucent, broadly conical to rounded apex, KOH+ pale yellow, lactic acid+ pale yellow, soft-textured. *Periphyses* copious, embedded in gel matrix, simple or branched, septate. *Basal hyphae* sparse and short, hyaline, thick-walled. *Peridium* in vertical section composed of subglobose to angular thick-walled cells; cells forming a *textura angularis* in surface view. *Paraphyses* slightly moniliform, thin-walled, early deliquescing. *Asci* 8-spored, unitunicate, cylindrical, short-stipitate, apically truncate to slightly rounded, with a conspicuous, refractive apical ring, discoid to wedge-shaped. *Ascospores* obliquely uniseriate, ellipsoid with narrowly to broadly rounded ends, equally 1-septate, slightly constricted at septum, with two large guttules in each cell, hyaline to pale yellowish brown, wall roughened by short, sinuous, brown, thick ribs, sometimes anastomosed. **Asexual morph:** *Conidiomata* fusarium-like. *Microconidia* absent. *Macroconidia* cylindrical, slightly curved, acute at tip, truncate to rounded at base, 3–4 (–5)-septate (Adapted from Lechat & Fournier, 2015).

Known distribution: South of France: Ariège, Lozère (Lechat & Fournier, 2015)

Notes: Lechat and Fournier (2015) erected the monotypic genus *Varicosporella* for *V. aquatica* collected from freshwater habitats. The fungus is related to Bionectriaceae in having KOH and lactic acid negative, pale orange ascomata (Rossman et al., 1999). However, it is typical of Nectriaceae in having a fusarium-like asexual morph, and the

relationship was supported by phylogenetic analysis (Rossman et al., 1999; Lechat & Fournier, 2015, This study).

Type species: ***Varicosporella aquatica*** Lechat & J. Fourn., Ascomycete.org 7(1): 2 (2015)

Index Fungorum number: IF810691, Facesoffungi number: FoF11021

Descriptions and illustrations: see Lechat & Fournier (2015).

Varicosporellopsis Lechat & J. Fourn., Ascomycete.org 8(3): 96 (2016)

Index Fungorum number: IF815311, Facesoffungi number: FoF11022

On submerged twig of *Buxus sempervirens*. **Sexual morph:** Ascomata 240–280 μm high, 170–230 μm diam., astromatic, solitary, superficial with base slightly immersed in substrate, subglobose, laterally collapsing upon drying, pale orange, with a translucent, broadly conical to rounded apex, KOH-, LA very pale yellow to nearly hyaline, soft-textured. *Peridium* of two strata in vertical; composed of subglobose, subangular cells, covered by smooth, tan or hyaline hyphae in face view. *Ostiolar canal* periphysate. *Paraphyses* moniliform, early deliquescing paraphyses *Asci* unitunicate, 8-spored, cylindrical, short-stipitate, apically truncate to slightly rounded with a faint apical ring-like thickening. *Ascospores* obliquely uniseriate, ellipsoid with narrowly to broadly rounded ends, equally 1-septate, slightly constricted at septum, hyaline to pale yellowish brown, guttulate, wall roughened by short, sinuous, brown, thick ribs, sometimes anastomosed. **Asexual morph:** Acremonium-like. *Conidiophores* macronematous, mononematous, unbranched, flexuous, hyaline, smooth-walled. *Conidiogenous cells* monophialidic, with a slightly flared collarette. *Conidia* 6–11 × 2.8–3.2 μm, narrowly ellipsoidal to subcylindrical. *Verticillate conidiophores* arising laterally from submerged hyphae. *Conidiogenous cells* phialidic, cylindrical, subulate, smooth, hyaline to pale salmon. *Conidia* 5–8 × 3–4.5 μm, widely ellipsoidal, attenuated at base without a flat abscission scar, hyaline, smooth-walled (Adapted from Lechat & Fournier, 2016b).

Known distribution: Southern France (Ariège) (Lechat & Fournier, 2016b)

Notes: Lechat and Fournier (2016b) erected monotypic genus *Varicosporellopsis* for *V. aquatilis* collected from freshwater habitats. *Varicosporellopsis* is more similar to *Variscoporella*, which was reported from freshwater habitat, in having KOH-negative, pale orange, astromatic ascomata, but differs in having acremonium-like asexual morphs while *Varicosporella* has a fusarium-like asexual morph (Lechat & Fournier, 2016b).

Type species: ***Varicosporellopsis aquatilis*** Lechat & J. Fourn., Ascomycete.org 8(3): 87 (2016)

Index Fungorum number: IF815312, Facesoffungi number: FoF11023

Descriptions and illustrations: see Lechat & Fournier (2016b).

Vesicladiella Crous & M.J. Wingf., in Crous, Wingfield, Alfenas & Silveira, Mycotaxon 50: 454 (1994)

Index Fungorum number: IF26064, Facesoffungi number: FoF11024

Associated with *Araucaria* leaf litter. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* sporodochial, scattered to gregarious, white. *Stipe extensions* erect, unbranched, aseptate, thick-walled, terminating in a thin-walled vesicle. *Conidiophores* reduced to conidiogenous cells. *Phialides* discrete, determinate, formed intercalary or lateral, ampulliform, with collarettes. *Conidia* aseptate, cylindrical with rounded ends, guttulate, hyaline, smooth-walled (Crous et al., 1994).

Known distribution: Australia (Crous et al., 1994)

Notes: Crous et al. (1994) introduced monotypic genus *Vesicladiella* to accommodate vesiculate hyphomycete *Pulvinotrichum capitatum*. The genus was not allocated to a family (Crous et al., 1994). *Vesicladiella* is characterized by sporodochial conidiomata, stipe extensions terminating in a vesicle, ampulliform phialides and cylindrical, aseptate, hyaline conidia (Crous et al., 1994). *Vesicladiella* has been maintained in Bioncetriaceae by Maharachchikumbura et al. (2015, 2016). No sequence data are available. By considering the morphology, we propose to retain *Vesicladiella* in Nectriaceae until the phylogenetic position is confirmed by fresh collections and molecular data.

Type species: ***Vesicladiella capitata*** (B. Sutton) Crous & M.J. Wingf. [as '*capitatum*'], Mycotaxon 50 456 (1994)

Basionym: *Pulvinotrichum capitatum* B. Sutton, Sydowia 41: 338 (1989)

Index Fungorum number: IF361733, Facesoffungi number: FoF11025, Figure 2.89

On dead leaves of *Araucaria bidwellii*. *Mycelium* thick, septate, light brown, thick-, smooth-walled. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* sporodochial, scattered to gregarious, white. *Stipe extensions* up to 145 µm long, erect, aseptate, unbranched, hyaline, thick-, smooth-walled, terminating into vesicle. *Vesicle* 3–

4.5 µm wide, ellipsoid to clavate, hyaline, thin-walled. *Conidiophores* reduced to conidiogenous cells. *Phialides* 3–4 × 0.8–1 µm, discrete, ampulliform, with minute collarettes, hyaline, smooth-walled. *Conidia* 6–8 × 1.5 µm, aseptate, cylindrical, with rounded ends, bi-guttulate, hyaline, smooth-walled.

Note (a) Herbarium material with label. (b) Conidiomata on host substrate. (c) Phialides attached to conidiophores. (d) Phialide with conidia. (e) Conidia. (f, g) Stipe extensions with vesicles. Scale bars: b = 500 µm, c–e = 10 µm, f, g = 20 µm.

Figure 2.89 *Vesicladiella capitata* (IMI 263277a, holotype)

Material examined: AUSTRALIA, Queensland, Boombana National park, on dead leaves of *Araucaria bidwellii*, B.C. Sutton and J.L. Alcorn, 27 August 1981, IMI 263277a, **holotype**.

Volutella Tode, Fung. mecklenb. sel. (Lüneburg) 1: 28 (1790)

= *Volutellonectria* J. Luo & W.Y. Zhuang, Phytotaxa 44: 3 (2012)

Index Fungorum number: IF39165, Facesoffungi number: FoF10672

Saprobic, plant *pathogenic*, on decaying herbaceous debris and wood, some are soil-borne. **Sexual morph:** *Ascomata* perithecial, astromatic or occurring a thin basal stroma, superficial, solitary or in small groups pyriform to obpyriform, apex acute, laterally pinched or not collapsing upon drying, orange to red, KOH+ dark red, surface smooth or hairy. *Asci* 8-spored, unitunicate, subcylindrical to clavate, with an apical ring. *Ascospores* 1-septate, ellipsoidal, fusiform or cylindrical to biconic, hyaline, smooth- or finely roughened-walled. **Asexual morph:** Hyphomycetous. *Conidiophores* sporodochial or synnematal, arising from a discreet stroma, sessile or short stipitate, unbranched, setose. *Setae* occurring around the margin of conidiomata, hyaline, usually arising from the stromatic base. *Synnemata* determinate, pale, composed of a stipe and a divergent capitulum of conidiophores with conidial mass. *Stipe* comprising of parallel hyphae. *Conidiophores* branching once or twice monochasial, 2-level verticillate, monoverticillate or irregularly biverticillate. *Conidiogenous cells* monophialidic, subulate, mostly with a conspicuous periclinal thickening, hyaline. *Conidia* ellipsoidal, ovate or oblong, aseptate, hyaline, occur in slimy white, yellow, orange or pink masses (Adapted from Gräfenhan et al., 2011; Lombard et al., 2015).

Known distribution: Worldwide

Notes: *Volutellonectria* was considered as a synonym of *Volutella* by Lombard et al. (2015) on the basis of multi-locus phylogeny. Species previously recognised as *Volutella buxi* and *Volutella pachysandricola*, which are morphologically and phylogenetically distinct from species of *Volutella sensu stricto*, were transferred to *Pseudonectria* and *Coccinonectria* (Gräfenhan et al., 2011; Lombard et al., 2015). However, a comprehensive revision of the genus is required as much less research has been conducted (Gräfenhan et al., 2011).

Type species: ***Volutella ciliata*** (Alb. & Schwein.) Fr., Syst. mycol. (Lundae) 3(2): 467 (1832)

Index Fungorum number: IF208513, Facesoffungi number: FoF11027

Descriptions and illustrations: see Lombard et al. (2015)

Volutella consors (Ellis & Everh.) Seifert, Gräfenhan & Schroers, in Gräfenhan, Schroers, Nirenberg & Seifert, Stud. Mycol. 68: 109 (2011)

Basionym: *Dialonectria consors* Ellis & Everh., J. Mycol. 4(12): 122 (1888)

= *Nectria consors* (Ellis & Everh.) Seaver, Mycologia 1(2): 61 (1909)

Index Fungorum number: IF519455, Facesoffungi number: FoF11028, Figures 2.90, 2.91

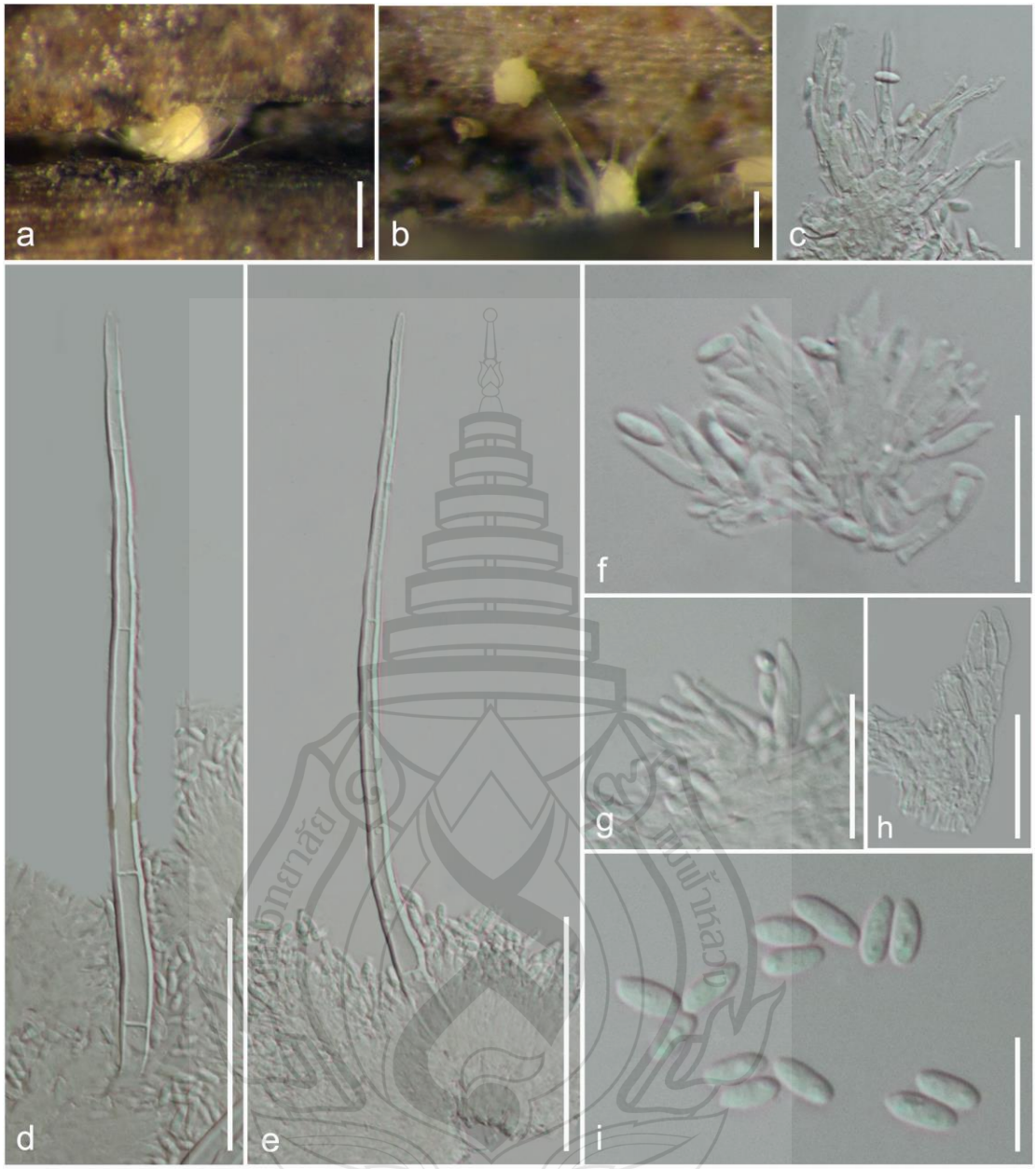
On dead leaves of *Phormium* sp. **Sexual morph:** *Ascomata* 210–270 µm × 150 – 220 µm diam., solitary or in small groups of 2–6, on a thin basal stroma, perithecial, pyriform, laterally pinched when dry, redish orange, ostiolate, acutely papillate, KOH+ dark red. *Papilla* composed of narrow hyphal elements, slightly darker red, lighter at the apex. *Perithecial hairs* arising from surface cells of the peridium, inconspicuous. *Peridium* prosenchymatous in face view, cells pale orange brown, smooth-walled. *Asci* 45–50 µm× 5–6 µm, 4–8-spored, unitunicate, cylindrical to clavate, apex rounded, with a J- apical ring. *Ascospores* 10–11 × 2.5–3 µm, overlapping, fusiform, ellipsoidal or naviculate, 1-septate, not constricted at the septum, hyaline or pale brown, smooth-walled. **Asexual morph:** Hyphomycetous. *Conidiomata* sporodochial. *Sporodochia* occurring on stromatic base, scattered, sessile or short stipitate, unbranched, white to pale yellow, setose. *Conidial mass* conical to hemispherical, pale yellow, gelatinous. ***Setae*** 250–260 µm long, arising from the stromatic base, lined around the conidiomata, unbranched, septate, wider at the base, tapering towards the acute or rounded apex, hyaline, thick-, smooth-walled. *Peripheral hyphae* 30–38 × 2–3 µm, occurring on the stromatic base and surrounding the conidophores, branched, septate, tips rounded, white, thin-, smooth-walled. *Conidiophores* 25–30 µm long × 2–3 µm wide, occur on stromatic base, aggregated, monomorphic, penicillate, branching once or twice, each terminal branch producing 2–4 phialides, hyaline, smooth-walled. *Phialides* 10–15 × 2–3 µm, cylindrical, tapering towards the apex, with a widely flared collarette, hyaline, smooth-walled. *Conidia* 5–8 × 1.5–2.5 µm, ellipsoidal to cylindrical, aseptate, eguttulate or biguttulate; with a protruding, flattened, basal hilum; hyaline, smooth-walled.

Material examined: NEW ZEALAND, Taranaki, Mt. Egmont National Park, vicinity of Stratford Mt. House, trial to Curtis' Falls, on dead leaves of *Phormium* sp., G.J. Samuels 73-215 and C.S. Samuels, 2 October 1973, PDD 32034.

Notes: We were unable to locate authentic material of *Volutella ciliate*. Instead, a reliable material of *V. consors* determined by G.J. Samuels was studied (Samuels, 1977).

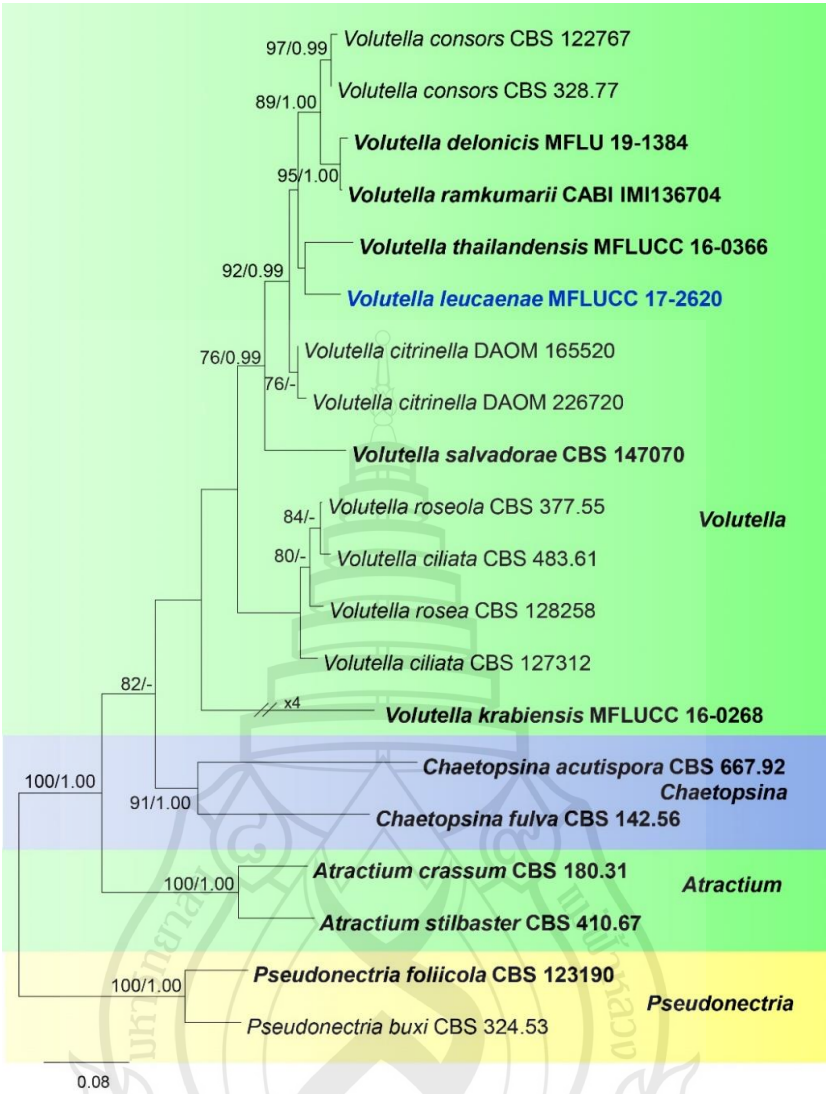
Note (a, b) Herbarium material labels. (c) Herbarium material. (d, e) Ascomata on host substrate. (f, g) Ostiolar region of conidioma mounted in water. (h, i) Peridium in surface view. (j) Ascus. (k–p) Ascospores. Scale bars: d, e = 200 µm, f, g = 100 µm, h, i = 50 µm, j = 20 µm, k–p = 10 µm.

Figure 2.90 *Volutella consors* (PDD 32034, sexual morph)



Note (a, b) Sporodochia on host substrate. (c) Marginal hyphae. (d, e) Setae. (f–h) Conidiophores with conidiogenous cells and conidia. (i) Conidia. Scale bars: a, b = 100 µm, c = 20 µm, d, e = 50 µm, f–h = 20 µm, i = 10 µm.

Figure 2.91 *Volutella consors* (PDD 32034, asexual morph)



Note Twenty strains are included in the combined analyses, which comprised 2709 characters (LSU: 832, ITS: 589, *TUB2*: 729, *TEF1*: 559), including gaps. Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to *Pseudonectria buxi* (CBS 324.53) and *Pseudonectria foliicola* (CBS 123190). Ex-type strains are in bold. The newly generated sequences are indicated in blue. The scale bar indicates 0.08 nucleotide changes per site.

Figure 2.92 Phylogram generated from maximum likelihood analysis based on combined LSU, ITS, TUB2 and TEF1 sequence data of *Volutella*, *Chaetopsina* and *Atractium* taxa

Volutella leucaenae R.H. Perera, Maharachch., E.B.G. Jones, & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF559633, Facesoffungi number: FoF11029, Figure 2.93

Etymology: Name refers to the host genus *Leucaena* from which it was collected.

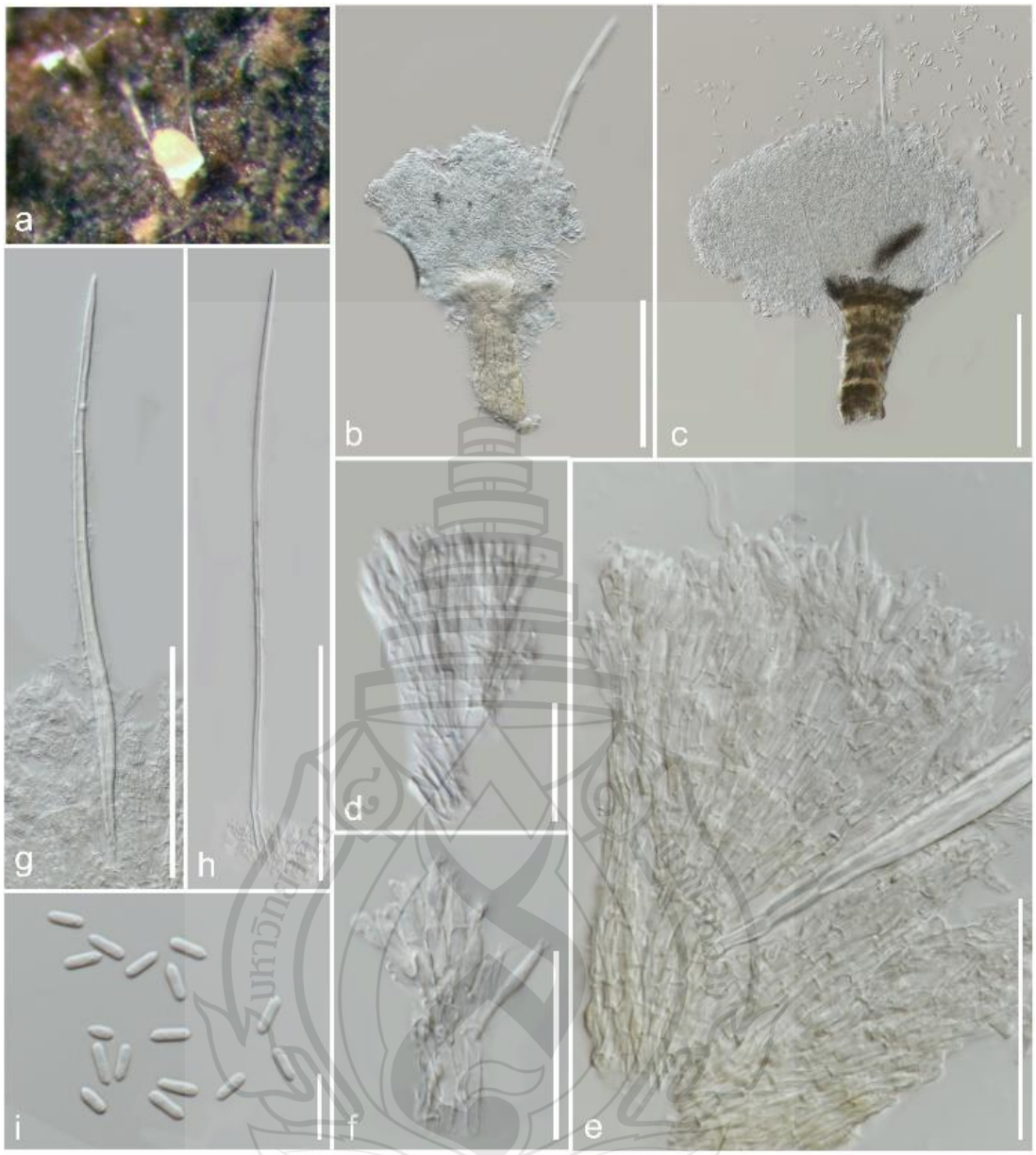
Saprobic on stem bark of *Leucaena leucocephala*. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* hyphomycetous, synnematous. *Synnemata* seated on stromatic base, scattered, determinate, composed of a stipe and a divergent capitulum of conidiophores, unbranched, white to pale yellow, setose. *Conidial mass* conical to hemispherical, white to pale pale yellow, gelatinous. *Stipe* composed of parallel hyphae, cylindrical, erect, initially pale brown, becoming brown with dark brown rings when mature. *Setae* 170–230 µm long, arising from the parallel hyphae of the stipe, occurring around the margin of conidiomata, unbranched, septate, wider at the base, tapering towards the acute or rounded apex, straight or slightly curved, sterile, hyaline, thick-, smooth-walled. *Conidiophores* 100–145 µm long × 3.2–4 µm wide ($\bar{x}$ = 120 × 3.7 µm), arising from the parallel hyphae of the stipe, aggregated, monomorphic, penicillate, septate, branching once or twice, each terminal branch producing 2–4 phialides, hyaline, smooth-walled. *Conidiogenous cell* 7.1–10 × 1.5–3 µm ($\bar{x}$ = 8.5 × 2.2 µm), phialidic, lageniform to cylindrical, tapered to the apex, periclinal thickening conspicuous, with a widely flared collarette, hyaline, smooth-walled. *Conidia* (3.7–) 4.8–6.7 × 1.4–1.7 µm ($\bar{x}$ = 5.6 × 1.5 µm), cylindrical, aseptate, bi-guttulate; with a protruding, flattened, basal hilum; hyaline, smooth-walled, occurring as pale slimy masses.

Culture characteristics: Ascospores germinating on PDA within 12 hrs. Colony on PDA becoming 45 mm diam. within 7 days at 25℃, circular, with sparse aerial mycelium, surface flat, smooth, above and reverse hyaline to white.

Material examined: THAILAND, Chiang Mai Province, Mae Rim District, on decaying stem bark of *Leucaena leucocephala* (Fabaceae), 18 September 2017, R. H. Perera, Rim21b (MFLU 19-0977, **holotype**), **ex-type** living culture MFLUCC 17-2620.

GenBank numbers: LSU: ON787622, ITS: ON787631, TEF1: ON892551, TUB2: ON892558

Notes: *Volutella leucaenae* MFLUCC 17-2620 clustered with ex-type of *Volutella thailandensis* (MFLUCC 16-0366), which was collected from Thailand, in our



Note (a) Synnema on host substrate. (b, c) Synnemata mounted on water. (d–f) Conidiophores with conidiogenous cells with phialides. (g, h) Setae. (i) Conidia. Scale bars: b, c = 100 µm, d = 20 µm, e = 50 µm, f = 20 µm, g, h = 100 µm, i= 10 µm.

Figure 2.93 *Volutella leucaenae* (MFLU 19-0977, holotype)

phylogenetic analysis (Figure 2.92). New collection has smaller conidiogenous cells when compared to *V. thailandensis* (7.1–10 × 1.5–3 vs. 7–15 9 1– 2.5), while

conidial measurements of both taxa are overlapping (Tibpromma et al. 2018). *Volutella leucaenae* (MFLUCC 17-2620) and *V. thailandensis* (MFLUCC 16-0366) showed 20 different nucleotides in the ITS region (4.1%, 4 gaps) and 9 in LSU sequences (1.1%, 0 gaps). We therefore introduce *V. leucaenae* as a new species.

Xenoleptographium Marinc., T.A. Duong, Z.W. de Beer & M.J. Wingf., in Crous et al., Persoonia 35: 319 (2015)

Index Fungorum number: IF812683, Facesoffungi number: FoF11030

Isolated from exposed xylem tissues of *Gmelina arborea*. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiophores* macronematous, mostly single, erect. *Conidiogenous cells* phialidic, cylindrical, tapering to the apex, with inconspicuous collarettes, hyaline. *Conidia* ellipsoid, asymmetric, with truncated base, aseptate, hyaline, smooth-walled, occur in yellowish slimy droplets. **Synasexual morph:** Acremonium-like. *Conidiophores* micro- or macronematous. *Conidiogenous cells* hyaline, cylindrical tapering gradually towards the apex with distinct collarette. *Conidia* fusiform with truncated base, hyaline, occur in colourless slimy droplets (Adapted from Crous, Wingfield, Le Roux et al., 2015).

Known distribution: Indonesia (Crous, Wingfield, Le Roux et al., 2015)

Notes: This monotypic genus is typified by *Xenoleptographium phialoconidium* (Crous, Wingfield, Le Roux et al., 2015). *Xenoleptographium* is morphologically related to *Leptographium* (Ophiostomataceae) but differs in enteroblastic conidiogenous cells and lack of tolerance to cycloheximide (Crous, Wingfield, Le Roux et al., 2015).

Type species: ***Xenoleptographium phialoconidium*** Marinc., T.A. Duong, Z.W. de Beer & M.J. Wingf., in Crous et al., Persoonia 35: 319 (2015)

Index Fungorum number: IF814898, Facesoffungi number: FoF11031

Descriptions and illustrations: see Crous, Wingfield, Le Roux et al. (2015)

Xenonectriella Weese, Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 128: 749 (1919)

Index Fungorum number: IF5822, Facesoffungi number: FoF11032

Lichenicolous on apothecia or thali of lichens. **Sexual morph:** *Ascomata* perithecial, immersed to semi-immersed in the host thallus, globose, papillate, brown, orange or red, smooth walled, ostiolate. *Ostiolar channel* lined with periphyses. *Peridium* consisting of 2 strata, outer stratum yellow, orange or red, made of compressed thick-

walled cells, KOH+ red to violet, lactic acid+ greenish-yellow; inner stratum of elongate, hyaline, thin-walled cells. *Paraphyses* present only when young, evanescent. *Asci* 2–8-spored, unitunicate, cylindrical, with a simple apex. *Ascospores* uniseriate, hyaline, becoming pale orange to brown when mature, smooth-walled, perispore becoming verrucose to tuberculate when mature. **Asexual morph:** *Conidiomata* fusarium-type, sporodochial. *Conidiophores* irregular in shape, septate, branched, hyaline. *Conidiogenous cells* terminal, flask-shaped, hyaline, thin-walled. *Conidia* arising singly on the conidiogenous cells, multi-septate, crescent-shaped, with a blunt apex, tapering at the base, hyaline, smooth-walled (Rossman et al., 1999; Berger et al., 2021).

Known distribution: European countries (Austria, Germany, France. Sweden, Turkey) (Rossman et al., 1999), Russia, Guatemala, Dominican Republic, USA (Etayo & van den Boom, 2013; Zhurbenko, 2014; Zhurbenko & Vershinina, 2014).

Notes: Weese (1919) described a new genus *Xenonectriella* to place *Xenonectriella lutescens*, which has been considered as a nectriella-like fungus. Rossman et al. (1999) accepted *Xenonectriella* in Nectriaceae considering the morphological relatedness to *Cosmospora*, Nectriaceae. *Xenonectriella* species are characterised by cylindrical asci, relatively colourful multi-septate ascospores, with reddish-orange to brownish tubercles, fusarium-like asexual morph and lichenicolous habit (Rossman et al., 1999; Zhurbenko & Vershinina, 2014). They are lichenicolous, commonly growing on foliose lichens (Diederich et al., 2018; Berger et al., 2021). There are 21 species are recognized to date (Species Fungorum, 2022). Sequences are unavailable.

Type species: ***Xenonectriella lutescens*** (Arnold) Weese, Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 128: 749 (1919)

Basionym: *Nectria lutescens* Arnold ex Rehm, Hedwigia 22(4): 54 (1883)

Index Fungorum number: IF432184, Facesoffungi number: FoF11033, Figure 2.94

Lichenicolous, on thallus of *Solorina saccata*. **Sexual morph:** *Ascomata* 190–200 µm diam. × 200–240 µm high, scattered or in clusters, partially or completely immersed in the lichen thallus, astromatic, ovoid to pyriform, red, becoming brown with age, KOH+ purple, LA+, with a truncate apex or sometimes with a small papilla, ostiolate, ostiolar areas visible as orangish spots on the host. *Ostioler canal* broad, periphysate. *Periphyses* 0.9–1.8 µm diam. ($\bar{x}$ = 1.5 µm, numerous, filiform, straight,

hyaline. *Peridium* 40–50 µm thick near the ostiole, 20–36 µm thick below, of 2 strata, outer stratum of thick-walled orange-red angular rounded to elongate cells of *textura angularis*, inner stratum of hyaline, compressed cells of *textura primatica*. *Paraphyses* 2–6 µm diam., occasional, branched, irregular in shape, thin-walled, constricted at septa, hyaline, lying between the asci. *Asci* 65–90 × 9–10.5 µm ($\bar{x}$ = 76 × 9.8 µm), 2–8-spored, unitunicate, cylindrical, with a long stipe, thin-walled, not fissitunicate, apex simple. *Ascospores* 8.5–15 × 6.7–10 µm ($\bar{x}$ = 11.2 × 8.6 µm), uniseriate, (0–)1-septate, ellipsoidal, slightly constricted at septum, later merged into (1–)4(–8) to form irregular or cylindrical clusters, (10–)19–48 × 9–11.8 µm ($\bar{x}$ = 32 × 10. 5 µm), with rounded ends, transversely pluriseptate (1–12, often oblique and occasionally forming a zigzag) or rarely submuriform, constricted or sometimes slightly bent at the septa, initially hyaline, pale yellow-brown when mature, guttulate, walls smooth or, rather wrinkled in old spores, without a gelatinous sheath or appendages. **Asexual morph:** Undetermined.

Material examined: GERMANY, Bavaria, Kreuzberg near Vilseck, Oberpfalz, on *Solorina saccata*, September 1882, F. Arnold, Rehm, Ascomyc. no. 681, (M), M-0043827, **isolectotype**.

Note (a, b) Herbarium material labels. (c) Herbarium material. (d) Ascoma on the host. (e) Transverse section of ascomata. (f) Transverse section of ostiolar region. (g, h) Transverse sections of peridium (h in 5% KOH). (i) Paraphyses. (j, k) Asci. (l–s) Ascospores formed by aggregation of 1-septate spores (k, l immature; q, s old). Scale bars: d = 500 µm, e, f = 100 µm, g–k = 20 µm, l–s = 10 µm.

Figure 2.94 *Xenonectriella lutescens* (M-0043827, isolectotype)

2.3.7 Stromatonectriaceae R.H. Perera, E.B.G. Jones, Maharachch., & K.D. Hyde*, fam. nov.*

Stromatonectriaceae R.H. Perera, E.B.G. Jones, Maharachch., & K.D. Hyde, ***fam. nov.***

Index Fungorum number: IF559639, Facesoffungi number: FoF10921

Saprobic, plant *pathogenic*, on woody substrates. *Stromata* pulvinate, erumpent from bark, variable in shape and colour, yellow over orange to red or purple, KOH-. **Sexual morph:** *Ascomata* perithecial, immersed or superficial, crowded atop the stroma surface, spheroid, soft-textured, KOH-. *Hamathecium* consisting exclusively of periphyses. *Paraphyses* present. *Asci* 8-spored, unitunicate, clavate or fusoid, lacking an apical ring. *Ascospores* bi-seriate, ellipsoid, oblong or fusoid, 1-septate, hyaline, yellowish or rosy, smooth-walled. **Asexual morph:** *Conidiomata* gyrostroma-like, pycnidial, occurring on the surface of stroma, semiglobose or pulvinate, multi-loculate, short hairs present on the surface. *Conidiogenous cells* phyalidic. *Phyalides* subulate or narrowly lageniform. *Conidia* aseptate, cylindrical or allantoid, hyaline, smooth-walled.

Type genus: ***Stromatonectria*** Jaklitsch & Voglmayr

Notes: Stromatonectriaceae formed a monophyletic clade sister to Tilachlidiaceae with moderate statistical support (82% MLBT; Figure 2.1). Centrum characteristics, asci and ascospores of *Stromatonectria* are typical of Bionectriaceae and Nectriaceae. KOH negative stromata and ascomata of *Stromatonectria* resemble the Bionectriaceae. However, *Stromatonectria* is characterized by producing gyrostroma-like, pycnidial conidiomata, which is not a characteristic of Bionectriaceae taxa (Jaklitsch & Voglmayr, 2011). Hence, we introduce the new family Stromatonectriaceae based on multi gene analysis and morphological uniqueness of *Stromatonectria*.

Ecological and economic significance of Stromatonectriaceae

Stromatonectria caraganae is a weak plant parasite causing branch blight of Caragana arborescens (Zhou et al., 2018). Being saprobes, *Stromatonectria* involved in nutrient cycling (Dighton, 1995). Prusa (2018) revealed that a cultivated strain of *Stromatonectria* shows antimicrobial activity against *Saccharomyces cerevisiae*.

Genera included in Stromatonectriaceae (*taxonomic notes provided)

Stromatonectria Jaklitsch & Voglmayr*

Stromatonectria Jaklitsch & Voglmayr, Mycologia 103(2): 435 (2011)

Index Fungorum number: IF518755, Facesoffungi number: FoF10922

Saprobic, weak plant *pathogenic*, on woody substrates. *Stromata* pulvinate, erumpent from bark, variable in shape and colour, yellow over orange to red or purple, KOH-. **Sexual morph:** *Ascomata* perithecial, immersed or superficial, crowded atop the stroma surface, spheroid, soft-textured, KOH-. *Hamathecium* consisting exclusively of periphyses. *Paraphyses* present. *Asci* 8-spored, unitunicate, clavate or fusoid, lacking an apical ring. *Ascospores* bi-seriate, ellipsoid, oblong or fusoid, 1-septate, hyaline, yellowish or rosy, smooth-walled. **Asexual morph:** *Conidiomata* gyrostroma-like, pycnidial, occurring on the surface of stroma, semiglobose or pulvinate, multi-loculate, short hairs present on the surface. *Conidiogenous cells* phyalidic. *Phyalides* subulate or narrowly lageniform. *Conidia* aseptate, cylindrical or allantoid, hyaline, smooth-walled (Adapted from Jaklitsch & Voglmayr, 2011).

Known distribution: Austria (Jaklitsch & Voglmayr, 2011), China (Zhou et al., 2018), Ukraine (Prylutskyi et al., 2017; Khudych, 2021)

Notes: Jaklitsch and Voglmayr (2011) designated the monotypic genus *Stromatonectria* based on *Myrmaeciella caraganae. Stromatonectria* has KOH-negative stromata and ascomata, which is typical to Bionectriaceae, and hypocrea-like stroma and nectria-like centrum (Jaklitsch & Voglmayr, 2011). Jaklitsch and Voglmayr (2011) accepted *Stromatonectria* in Bionectriaceae based on LSU phylogeny. Combined gene analysis revealed that *Stromatonectria* is not related to Bionectriaceae and distinct (Figure 2.1).

Type species: ***Stromatonectria caraganae*** (Höhn.) Jaklitsch & Voglmayr, Mycologia 103(2): 435 (2011)

Index Fungorum number: IF518756, Facesoffungi number: FoF10923

Descriptions and illustrations: see Jaklitsch & Voglmayr (2011)

2.3.8 Tilachlidiaceae L. Lombard & Crous

Based on morphology, *Septofusidium* was classified in Nectriaceae by Gams (1971). Lombard et al. (2015) erected Tilachlidiaceae to accommodate *Tilachlidium* and *Septofusidium*. The type genus *Tilachlidium* was previously accepted in Hypocreales, *incertae sedis* (Gams, 1971). Later, a new genus *Psychronectria* was added to the family by Pawłowska et al. (2017) supported by multigene analysis of ITS, LSU, TEF1 and ACT regions. *Psychronectria* species are associated with mosses (Pawłowska et al., 2017). The placement of these families in Hypocreales was confirmed by the subsequent phylogenetic and molecular clock analyses (Maharachchikumbura et al., 2016; Hyde et al., 2017, 2020).

Ecological and economic significance of Tilachlidiaceae

Most *Tilachlidium* species are saprophytic on various substrata including other fungi such as dried Basidiomycetes (Mains, 1951). *Tilachlidium brachiatum* is a saprobic fungus growing on *Agaricus galericulatus* and *Hypholoma fasciculare* (Mains, 1951, Preuss, 1851). Some *Tilachlidium* species found on soil as semisaprophytes (Gouli et al., 2013). *Tilachlidium* also contains entomogenous species (*T. larvarum*) on lepidopterous insects (Mains, 1951). Pereira and Stimac (1997) discussed the potential use of *Tilachlidium* as a biological control agent of urban pest ants.

Tilachlidiaceae L. Lombard & Crous, in Lombard, van der Merwe, Groenewald & Crous, Stud. Mycol. 80: 237 (2015)

Index Fungorum number: IF810273, Facesoffungi number: FoF01280

Saprobic or *parasitic* on other fungi, entomogenous on lepidopterous insects, *bryophilous* or isolated from soil. **Sexual morph:** *Ascomata* up to 500 µm diam., perithecial, seated on a loose stroma or emerging directly from the mycelium covering the host tissues, solitary or in small groups of 3–4, subglobose, pink, orange, or pale red, KOH-, LA-, surface smooth, covered by mycelium in the lower part, apapillate, ostiolate. *Ostiolar* canal lined with thin periphyses. *Asci* 6–8-spored, unitunicate, clavate or cylindrical, short pedicellate. *Ascospores* irregularly ovoid or ellipsoidal, muriform, with (1–)3–4(–5) transverse septa, 2–13 celled, occasionally slightly constricted at septa, hyaline to yellow. **Asexual morph:** Hyphomycetous. *Conidiophores* synnematous or acremonium-like. *Synnemata* terete, cylindrical, tapering to the apex, unbranched to branched, composed of bundles of parallel longitudinal, closely compacted hyphae,

bearing 1–4 conidiogenous cells at the tip. *Conidiogenous cells* phialidic, scattered, cymbiform to cylindrical, tapering to the apex, aseptate, collarettes visible, hyaline. *Conidia* fusiform to ellipsoid to sub-cylindrical, aseptate or 1–3-septate in culture, hyaline, walls smooth to finely ornamented, with or without mucoid sheath, born in chains or, aggregating into large spherical or irregular white masses (Adapted from Lombard et al., 2015; Hyde et al., 2020).

Type genus: ***Tilachlidium*** Preuss (1851)

Notes: Tilachlidiaceae showed close phylogenetic affinity to Calcarisporiaceae (Hyde et al., 2020). In our study Tilachlidiaceae grouped sister to Stromatonectriaceae fam. nov with moderate statistical support (82% MLBT; Figure 2.1). *Septofusidium* was previously accepted in Tilachlidiaceae and, here it has been transferred to Bionectricaceae based on phylogenetic analysis (Figure 2.1).

Genera included in Tilachlidiaceae (*taxonomic notes provided)

Psychronectria J. Pawłowska, Istel, Wrzosek & D. Hawksw.

Tilachlidium Preuss*

Tilachlidium Preuss, Linnaea 24: 126 (1851)

Index Fungorum number: IF10236, Facesoffungi number: FoF02138

Fungicolous, growing on dead carpophores of Basidiomycota representatives or entomogenous mostly on lepidopterous or sometimes on hymenopterous insects. **Sexual morph:** Undetermined. **Asexual morph:** Hyphomycetous. *Synnemata* cylindrical, unbranched or branched, tapering to the apex, consisting of bundles of parallel, longitudinal, usually closely compacted hyphae. *Conidiogenous cells* phialidic, born singly or in groups, on terminal ends or as lateral cells of synnematal hyphae, scattered, subulate, tapering to an acute apex, or cylindrical, hyaline. *Conidia* oblong to ellipsoidal, aseptate, hyaline, smooth-walled, with mucoid sheath, agglutinating into large spherical or irregular white clumps (Adapted from Lombard et al., 2015).

Known distribution: Worldwide (Mains, 1951; Lombard et al., 2015; Pawłowska et al., 2017)

Notes: Preuss (1851) introduced asexual genus *Tilachlidium* based on *T. pinnatum*. The genus was accepted in Hypocreales *incertae sedis* by Gams (1971). Later, Lombard et al. (2015) introduced a new family Tilachlidiaceae to accommodate

Tilachlidium and *Septofusidium*. Lombard et al. (2015) synonymysed *T. pinnatum* (1851) over older name *T. brachiatum* (1941). Only sexual stage of *Tilachlidium* was recorded so far (Lombard et al., 2015; Liang et al., 2016). Sequence data are available for the type species of *T. brachiatum* and *T. poneraticum* (GZAC XCH-ant-710, KP890686) in GenBank.

Type species: ***Tilachlidium brachiatum*** (Batsch) Petch, in Ellis, Trans. Norfolk Norw. Nat. Soc. 15: 198 (1941)

= *Clavaria brachiata* Batsch, Elench. fung. (Halle): 233 (1786)

= *Isaria brachiata* (Batsch) Schumach., Enum. pl. (Kjbenhavn) 2: 443 (1803)

= *Tilachlidium pinnatum* Preuss, Linnaea 24: 127 (1851)

= *Tilachlidium ramosum* (Mains) Mains, Mycologia 43(6): 714 (1952) [1951]

≡ *Hirsutella ramosa* Mains, Mycologia 41(3): 308 (1949)

Index Fungorum number: IF291402, Facesoffungi number: FoF10853, Figures 2.95, 2.96

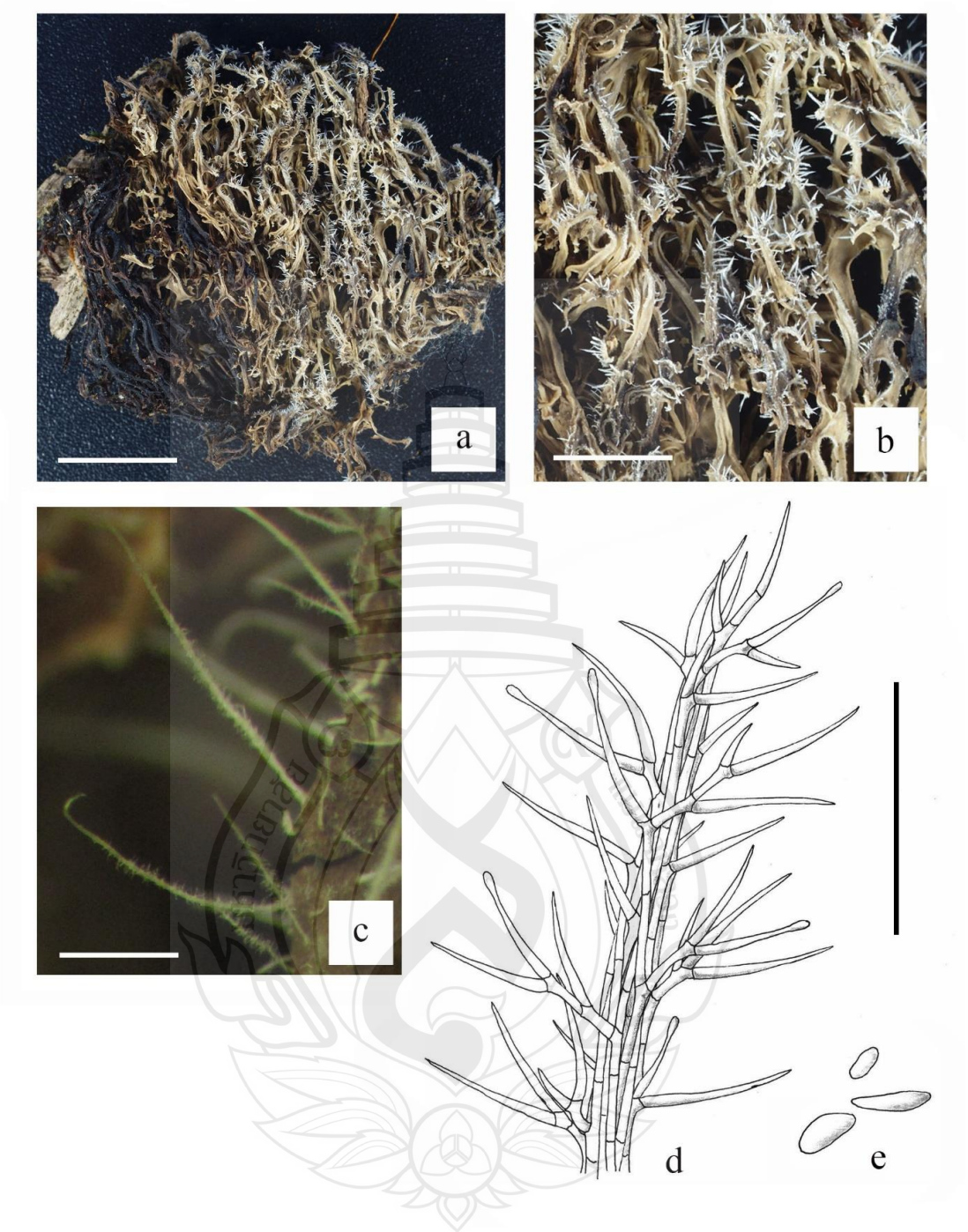
Entomogenous on fragments of lepidopterous larva. **Sexual morph:** Undetermined. **Asexual morph:** Hyphomycetous. *Synnemata* 30–100 µm wide, slender, cylindrical, wider at the base, gradually narrowing towards the apex, irregularly branched, light yellow at the base, above white, consisting of bundles of parallel, longitudinal, closely compacted, multi-septate hyphae, bearing 1–3 conidiogenous cells at the tip. *Conidiogenous cells* 22–36 µm long × 3.4–4.5 µm wide ($\bar{x}$ = 29 × 4 µm), phialidic, septate, wider at the base, narrowing towards the apex, without collarets, scattered on the upper part of the stem and branches of synnemata, hyaline. *Conidia* 4.7–6.3 × 1.4–1.8 µm ($\bar{x}$ = 5.5 × 1.6 µm), aseptate, oblong, covered by a slight mucoid layer, aggregating into spherical masses, hyaline, smooth-walled.

Material examined: CANADA, Nova Scotia, Salmon River, fragments of lepidopterous larva on a mossy log, 7 September 1931, L.E. Wehmeyer 1474, MICH 15719, **holotype of *Tilachlidium ramosum***. UKRAINE, Donetsk Region, Lyman district, National Nature Park “Sviati Hori”, Drobyshevs`ke forestry, floodplain forest on the right bank of Siverskyi Donets river, on the decomposed basidiomata of *Artomyces pyxidatus* (Pers.) Jülich, 19 May 2009, A. Akulov, CWU (Myc) AS3302.

Notes: *Tilachlidium brachiatum* is a fungicolous species that sporulate on dead carpophores of various Basidiomycota representatives. *T. brachiatum* is found on many

Note (a) Herbarium material. (b, c) Synnemata on the host. (d) Base of a synnema. (e) Close-up view of hyphae of synnemata. (f) Arrangement of hyphae in synnema and phialides. (g) Conidial mass attached to a phialide. (h) Synnema and phialides. (i) Conidia. Scale bars: b, c = 1 mm, d = 500 µm, e = 50 µm, f–h = 100 µm, i = 10 µm.

Figure 2.95 *Tilachlidium brachiatum* (MICH 15719)



Note (a, b) Basidiomata of *Artomyces pyxidatus* infected by *T. brachiatum*. (c, d) Synnemata. (e) Conidia. Scale bars: a = 25 mm, b = 75 mm, c = 3 mm, d = 25 µm.

Figure 2.96 *Tilachlidium brachiatum* (CWU (Myc) AS 3302)

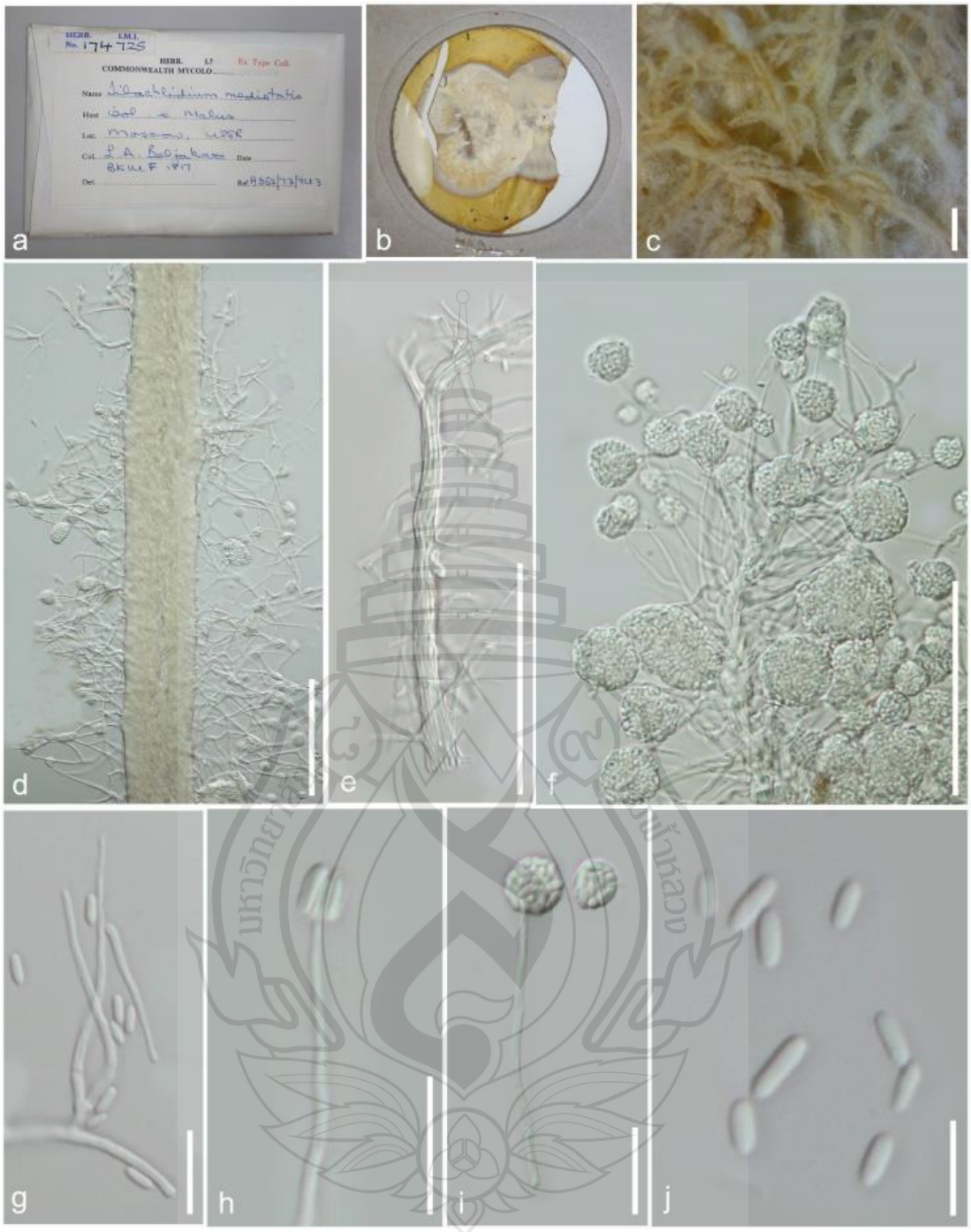
genera of host fungi, but often they are so strongly decayed that they cannot be identified anymore. Also entomogenous on fragments of lepidopterous larvaes (previously known as the separate species *T. ramosum*).

Tilachlidium medietatis Novobr., Nov. sist. Niz. Rast. 9: 185 (1972)

Index Fungorum number: IF324619, Facesoffungi number: FoF10854, Figure 2.97

Isolated from *Malus. Mycelium* flat, with a smooth, damp, velvety or flaccid texture, sometimes cottony, light pink to orange, and sometimes yellow or white. **Sexual morph:** Undetermined. **Asexual morph:** Hyphomycetous. *Synnemata* numerous, slender, cylindrical, irregularly branched, wider at the base, gradually narrowing towards the apex, white or light yellow, consisting of bundles of parallel, longitudinal, closely compacted hyphae. *Hyphae* 1.0–1.5 µm diam., thin, multi-septate. *Conidiogenous cells* phialidic, slender, arising singly or in groups of 2–3, septate, wider at the base, narrowing towards the apex, without collarets, scattered on the upper part of the stem and branches of synnemata, hyaline. *Conidia* 3–6 × 0.9–1.8 µm ($\bar{x}$ = 5.2 × 1.4 µm), aseptate, slightly cylindrical or ellipsoidal, sometimes ovoid, hyaline, smooth-walled, covered by a slight mucoid layer, aggregating into spherical clumps.

Material examined: RUSSIA, Moscow, *Malus*, Beljakova L.A, IMI 174725, **Holotype**.



Note (a) Herbarium material label. (b) Herbarium material. (c) Synnemata on culture. (d) Synnema with phialides. (e) Bundles of hyphae. (f–i) Phialides with conidial masses. (j) Conidia. Scale bars: c = 500 µm**,** d, f = 50 µm, g–i = 10 µm, j = 5 µm.

Figure 2.97 *Tilachlidium medietatis* (IMI 174725, Holotype)

2.3.9 Xanthonectriaceae R.H. Perera, E.B.G. Jones, Maharachch., & K.D. Hyde*, fam. nov.*

Xanthonectriaceae R.H. Perera, E.B.G. Jones, Maharachch., & K.D. Hyde, ***fam. nov.***

Index Fungorum number: IF559640, Facesoffungi number: FoF10924

On dead plant material in terrestrial or freshwater habitats. **Sexual morph:** *Ascomata* perithecial, superficial, astromatic, solitary or in groups, sometimes fused, globose, pale yellow to bright yellow or bright orange, KOH-, LA-, surface glabrous. *Asci* 8-spored, unitunicate, fusiform to clavate, apex without an apical ring. *Ascospores* long fusiform, 3–9 septate, hyaline, spinulose. **Asexual morph:** Acremonium-like, simple conidiophores arising from hyphae or sporodochial. *Conidiophores arising from hyphae* macronematous, mononematous, unbranched, straight or flexuous, hyaline, smooth-walled. *Conidiogenous cells* monophialidic, terminal, with unflared collarette, hyaline, smooth-walled. *Conidia* aseptate, narrowly ellipsoidal to subcylindrical, hyaline, smooth-walled, held in small slimy drop at tip of phialide or as a dry chain. *Sporodochial conidiophores* fasciculate, arising from hyphae. *Conidiogenous cells* without collarette. *Conidia* aseptate, narrowly ellipsoidal to subcylindrical, hyaline, smooth-walled, held in large slimy drops.

Type genus: ***Xanthonectria*** J. Fourn. & P.-A. Moreau

Notes: Here we introduce a new family Xanthonectriaceae to accommodate *Xanthonectria* and *Bullanockia*, which were previously placed in Bionectriaceae. No sexual morph was recorded for *Bullanockia*, and both *Xanthonectria* and *Bullanockia* produce acremonium-like asexual morphs (Crous, Wingfield, Burgess et al., 2016; Lechat et al., 2016a). In the phylogenetic analysis done by Voglmayr and Jaklitsch (2019) *Xanthonectria* and *Bullanockia* formed a basal clade in Bionectriaceae sister to *Kallichroma* and *Ijuhya*. That results indicate the distant phylogenetic relationship of *Xanthonectria* and *Bullanockia* to the family Bionectriaceae. Currently *Kallichroma* and *Ijuhya* are considered as a distinct family (in this study, Figure 2.1). In the current study, Xanthonectriaceae formed a monophyletic clade sister to Flammocladiellaceae, *Kallichroma* and *Ijuhya* with high statistical support (90% MLBT, Figure 2.1).

Ecological and economic significance of Xanthonectriaceae

Species of Xanthonectriaceae are possibly saprobic fungi and involved in nutrient cycling (Dighton, 1995), associated on dead plant parts in terrestrial habitats (Lechat et al., 2016a).

Genera included in Xanthonectriaceae (*taxonomic notes provided)

Bullanockia Crous

Xanthonectria J. Fourn. & P.-A. Moreau*

Xanthonectria J. Fourn. & P.-A. Moreau, in Lechat, Fournier & Moreau, Ascomycete.org 8(4): 173 (2016)

Index Fungorum number: IF816960, Facesoffungi number: FoF10925

Possibly *saprobic*, on dead plant parts in terrestrial habitats, sometimes on wood submerged in freshwater. **Sexual morph:** *Ascomata* perithecial, 240–380 μm diam., superficial, astromatic, solitary or in groups of 2–6, sometimes fused, globose, collapsing upon drying, pale yellow to bright yellow or bright orange, KOH-, LA-, surface glabrous, ostiolate. *Ostioles* minutely papillate, with a periphysate ostiolar canal. *Peridium* cells forming *textura epidermoidea* in surface view; vertical section up to 80 μm thick, of three strata, outer stratum formed of subglobose to globose, thick-walled cells; middle stratum of globose to ellipsoidal, thick-walled cells containing scattered orange oily droplets; inner stratum formed of elongated, hyaline, thin-walled cells with abundant orange oily droplets. *Paraphyses* filamentous, containing orange, oily droplets. *Asci* 8-spored, unitunicate, fusiform to clavate, short-stipitate, apex rounded, without an apical ring. *Ascospores* multiseriate, long fusiform, ends rounded, 3–9 septate, hyaline, spinulose. **Asexual morph:** Acremonium-like. *Primary conidiophores* arising from hyphae, macronematous, mononematous, unbranched, flexuous, hyaline, smooth-walled. *Conidiogenous cells* monophialidic, with unflared collarette. *Conidia* aseptate, narrowly ellipsoidal to subcylindrical, apex rounded, base with an abscission scar, hyaline, smooth-walled, held in small slimy drop at tip of phialide. *Sporodochia* present. *Sporodochia* 150– 180 μm diam., formed at margin of colony. *Conidiophores* fasciculate, arising from hyphae. *Conidiogenous cells* 8–30 μm long, without collarette. *Conidia* aseptate, narrowly ellipsoidal to subcylindrical, apex rounded, base with an abscission scar, hyaline, smooth-walled, held in large slimy drops. (Adapted from Lechat et al., 2016a).

Notes: Desmazières (1840) described the hypocrealean fungus *Sphaeria pseudopeziza*. However, the actual placemet of *Sphaeria pseudopeziza* was unclear for decades and, was maintained in different genera such as *Calonectria*, *Dialonectria* and *Nectria* by various authors (Desmazières, 1840; Saccardo, 1878a; Rossman et al., 1999). Lechat et al. (2016a) held a different perspective on *Sphaeria pseudopeziza* (as *Nectria pseudopeziza*) and recognized its resemblance to Bionectriaceae. They introduced the monotypic genus *Xanthonectria* to accommodate *Nectria pseudopeziza* and placed it in the Bionectriaceae based on morphology, culture characteristics and, LSU and ITS phylogeny. *Xanthonectria* is characterized by astromatic, superficial, soft-textured, glabrous, bright coloured ascomata without KOH or lactic acid reactions, multi-septate, long fusiform, ascospores and acremonium-like asexual morph. In current study *Xanthonectria* groups sister to the clade representing *Bullanockia* with high statistical support (94% MLBT; 100% BYPP, Figure 2.1).

Known distribution: Worldwide (Lechat et al., 2016a, This study)

Type species: ***Xanthonectria pseudopeziza*** (Desm.) Lechat, J. Fourn. & P.-A. Moreau, in Lechat, Fournier & Moreau, Ascomycete.org 8(4): 173 (2016)

Basionym: *Sphaeria pseudopeziza* Desm. [as '*pseudo-peziza*'], Annls Sci. Nat., Bot., sér. 2 13: 186 (1840)

≡ *Calonectria pseudopeziza* (Desm.) Sacc., Michelia 1 (3): 307 (1878)

≡ *Dialonectria pseudopeziza* (Desm.) Cooke, Grevillea 12(no. 64): 111 (1884)

≡ *Nectria pseudopeziza* (Desm.) Rossman, Mycotaxon 8 (2): 536 (1979)

See Indexfungorum for other synonyms.

Index Fungorum number: IF816961, Facesoffungi number: FoF10926, Figure 2.98, 2.99

On dead branches of *Robinia pseudoacacia*. **Sexual morph:** *Ascomata* 240–340 μm diam., solitary or in small groups of 2–6, superficial, tightly attached to host, astromatic, perithecial, globose, collapsing cupulate or apically flattened upon drying, pale yellow to pale orange or pale brownish orange, KOH-, surface glabrous. *Ostioles* slightly papillate at centre, periphysate. *Peridium* 40–50 μm thick, wider around ostiole 70–80 μm, composed of three strata; outer stratum 17–37 μm thick, comprising subglobose to globose, thick-walled cells, containing abundant oily droplets; middle stratum 12–25 μm thick, comprising globose to ellipsoidal, thick-walled, hyaline cells,

becoming more flattened towards the centrum with oily droplets; inner stratum 7–15 μm thick, composed of elongated, hyaline, thin-walled cells, sometimes with oily droplets; cells forming a *textura epidermoidea* in surface view *Asci* 70–110 × 12–23 μm ($\bar{x}$ = 88 × 17 μm), 2–8-spored, unitunicate, clavate to fusiform, short-pedicellate, apex rounded, without an apical ring. *Ascospores* 27–46 × 4.3–5.5 μm ($\bar{x}$ = 37 × 5 μm), irregularly multiseriate, narrowly fusiform with rounded ends, 3, 5–7(–8) septate, straight or curved, hyaline, smooth-walled or slightly spinulose. **Asexual morph:** see Lechat et al. (2016a).

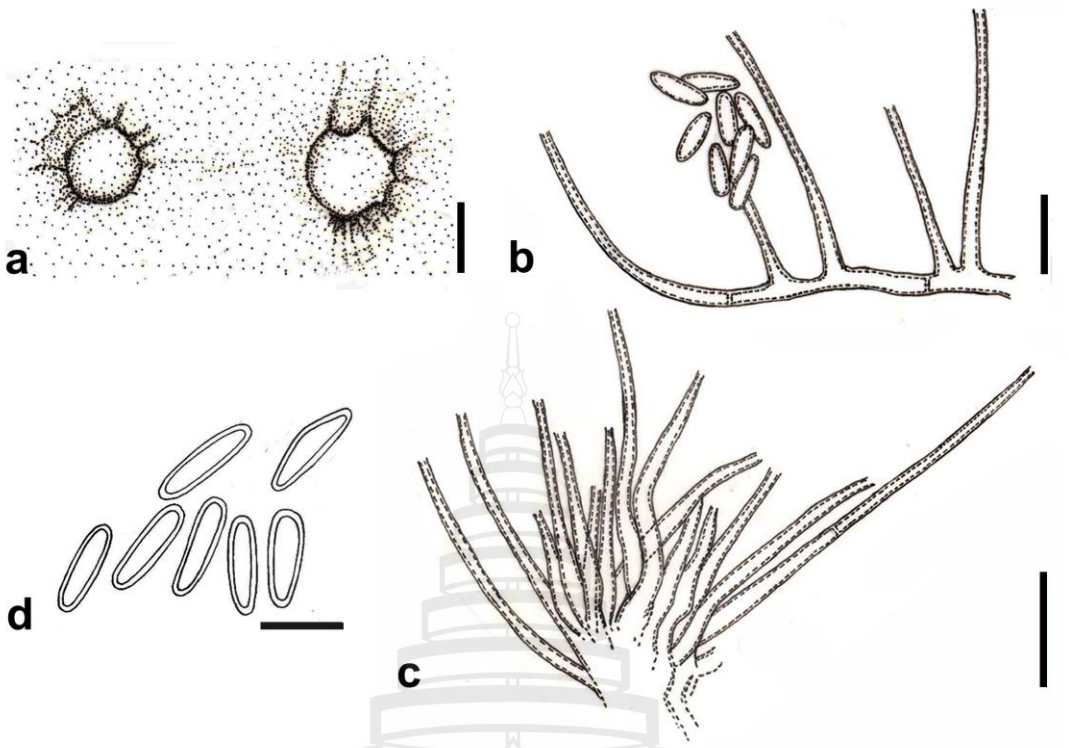
Material examined: ITALY, Forlì-Cesena Province, near Meldola, on a dead aerial branch of *Robinia pseudoacacia* (Fabaceae), 27 January 2016, Erio Camporesi, IT2808, MFLU 16-0513.

GenBank numbers: ITS: ON230054, LSU: ON230061, TEF1: ON238005

Notes: In our collection, we did not observe orange ascomata or, paraphyses and peridium cells filled with bright orange oily droplets, which were recorded in authentic specimens of *Xanthonectria pseudopeziza* by Lechat et al. (2016a). Cultures were not obtained; hence DNA was extracted from fruiting bodies for sequencing purpose. The asexual morph was redrawn based on Lechat et al. (2016a).

Note (a) Herbarium material. (b–d) Ascomata on host (d rehydrated with water). (e) Vertical section of ascoma. (f) Vertical section of peridium. (g–k) Asci. (l–r) Ascospores. Scale bars: d = 500 µm, e = 200 µm, f = 20 µm, g–k = 50 µm, l–r = 20 µm.

Figure 2.98 *Xanthonectria pseudopeziza* (MFLU 16-0513)



Note (a) Sporodochia at margin of the colony. (b) Primary conidiophores and conidia. (c) Conidiophores from sporodochium. (d) Conidia. Scale bars: a = 100 µm, b, c = 10 µm, d = 5 µm.

Figure 2.99 *Xanthonectria pseudopeziza* (CLL15075, redrawn from Lechat et al., 2016a)

Bullanockia Crous, in Crous et al., Persoonia 37: 327 (2016)

Index Fungorum number: IF819077, Facesoffungi number: FoF10927

On leaves of *Kingia australis*. *Mycelium* of septate, branched, hyaline, smooth-walled hyphae. **Sexual morph:** Undetermined. **Asexual morph:** Acremonium-like. *Conidiophores* solitary, erect, sub-cylindrical, septate, straight or flexuous. *Conidiogenous cells* phialidic, terminal, with minute non-flared collarette, hyaline, smooth-walled. *Conidia* subcylindrical, ends obtuse, sometimes base faintly truncate, straight to somewhat curved, granular to guttulate, hyaline, smooth-walled, solitary, held in slimy mass, or arrange in a dry chain (Adapted from Crous, Wingfield, Burgess et al., (2016).

Known distribution: Australia (Crous, Wingfield, Burgess et al., 2016)

Notes: Crous, Wingfield, Burgess et al. (2016) established the unispecific genus *Bullanockia* for *B. australis*, which was collected from leaves of *Kingia australis*. Currently, the genus is known only from the type species. Molecular studies of LSU sequences confirmed the taxonomic placement of *Bullanockia* in Bionectriaceae (Crous, Wingfield, Burgess et al., 2016). In the current phylogenetic analysis *Bullanockia* grouped with *Xanthonectria* with high statistical support (94% MLBT; 100% BYPP, Figure 2.1). Both *Bullanockia* and *Xanthonectria* are characterized by producing acremonium-like asexual morphs (Crous, Wingfield, Burgess et al., 2016; Lechat et al., 2016a).

Type species: ***Bullanockia australis*** Crous, in Crous et al., Persoonia 37: 327 (2016)

Index Fungorum number: IF819078, Facesoffungi number: FoF10928

Descriptions and illustrations: see Crous, Wingfield, Burgess et al. (2016)

2.3.10 Hypocreales, Genera *incertae sedis* (* Taxonomic Notes Provided)

Bryonectria Döbbeler*

Ticonectria Döbbeler*

Trichonectria Kirschst.*

Bryonectria Döbbeler, Nova Hedwigia 66(3-4): 334 (1998)

Index Fungorum number: IF27880, Facesoffungi number: FoF10929

Bryophilous, biotrophic on liverworts and mosses. *Hyphae* grow superficially over host leaves and stems, preferring the anticlinal cell walls, ramified and anastomosing, colourless, thick-walled. **Sexual morph:** *Ascomata* 100–180 µm diam., perithecial, astromatic, develop superficially on leaves or in the leaf axils, ovoid, conical to pyriform, colourless to hyaline, sometimes yellowish, light orange or red, usually without setae, ostiolate. *Ostiolar canal* filled with periphyses. *Peridium* in surface view comprises irregularly ramified and anastomosing hyphal cells with thick, merging walls, KOH-. *Apical paraphyses* present. *Asci* 4- or 8-spored, cylindrical to clavate, freely floating in squash mounts. *Ascospores* 1- or 2-septate, ellipsoid to cylindrical, colourless, epispore usually cyanophilous. **Asexual morph:** *Appressoria* aseptate, 1- or up to 3-septate, formed laterally on hyphae, circular to elliptical or undulate in outline, sessile or

pedicellate, haustoria absent. *Conidiogenous cells* occur laterally on the hyphae, phialidic, sessile, occasionally forming cushion-shaped conidiomata. *Conidia* tiny, globose or rod-shaped, colourless (Döbbeler & Davison, 2018).

Notes: Döbbeler (1998) established the bryophilous genus *Bryonectria* based on *B. hylocomii* and referred it to the Hypocreales without assigning to a family. Lumbsch & Huhndorf (2010) listed it in Bionectriaceae and this was followed by Maharachchikumbura et al. (2015). However, Döbbeler and Davison (2018) maintained *Bryonectria* in Hypocreales genera *incertae sedis*. Here we follow Döbbeler and Davison (2018). Currently 20 species are accommodated in the genus. No DNA sequence data are available.

Known distribution: Costa Rica, Ecuador, Colombia, Malaysia, Indonesia, Philippines, Papua New Guinea, Tanzania, USA, Europe, Romania

Type species: ***Bryonectria hylocomii*** (Döbbeler) Döbbeler, Nova Hedwigia 66(3-4): 335 (1998)

= *Nectria hylocomii* Döbbeler, Mitt. bot. StSamml., Münch. 14: 78 (1978)

Index Fungorum number: IF444741, *Facesoffungi number*: FoF10930

Descriptions and illustrations: see Döbbeler (1998)

Ticonectria Döbbeler, Nova Hedwigia 66(3-4): 362 (1998)

Index Fungorum number: IF27898, Facesoffungi number: FoF10931

Bryophilous, perianth-inhabiting; biotrophic on gametophyte, necrotrophic on sporophyte of certain groups of liverworts. **Sexual morph:** *Ascomata* up to 280 µm diam., perithecial, pyriform, hyaline to dark, light or ocher-brown, without setae. *Ostioles* pronounced, punctiform; periphyses filamentous, lying in a gelatinous substance. *Peridium* composed of irregular, thick-walled hyphae. *Apical paraphyses* inconspicuous. *Asci* usually 4 or 8-spored (sometimes 8 or fewer spores per ascus), unitunicate, cylindrical, lacking apical structures. *Ascospores* ellipsoid, narrowly ellipsoidal to ovoid, 1-septate, often constricted at the septum, hyaline, walls slightly rough, cyanophilous. *Hyphae* growing superficially, sometimes covering the inner perianth surface, and intercellular within walls of the sporophyte and the gametophytic stem, hyaline, thick-, sometimes with cyanophilous walls. **Asexual morph:** *Conidiomata* superficial at the

perianth base between the leaves, cushion-like, hyaline. *Conidiogenous cells* slender. *Conidia* 6–8 µm diam., globose, thick-walled, hyaline.

Known distribution: Honduras, Surinam, French Guiana (Döbbeler, 1998), Costa Rica, (Döbbeler, 1998, 2010), Indonesia (Döbbeler, 2018).

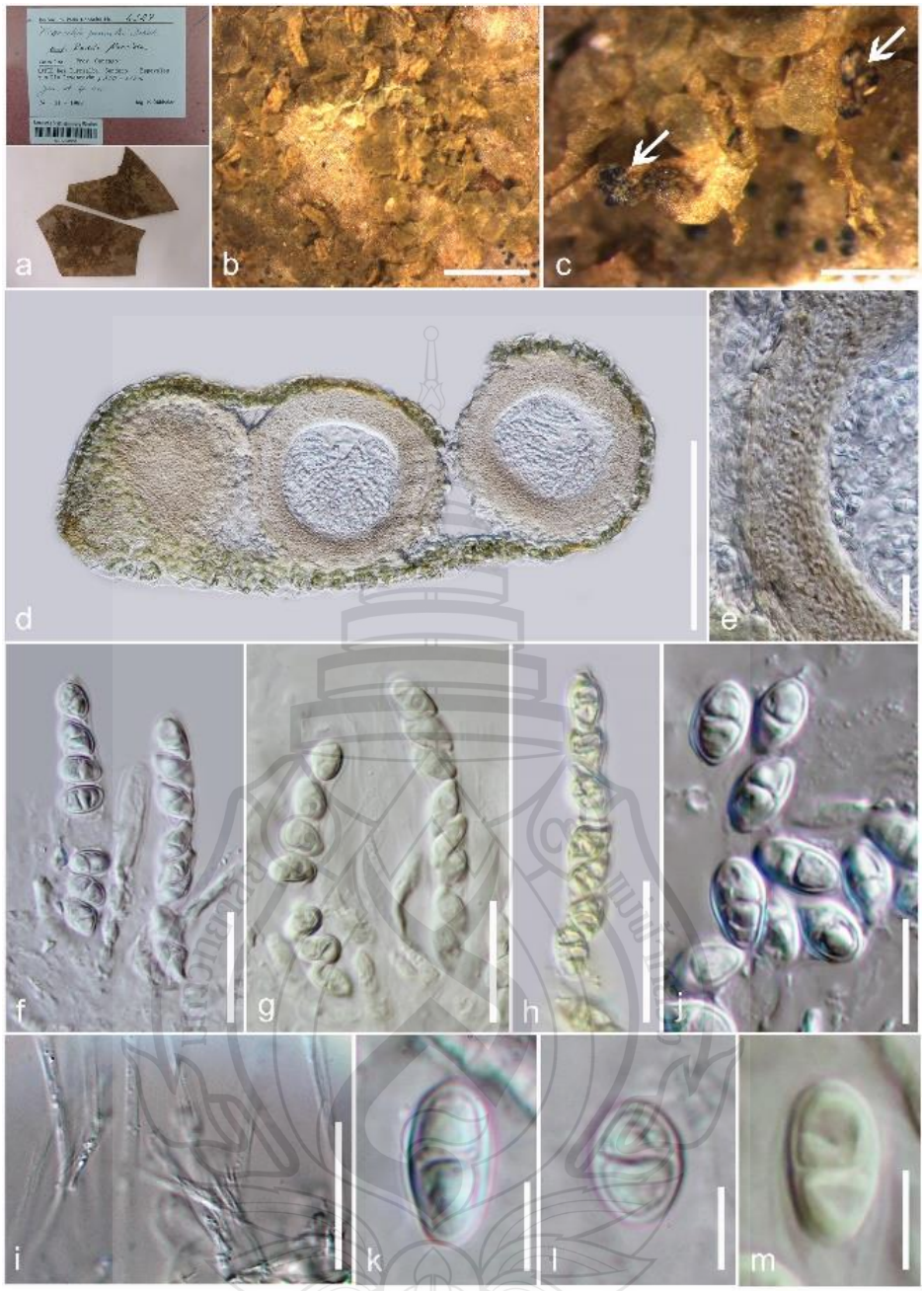
Notes: Döbbeler (1998) erected *Ticonectria* for *T. perianthii*. Currently there are three species in the genus but no DNA data are available. *Ticonectria* species are known to be associated with *Radula* species and *Cyclolejeunea convexistipa* (Döbbeler, 1998, 2010, 2018). Asexual morph only known for *Ticonectria perianthii* (Döbbeler, 1998, 2010, 2018).

Type species: ***Ticonectria perianthii*** Döbbeler, Nova Hedwigia 66(3-4): 362 (1998)

Index Fungorum number: IF445482, Facesoffungi number: FoF10932, Figure 2.100

Parasite within perianths of *Radula flaccida*. **Sexual morph:** *Ascomata* 150–250 × 135–210 µm ($\bar{x}$ = 180 × 165 µm), perithecial, arise singly, within the upper part of a perianth, pyriform, hyaline to dark brown, setae absent. *Peridium* of single stratum, composed of irregular, thick-walled hyphae. *Asci* 42–58 × 6–9 µm ($\bar{x}$ = 51 × 7.5 µm), 8-spored, unitunicate, cylindrical, apex simple, lacking an internal apical ring. *Ascospores* 6.7–9.4 × 4–5.5 µm ($\bar{x}$ = 7.9 × 4.7 µm), uniseriate to obliquely uniseriate, ellipsoid to ovoid, 1-septate, not constricted at the septum, hyaline, walls slightly rough, cyanophilous. *Hyphae* superficial, occasionally covering the inner perianth surface, and intercellular at the interface between gametophyte and sporophyte, with cyanophilous walls. **Asexual morph:** *Conidiomata* superficial at the perianth base between the leaves, cushion-like, hyaline. *Conidiogenous cells* slender. *Conidia* 6–8 µm diam., globose, thick-walled, hyaline (Asexual morph description adapted from Döbbeler, 2010).

Material examined: COSTA RICA, Cartago Province: CATIE at Turrialba, Sendero Espaveles zum Rio Reventazon, 500–610 m, on perianth of *Radula flaccida*, 24 November 1988, leg. P. Döbbeler 6327, M-0223664, **holotype**.



Note (a) Herbarium material and label. (b, c) Appearance of ascomata in host perianths (c ascomata are indicated in white arrows). (d) Vertical section of the leaf with ascomata. (e) Vertical section of peridium. (f–h) Asci (g in 3% KOH, h in Melzer's reagent). (i) Hyphae. (j–m) Ascospores (m in 3% KOH). Scale bars: b = 200 µm, c = 500 µm, d = 200 µm, e–i = 20 µm, j =10 µm, k–m = 5 µm.

Figure 2.100 *Ticonectria perianthii* (M-0223664, holotype)

Trichonectria Kirschst., Verh. bot. Ver. Prov. Brandenb. 48: 60 (1906) [1907]

Index Fungorum number: IF5563, Facesoffungi number: FoF10933

Notes: The lichenicolous genus *Trichonectria* was previously accepted in Bionectriaceae by several authors (Maharachchikumbura et al., 2015, 2016; Wijayawardene et al., 2020, 2022). However, DNA data analysis by Flakus et al. (2019) revealed that the genus is related to Nectriaceae. However, the phylogenetic placement of *Trichonectria* within Nectriaceae is statistically not well-supported in their analysis. Current combined gene analysis of ITS, LSU, RPB2, TEF1 and TUB2 regions revealed that the familial placement of *Trichonectria* within Hypocreales is uncertain (Figure 2.1).

2.3.11 Excluded or Doubtful Genera

Murinectria M. Niranjan & V.V. Sarma, in Hyde et al., Mycosphere 11(1): 738 (2020)

Notes: Hyde et al. (2020) introduced the new genus *Murinectria* to the family Nectriaceae. LSU and ITS sequences of ex-type of *Murinectria murispora* are available in the Genbank. We observed that the ex-type of *M. murispora* clade with *Stilbocrea* strains in Bionectriaceae (Figure 2.1). Morphologically the fungus clearly resembles *Nectria pseudotrichia*, *N. polythalama* and *N. pseudocinnabarina* (Hirooka et al., 2012). Therefore, we exclude *Murinectria* from the Nectriaceae. Resequencing is required to clarify the taxonomic placement of this fungus.

CHAPTER 3

TAXONOMIC NOTES ON FALCOCLADIALES AND SELECTED FAMILIES OF SORDARIOMYCETES

3.1 Introduction

In this chapter reviews order Falcocladiales and ten families of the class Sordariomycetes namely, Apiosporaceae, Chaetosphaeriaceae, Catabotrydaceae, Cylindriaceae, Delonicicolaceae, Flammocladiaceae, Phaeochoraceae, Pseudotruncatellaceae, Thyridiaceae and Obryzaceae. This section brings together descriptions, notes on the history, and illustrations of type or representative taxa of each family, a list of accepted genera and a key to the accepted taxa. Furthermore, Obryzaceae is excluded from Sordariomycetes, families *incertae sedis*.

3.2 Results and Discussion

Falcocladiales R.H. Perera, Maharachch., S. Somrithipol, S. Suetrong & K.D. Hyde, ***ord. nov.***

Type family: Falcocladiaceae

Index Fungorum number: IF551132; Facesoffungi number.: FoF00606

This monotypic order in the subclass Hypocreomycetidae is introduced to accommodate the family Falcocladiaceae. Members of this family are saprobes on leaf litter and leaves including *Eucalyptus grandis* and *E. camaldulensis* in tropical, terrestrial habitats (Crous et al., 1994; Jones et al., 2014).

Sexual morph: Undetermined. **Asexual morph:** *Conidiomata* hyaline, sporodochial or synnematal, or penicillate, arising from the mycelium or from a stroma or from microsclerotia, thick-walled with non-septate stipe extensions that terminate in thin-

walled sphaeropendunculate vesicles. *Conidiophores* hyaline, non to multi-septate, branched, forming three series of branches per conidioma (primary, secondary and tertiary), subcylindical. *Conidiogenous cells* phialidic, arranged in 2–6 whorls, necks elongate, with minute collarettes. *Conidia* transseptate, hyaline, falcate, with short apical and basal appendages (Adapted from Jones et al., 2014).

Type species: ***Falcocladium multivesiculatum*** S.F. Silveira, Alfenas, Crous & M.J. Wingf., Mycotaxon 50: 448 (1994)

Notes: The order presently includes one hyphomycetous asexual genus Falcocladium introduced by Crous et al. (1994). Jones et al. (2014) introduced the monotypic family Falcocladiaceae based on SSU and LSU sequence data to accommodate the members of genus *Falcocladium* and suggested further taxon sampling was needed to determine its ordinal status. There is no recorded sexual morph for this order. In the molecular analysis Falcocladiales is most closely related to the order Coronophorales.

Apiosporaceae K.D. Hyde et al., in Hyde et al., Sydowia 50(1) 23 (1998)

Facesoffungi number: FoF01364

Pathogenic or *saprobic* on leaves, stems and roots of Arecaceae (palms), Cyperaceae (sedges) and Poaceae (grasses and bamboo), or e*ndophytic* on plant tissues, lichens, and marine algae, occasionally infecting humans, or isolated from soil. **Sexual morph:** *Pseudostromata* immersed or semi-immersed in host epidermis, becoming erumpent, through a longitudinal split in the host. *Ascomata* perithecial, globose, densely arranged, immersed in *Pseudostromata*, with papillate ostioles. *Peridium* composed of small, brown cells of *textura angularis Asci* 8-spored, unitunicate, clavate to broadly cylindrical, short pedicellate. *Paraphyses* hyphae-like, broad, septate, branched. *Ascospores* overlapping 1–3-seriate to irregularly arranged, 1-septate, apiosporous, ellipsoidal, in equilateral, straight or curved, hyaline, smooth-walled, with or without gelatinous sheath. **Asexual morph:** Coelomycetous or hyphomycetous. *Conidiomata* sporodochial, solitary to gregarious, immersed, erumpent from host tissue when mature, irregular, black, carbonaceous, coriaceous. *Conidiomata basal stroma* composed of several layers of dark brown to hyaline thick-walled cells at the side, thin upper wall cells of *textura angularis*. *Setae* lacking, or present occasionally, if present intermingled among conidiophores. *Conidiophores* arising from hyphae or aggregated in a brown

stroma, forming black sporodochia, forming conidia terminally and laterally, brown to dark brown. *Setae* present or absent, erect, sparsely septate, pale brown to brown, smooth-walled. *Conidiogenous cells* discrete, basauxic, doliiform to ampulliform or cylindrical, brown, smooth to finely verruculose. *Conidia* unicellular, brown to dark brown, smooth-walled or with minute wall ornamentations, with a truncate basal scar, guttulate to granular, frequently with an equatorial germ slit.

Notes: This family was introduced by Hyde et al. (1998) with *Apiospora montagnei* Sacc. as the type species. Earlier the genus *Apiospora* had been assigned to Lasiosphaeriaceae by Barr (1990). Hyde et al. (1998) considered that the sexual and asexual morphs (*Arthrinium*, *Cordelia* and *Pteroconium*) of *Apiospora* differed from those in Lasiosphaeriaceae and proposed the family Apiosporaceae to accommodate *Apiospora*. Hyde et al. (1998) did not suggest any order placement for Apiosporaceae. Smith et al. (2003) analyzed LSU and SSU sequence data and showed that members of Apiosporaceae cluster within the order *Xylariales*, but relationships to other families of Xylariales was uncertain. Lumbsch and Huhndorf (2010) listed Apiosporaceae in Sordariomycetes family *incertae sedis*. Crous and Groenewald (2013) used phylogenetic analysis to confirm *Apiosporaceae* as a family within Xylariales, and sister to *Amphisphaeriaceae*. Hyde et al. (1998) considered *Dictyoarthrinium*, *Endocalyx*, *Scyphospora* and *Spegazzinia* as other possible genera of this family, but molecular data is lacking to confirm this (Crous & Groenewald, 2013). *Arthrinium* was confirmed as the asexual morph of *Apiospora* by molecular data (Crous & Groenewald, 2013; Senanayake et al., 2015) and *Apiospora*, *Cordella* and *Pteroconium* were reduced to synonymy with *Arthrinium* (Crous & Groenewald, 2013). Maharachchikumbura et al. (2015) listed six genera under *Apiosporaceae*.

Type genus*:* ***Arthrinium*** Kunze, in Kunze & Schmidt, Mykologische Hefte (Leipzig) 1: 9 (1817)

Facesoffungi number: FoF02100

Saprobic or *pathogenic* on monocotyledons, especially grasses, or endophytic on plant tissues, lichens, and marine algae, occasionally infecting humans, or isolated from soil. **Sexual morph:** *Pseudostromata* visible as raised, linear, blackened areas on the host surface, with neck and upper surface visible through slits in the host tissue, mostly gregarious, fusiform, ellipsoid to irregular, black, cells between ascomata and darkened

layer above usually thick, composed of brown cells of *textura angularis*. *Ascomata* solitary or usually gregarious in linear groups, immersed in pseudostromata, subglobose to globose, membranous, papillate, ostiolate. *Ostiole* periphysate. *Peridium* composed of several layers, of small, brown or reddish brown to hyaline cells of *textura angularis*. *Hamathecium* composed of dense, hypha-like, long, broad, septate, branched, paraphyses. *Asci* 8-spored, unitunicate, broad cylindrical to clavate or subglobose, short pedicellate, without an apical ring. *Ascospores* overlapping 1–3-seriate to irregularly arranged, hyaline, apiosporous, with a large, straight or curved, upper cell and smaller lower cell, usually surrounded by a gelatinous sheath. **Asexual morph:** Coelomycetous or hyphomycetous. *Conidiomata* sporodochial, solitary to gregarious, immersed, erumpent from host tissue when mature, irregular, black, carbonaceous, coriaceous. *Conidiomata* basal stroma composed of several layers of dark brown to hyaline cells of *textura angularis*, with thick side wall, thin at upper and lower walls. *Setae* lacking, or occasionally present, intermingled among conidiophores. *Conidiophore* verrucose, flexuous. *Conidiophore mother cells* ampulliform, with a verrucose wall, producing a single hyphoid, cylindrical, 1–2-septate. *Conidiogenous cells* basauxic, cylindrical, smooth-walled or verrucose. *Conidia* subglobose to globose, dark brown, smooth-walled or with minute wall ornamentations, with a truncate basal scar.

Type species: ***Arthrinium caricicola*** Kunze & J.C. Schmidt, Mykologische Hefte (Leipzig) 1: 9 (1817)

Notes: *Apiospora* was identified as a genus in the family Amphisphaeriaceae based on morphology by Müller and von Arx (1962). Later it was transferred to Hyponectriaceae by Barr (1976). Barr (1990) moved *Apiospora* to Lasiosphaeriaceae and this was followed by Barr and Cannon (1994) and Hawksworth et al. (1995). Hyde et al. (1998) introduced a new family *Apiosporaceae* to accommodate the genus *Apiospora*, with *A. montagnei* as the type species. Phylogenetic analyses by many authors accepted *Apiospora* as a distinct group in the order *Xylariales* (Huhndorf et al., 2004; Zhang et al., 2006; Jaklitsch & Voglmayr, 2012; Dai et al., 2014). Index Fungorum (2016) lists 55 epithets under genus *Apiospora*. Crous and Groenewald (2013) synonymized the sexual name *Apiospora* under the asexual name *Arthrinium*, since *Arthrinium* is the older and more commonly encountered, and more frequently used name in the literature. The link between *Arthrinium* and *Apiospora* has also been confirmed by molecular data by Crous

and Groenewald (2013), and this was followed by Maharachchikumbura et al. (2015) and Senanayake et al. (2015). Crous and Groenewald (2013) synonymised *Pteroconium* and *Cordella* under *Arthrinium.*

Other genera included

Appendicospora K.D. Hyde, Sydowia 47(1): 31 (1995)

Type species: ***Appendicospora coryphae*** (Rehm) K.D. Hyde, Sydowia 47(1): 32 (1995)

Dictyoarthrinium S. Hughes, Mycol. Pap. 48: 29 (1952)

Type species: ***Dictyoarthrinium quadratum*** S. Hughes, Mycol. Pap. 48: 30 (1952)

Endocalyx Berk. & Broome, J. Linn. Soc., Bot. 15(1): 84 (1876) [1877]

Type species: ***Endocalyx thwaitesii*** Berk. & Broome, J. Linn. Soc., Bot. 15(1): 84 (1876) [1877]

Scyphospora L.A. Kantsch., Bolêz. Rast. 17: 87 (1928)

Type species: ***Scyphospora phyllostachydis*** Kantsch. [as 'phyllostachidis'], Bolêz. Rast. 17: 88 (1928)

Spegazzinia Sacc., Spegazzinia: [1] (1879)

Type species: ***Spegazzinia ornata*** Sacc., Michelia 2(no. 6): 172 (1880)

Key to the genera with sexual morph

1. Ascomata stromatic, asci clavate to broadly cylindrical, ascospores ellipsoidal without appendages.....*Apiospora*

1. Ascomata astromatic, asci clavate, ascospores clavate with appendages at one end .....*Appendicospora*

Key to the genera with asexual morph

1. Coelomycetous or hyphomycetous, conidiomata acervular, pycnidial, sporodochial or synnematous, conidia 1-celled.....2

1. Hyphomycetous, conidiomata synnematous or sporodochial, conidia 4 or 16-celled, muriform or often septate.....3

3. Conidia 4-celled, smooth to spinose .....*Spegazzinia*

3. Conidia 4 or16-celled, conidiomata verrucose or tuberculate..... *Dictyoarthrinium*

4. Conidiomata acervular, conidia, smooth-walled.....*Scyphospora*
4. Conidiomata, smooth, verrucose, ornamented or with minute wall ornamentations 5
5. Conidiomata cup-shaped to funnel-shaped, surrounded by setae, conidia dark brown, smooth-walled or with minute wall ornamentations.....*Endocalyx*
5. Conidiomata not cupulate or funnel-shaped, setae absent or occasionally present, conidia hyaline becoming dark brown at maturity, smooth, verrucose, ornamented .....*Arthrinium*

Chaetsphaeriaceae Réblová, M.E. Barr & Samuels, Sydowia 51(1): 56 (1999)

Index Fungorum number: IF82100; *Facesoffungi number*: FoF01139, Figure 3.1; 825 species.

Saprobic on wood or decaying plant parts including leaves, fruits in terrestrial and aquatic habitats, sometimes isolated from soil and fresh plant parts such as leaves, less commonly *pathogenic*. **Sexual morph**: *Ascomata* perithecial, gregarious or scattered, solitary, superficial or basally immersed on a thin stroma or on a thin subiculum, ovoid, globose to subglobose, carbonaceous, coriaceous or membranaceous, dark brown to black, rough, smooth or with short setae, papillate, the apex collapsing when dry. *Ostiole* lined with hyaline periphyses or absent. *Subiculum* thin, scanty, brown to dark brown, septate, of unbranched hyphae. *Peridium* composed of two layers, outer layer comprising brown cells of *textura epidermoidea* or *angularis*, carbonaceous; inner layer comprising hyaline cells of *textura prismatica*, thin, membranaceus. *Paraphyses* numerous, septate, unbranched, tapering, filiform or cylindrical. *Asci* 8-spored, unitunicate, thin-walled, clavate to cylindrical, long or short pedicellate, with J- apical ring. *Ascospores* 2–3-seriate, fusiform, cylindrical to ellipsoid, straight or sometimes curved, 0–3-septate, with or without fragmenting, hyaline or brown or becoming dark coloured in part, smooth or striate, with guttules, sheath or appendages. **Asexual morph**: Hyphomycetous or coelomycetous. When hyphomycetous, *Conidiophores* macronematous, mononematous, scattered or gregarious, dark brown or hyaline, straight or flexuous, septate, branched or unbranched, with short encircling collar hyphae. *Conidiogenous cells* monophialidic or polyphialidic, holoblastic or enteroblastic, proliferating percurrently or sympodial, hyaline, with a distinct funnel-shaped collarette, smooth-walled. *Conidia* aggregated, continuous or mucilaginous, aseptate to multi-septate, flexuous, fusiform, allantoid,

cylindrical or doliiform, curved or straight, hyaline to dark brown. When coelomycetous, *Conidiomata* stromatic, scattered or aggregated, superficial, cupuliform or globose, unilocular, setose, comprising black to dark brown cells of *textura angularis* or *intricata*. *Setae* numerous, black to brown, septate, ovoid to cylindrical or arising from the outer elements of excipulum, smooth, thick-walled, multi-septate. *Conidiophores* lining the basal stroma in a dense layer or arising from conidiomatal cavity, brown, 4–6-septate, unbranched, cylindrical, thin-walled, smooth. *Conidiogenous cells* integrated, determinate, holoblastic or enteroblastic, phialidic with conspicuous periclinal thickening at an attenuated apex, brown, smooth, subcylindrical to lageniform. *Conidia* aseptate, globose to subglobose or ellipsoid, fusiform to allantoid, curved or straight, obtuse to sub-obtusely rounded at apex, truncate at base, eguttulate or guttulate, hyaline to brown, thin, smooth-walled, with a single, cellular, unbranched, flexuous, with tubular appendage at each end, separated by a septum, with basal asymmetrically located appendage.

Type genus: ***Chaetosphaeria*** Tul. & C. Tul.

Notes: The family Chaetosphaeriaceae was proposed without any description by Locquin (1984) to accommodate five genera including *Chaetosphaeria*, Loramyces, *Niesslia*, *Rhagadostoma*, and *Zignöella*. This was not considered as a validly published family (Hawksworth & David, 1989, Art. 36.1, Grueter et al., 1994). Hence, Réblová et al. (1999) re-introduced the family based on *Chaetosphaeria*, to accommodate another six genera: *Ascocodinaea*, *Melanochaeta*, *Melanopsammella*, *Porosphaerella*, *Porosphaerellopsis*, and *Striatosphaeria*. Réblová et al. (1999) maintained Chaetosphaeriaceae in Sordariales based on morphology. Based on LSU sequence data, Huhndorf (2004) placed the family in Chaetosphaeriales. Subsequently more genera were added to the family and, Maharachchikumbura et al. (2016) accepted 37 genera. Maharachchikumbura et al. (2016) aknowledged the taxonomic confusion of genera in the family and the need for a monograph with molecular support for accepted genera. Crous, Wingfield, Burgess et al. (2016) introduced *Adautomilanezia* and *Eucalyptostroma* to Chaetosphaeriaceae. Ma, Xia et al. (2016) introduced the hyphomycetes genus *Anacacumisporium* based on phylogenetic analyses. Five genera, *Codinaeopsis*, *Dictyochaetopsis*, *Phaeostalagmus*, *Phialogeniculata* and *Zignoëlla*, previously listed by Maharachchikumbura et al. (2016) in Chaetosphaeriaceae, were not considered by Wijayawardene et al. (2018). Wijayawardene et al. (2018) listed 38 genera

in Chaetosphaeriaceae including *Adautomilanezia*, *Anacacumisporium*, *Conicomyces*, *Eucalyptostroma*, *Menisporopsis* and *Pseudolachnella*. Yang et al. (2018) placed *Nawawia* and *Phialosporostilbe* in Chaetosphaeriaceae based on LSU and ITS DNA sequence data. A new genus *Multiguttulispora* was added to the family by Lin et al. (2019). Crous, Wingfield et al. (2018) provided first DNA sequence data for the genus *Polynema* and placed it in Chaetosphaeriaceae. In this entry the sexual morph of *Chaetosphaeria jonesii* R.H. Perera, Maharachch. & K.D. Hyde is illustrated.

Ecological and economic significance

Chaetosphaeriaceae members are saprobes in terrestrial and aquatic habitats (Réblová et al., 1999; Maharachchikumbura et al., 2016). As examples *Dictyochaeta*, *Tainosphaeria* and *Menisporopsis* are aquatic, while *Adautomilanezia*, *Chaetosphaeria* and *Thozetella* are terrestrial saprobes (Réblová et al., 1999; Ho et al., 2001; Crous, Wingfield, Richardson et al., 2016; Liu et al., 2016; Perera, Maharachchikumbura, Bhat et al., 2016). Chaetosphaeriaceae species have the ability to decompose lignocellulose substrates in woody litter and release nutrients (Yuen et al., 1998; Hyde et al., 2016; Liu et al., 2016). Hence, they play an important role in nutrient and carbon cycling and ecosystem functioning (Palmer et al., 1997; Wong et al., 1998; Hyde et al., 2016). Two *Eucalyptostroma* species (*E. eucalypti* Crous & M.J. Wingf. and *E. eucalyptorum* Crous & M.J. Wingf.) were isolated from leaf spots of *Eucalyptus* (Crous, Wingfield, Richardson et al., 2016; Crous, Wingfield et al., 2018). However, there is no study confirming any pathogenicity in Chaetosphaeriaceae species. Some *Dinemasporium* species have been reported to produce secondary metabolites (Yamaguchi et al., 2005; Krohn et al., 2008; Hashimoto et al., 2015).

Genera included in Chaetosphaeriaceae

Adautomilanezia Gusmão, S.S. Silva, Fiuza, L.A. Costa & T.A.B. Santos, Persoonia 37: 229 (2016)

Index Fungorum number: IF815142; 1 species with molecular data.

Type species: ***Adautomilanezia caesalpiniae*** Gusmão, S.S. Silva, Fiuza, L.A. Costa & T.A.B. Santos

Notes: The monotypic, hyphomycetous genus *Adautomilanezia* was introduced by Crous, Wingfield, Richardson et al. (2016) based on LSU sequence data. The type species, *A. caesalpinia*, was isolated from decaying twigs of *Caesalpina echina* in Brazil

(Crous, Wingfield, Richardson et al., 2016). The genus is characterised by sporodochial conidiomata with setae, enteroblastic conidiogenous cells and oblong to clavate, multi-septate conidia (Crous, Wingfield, Richardson et al., 2016).

Anacacumisporium Y.R. Ma & X.G. Zhang, Cryptog. Mycol. 14: 8 (2016)

Index Fungorum number: IF811418; 1 species with molecular data.

Type species: ***Anacacumisporium appendiculatum*** Y.R. Ma & X.G. Zhang

Notes: The monotypic, hyphomycetous genus *Anacacumisporium* was established by Ma, Xia et al. (2016) with the single species *A. appendiculatum*, which was isolated from decaying wood in China (Ma, Xia et al., 2016). The genus is characterized by mononematous, macronematous conidiophores, inconspicuous phialidic conidiogenous cells and euseptate conidia with an appendage at the tip and base, aggregated in slimy masses (Ma, Xia et al., 2016).

Ascochalara Réblová, Sydowia 51(2): 212 (1999)

Index Fungorum number: IF28371; 1 morphological species.

Type species: ***Ascochalara gabretae*** Réblová

Notes: *Ascochalara* was introduced by Réblová (1999) to accommodate the lignicolous species, *A. gabretae*, characterised by black, papillate ascomata, covered with greyish to whitish powder, cylindrical-clavate asci with a J-, refractive apical ring and fusiform ascospores disarticulating into part ascospores within the asci. The asexual morph of the fungus is charala-like, with conidiophores mononematous, macronematous, phialidic conidiogenous cells and sub-cylindrical to wedge-shaped, aseptate conidia.

Brunneodinemasporium Crous & R.F. Castañeda, Persoonia, Mol. Phyl. Evol. Fungi 28: 128 (2012)

Index Fungorum number: IF800158; 2 species with molecular data.

Type species: ***Brunneodinemasporium brasiliense*** Crous & R.F. Castañeda

Notes: The coelomycetous genus *Brunneodinemasporium* was introduced by Crous et al. (2012) based on a dinemasporium-like species. Lu et al. (2016) added *B. jonesii* Y.Z. Lu, Jian K. Liu & K.D. Hyde based on LSU and ITS sequence data. *Brunneodinemasporium* species are characterised by cupulate, setose conidiomata, with tightly aggregated brown conidiogenous cells and pale brown aseptate conidia (Crous et al., 2012; Lu et al., 2016). Species of this genus occur on decaying wood and leaves in terrestrial and freshwater habitats (Crous et al., 2012; Lu et al., 2016).

Catenularia Grove, Syll. fung. (Abellini) 4:303 (1886)

Index Fungorum number: IF7506; 22 morphological species (Species Fungorum 2019).

Type species: ***Catenularia simplex*** Grove

Notes: Saccardo (1886) established the hyphomycetous genus *Catenularia* to accomodate cies *C. simplex* and *C. atra* (Corda) Sacc. Species are lignicolous and found on dead wood and decaying leaves and herbaceous substrates (Hughes & Kendrick, 1965; Matsushima, 1971; Subramanian & Bhat, 1987; Li et al., 2017). *Catenularia* species are characterised by macronematous, mononematous, simple or flexuous conidiophores, monophialidic, collarette conidiogenous cells and aseptate phragmoconidia formed solitary or in chains (Saccardo, 1886; Holubová-Jechová, 1982; Li et al., 2017).

Chaetosphaeria Tul. & C. Tul., Select. fung. carpol. (Paris) 2: 252 (1863)

Index Fungorum number: IF970; Facesoffungi number: FoF01140; 138 morphological species (Species Fungorum 2019), 45 species with molecular data.

Type species: ***Chaetosphaeria innumera*** Berk. & Broome ex Tul. & C. Tul.

Notes: Species of the genus are characterized by black ascomata with surface smooth or covered by setae, 8-spored asci, with a small, distinct, refractive, J-, apical ring and septate, hyaline ascospores (Maharachchikumbura et al., 2016; Fernández et al., 2006). The asexual morph of *Chaetosphaeria* is hyphomycetous with macronematous or mononematous conidiophores, monophialidic or polyphialidic, conidiogenous cells, aseptate to multi-septate, guttulate or eguttulate conidia, with or without appendages (Maharachchikumbura et al., 2016; Fernández et al., 2006). *Chaetosphaeria* species are saprobes on decaying plant material in terrestrial and freshwater habitats (Fernández & Huhndorf, 2005; Perera, Maharachchikumbura, Bhat et al., 2016). The sexual morph of *Chaetosphaeria jonesii* R.H. Perera, Maharachch. & K.D. Hyde is illustrated (Figure 3.1).

Note (Material examined: THAILAND, Chiang Mai Province, on decorticated wood, 5 August 2015, S. Boonmee, RHP 121 (MFLU 16-1020, holotype). (a) Herbarium material. (b) Appearance of ascomata on host substrate. (c) Section of ascoma. (d) Setae. (e) Paraphyses. (f–h) Asci. (i) Close up of apical ascus in Melzer's reagent. (j–l) Ascospores. Scale bars: b = 200 µm, c = 100 µm, d–h = 50 µm, i–l = 10 µm.

Figure 3.1 *Chaetosphaeria jonesii*

Chloridium Link, Mag. Gesell. naturf. Freunde, Berlin 3(1–2): 13 (1809)

= *Gonytrichum* Nees & T. Nees, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 9: 244 (1818)

= *Melanopsammella* Höhn., Annls mycol. 17(2/6): 121 (1920) [1919]

Index Fungorum number: IF7624; 66 morphological species (Species Fungorum 2019), 11 species with molecular data.

Type species: ***Chloridium viride*** Link

Notes: *Chloridium* is characterised by mononematous or macronematous conidiophores, monophialidic or polyphialidic conidiogenous cells, with a funnel-shaped collarette and hyaline to brown, eguttulate or guttulate, appendaged or non-appendaged conidia (Link, 1809; Seifert et al., 2011; Wei et al., 2018). Réblová et al. (2016) pointed out that the generic type of *Chloridium*, *C. viride* is congeneric with *Melanopsammella inaequalis*, the type of *Melanopsammella* (Réblová & Winka, 2000, Fernández et al., ,2006, Crous et al., 2012). Hughes (1951) revealed that the generic type of *Gonytrichum*, *G. caesium*, is the asexual morph of *Melanopsammella inaequalis*. By considering above facts, Réblová et al. (2016) proposed that *Gonytrichum* and *Melanopsammella* are synonyms of *Chloridium*. Hence, the widely used generic name *Chloridium* was conserved over *Gonytrichum* and *Melanopsammella* (Réblová et al., 2016; Wei et al., 2018). Wijayawardene et al. (2018) incorrectly treated *Chloridium*, *Gonytrichum* and *Melanopsammella* as three distinct genera. Here we follow Réblová et al. (2016) which is also confirmed in our phylogenetic analysis of combined ITS and LSU DNA sequence data. Furthermore, *Chloridium* species seems to be polyphyletic within Chaetosphaeriaceae.

Codinaea Maire, Publ. Inst. Bot. 3(4): 15 (1937)

Index Fungorum number: IF7720; 53 morphological species (Species Fungorum 2019), 3 species with molecular data.

Type species: ***Codinaea aristata*** Maire

Notes: *Codinaea* was introduced based on *C. aristata* (Maire, 1937). Later, Gamundi et al. (1977) examined several specimens of *Dictyochaeta* fuegiana Speg. and proposed *Codinaea* as a synonym of *Dictyochaeta*. Their treatment was accepted by most authors and many *Codinaea* taxa have been moved to *Dictyochaeta* (Cruz et al., 2009, Liu et al., 2016; Whitton et al., 2012a). However, re-examination of the two collections,

on which Gamundí et al. (1977) based their description of *D. fuegiana* (LPS 38629, LPS 38630), revealed a fungus was misidentified as the type of *Dictyochaeta fuegiana* (Réblová, 2004). Réblová (2004) re-examined the type specimen of *Dictyochaeta fuegiana* and gave more detailed descriptions. Molecular studies by Réblová and Winka (2000) revealed that *Dictyochaeta* species with or without setulae clustered into distinct subgroups in the phylogenetic tree. Réblová (2000) proposed to retain the genus name *Codinaea* for species with setulae and placed species without setulae in *Dictyochaeta*. Seifert et al. (2011) and Li et al. (2012) accepted Réblová (2000) suggestion on segregation of *Codinaea* and *Dictyochaeta* as separate genera delineated by the presence or absence of conidial setulae and accepted both *Codinaea* and *Dictyochaeta* as valid genera.

Wijayawardene et al. (2018) and Hernández-Restrepo (2017) also treated them as two distinct genera. Currently, 104 species of *Dictyochaeta* and 53 species of *Codinaea* have been described (Index Fungorum, 2019). However, only few have DNA sequence data. There are no ex-type sequence data are available for the generic types of *Codinaea* or *Dictyochaeta*. Our phylogenetic analysis based on the available sequences of *Dictyochaeta* and *Codinaea* species, revealed that species of both genera are polyphyletic within Chaetosphaeriaceae. Therefore, a detailed morpho-molecular analysis with more taxonomic sampling would be required to finally confirm the phylogenetic status of *Codinaea* and *Dictyochaeta*. Here we keep the *Codinaea* and *Dictyochaeta* as separate genera until the generic types of *Codinaea* and *Dictyochaeta* and will be recollected, sequenced and confirmed the link by molecular data.

Conicomyces R.C. Sinclair, Eicker & Morgan-Jones, Mycologia 75(6): 1100 (1983)

Index Fungorum number: IF11019; 4 morphological species (Species Fungorum 2019), 1 species with molecular data.

Type species: ***Conicomyces transvaalensis*** R.C. Sinclair, Eicker & Morgan-Jones

Notes: The hyphomycetous genus *Conicomyces* was introduced by Sinclair and Eicker (1983). Species of *Conicomyces* are lignicolous being saprobic on decaying woody substrates (Holubová-Jechová, 1973a; Sinclair & Eicker, 1983; Illman & White, 1985; Liu et al., 2015). *Conicomyces* species are characterised by cone-shaped, setose

synnemata, macronematous, enteroblastic conidiophores and aseptate, fusiform conidia bearing an apical appendage (Sinclair & Eicker, 1983).

Craspedodidymum Hol.-Jech., Česká Mykol. 26(2): 70 (1972)

Index Fungorum number: IF7804; 14 morphological species (Species Fungorum 2019).

Type species: ***Craspedodidymum elatum*** Hol.-Jech.

Notes: The hyphomycetous genus *Craspedodidymum* was introduced by Holubová-Jechová (1972) based on *C. elatum*. *Craspedodidymum* species are saprobic fungi occur on decaying plant material (Yanna et al., 2000; Pinruan et al., 2004; Ma et al., 2011). Species of this genus are characterised by macronematous conidiophores and apically swollen conidiogenous cells with a large funnel-shaped terminal collarette (Pinruan et al., 2004).

Cryptophiale Piroz., Can. J. Bot. 46: 1123 (1968)

Index Fungorum number: IF7833; 22 morphological species (Species Fungorum 2019), 2 species with molecular data.

Type species: ***Cryptophiale kakombensis*** Piroz.

Notes: The hyphomycetous genus *Cryptophiale* was introduced by Pirozynski (1968) based on *C. kakombensis*. Cryptophiale species are saprobes occur on decaying leaves, wood, roots and bark (Pirozynski, 1968; Goh & Hyde, 1996). Species of the genus are characterised by unbranched or apically dichotomous or verticillate, setiform, conidiophores, monophialidic, obscured conidiogenous cells in two rows and unicellular to multiseptate, hyaline conidia produced in slimy masses on one side of the conidiophore (Pirozynski, 1968, Seifert et al., 2011; Yang et al., 2018).

Dendrophoma Sacc., Michelia 2(no. 6): 4 (1880)

Index Fungorum number: IF7944; 113 morphological species (Species Fungorum 2019), 7 species with molecular data.

Type species: ***Dendrophoma cytisporoides*** Sacc.

Notes: *Dendrophoma* was proposed to be synonymous with *Dinemasporium* as *Dendrophoma cytisporoides* was related to *Dinemasporium graminum* (Sutton, 1965). However, Crous et al. (2012) epitypified Dendrophoma cytosporoides and confirmed that it is different from *Dinemasporium* based on morphological and DNA sequence data. Species of Dendrophoma occur on woody substrates and leaves, while some of them

reported as leaf pathogens (Howard & Albregts, 1973; Spegazzini, 1880; Moricca et al., 2016; Vu et al., 2019). The genus is characterised by stromatic, stipitate, setose conidiomata, discrete, or integrated, lageniform to subcylindrical conidiogenous cells and naviculate to botuliform conidia bearing an unbranched cellular appendage at each end (Crous et al., 2012).

Dictyochaeta Speg., Physis, Rev. Soc. Arg. Cienc. Nat. 7: 18 (1923)

Index Fungorum number: IF7996; 104 morphological species (Species Fungorum, 2019), 13 species with molecular data.

Type species: ***Dictyochaeta fuegiana*** Speg.

Notes: *Dictyochaeta* was erected by Spegazzini (1923) based on Dictyochaeta fuegiana. Species of this genus are saprobes on decaying plant parts (Kuthubutheen, 1991; Réblová & Winka, 2000; Whitton et al., 2000). For more details, see note under *Codinaea*. *Dictyochaeta* is characterised by macronematous, mononematous, pale brown to dark brown conidiophores, mono- or polyphialidic, sympodially proliferating conidiogenous cells with flared collarettes and hyaline, clavate conidia without setulae (Réblová & Winka, 2000).

Dinemasporium Lév., Annls Sci. Nat., Bot., sér. 3 5: 274 (1846)

Index Fungorum number: IF8040; 79 morphological species (Species Fungorum, 2019), 20 species with molecular data.

Type species: ***Dinemasporium graminum*** (Lib.) Lév. (Pers.) Sacc.

Notes: *Dinemasporium* species are coelomycetes, mainly occurring on various plant and woody substrates, including decaying wood (Nag Raj, 1993; Hashimoto et al., 2005; Crous et al., 2012; Duan et at., 2007). Few were isolated from soil and human sputum (Nag Raj, 1993; Hashimoto, et al. 2015; Crous et al., 2012). The genus is characterised by superficial, setose, cupulate conidiomata, discrete or integrated conidiogenous cells and, fusiform, naviculate or allantoid, aseptate conidia, with one setulae at each end, with or without lateral appendages (Crous et al., 2012).

Eucalyptostroma Crous & M.J. Wingf., Persoonia 37: 311 (2016)

Index Fungorum number: IF819066; 2 species with molecular data.

Type species: ***Eucalyptostroma eucalypti*** Crous & M.J. Wingf.

Notes: The hypomycetes genus *Eucalyptostroma* was established by Crous, Wingfield, Burgess et al. (2016). This genus comprises two species and both were

isolated from symptomatic leaves of *Eucalyptus pellita* (Crous, Wingfield, Burgess et al., 2016; Crous, Wingfield et al., 2018). *Eucalyptostroma* species are characterised by sporodochial conidiomata lacking setae, penicillate conidiogenous apparatus, and aseptate hyaline conidia, without appendages (Crous, Wingfield, Burgess et al., 2016; Crous, Wingfield et al., 2018).

Exserticlava S. Hughes, N.Z. J Bot. 16(3): 332 (1978)

Index Fungorum number: IF8242; 7 morphological species (Species Fungorum, 2019), 1 species with molecular data.

Type species: ***Exserticlava vasiformis*** (Matsush.) S. Hughes

Notes: The hyphomycetous genus *Exserticlava* has been reported from decaying wood substrates in terrestrial and fresh water habitats (Hughes, 1978; Tsui et al., 2001; Cai & Hyde, 2007; Ren et al., 2011). The genus is characterised by simple conidiophores bearing single polyblastic, funnel-shaped, conidiogenous cells and disto-septate conidia (Hughes, 1978; Kirk, 1985; Tsui et al., 2001).

Hemicorynespora M.B. Ellis, Mycol. Pap. 131: 19 (1972)

Index Fungorum number: IF8499; 14 morphological species (Species Fungorum, 2019).

Type species: ***Hemicorynespora deightonii*** M.B. Ellis

Notes: Most *Hemicorynespora* species are saprobes which have been collected from dead leaves, branches, rachides or petioles, from tropical localities (Ellis, 1972; Mercado et al., 1997; Delgado et al., 2007; Ma et al., 2012; Ma, Ma et al., 2016). The genus is characterized by macronematous, mononematous conidiophores, determinate or percurrently elongated conidiogenous cells and, acrogenous, 0–1-septate, conidia, seceding schizolytically (Ellis, 1972, Seifert et al., 2011; Ma, Ma et al., 2016).

Infundibulomyces Plaingam, Somrith. & E.B.G. Jones, Can. J. Bot. 81(7): 732 (2003)

Index Fungorum number: IF28753; 2 species with molecular data.

Type species: ***Infundibulomyces cupulata*** Plaingam, Somrith. & E.B.G. Jones

Notes: The coelomycete genus *Infundibulomyces* is known only from the tropics and are considered as saprobes (Plaingam et al., 2003; Somrithipol et al., 2008). Species of this genus are characterised by stromatic, cupulate to infundibuliform conidiomata, irregularly branched conidiophores, cylindrical conidiogenous cells and holoblastic

cylindrical conidia, bearing two filiform appendages at each end (Plaingam et al., 2003; Somrithipol et al., 2008).

Kionochaeta P.M. Kirk & B. Sutton, Trans. Br. mycol. Soc. 85(4): 712 (1986) [1985]

Index Fungorum number: IF11111; 13 morphological species (Species Fungorum, 2019), 3 species with molecular data.

Type species: ***Kionochaeta ramifera*** (Matsush.) P.M. Kirk & B. Sutton

Notes: Species of *Kionochaeta* occur on decaying leaves and twigs in freshwater and terrestrial habitats (Crous et al., 1994; Kuthubutheen et al., 1988; Goh & Hyde, 1997; Yanna & Hyde, 2002). *Kionochaeta* species are characterised by macronematous, mononematous, solitary conidiophores, densely clustered, monophialidic, ampulliform, conidiogenous cells and, aseptate, acerose, hyaline to pale yellow conidia aggregated into a slimy drop (Goh & Hyde, 1997; Okada et al., 1997).

Lecythothecium Réblová & Winka, Mycologia 93(3): 481 (2001)

Index Fungorum number: IF28485; 1 species with molecular data.

Type species: ***Lecythothecium duriligni*** Réblová & Winka

Notes: *Lecythothecium* is a monotypic genus typified by *L. duriligni*, which was collected from decaying wood of *Quercus* sp. (Réblová & Winka, 2001). Ths genus is characterised by immersed, flask-shaped ascomata, 8-spored, cylindrical asci with a refractive, J-, apical ring and ellipsoidal to fusiform transversely septate, versicolorous ascospores (Réblová & Winka, 2001). The asexual morph is hyphomycetous with macronematous, mononematous, unbranched conidiophores, proliferating percurrently and holoblastic, cylindrical to clavate or obclavate, 5–11-pseudoseptate, dark brown to reddish brown conidia (Réblová & Winka, 2001).

Menispora Pers., Mycol. eur. (Erlanga) 1: 32 (1822)

Index Fungorum number: IF8902; 44 morphological species (Species Fungorum, 2019), 7 species with molecular data.

Type species: ***Menispora glauca*** (Link) Pers.

Notes: *Menispora* is a hyphomycete genus established by Persoon (1822) based on *M. glauca*. *Menispora* species occur on decayed wood, the inner side of bark or on decayed leaves (Hughes & Kendrick, 1968; Holubová-Jechová, 1973; Réblová & Seifert,

2008). *Menispora* is characterised by macronematous, brown conidiophores, phialides in a lateral or terminal position with a tapering, strongly recurved apex and a incospicous collarette and hyaline conidia without or with polar setulae (Réblová & Seifert, 2008).

Menisporopsis S. Hughes, Mycol. Pap. 48: 59 (1952)

Index Fungorum number: IF8904; 11 morphological species (Species Fungorum, 2019), 3 species with molecular data.

Type species: ***Menisporopsis theobromae*** S. Hughes

Notes: Species of this hyphomycetous genus occur on decaying wood and leaf litter (Hughes & Kendrick, 1968; Ruiz et al., 2001). The genus is characterised by synnematous conidiophores with a central, simple, subulate, tall seta, phialidic conidiogenous cells and appendaged conidia aggregated into a slimy mass (Ellis, 1971; Tsui et al., 1999).

Miyoshiella Kawam., Jap. J. Bot. 4: 295 (1929)

Index Fungorum number: IF3228; 4 morphological species (Species Fungorum, 2019).

Type species: ***Miyoshiella fusispora*** (Kawam.) Kawam.

Notes: *Miyoshiella* species are saprobes on decayed wood (Kawamura et al., 1929; Réblová, 1999). They are wide spread in temperate Europe and Asia (Réblová 1999). Species of this genus are characterised by astromatic, papillate ascomata, asci with refractive, J- apical ring and 3-septate hyaline ascospores (Réblová, 1999). The asexual morph is hyphomycetous with semi-macronematous conidiophores, monoblastic, ampulliform conidiogenous cells and holoblastic, septate, cylindrical to clavate, medium to dark brown conidia (Réblová, 1999).

Nawawia Marvanová, Trans. Br. mycol. Soc. 75(2): 227 (1980)

Index Fungorum number: IF9081; 5 morphological species (Species Fungorum, 2019), 1 species with molecular data.

Type species: ***Nawawia filiformis*** (Nawawi) Marvanová.

Notes: *Nawawia* species occur on dead plant parts including stems, wood and leaves in freshwater habitats (Hyde et al., 1996; Goh et al., 2014; Peng et al., 2016; Yang et al., 2018). Yang et al. (2018) has recollected and provided sequence data for the generic type species, *Nawawia filiformis*. Their phylogenetic analysis confirmed the placement of Nawawia within Chaetosphaeriaceae. *Nawawia malaysiana* Crous & S.S.

Lee was the only Nawawia species with molecular data (Crous, Groenewald et al., 2009). However, Yang et al. (2018) observed that *N. malaysiana* is unrelated with *Nawawia*, and introduced new genus *Neonawawia*, to accommodate *Nawawia malaysiana*, Chaetosphaeriales genera incertae sedis. *Nawawia* is characterised by brown, macronematous conidiophores, monophialidic or sometimes with annellidic conidiogenous cells and turbinate-tetrahedral to obpyramidal conidia with the blunt corners at the distal end with a distinct hair-like appendage at each end (Hyde et al., 1996; Peng et al., 2016; Yang et al., 2018).

Neopseudolachnella A. Hashim. & Kaz. Tanaka, Mycologia 107(2): 385 (2015)

Index Fungorum number: IF808687; 3 species with molecular data.

Type species: ***Neopseudolachnella acutispora*** A. Hashim. et al.

Notes: The coelomycetous genus *Neopseudolachnella* was established to accommodate species with acervuloid, setose conidiomata lacking a peridium, when compared to *Pseudolachnea* and *Pseudolachnella* species (Hashimoto et al., 2015). Neopseudolachnella species have septate conidia bearing a single to multiple appendages at each end (Hashimoto et al., 2015). *Neopseudolachnella* species are associated with Poaceae hosts in Japan (Hashimoto et al., 2015).

Phialosporostilbe Mercado & J. Mena, Revta Jardín bot. Nac., Univ. Habana 6(3): 57 (1985)

Index Fungorum number: IF11162; 5 morphological species (Species Fungorum, 2019), 1 species with molecular data.

Type species: ***Phialosporostilbe turbinata*** Mercado & J. Mena

Notes: Mercado et al. (1985) introduced the hyphomycetous genus Phialosporostilbe based on *P. turbinata*, which was isolated from dead stems of Arthrostylidium in Cuba. The placement of *Phialosporostilbe* within Chaetosphaeriaceae was confirmed by DNA molecular data by Yang et al. (2018). The genus is characterized by synnematous conidiomata, monophialidic conidiogenous cells and subhyaline, turbinate or cordiform conidia with three apical setulae (Sierra & Portales, 1985; Yang et al., 2018).

Polynema Lév., Annls Sci. Nat., Bot., sér. 3 5: 274 (1846)

Index Fungorum number: IF9556; 13 morphological species (Species Fungorum, 2019), 1 species with molecular data.

Type species: ***Polynema ornata*** (De Not.) Lév.

Notes: The coelomycetes genus *Polynema* was introduced by Léveillé (1846). The genus was redescribed by Sutton (1968) and accepted *Neobarclaya* as a synonym of *Polynema*. Nag Raj (1978) identified *Neobarclaya* is distinct from *Polynema* and, was segregated from *Polynema*. Crous, Wingfield et al., (2018) confirmed the placement of *Polynema* in Chaetosphaeriaceae based on phylogenetic analysis of ITS DNA sequence data. Members of *Polynema* are mainly saprobes associated with plant leaves, culms and dead wood (Nag Raj, 1993; Crous, Wingfield et al., 2018). The genus is characterized by acervuloid, cupulate, setose conidiomata, hyaline conidiophores, discrete or integrated, cylindrical to clavate, hyaline conidiogenous cells and fusoid to subcylindrical, aseptate or 3 septate, mostly hyaline conidia with attenuated or filiform appendages at each end (Nag Raj, 1993; Crous, Wingfield et al., 2018).

Pseudodinemasporium A. Hashim. & Kaz. Tanaka, Mycologia 107(2): 390 (2015)

Index Fungorum number: IF808707; 1 species with molecular data.

Type species: ***Pseudodinemasporium fabiforme*** A. Hashim., G. Sato & Kaz. Tanaka

Notes: The monotypic, coelomycetous genus *Pseudodinemasporium* was proposed to include *P. fabiform*, which occurs on dead twigs of *Betula platyphylla* (Hashimoto et al., 2015). The genus is characterised by stromatic, acervular, setose conidiomata, phialidic conidiogenous cells and aseptate conidia, bearing an appendage at each end (Hashimoto et al., 2015).

Pseudolachnea Ranoj., Annls mycol. 8(3): 393 (1910)

Index Fungorum number: IF9587; 10 morphological species (Species Fungorum, 2019), 2 species with molecular data.

Type species: ***Pseudolachnea insignis*** Velen.

Notes: The coelomycetous genus *Pseudolachnea* occur on twigs or wood of various angiosperms (Ranojević, 1910; Sutton, 1980; Nag Raj, 1993; Hashimoto et al., 2015). The genus is characterised by stromatic, acervular, setose conidiomata, phialidic conidiogenous cells and one-septate conidia, bearing a filiform appendage at each end.

Pseudolachnella Teng, Sinensia, Shanghai 7: 775 (1936)

Index Fungorum number: IF9588; 17 morphological species (Species Fungorum 2019), 11 species with molecular data.

Type species: ***Pseudolachnella scolecospora*** (Teng & C.I. Chen) Teng

Notes: *Pseudolachnella* species mostly occur on bamboo, while some species occur on twigs or wood of various angiosperms (Hashimoto et al., 2015). The genus is characterized by stromatic, acervular conidiomata with marginal setae, phialidic conidogenous cells and multiseptate conidia with single to multiple appendages at each end (Hashimoto et al., 2015).

Pyrigemmula D. Magyar & Shoemaker, Mycol. Progr. 10(3): 310 (2011)

Index Fungorum number: IF517148; 1 species with molecular data.

Type species: ***Pyrigemmula aurantiaca*** D. Magyar & Shoemaker

Notes: *Pyrigemmula* is a monotypic genus based on hyphomycete *P. aurantiaca* (Magyar et al., 2011) and was isolated from inner bark or bark fissures of grapevines and also from other woody hosts (Magyar et al., 2011). Even though *P. aurantiaca* occurs on fresh plant material, the ecological role of the species is not understood (Magyar et al., 2011). *Pyrigemmula aurantiaca* is characterised by pear-shaped, brown conidiogenous cells and distoseptate, reddish brown conidia without appendages (Magyar et al., 2011).

Rattania Prabhug. & Bhat, Mycotaxon 108: 218 (2009)

Index Fungorum number: IF512876; 1 species with molecular data.

Type species: ***Rattania setulifera*** Prabhug. & Bhat

Notes: The monotypic genus *Rattania* was introduced based on an endophytic hyphomycete *R. setulifera* isolated from fresh leaves of *Calamus thwaitesii* (Prabhugaonkar & Bhat, 2009). The genus is characterised by sporodochial, setose conidiomata, monoblastic conidiogenous cells and 0–multiseptate, setulate conidia (Prabhugaonkar & Bhat, 2009).

Sporoschisma Berk. & Broome, Gard. Chron., London: 540 (1847)

Index Fungorum number: IF10042; 22 morphological species (Species Fungorum, 2019), 7 species with molecular data.

Type species: ***Sporoschisma mirabile*** Berk. & Broome

Notes: The hyphomycetous genus *Sporoschisma* has cosmopolitan distribution (Goh et al., 1997; Ho et al., 2001, 2002; Zelski et al., 2014; Luo et al., 2016; Yang et al., 2016). Species of the genus are mostly occurring on submerged wood in freshwater

habitats, while some species have been collected from rotting leaves (Hughes, 1966; Goh et al., 1997; Ho et al., 2001, 2002; Zelski et al., 2014; Luo et al., 2016; Yang et al., 2016). Sporoschisma species are characterized by cylindrical, stipitate conidiophores, with a swollen venter and a long, cylindrical neck, monophialidic conidiogenous cells and cylindrical conidia occurring in endogenously chains with basipetal succession (Luo et al., 2016; Zelski et al., 2014).

Striatosphaeria Samuels & E. Müll., Sydowia 31(1–6): 131 (1979) [1978]

Index Fungorum number: IF5282; 1 species with molecular data.

Type species: ***Striatosphaeria codinaeaphora*** Samuels & E. Müll.

Notes: The monotypic genus *Striatosphaeria* was based on lignicolous fungus *S. codinaeaphora*, which was isolated from bark of unidentified dead tree, in Brazil (Samuels & Muller, 1979. The genus is characterised by ostiolate ascomata seated on a small, basal stroma, 4–8-spored, cylindrical asci and 1-septate, brown, ascospores without appendages.

Tainosphaeria F.A. Fernández & Huhndorf, Fungal Diversity 18: 44 (2005)

Fungorum number: IF28947; 3 species with molecular data.

Type species: ***Tainosphaeria crassiparies*** F.A. Fernández & Huhndorf

Notes: This genus is typified by *T. crassiparies*, which was isolated from a *Hymenaea* seed pod (Fernández & Huhndorf, 2005). Species of this genus are saprobes and recorded from both terrestrial and freshwater habitats (Fernández & Huhndorf, 2005; Liu et al., 2016; Lu et al., 2016). Species of *Tainosphaeria* are characterized by subglobose to ovoid ascomata, cylindrical, pedicellate asci, with an J- apical ring, and narrow-fusiform, septate, ascospores (Fernández & Huhndorf, 2005). The asexual morph is hyphomycetous, with mononematous, unbranched conidiophores, phyalidic conidiogenous cells with a collarette and ellipsoidal to clavate, or falcate, hyaline conidia (Fernández & Huhndorf, 2005; Liu et al., 2016; Lu et al., 2016).

Thozetella Kuntze, Revis. gen. pl. (Leipzig) 2: 873 (1891)

Index Fungorum number: IF10214; 26 morphological species (Species Fungorum, 2019), 17 species with molecular data.

Type species: ***Thozetella nivea*** (Berk.) Kuntze

Notes: Most *Thozetella* species have been reported from decaying plant material and soil in tropical habitats, while some species were reported in temperate habitats

(da Silva & Grandi, 2013). Species of this genus are characterised by sporodochial or synnematous conidiomata, phialidic conidiogenous cells, and aseptate conidia, with unbranched setula at each end and sterile microawns (Sutton & Cole, 1983; Paulus et al., 2004; Jeewon et al., 2009).

Umbrinosphaeria Réblová, Mycotaxon 71: 17 (1999)

Fungorum number: IF28309; 1 species with molecular data.

Type species: ***Umbrinosphaeria caesariata*** (Clinton & Peck) Réblová

Notes: The monotypic, sexual morphic genus *Umbrinosphaeria* was introduced to accommodate saprobic fungus U. caesariata, which was collected on decaying wood of Fagus sylvatica (Réblová, 1999a; Réblová & Winka, 2001). Species of this genus are characterised by papillate, setose ascomata, 8-spored, cylindrical asci with refractive, J- apical ring and multi-septate, fusiform, versicoloured ascospores (Réblová, 1999a; Réblová & Winka, 2001).

Zanclospora S. Hughes &W.B. Kendr., N.Z. J Bot. 3: 151 (1965)

Index Fungorum number: IF10468; 9 morphological species (Species Fungorum, 2019), 3 species with molecular data.

Type species: ***Zanclospora novae-zelandiae*** S. Hughes & W.B. Kendr.

Notes: Species of this genus are saprobes on plant parts such as dead wood and leaves (Almeida et al., 2013; Hughes & Kendrick, 1965). *Zanclospora* species are characterized by sterile setae, setiform conidiophores, with a verruculose, dark brown apex, setiform conidiophores and bacilliform, aseptate conidia (Almeida et al., 2013).

Key to the sexual/ asexual genera of Chaetosphaeriaceae

1. Ascomata immersed or semi-immersed 2

1. Ascomata superficial.....3

2. Ascomata globose to subglobose; ascospores 1–3-septate, hyaline, not fragmenting, allantoid or ellipsoid.....*Chaetosphaeria*

2. Ascomata ovoid; ascosporesmulti-septate, versicolored, fusiform, straight or inequilateral.....*Lecythothecium*

3. Ascomata carbonaceous.....4

3. Ascomata membranous.....7

4. Ascospores fragmenting at maturity ..... *Ascochalara*

4. Ascospores not fragmenting 5
5. Ascospores fusiform, straight or inequilateral 6
5. Ascospores ellipsoid, striate, germ pore in the median septum .....*Striatosphaeria*
6. Ascospores hyaline, concolourous, 3-septate .....*Miyoshiella*
6. Ascospores with middle cells brown and the end cells hyaline, versicolored, multi-septate .....*Umbrinosphaeria*
7. Ascomata smooth or setose, ascospores that disarticulate into part-spores .....*Melanopsammella*
7. Ascomata rough, ascospores not disarticulate into part-spores ..... *Tainosphaeria*

Key to asexual genera of Chaetosphaeriaceae

1. Coelomycetous taxon 2
1. Hyphomycetous taxon 10
2. Conidiomata comprising black to brown cells of textura intricate .....*Dendrophoma*
2. Conidiomata comprising black to brown cells of textura angularis 3
3. Conidia multiseptate .....*Pseudolachnella*
3. Conidia mainly 0–1-septate, occasionally 3 septate 4
4. Conidia oblong or fusiform to subcylindrical, conidia aseptate or 3-septate, hyaline to brown, produce only one type of conidia 5
4. Conidia fusiform with obtuse ends, 1-septate, hyaline, smooth macro conidia with appendages, intermixed with aseptate microconidia .....*Pseudolachnea*
5. Conidiomata setae absent .....*Infundibulomyces*
5. Conidiomata setae present 6
6. Conidia fusiform to subcylindrical with acute or subobtuse apex and truncate base, aseptate or 3-septate, mostly hyaline, occasionally pale brown .....*Polynema*
6. Conidia oblong to fusiform, aseptate, hyaline to brown 7
7. Conidiophores brown, unbranched .....*Brunneodinemasporium*
7. Conidiophores apex hyaline, base brown 8
8. Conidia ovoid to ellipsoidal .....*Pseudodinemasporium*
8. Conidia cylindrical to subcylindrical or allantoid to lunate 9
9. Conidia allantoid to lunate .....*Dinemasporium*
9. Conidia cylindrical to subcylindrical .....*Neopseudolachnella*

10. Conidia collarette present 11
10. Conidia collarette absent..... 20
11. Conidia multi-septate 12
11. Conidia 0–3-septate..... 14
12. Conidiogenous cells globose to subglobose, conidia oblong to clavate .....*Adautomilanezia*
12. Conidiogenous cells lageniform or cylindrical, conidia fusiform or cylindrical to doliiform..... 13
13. Conidia brown, cylindrical to doliiform, phragmosporous .....*Sporoschisma*
13. Conidia hyaline, fusiform, not phragmosporous.....*Conicomyces*
14. Conidia lack appendages, if present conidia are globose and surrounded by a sheath of fibrillar appendages 15
14. Conidia with appendages at the ends or edges, surface not surrounded by appendages 16
15. Conidiophores pale orange-brown, forming a penicillate conidiogenous apparatus .....*Eucalyptostroma*
15. Conidiophores brown, erect, bearing a terminal conidiogenous cell, lack penicillate conidiogenous apparatus.....*Craspedodidymum*
16. Conidia aseptate, hyaline, turbinate-tetrahedral to obpyramidal in shape, with their blunt corners at the distal end each provided with a distinct hair-like appendage 17
16. Conidia 0-3 septste, ellipsoid, fusiform, clavate, cylindrical to allantoid, sometimes sublunate; with or without appendages at the ends 18
17. Coidiomata sporodochial, conidiophores hyaline to pale brown, occurs on conidial mass of foliicolous Satchmopsis species .....*Neonawawia*
17. Coidiomata synnematous or solitary, conidiophores brown, occurs on submerged plant parts.....*Nawawia*
18. Conidiophores compact, coidiomata synnematous, conidia 0–1 septate *Menisporopsis*
18. Conidiophores solitary, rarely synnematous, conidia 0–3 septate 19
19. Conidiophores brown at the base, colourless, conidia brown to dark brown or bicolorus.....*Anacacumisporium*
19. Conidiophores pale brown to dark brown, conidia hyaline..... *Dictyochaeta*
20. Conidia thick-walled, capitate hyphae present..... 21

20. Conidia thin-walled, capitate hyphae absent 22
21. Conidia obovoid, aseptate..... *Catenularia*
21. Conidia ellipsoid, 1–3-septate .....*Exserticlava*
22. Conidia inverted T-shaped or L-shaped, straight or obpyriform ..... *Thozetella*
22. Conidia slightly curved or not curved..... 23
23. Conidia curved 24
23. Conidia not curved 28
24. Conidia lunate..... 25
24. Conidia clavate, fusiform or cylindrical 26
25. Conidia with appendages at the ends..... *Codinaea*
25. Conidia lacking appendages ..... *Zanclospora*
26. Conidia cylindrical, hyaline to yellow-green, strongly recurved ..... *Menispora*
26. Conidia clavate or fusiform 27
27. Conidia aseptate, rounded at the apex..... *Kionochaeta*
27. Conidia 0–multi-septate, with appendages at the ends ..... *Rattania*
28. Conidia aseptate 29
28. Conidia septate 30
29. Conidia subglobose to oval, hyaline to light brown.....*Gonytrichum*
29. Conidia cylindrical, ovoid, reniform..... *Chloridium*
30. Conidia hyaline.....*Cryptophiale*
30. Conidia grey, brown to reddish brown 31
31. Conidia acrogenous, obovoid to obclavate, constricted at the basal septum .....*Hemicorynespora*
31. Conidia not acrogenous, not constricted, long oblong.....*Pyrigemmula*

Catabotrydaceae Petr. ex M.E. Barr, Mycotaxon 39: 83 (1990)

Facesoffungi number: FoF01372; Figure 3.2

Saprobic on dead leaves and stems of tropical monocotyledons**. Sexual morph**: *Stromata* irregularly scattered, occasionally coalescing, conspicuous, multi-loculate, superficial, with base slightly penetrating the epidermis at regular intervals, discoid to pulvinate, reddish brown to black, surface scurfy, flat or slightly convex, composed of rather thin-walled, reddish yellow cells of *textura angularis*, *textura globosa* and *textura*

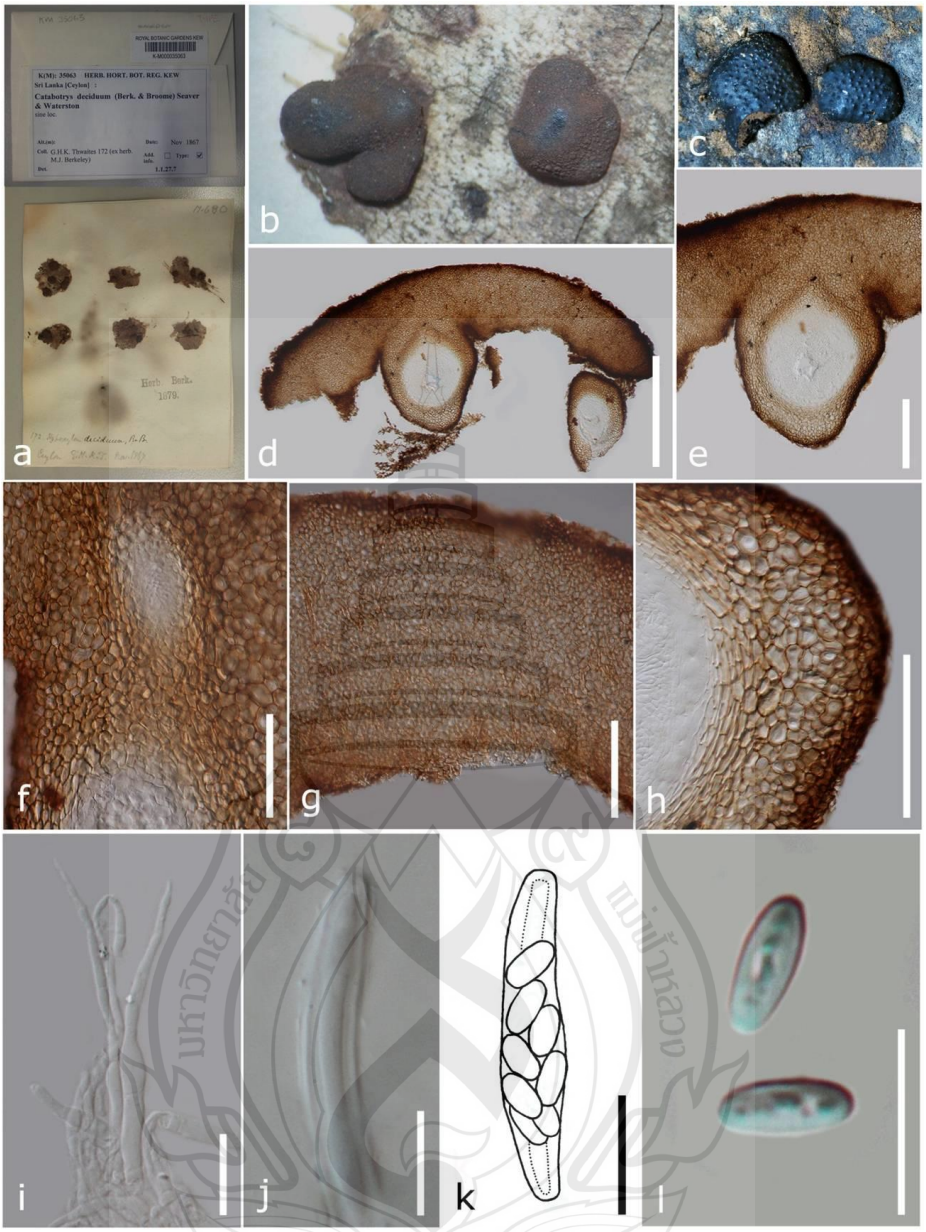
epidermoidea. *Ascomata* perithecial, deeply imbedded in stromatic columns, globose, with a long, periphysate, ostiolar neck. *Peridium* thick, composed of several layers of compressed, reddish brown cells of *textura angularis*. *Paraphyses* hypha-like, numerous, tapering towards the apex, not embedded in a gelatinous matrix. *Asci* 8-spored, unitunicate, broad cylindrical, short pedicellate, apically rounded or truncate, with a J-, discoid, refractive, apical ring. *Ascospores* bi-seriate, hyaline, 1-celled, ellipsoidal to cylindrical, smooth-walled, lacking a mucilaginous sheath. **Asexual morph**: Undetermined.

Type: ***Catabotrys*** Theiss. & Syd.

Notes: The monotypic family Catabotrydaceae was proposed by Petrak (1954) to accommodate the genus *Catabotrys*. Later this family was validated by Barr (1990). According to the characteristics of hamathecium and asci, Catabotrydaceae has been placed in Sordariales (Barr, 1990b). Hyde et al. (2000) placed Catabotrydaceae in Xylariales, while Kirk et al. (2001) suggested that it is morphologically similar to some Boliniaceae and thus the order *Boliniales* was introduced to include both families. Huhndorf et al. (2004) showed that the relationship between Catabotrydaceae and Boliniaceae is not supported by molecular data, hence Catabotrydaceae was excluded from Boliniales and placed in Sordariomycetidae family *incertae sedis*. Although analysis of combined TUB2, LSU and RPB2 sequence data by Miller and Huhndorf (2005) indicated that *C. decidua* is a member of *Diaporthales*, however, recent molecular studies by Maharachchikumbura et al. (2015) confirmed that Catabotrydaceae clusters with Amplistromataceae, hence it has been placed in Amplistromatales.

Type species: ***Catabotrys deciduum*** (Berk. & Broome) Seaver & Waterston, Mycologia 38(2): 184 (1946)

Material examined: SRI LANKA, on unidentified dead palm, G.H.K. Thwaites 172 (ex herb. M.J. Berkeley), November 1867, K (M) 35063, holotype; Hyde & Cannon (1999). AUSTRALIA, Queensland, Cape Tribulation, J.E. Taylor, 15 April 1995, HKU(M) 4306).



Note a–b, d–j. Sri Lanka, c, i. Australia (a) Herbarium material with label. (b–c) Stromata on host surface. (d–e) Transverse section of stromata with ascomata. (f) Ostiole with periphyses. (g) Stromatic tissue. (h) Peridium. (i) Paraphyses. (j–k) Immature and mature asci. (l) Ascospores. Scale bars: d = 500 µm, e = 200 µm, f–h = 100 µm, i = 20 µm, j–l = 10 µm.

Figure 3.2 *Catabotrys deciduum*

Cylindriaceae Crous & L. Lombard, Fungal Systematics and Evolution 1: 183 (2018)

Index Fungorum number: IF824770, 32 species.

Associated with plant substrates, especially leaves. Sexual morph: Undetermined. Asexual morph: Mycelium composed of septate, branched, hyaline, smooth-walled hyphae. Conidiophores sporodochial or solitary, erect, hyphae and basal part of conidiophores subcylindrical, erect, septate, branched, becoming pale brown, smooth-walled. Conidiogenous cells terminal and intercalary, subcylindrical, hyaline, smooth-walled, with several sympodial flat-tipped loci, unthickened, not darkened. Ramoconidia subcylindrical, guttulate, hyaline, smooth-walled. Conidia aseptate, arranged in long, branched chains, scars not thickened, slightly refractive, hyaline, smooth-walled (adapted from Crous, Schumacher et al., 2018).

Type genus: ***Cylindrium*** Bonord.

Notes: The genus Cylindrium was considered as Hypocreales *incertae sedis* by Lombard et al. (2015). Crous, Schumacher et al. (2018) introduced Cylindriaceae in Hypocreales to accommodate this genus based on phylogenetic analysis of ITS sequence data.

Economic and ecological significance

Cylindrium purgamentum (Crous) Crous was isolated from leaf litter (Crous, Schumacher et al., 2018). Other species such as *C. syzygii* (Crous & R.G. Shivas) Crous and *C. algarvense* were isolated from *Syzygium* and *Eucalyptus* leaves (Cheewangkoon et al., 2009; Crous et al., 2011). However, so far there are no report of *Cylindrium* species as a leaf pathogen.

Genus included in Cylindriaceae

Cylindrium Bonord., Handb. Allgem. mykol. (Stuttgart): 34 (1851)

Index Fungorum number: IF7865; 6 morphological species (Species Fungorum, 2019), 5 species with molecular data.

Type species: ***Cylindrium elongatum*** Bonord.

Notes: This asexual morphic genus is characterized by sporodochial conidiomata, subcylindrical conidiogenous cells and aseptate hyaline conidia arranged in long chains (Bonorden, 1851; Crous, Schumacher et al., 2018). However, the actual taxonomic placement of *Cylindrium* was doubtful for years. *Cylindrium elongatum* was accepted in

Hypocreales incertae sedis by Lombard et al. (2015). Crous, Schumacher et al. (2018) revealed that *Cylindrium* is a member of Hypocreales and described the new family Cylindriaceae based on ITS DNA data.

Delonicicolaceae R.H. Perera, Maharachch. & K.D. Hyde, Cryptog. Mycol. 38(3): 334 (2017)

Index Fungorum number: IF553776; Facesoffungi number: FoF03604, 4 species. *Saprobic* on fabaceous hosts. **Sexual morph:** *Pseudostromata* conspicuously pulvinate to inconspicuous, embedded in host tissue or erumpent to rarely superficial, visible as raised, dark spots on the host surface, more or less elevated patches on the wood or erumpent through the bark, yellowish, brown to black; sometimes covered by yellow to yellow-green, bright turquoise, scurf. *Ascomata* perithecial, immersed in pseudostroma, multi-loculate, aggregated, globose, subglobose to conical or irregular, subhyaline to pale brown, ostiolate. *Ostioles* papillate. *Peridium* composed of subhyaline to medium brown cells of textura angularis to textura prismatica, KOH-. *Paraphyses* septate, unbranched or occasionally branched, hyaline. *Asci* 8-spored, unitunicate, arising from the base or margins of the ascomata, clavate to cylindrical, straight, curved to sinuous, thin-walled, inamyloid, without a distinct apical ring. *Ascospores* bi-seriate to uniseriate, hyaline, ellipsoid or allantoid, equilateral or inequilateral, with rounded apices, aseptate or 1-septate, not constricted at the septa, thin-walled, smooth, without appendages or gelatinous sheath. **Asexual morph:** Undetermined.

Type genus: ***Delonicicola*** R.H. Perera, Maharachch. & K.D. Hyde

Notes: Perera et al. (2017) introduced the family Delonicicolaceae (Delonicicolales) to accommodate *Delonicicola* and *Liberomyces*. Later, Liberomyces was synonymised under *Leptosillia* and added to Leptosilliaceae (Voglmayr et al., 2019). A new genus *Furfurella* was added to Delonicicolaceae based on morphological and molecular evidence by Voglmayr et al. (2019). Vitale et al. (2018) and Voglmayr et al. (2019) accepted Delonicicolaceae within Xylariales. However, based on our phylogenetic analysis we maintain Delonicicolaceae in the order Delonicicolales following the classification of Perera et al. (2017).

Ecological and economic significance

Delonicicola siamense is a saprobic fungus occurring on decaying seed pods of *Delonix regia* (Perera et al., 2017). Saprobes can promote the decay process of various

plant substrates and contribute to nutrient cycling in forest ecosystems (Somrithipol, Jones et al., 2002; Fukasawa et al., 2012). There are no reports of pathogenic species in *Delonicicola* or Furfurella (Perera et al., 2017; Voglmayr et al., 2019).

Genera included in Delonicicolaceae

Delonicicola R.H. Perera, Maharachch. & K.D. Hyde, Cryptog. Mycol. 38(3): 334 (2017)

Index Fungorum number: IF553772; Facesoffungi number: FoF03605, 1 species with molecular data.

Type species: ***Delonicicola siamense*** R.H. Perera, Maharachch. & K.D. Hyde

Notes: The sexual morphic, monotypic genus *Delonicicola* was established based on *Delonicicola siamense*, which was isolated from *Delonix regia* seed pods in Thailand (Perera et al., 2017). *Delonicicola* species are saprobes, characterized by pseudostromatal immersed, papillate ascomata, short pedicellate asci and 1-septate, hyaline ascospores (Perera et al., 2017). *Delonicicola siamense* is illustrated in this entry.

Furfurella Voglmayr & Jaklitsch, Persoonia 42: 237 (2019)

Index Fungorum number: IF829925; 3 species with molecular data.

Type species: ***Furfurella stromatica*** Voglmayr & Jaklitsch

Notes: *Furfurella* was introduced by Voglmayr et al. (2019) to accommodate *F. luteostiolata* Voglmayr & Jaklitsch, *F. nigrescens* Voglmayr & Jaklitsch and *F. stromatica* (type species). *Furfurella* species are associated with dead branches of fabaceous plants in the Mediterranean basin (Voglmayr et al., 2019). The genus is characterised by erumpent pseudostromata with bright yellow, yellow-green to turquoise scurfs, clavate to cylindrical asci and allantoid, aseptate ascospores.

Key to genera of Delonicicolaceae

1. Bright yellow, yellow-green to turquoise scurf on the stromata and ostioles, ascospores allantoid, aseptate ..... *Furfurella*

1. Bright yellow, yellow-green to turquoise scurf are absent on the stromata and ostioles, ascospores ellipsoid, 1-septate ..... *Delonicicola*

Flammocladiaceae Crous, L. Lombard & R.K. Schumach.

Index Fungorum number: IF819623, 1 species.

Fungicolous on *Massaria* spp. on corticated branches of *Acer*. **Sexual morph**: *Ascomata* perithecial, pale luteous to yellow-orange, aggregated in clusters, on a single stromatic base, covered in a dirty white crustose layer, turning pale luteous to dirty white, KOH-, ostiolate. *Ostiole* papillate, periphysate. *Peridium* 3–4 layers of subhyaline, smooth-walled cells of *textura angularis*. *Asci* unitunicate, 8-spored, fasciculate, fusoidal-ellipsoidal to subclavate, hyaline, smooth-walled. *Ascospores* hyaline, fusoidal-ellipsoidal with obtuse ends, septate, warty, not to slightly constricted at septa. **Asexual morph**: *Conidiomata* sporodochial, determinate, hyaline, becoming orange. *Conidiophores* subcylindrical, septate, branched. *Conidiogenous cells* subcylindrical, terminal and intercalary, hyaline, smooth-walled, proliferating sympodially at apex. *Conidia* slimy, solitary, granular to guttulate, straight to gently curved, subcylindrical to narrowly obclavate, hyaline, smooth-walled.

Type genus: ***Flammocladiella*** Crous et al.

Notes: Flammocladiaceae was introduced to accommodate the monotypic genus *Flammocladiella* by Crous, Schumacher et al. (2015). In the molecular analysis by Hongsanan et al. (2017) and Sun et al. (2017), Flammocladiaceae grouped within Clavicipitaceae, hence was not treated as a separate family. Further, Hongsanan et al. (2017) synonymized Flammocladiaceae under Clavicipitaceae based on phylogenetic data and, it this was followed by Wijayawardene et al. (2018). However, in the molecular clock analysis by Hyde, Maharachchikumbura et al. (2017) Flammocladiaceae forms a separate clade sister to Clavicipitaceae with low statistical support. Similar results were obtained from phylogenetic analysis by Maharachchikumbura et al. (2016) and Lechat & Fournier (2018b). Hence, we would like to treat Flammocladiaceae as an accepted family within Hypocreales, based on previous treatments and our phylogenetic analysis results.

Flammocladiella Crous et al., in Crous et al., Sydowia 67: 103 (2015)

Index Fungorum number: IF812530, 1 species with molecular data.

Type species: ***Flammocladiella decora*** (Wallr.) Lechat & J. Fourn.

= *Flammocladiella aceris* Crous et al., in Crous et al., Sydowia 67: 104 (2015)

= *Nectria massariae* Pass., in Rabenhorst, Fungi europ. exsicc.: no. 1827 (1874)

Notes: *Flammocladiella* was introduced by Crous, Schumacher et al. (2015) based on a single species *F. aceris* Crous et al. Lechat and Fournier (2018b) proposed *Flammocladiella decora* comb. nov. to accommodate *Nectria decora* (Wallr.) Fuckel. *Flammocladiella decora* produces long, subcylindrical conidia and a sexual morph, which are indistinguishable from *F. aceris* (Lechat & Fournier, 2018b). Considering morphological similarities and phylogenetic analyses Lechat and Fournier (2018b) regarded *F. aceris* as a synonym of *F. decora*. The genus is characterised by yellowish ascomata seated on ascomata of *Massaria* species, aggregate in clusters, covered by a crustose layer, having a papillate, periphysate ostiolar region, and a sporodochial asexual morph forming flame-like conidial masses, conidia subcylindrical, flexuous (Crous, Schumacher et al., 2015; Lechat & Fournier, 2018b).

Economic significance

Flammocladiella decora is a fungicolous species occurring on immersed ascomata of *Massaria* species (Lechat & Fournier, 2018b). Currently, there is no data on the economic significance of *Flammocladiella* species.

Phaeochoraceae K.D. Hyde et al., in Hyde et al., Syst. Ascom. 15(1-2): 118 (1997)

Facesoffungi number: FoF01910

Saprotrophic or *biotrophic* on leaves of palms. **Sexual morph**: *Stromata* scattered as blackened regions on the host, rarely inconspicuous, usually raising the substrate surface, 1– to multi-loculate, ostiole conspicuous or not. *Ascomata* ellipsoidal to subglobose, dark brown, clustered or solitary, if solitary single ostiolate, when clustered ostiolar necks together to form a multi-ostiolate cavity. *Ostioles* conspicuous or inconspicuous. *Peridium* several layered, composed of flattened, brown to dark brown-walled cells, thinner at the base. *Interascal tissue* present only in some taxa, composed of paraphyses-like hyphae, wide, septate, tapered, thin-walled, guttulate, evanescent at maturity. *Asci* 6–8-spored, unitunicate, fusiform or saccate, very thin-walled, long or short pedicellate, usually without apical structures, deliquescing early. *Ascospores* uniseriate to biseriate, yellow to olivaceous or various shades of brown, aseptate, ellipsoidal, fusiform or cylindrical, thick-walled, sometimes with one flattened face, sometimes delicately striate, with or without appendages. **Asexual morph**: Coelomycetous. *Conidiogenous cells* narrowly conical, usually proliferating percurrently,

but occasionally sympodially, periclinal thickening visible, without a collarette. *Conidia* aseptate, narrowly fusiform to bacillar, hyaline, thin-walled (Hyde et al., 1997; Hyde & Cannon, 1997; Taylor & Hyde, 2003).

Type: ***Phaeochora*** Höhn.

Notes: The family *Phaeochoraceae* was introduced by Hyde et al. (1997) to accommodate *Phaeochora* and two other genera (*Serenomyces*, *Cocoicola*) previously placed in the *Phyllachoraceae*. Later, *Phaeochoropsis* was also included in this family based on morphology (Hyde & Cannon, 1997). Although Hyde et al. (1997) tentatively placed this family in the order *Phyllachorales*, no molecular data are available to confirm its phylogenetic placement and assign it to any order. This family is characterized by ascomata developing in a pseudostromata aseptate brown ascospores, and clavate to saccate evanescent asci (Hyde et al., 1997; Hyde & Cannon, 1997). The description above is a combination of characters from Hyde et al. (1997), Hyde and Cannon (1997) and Taylor and Hyde (2003).

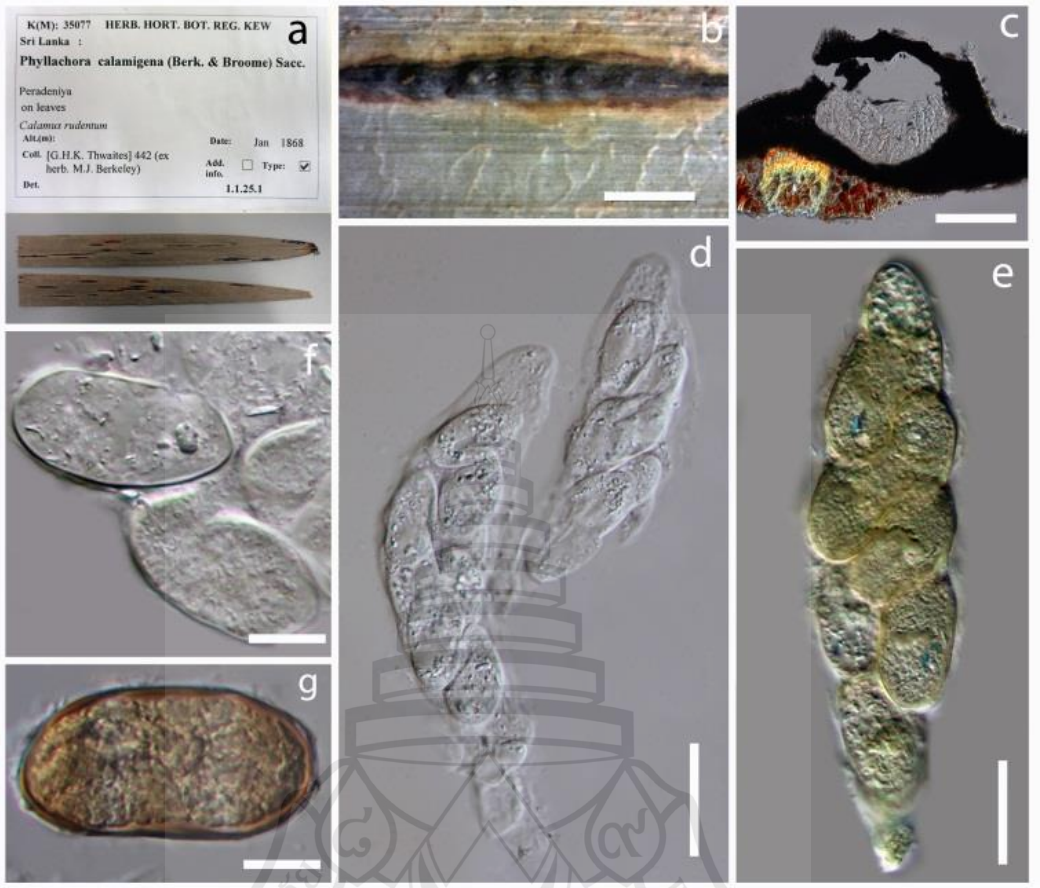
Phaeochora Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1513 [53 repr; in clave] (1909)

Facesoffungi number: FoF02125; Figure 3.3

Saprotrophic or *biotrophic* on leaves of palms. **Sexual morph**: *Stromata* scattered as blackened regions, shiny black, conspicuous on upper and lower leaf surfaces, rarely coalescing, uniloculate to multi-loculate, composed of brown cells of *textura globosa* and crystalline granules. *Ostiole* inconspicuous. *Ascomata* oblate to subglobose, dark brown. *Peridium* several layered, composed of strongly flattened, brown-walled cells, thinner at the base. *Periphyses* and *interascal tissue* lacking. *Asci* 8-spored, unitunicate, thin-walled, saccate, short pedicellate, without an apical ring, evanescent. *Ascospores* biseriate, triseriate to multi-seriate or irregular. golden to mid-brown, aseptate, ellipsoidal to fusiform, with one flattened face, thick-walled, smooth or minutely verruculose, with globose, hyaline appendages near the apices of the flattened surface. **Asexual morph**: Coelomycetous. *Peridium* single layered, composed of brown cells of *textura angularis*. *Conidiogenous cells* narrowly conical, usually proliferating percurrently, occasionally sympodially, periclinal thickenings visible, without collarette. *Conidia* aseptate, narrowly fusiform to bacillar, hyaline, thin-walled.

Type species: ***Phaeochora chamaeropis*** (Cooke) Höhn. [as 'chamaeropsidis'], Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1513 [53 repr; in clave] (1909)

Notes: von Höhnel (1909) introduced the genus *Phaeochora* to accommodate *Auerswaldia chamaeropis* (Cooke) Sacc. (Syn. *Dothidea chamaeropis* Cooke). It was recognized by 'phyllachoroid' stromata embedded in the epidermis and parenchyma, and not disrupting the covering epidermal layer. Hohnel consider *A. chamaeropis* as the type and introduced another species, *A. densa* E. Bormmer & M. Rousseau to the genus. However, *A. densa* was transferred to *Sphaerodothis* (Sacc. & P. Syd.) Shear by Shear (1909), but its identity remains unclear. Study by Joly (1961) only provide a short description to the *Sphaerodothis* and the host species was not recorded by the original authors, the fungaus has described simply as occurring on *Coriaceous* leaves in Costa Rica. Müller (1965) clarified the earliar name of the type species of *Phaeochora* as *Sphaeria steinhelii* Mont. and transferred it as *Phaeochora steinhelii* Mont. E. Mull. *Phaeochora* is superficially similar to *Sphaerodothis*, and the two genera were treated as synonyms by von Arx and Muller (1954) and Joly (1961). However, the Genus *Phaeochora* is characterized by oblate to subglobose ascomata and golden to mid-brown, aseptate, ellipsoidal to fusiform, ascospores with appendages near the apices of the flattened surface (Hyde et al., 1997).



Note (Material examined: SRI LANKA, Peradeniya, on leaves of *Calamus rudentum* Lour. (*Arecaceae*), G.H.K. Thwaites 442 (ex herb. M.J. Berkeley), January 1868 (K(M) 35077, holotype) (a) Herbarium material with label. (b) Stromata on host substrate. (c) Transverse section through stroma showing ascoma (d) Immature asci. (e) Ascus in Melzer's reagent. (f, g) Immature and mature ascospores. Scale bars: b, c = 200 µm, d, e = 20 µm, f, g = 10 µm.

Figure 3.3 *Phaeochora calamigena*

Other genera included

Cocoicola K.D. Hyde, Nova Hedwigia 60(3-4): 600 (1995)

Type species: ***Cocoicola cylindrospora*** (C. Booth & D.E. Shaw) K.D. Hyde, Nova Hedwigia 60(3-4): 600 (1995)

Phaeochoropsis K.D. Hyde & P.F. Cannon, Mycol. Pap. 175: 30 (1999)

Type species: ***Phaeochoropsis neowashingtoniae*** (Shear) K.D. Hyde & P.F. Cannon, Mycol. Pap. 175: 33 (1999)

Serenomyces Petr., Sydowia 6(1-4): 296 (1952)

Type species: ***Serenomyces shearii*** Petr., Sydowia 6(1-4): 296 (1952)

Key to the genera of *Phaeochoraceae*

1. Ascospores asymmetrical 2
1. Ascospores symmetrical 3
2. Ascospores, striate, surrounded by mucilage when young, without polar appendages .....*Phaeochoropsis*
2. Ascospores smooth or verrucose, not surrounded by mucilage, with polar appendages .....*Phaeochora*
3. Ascospores light brown.....*Serenomyces*
3. Ascospores yellow or olivaceous ..... *Cocoicola*

Pseudotruncatellaceae Crous, in Crous et al., Persoonia 42: 309 (2019)

Index Fungorum number: IF830823, 2 known species.

Saprobic on dead plant stems or associated with leaves. **Asexual morph**: coelomycetous. *Conidiomata* acervular to pycnidioid, gregarious, immersed to semi-immersed, oval. *Peridium* of hyaline to pale brown, thick-walled cells forming *textura angularis Conidiophores* arising from basal and lateral cells in cavity, cylindrical, septate, branched or rarely unbranched, sometimes reduced to conidiogenous cells, hyaline, smooth-walled. *Conidiogenous cells* subcylindrical, proliferating percurrently at apex, hyaline, smooth-walled. *Conidia* fusoid, straight, 2 or 3-septate, with 2–3(–4) tubular apical appendages; two median cells guttulate, fusoid, dark brown, thick-, smooth-walled; basal cell, narrowly obconic with a truncate base, hyaline, smooth-walled. **Sexual morph**: Undetermined.

Type genus: ***Pseudotruncatella*** R.H. Perera et al.

Notes: The family Pseudotruncatellaceae was introduced by Crous, Carnegie et al. (2019) to accommodate single genus *Pseudotruncatella*), which was previously placed in Amphisphaeriales *incertae sedis* (Perera, Maharachchikumbura et al., 2018).

Pseudotruncatella R.H. Perera et al, in Perera et al., Phytotaxa 338(2): 181 (2018)

Index Fungorum number: IF553932; Facesoffungi number: FoF03838; 2 morphological species (Species Fungorum 2019), 2 confirmed species based on molecular data.

Type species: ***Pseudotruncatella arezzoensis*** R.H. Perera et al.

Notes: Perera, Maharachchikumbura et al. (2018) established asexual morphic genus *Pseudotruncatella* to accomodate *P. arezzoensis.* Later the second species, *P. bolusanthi* Crous was added to the genus and family Pseudotruncatellaceae was introduced to accommodate them (Crous, Carnegie et al., 2019). (Crous et al., 2019). The genus is characterized by acervular to pycnidioid conidiomata, holoblastic, annellidic, conidiogenous cells, 2 or 3-septate, fusiform to clavate conidia with up to 2–3(–4) apical appendages and dark brown median cells (Perera, Maharachchikumbura et al., 2018; Crous, Carnegie et al., 2019).

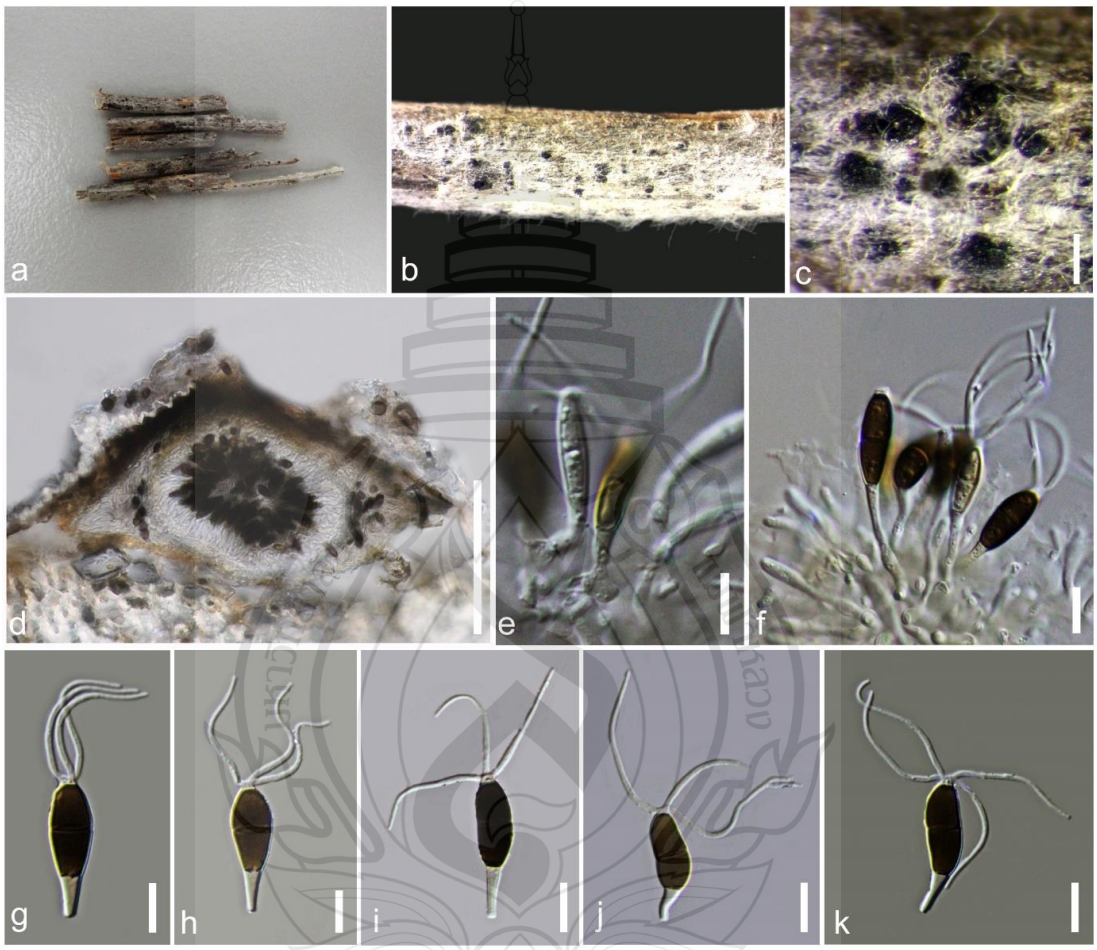
Pseudotruncatella arezzoensis R.H. Perera et al., in Perera et al., Phytotaxa 338(2): 181 (2018

Index Fungorum number: IF553933; Facesoffungi number: FoF03839, Figure 3.4

Saprobic on dead stems of *Cytisus* and *Helichrysum* species. **Sexual morph**: Undetermined. **Asexual morph**: *Conidiomata* 235–270 μm high, 270–280 μm wide, pycnidioid, scattered or gregarious, round to oval, immersed to semi-immersed. *Peridium* of 3.5–6.5 μm wide, hyaline to pale brown, thick-walled cells forming *textura angularis*. *Conidiophores* 14–35 × 1.5–3.2 μm ($\bar{x}$ = 21.5 × 2.2 μm, n = 10) diam., arising basal and lateral cavity-surface of conidiomata, cylindrical, septate, branched, at times unbranched or reduced to conidiogenous cells, hyaline, smooth-walled. *Conidiogenous cells* 6–25 × 1.4–3 μm ($\bar{x}$ = 16.5 × 2 μm, n = 15) diam., cylindrical, occasionally ampulliform, holoblastic, annelledic, proliferating percurrently, hyaline, smooth-, thick-walled. *Conidia* 20–25 × 5.5– 6.5 μm diam. ($\bar{x}$ = 22 × 5.8 μm, n = 20), fusiform to clavate, straight, 3-septate, not constricted at septa, bearing 3(–4) apical appendages, guttulate; basal cell 4.5–7 × 2.5–3.3 diam., narrowly obconic with a truncate base, hyaline, smooth-, thick-walled; 2-median cells together 6.6–8.5 × 4.3–6.5 diam., dark brown, thick-, smooth-walled; upper median cell subcylindrical to conic, lower median cell narrowly obconic,

thick-walled; apical cell conic, hyaline, smooth-walled 1.6–2.8 × 1.4–2.6; apical appendages 20–25 µm long, simple, tubular, hyaline, smooth-walled.

Material examined: ITALY, Arezzo Province, Croce di Pratomagno, aerial stem of *Helichrysum italicum* (Roth) G. Don fil. (Asteraceae), Erio Camporesi, 18 July 2013, IT 1322E (MFLU 17-1776, **paratype**).



Note (a) Herbarium material. (b, c) Conidiomata on host. (d) Vertical section of conidioma. (e, f) Conidiogenous cells with mature and immature conidia. (g–k) Conidia. Scale bars: c = 500 µm, d = 200 µm, e–k = 10 µm.

Figure 3.4 *Pseudotruncatella arezzoensis* (MFLU 17-1776, paratype)

Ecological and economic significance

Pseudotruncatella arezzoensis is a saprobe on woody substrates (Perera, Maharachchikumbura et al., 2018). Saprobic fungi play an important role in nutrient and carbon cycling in ecosystems (Harley, 1971). *Pseudotruncatella bolusanthi* associated with plant leaves of *Bolusanthus speciosus* (Crous, Carnegie et al., 2019). However, there is no study has confirmed pathogenicity of Pseudotruncatellaceae species yet.

Thyridiaceae J.Z. Yue & O.E. Erikss., Syst. Ascom. 6(2): 233 (1987)

Facesoffungi number: FoF01913

Saprobic or *hemibiotrophic* in woody substrates. **Sexual morph**: *Stromata* immersed, becoming erumpent to superficial, soft-textured, reddish brown to brightly pigmented. *Ascomata* immersed in stromata, globose, medium-sized, ostiolate. *Ostioles* periphysate, with short or long papilla or necks, sometimes convergent necks merging into one ostiole. *Peridium* composed of compressed rows of cells, externally brown, internally hyaline. Paraphyses filamentous, septate hyaline. *Asci* unitunicate, usually 8-spored, oblong cylindric, with shallow J-, apical ring. *Ascospores* uniseriate, shades of brown, ellipsoid or biconoid, symmetric, 1-septate or muriform. **Asexual morph**: Coelomycetous. *Conidiomata* stromatic, multi-loculate. *Conidiogenous cells* enteroblastic phialidic. *Conidia* small, hyaline. Holoblastic sympodial conidia also produced from hyphae (Barr, 1990b).

Type: ***Thyridium*** Nitschke

Notes: The family *Thyridiaceae* was introduced by Yue and Eriksson (1987) with *Thyridium vestitum* (Fr.) Fuckel as the type species. *Thyridium* and *Sinosphaeria* were included in this family (Yue & Eriksson, 1987). Later, *Thyridium* was expanded to include *Bivonella* and *Sinosphaeria* (Eriksson & Yue, 1989). The family *Thyridiaceae* was placed in *Hypocreales* and synonymised under *Hypocreaceae* by considering the bright pigmentation of stromatic tissues (in some genera like *Sinosphaeria*, pigments are soluble in alcohol and 5% KOH) and the presence of both paraphyses and periphysoids (Eriksson & Yue, 1989). Barr (1990) observed that bright pigments are not a unique character in *Hypocreales* and believed *Thyridium* (including *Sinosphaeria* and *Bivonella*) is different from *Hypocreales* and further maintained this as a separate family *Thyridiaceae* under *Xylariales*. Considering the morphological similarities to *Thyridium*, Barr (1990) included *Valsaria* and *Valsonectria* in *Thyridiaceae*. *Valsaria* is currently

placed in *Diaporthales* and *Valsonectria* in *Hypocreales* (Kirk et al., 2008; Jaklitsch et al., 2015). Rossman et al. (1999) placed *Balzania*, *Mattirolia* and *Thyronectroidea* in *Thyridiaceae*. Checa et al. (2013) examined the type species of *Balzania*, *Mattirolia*, *Thyridium* and *Thyronectroidea*, and accepted only *Mattirolia* and *Thyridium* within *Thyridiaceae*. They recognized *Balzania* and *Thyronectroidea* as synonyms of *Mattirolia* (Checa et al., 2013). Jaklitsch and Voglmayr (2014) revised *Mattirolia* and synonymised under *Thyronectria*. *Thyronectroidea* was considered as a synonym of *Thyronectria*, whereas *Thyronectria* is distantly related with *Thyridiaceae* (Jaklitsch & Voglmayr, 2014; Maharachchikumbura et al., 2015). According to the molecular analysis, *Thyridiaceae* is considered as a member of subclass *Sordariomycetidae* (Spatafora et al., 2006; Réblová, 2013; Jaklitsch & Voglmayr, 2014). Maharachchikumbura et al. (2015) placed *Thyridiaceae* in the newly introduced subclass *Diaporthomycetidae*, the phylogenetic placement of which is still uncertain within the subclass (Maharachchikumbura et al., 2015).

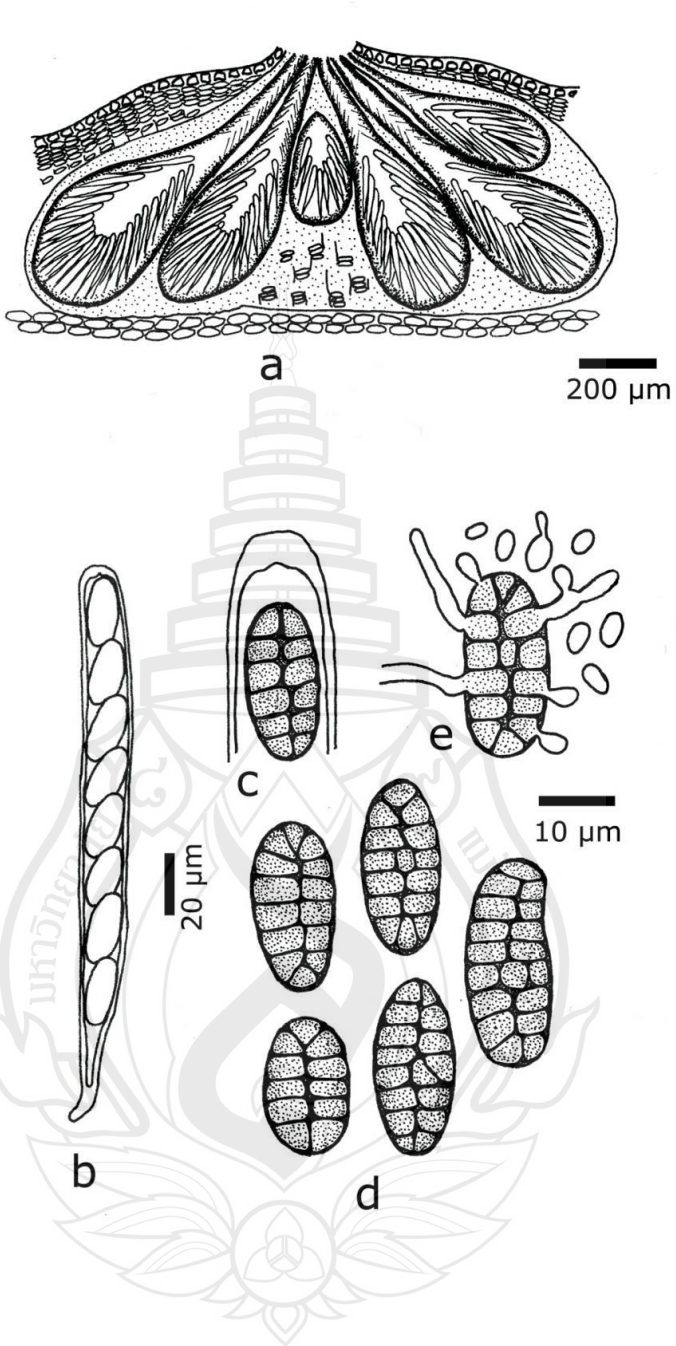
Thyridium Nitschke, Pyrenomyc. Germ. 1: 110 (1867)

Facesoffungi number: FoF02137; Figure 3.5

Saprobic or *hemibiotrophic* in woody substrates. **Sexual morph**: *Stromata* immersed or erumpent, formed by interwoven yellowish brownish to black hyphae and cells of the substrate, KOH +/-. *Ascomata* perithecial, globose, immersed in stromata, with short or long necks with convergent or separate ostioles. *Ostioles* periphysate. *Asci* 8-spored, cylindrical, with a J-, apical ring. *Ascospores* uniseriate, muriform, ellipsoid or biconoid, symmetric, pale brown to dark brown, or with thickened and pigmented septa. **Asexual morph**: Undetermined (Checa et al., 2013).

Type species: ***Thyridium vestitum*** (Fr.) Fuckel, Jb. nassau. Ver. Naturk. 23-24: 195 (1870) [1869-70]

Notes: The genus *Thyridium* was introduced by Nitschke (1867) to accommodate species with uniseriate, muriform, dark coloured ascospores, 8-spored asci and filiform paraphyses (Nitschke, 1867). Later, *Thyridium* was emended to incorporate *Bivonella* and *Sinosphaeria* as synonyms by Eriksson and Yue (1989). However, Barr (1990) did not accept *Bivonella* as a synonym of *Thyridium* since the type species of *Bivonella* (= *Sinosphaeria*) has periphysoids, which are not seen in the type species of *Thyridium* (Checa et al., 2013).



Note (a) Section through the host tissue and stromata. (b) Ascus with ascospores. (c) Apical part of an ascus. (d) Ascospores. (e) Germinated ascospore with primary conidia.

Figure 3.5 *Thyridium vestitum* (redrawn from Leuchtmann & Müller, 1986)

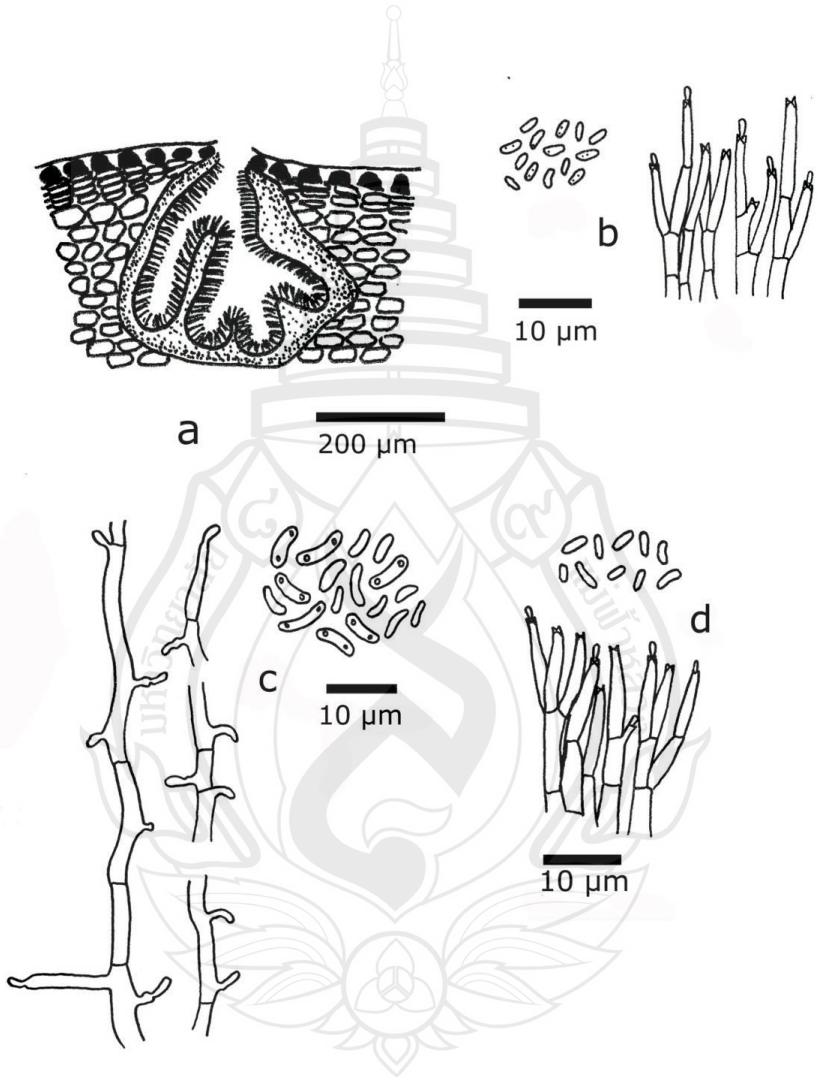
Other genera included

Mattirolia Berl. & Bres., Microm. Trid.: 55 (1889)

Type species: ***Mattirolia roseovirens*** Berl. & Bres., Microm. Trid.: 55 (1889)

Pleurocytospora Petr., Annls mycol. 21(3/4): 256 (1923)

Type species: ***Pleurocytospora vestita*** Petr., Annls mycol. 21(3/4): 256 (1923); Figure 3.6



Note (a) Section through the host tissue and stroma. (b) Conidiophores and conidia. (c) Conidia forming mycelium and conidia of 10 days old culture. (d) Conidiophores and conidia of the stroma in culture.

Figure 3.6 *Pleurocytospora vestita* (redrawn from Leuchtmann & Müller, 1986)

Key to sexual genera of *Thyridiaceae*

1. Stromata with short or long necks with convergent or separate ostioles, ascospores very pale brown to dark brown, or with thickened and pigmented septa..... *Thyridium*

1. Stromata without convergent ostioles, ascospores hyaline to greenish yellow when mature..... *Mattirolia*

Obryzaceae Körb. [as 'Obryzeae'], Syst. lich. germ. (Breslau): 427 (1855)

Lichenicolous with green algae on rocks or bark, rarely on mosses or parasitic on cyanobacterial lichens, in temperate regions. **Sexual morph**: *Ascomata* astromatic, perithecial, immersed, pyriform, ostiolate, with a periphysate ostiolar region. *Asci* 4–8-spored, unitunicate, clavate, narrowly ellipsoid to ovoid, thin-walled, short- pedicellate, apical ring not apparent, evanescence. *Ascospores* aseptate, hyaline, smooth-walled, lacking appendages, without a gelatinous sheath. **Asexual morph**: Undetermined.

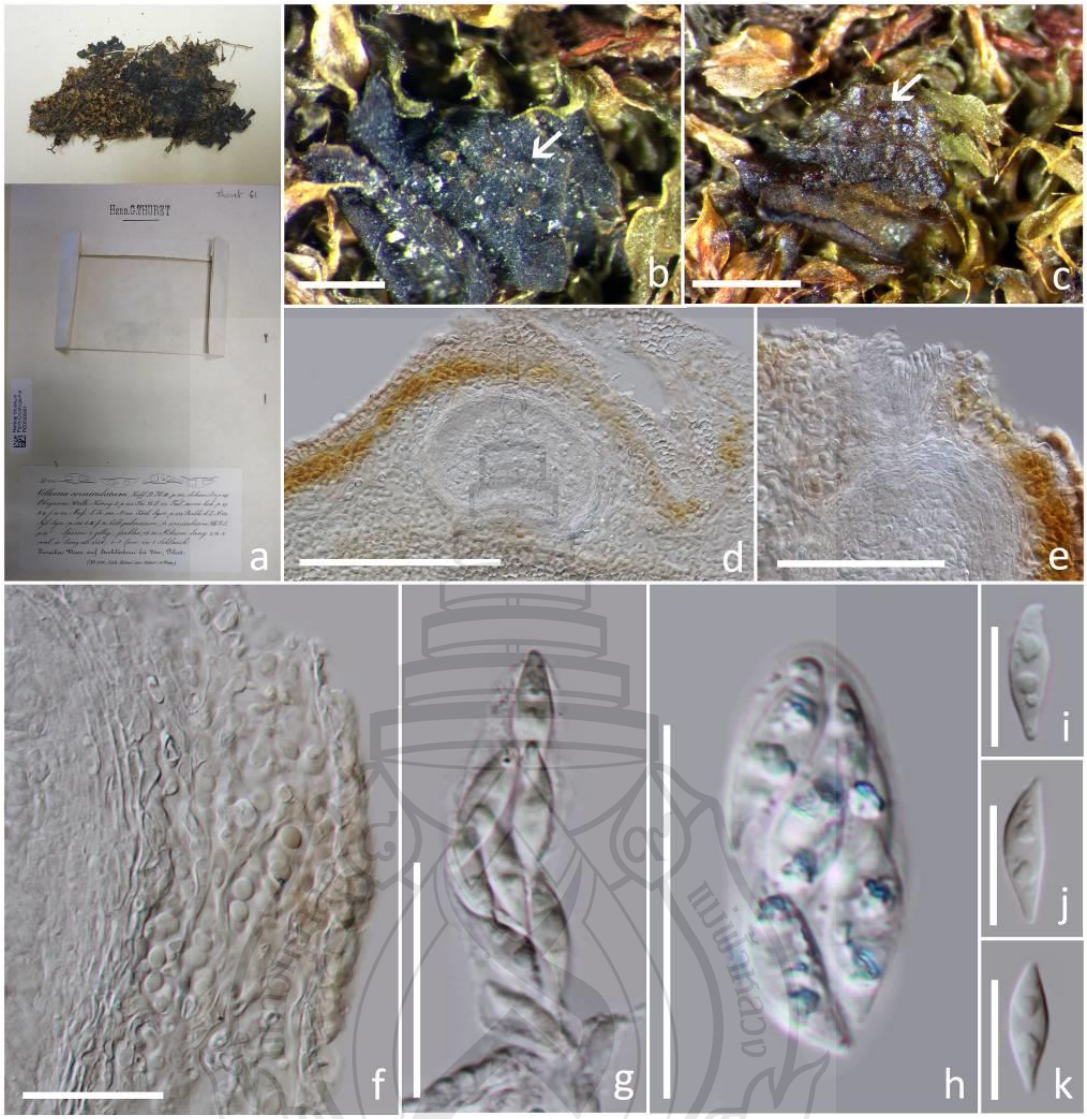
Type: ***Obryzum*** Wallr.

Notes: This is a poorly studied, monotypic family, for which no molecular data are available. *Obryzaceae* is coincident with *Gnomoniaceae* G. Winter, which is considered to be a well-known family name in plant pathology, while *Obryzaceae* was only recently reported in lichenological studies (McNeill et al., 2006). Hawksworth and Eriksson (1988) proposed that the name *Obryzaceae* should be rejected to conserve *Gnomoniaceae* and the proposal was accepted (McNeill et al., 2006). *Obryzaceae* was listed in *Sordariomycetes*, *families incertae sedis* by Lumbsch and Huhndorf (2010) and this was followed in Maharachchikumbura et al. (2015) and Index Fungorum (2016), indicative of the problems in picking up obscure literature.

It is obvious that *Obryzaceae* is distinct from *Gnomoniaceae* by their mode of life and morphological characters. Species of *Gnomoniaceae* are found in herbaceous plant material, in leaves, twigs or stems, and sometimes in bark or wood (Sogonov et al., 2008), have solitary, immersed astromatic ascomata, or ascomata aggregated with a rudimentary stroma and small, mostly less than 25 μm long, mainly aseptate to 1-septate, rarely multi-septate ascospores (Sogonov et al., 2008).

Type: ***Obryzum*** Wallr., Naturgesch. Flecht. 1: 253 (1825); Figure 3.7

Lichenicolous on rocks or bark, rarely on mosses or parasitic on cyanobacterial lichens of the genus *Leptogium*. **Sexual morph**: *Ascomata* astromatic, perithecial,



Note (a) Herbarium specimen with the label. (b, c) Appearance of ascomata on host substrate (see arrows, c in 5% KOH). (d) Transverse section through ascoma. (e) Transverse section through ostiole. (f) Peridium. (g, h) Mature asci. (i–k) Ascospores. Scale bars: b = 500 µm, c = 1 mm, d = 100 µm, e-h = 20 µm, i–k = 10 µm.

Figure 3.7 *Obryzum corniculatum* (material examined: PC 002061)

immersed, pyriform, ostiolate. *Ostiole* periphysate. *Peridium* colourless, but sometimes the ostiolar region lightly brown. *Asci* 4–8-spored, unitunicate, clavate, narrowly ellipsoid to ovoid, thin-walled, short-pedicellate, without an apical ring, evanescent. *Ascospores*

aseptate, fusiform to limoniform or ellipsoid, hyaline, smooth-walled, lacking appendages, without a gelatinous sheath. **Asexual morph**: Undetermined.

Type species: ***Obryzum corniculatum*** (Hoffm.) Wallr., Naturgesch. Flecht. 1: 253 (1825)

Notes: This genus is poorly studied and lacks molecular data in GenBank. Six epithets are currently listed under *Obryzum* (Index Fungorum, 2016).

CHAPTER 4

TAXONOMIC UPDATES WITH MOLECULAR PHYLOGENY OF SELECTED PHYTOPATHOGENIC GENERA IN NECTRIACEAE

4.1 Introduction

4.1.1 Genus *Calonectria*

Calonectria was first introduced based on *C. daldiniana* in 1867. *Calonectria* species are pathogenic to a wide range of woody and herbaceous plant hosts in tropical and subtropical areas (Crous, 2002; Lechat, Crous et al., 2010; Lombard et al., 2010a, b; Chen et al., 2011; Li et al., 2017). The sexual morphs of *Calonectria* are characterised by yellow to dark red ascomata, with scaly to warty walls, and clavate, 4–8- spored asci. They produce *Cylindrocladium* asexual morphs with branched conidiophores, cylindrical, septate conidia, and stipe extensions with terminal vesicles (Crous, 2002; Lombard et al., 2010b, 2016; Li et al., 2017).

4.1.2 Genus *Dactylonectria*

The genus *Dactylonectria* was introduced by Lombard et al. (2014) for a group of species which were previously treated in *Ilyonectria* (Chaverri et al., 2011; Cabral, Groenewald et al., 2012; Cabral, Rego, Crous et al., 2012; Cabral, Rego et al., 2012). In morphology, *Dactylonectria* resembles *Ilyonectria* and *Neonectria* but can be distinguished by their characteristic ovoid to obpyriform, smooth to finely warted, dark-red ascomata with a papillate ostiolar region at the apex (Lombard et al., 2014; Gordillo & Decock, 2018). Species of this genus are mostly associated with *Vitis* sp., while some species are also recorded from other hosts (Farr & Rossman, 2019).

4.1.3 Genus *Ilyonectria*

Species of *Ilyonectria* are important soil-borne pathogens of various woody and herbaceous plant hosts. *Ilyonectria* species are cosmopolitan and are found on a

wide range of hosts (Chaverri et al., 2011). They are mostly associated with root diseases and stem cankers (Seifert et al., 2003; Halleen et al., 2004, 2006; Chaverri et al., 2011; Cabral, Groenewald et al., 2012; Cabral, Rego, Crous et al., 2012; Cabral, Rego et al. 2012; Vitale et al., 2012; Lombard et al., 2013; Aiello et al., 2014). There are 23 species of *Ilyonectria*, all associated with disease symptoms of their original plant hosts (Chaverri et al., 2011; Cabral, Groenewald et al., 2012; Cabral, Rego et al., 2012; Lombard et al., 2013, 2014; Aiello et al., 2014). *Ilyonectria* is a well-known genus causing black foot rot of grapevines in various countries (Halleen et al., 2003, 2004, 2006; Chaverri et al., 2011; Cabral, Groenewald et al., 2012; Cabral, Rego, Crous et al., 2012; Cabral, Rego et al. 2012; Lombard et al., 2014).

4.1.4 Genus *Fusarium*

Fusarium is a genus with 20 monophyletic species complexes (Rana et al., 2017). Species formely belonged to *F. solani* species complex were transferred to genus *Neocosmospora* based on sexual morph characters and molecular phylogeny (Lombard et al., 2015; Sandoval-Denis & Crous, 2018). *Fusarium* species are saprobes, parasites, endophytes, soil-borne or isolated from water (Rana et al., 2017). Species of *Fusarium* are economically important fungi as they are responsible for blights, cankers, rots, and wilts of horticultural, ornamental and forest crops in both agricultural and natural ecosystems, worldwide, and also human infections (Rana et al., 2017; Varela et al., 2013; Peraldi et al., 2014; Al-Hatmi et al., 2019; Lombard, Van Doorn et al., 2019; Maryani et al., 2018, 2019). In nature, sexual morphs of *Fusarium* occur less commonly than the asexual morphs (Gräfenhan et al., 2011; Rossman et al., 1999).

4.1.5 Genus *Neonectria*

Neonectria is a cosmopolitan genus, and their asexual morphs are common in tropical and temperate regions (Chaverri et al., 2011). *Neonectria* species can be found on the bark of recently dead woody plants and sometimes on decaying herbaceous material (Samuels & Brayford, 1990; Samuels 1993, 1994; Rossman et al., 1999; Castlebury, et al. 2006; Chaverri, et al. 2011). Some species of *Neonectria*

are plant pathogens causing cankers and other diseases on hardwood and coniferous trees (Castlebury et al., 2006; Rossman & Palm-Hernádez, 2008; Crane et al., 2009; Chaverri et al., 2011; Schmitz et al., 2017; Wenneker et al., 2017). *Neonectria neomacrospora* has been added to the European and Mediterranean Plant Protection Organization (EPPO) alert list (EPPO, 2019).

4.2 Taxonomic Updates and Molecular Phylogeny of *Calonectria*

Classification: Sordariomycetes, Hypocreaomycetidae, Hypocreales, Nectriaceae

Type species: *Calonectria pyrochroa* (Desm.) Sacc., Michelia 1(no. 3): 308 (1878)

Distribution: Worldwide Disease

Symptoms: Box blight, Cutting rot, Damping off, Canker, Leaf spots, leaf and shoot blights, Red crown rot, Root rot

Species of *Calonectria* are capable of causing diseases in all plant parts. Most diseases have been recorded from young plants or recent field plantings. Symptoms vary according to host species, host age or developmental stage, environmental conditions and the *Calonectria* species itself (Barnes & Linderman, 2001). Leaf spots (caused by *C. colhounii, C. ilicola, C. indusiata* and *C. pteridis*) first appear as water-soaked lesions turning tan to dark brown, circular or irregular in shape surrounded by a red, dark brown or purple border with a chlorotic zone. Root necrosis is the main symptom of root rot caused by species such as *C. crotalariae* and *C. ilicola* (Lombard et al., 2010a). On conifers, there is necrosis of lateral and primary roots accompanied with blacking and splitting of the root cortex while on hardwoods, there is blackening of the root cortex with longitudinal cracking (Cordell & Skilling, 1975). Lesions may coalesce and completely destroy the root. Crown infection can occur with the spread of root infection leading to stunting, discoloration of foliage, defoliation and plant death (Lombard et al., 2010a).

Hosts: *Calonectria* species are soil borne pathogens and are mainly associated with forestry, agricultural and horticultural plants, on more than 100 plant families

(Chen et al., 2011; Crous et al., 1991; Crous, 2002; Gehesquiére et al., 2016; Lombard et al., 2010a, b; Li et al., 2017; Lopes et al., 2018). *Calonectria* species are less commonly associated with fruit rot as compared to leaf spot and root rot (Lopes et al., 2018).

4.2.1 Morphology Based Identification and Diversity of *Calonectria*

Calonectria species were known by *Cylindrocladium* names for many years. *Cylindrocladium* species were commonly found in nature and well known plant pathogens. Later *Calonectria* was conserved (Hawksworth, 2011; McNeill et al., 2012) over *Cylindrocladium* by Rossman et al. (2013). Most isolates were identified based on morphology. Later, polyphasic approaches based on morphology and sexual compatibility was used to delimit cryptic species (Schoch, Crous, Polizzi et al., 2001; Lombard et al., 2010a, b; Lombard, Wingfield et al. 2016) and these studies have revealed that there are many species of *Calonectria* yet to be discovered (Lombard et al., 2016). *Calonectria* has been subjected to numerous taxonomic studies and 129 species have been recognized based on both morphological and molecular approaches (Crous & Wingfield, 1994; Crous, 2002; Lechat, Crous et al., 2010; Li et al., 2017; Lombard et al., 2010a, b; Lombard, Wingfield et al. 2016; Maharachchikumbura et al., 2015, 2016; Lopes et al., 2018). Macroconidial dimensions and septation, and shape of the vesicle are the best diagnostic characters for identification of *Calonectria* (Schoch et al., 2000; Crous, 2002; Li et al., 2017). Perithecial colour, ascospore number within the asci, and ascospore septation and dimensions are also important for sexual morph identification (Lombard et al., 2010a). However, perithecia of *Calonectria* species are morphologically very similar, hence are not useful in identification (Crous & Wingfield, 1994; Crous, 2002). However, intraspecific variation in vesicle shape and conidial dimensions are commonly used in identification of *Calonectria*, which can result in taxonomic confusion (Crous & Seifert, 1998; Lombard, Wingfield et al., 2010b).

4.2.2 Molecular Based Identification and Diversity of *Calonectria*

Morphological data are essential to supplement DNA sequence data for accurate species identification (Lombard, Wingfield et al., 2016). Earlier studies used

ITS gene alone to separate *Cylindrocladium* species, however the ITS region contains few informative characters (Crous et al., 1999; Schoch, Crous, Wingfield et al., 2001; Lombard et al., 2010b). A genus-wide phylogeny can be inferred using TUB2, TEF1, CAM and HIS3 (Lombard, Wingfield et al., 2016; Crous, 2002). The LSU gene also provides little information in resolving species of the genus (Lombard et al., 2010b). This study reconstructs the phylogeny of *Calonectria* based on analyses of a combined TEF1, TUB2, CAM and His3 sequence data (Table 4.1, Figure 4.1). After Lombard et al., (2010a), this is the first multigene analysis for all the available *Calonectria* species. *Calonectria* species formed two major clades in our phylogenetic analysis, which define morphologically similar groups. Similar results were obtained in previous study by Lombard et al., (2010b) employing seven gene regions. However, insufficient data are available for the HIS3 gene region in GenBank. Therefore, it is difficult to have comparative phylogenetic analyses (Table 4.1).

Recommended genetic markers (Genus level): LSU and ITS

Recommended genetic markers (Species level): TUB2, TEF1, CAM, HIS3, ACT

Accepted number of species: There are 399 species epithets in Index Fungorum (2019) under this genus. However, 283 are accepted.

References: Lombard et al. (2010a, b, c, d), Lombard, Wingfield et al. (2016) and Maharachchikumbura et al. (2015, 2016) (morphology and phylogeny)

Table 4.1 Details of the *Calonectria* isolates used in the phylogenetic analyses. Ex-type (or ex-epitype) strains are marked with an asterisk

Species	Culture collection no.	TEF1	HIS3	CAM	TUB2
Calonectria acicola	CBS 114812*	GQ267291		GQ267359	DQ190590
C. aciculata	CMW 47645*	MF442644	MF442759	MF442874	MF442989
C. aconidialis	CBS 136086*	KJ462785	KJ463133	KJ463017	—
C. amazonica	CBS 116250*	KX784682	—	KX784555	KX784612
C. amazoniensis	CBS 115440*	KX784685	—	KX784558	KX784615
C. angustata	CBS 109065	FJ918551	DQ190696	GQ267361	AF207543

Table 4.1 (continued)

Species	Culture collection no.	TEF1	HIS3	CAM	TUB2
C. arbusta	CBS 136079*; CMW 31370; CERC1705	KJ462787	KJ463135	KJ463018	—
C. asiatica	CBS 114073*; CMW 23782; CBS 112954 SFE 726; CPC 3900	AY725705	AY725658	AY725741	AY725616
C. australiensis	CBS 112954*	GQ267293	DQ190699	GQ267363	DQ190596
C. avesiculata	CBS 313.92*; CMW 23670; CPC 2373; ATCC 38226	GQ267294	—	GQ267364	—
C. blephiliae	CBS136425*; CPC21859	KF777243	—	—	KF777246
C. brachiatica	CBS 123700*; CMW 25298	GQ267296	FJ696396	GQ267366	FJ696388
C. brasiliensis	CBS 230.51*; CMW 23670; CPC 2390	GQ267328	GQ267259	GQ267421	GQ267241
C. brassiana	CBS 134855*; CBS 13485	KM395883	—	KM396057	KM395970
C. brassicae	CBS 111869*; CMW 30982; CPC 2409; PC 551197	FJ918566	DQ190720	GQ267382	AF232857
C. brassicicola	CBS 112841*; CPC 4552	KX784689	—	KX784561	KX784619
C. brevistipitata	CBS 115671*; CPC 94	KX784693	—	KX784565	KX784623
C. canadiana	CBS 110817*; CPC 499	GQ267297	—	AY725743	AF348212
C. candelabrum	CPC 1675	FJ972525	—	GQ267367	FJ972426
C. cerciana	CBS 123693*; CMW 25309	FJ918559	FJ918528	GQ267369	FJ918510
C. chinensis	CBS 114827*; CMW 23674; CPC 4101	AY725710	AY725661	AY725747	AY725619
C. citri	CBS 186.36*; CMW 23675	FJ918559	FJ918528	GQ267369	AF333393
C. clavata	CBS 114557*; ATCC 66389; CPC 2536	GQ267305	DQ190623	GQ267377	AF333396
C. cliffordiicola	CBS 111812*; CPC 2631	KX784694	—	KX784566	KX784624
C. colhounii	CBS 293.79*	GQ267301	DQ190639	GQ267373	DQ190564
C. colombiana	CBS 115127; CMW 30871; CPC 1160	FJ972492	FJ972442	GQ267455	FJ972423
C. colombiensis	CBS 112220*; CMW 23676;	GQ267301	DQ190639	GQ267373	DQ190564

Table 4.1 (continued)

Species	Culture collection no.	TEF1	HIS3	CAM	TUB2
	CPC 723				
C. crousiana	CBS 127198*; CMW 27249	HQ285822	—	—	HQ285794
C. curvispora	CBS 116159; CMW 23693	GQ267302	AY725664	GQ267374	AF333394
C. cylindrospora	CBS 110666; CPC 496	FJ918557	FJ918527	GQ267423	FJ918509
C. densa	CBS 125261*; CMW 31182	GQ267352	—	GQ267444	GQ267232
C. duoramosa	CBS 134656*; LPF434	KM395853	KM396110	KM396027	KM395940
C. ecuadoriae	CBS 111406*; CPC 1635	GQ267303	DQ190705	GQ267375	DQ190600
C. ericae	CBS 114458; CPC 2019	KX784699	—	KX784571	KX784629
C. eucalypti	CBS 125275*	GQ267338	GQ267267	GQ267430	GQ267218
C. eucalypticola	CBS 134847*	KM395877	—	KM396051	KM395964
C. expansa	CBS 136247*; CMW 31392; CERC 1727	KJ462798	KJ463146	KJ463029	KJ462914
C. foliicola	CBS 136641*; CMW 31393; CERC 1728	KJ462800	—	KJ463031	KJ462916
C. frullaniae	CBS 127201*; CMW 27257	HQ285820	—	—	HQ285792
C. fujianensis	CBS 127201*; CMW 27257	HQ285820	HQ285806	—	HQ285792
C. glaebicola	CBS 134852*	KM395879	KM396136	KM396053	KM395966
C. gordoniae	CBS 112142*; CPC 3136; ATCC 201837	GQ267309	DQ190708	GQ267381	AF449449
C. gracilipes	CBS 111141*	GQ267311	DQ190644	GQ267385	DQ190566
C. gracilis	CBS 111284	GQ267324	DQ190647	GQ267408	DQ190567
C. guangxiensis	CBS 136092*; CMW 35409*; CERC 1900*; CPC 23506	KJ462803	KJ463151	KJ463034	KJ462919
C. hainanensis	CBS 136248*; CMW 35187; CERC 1863	KJ462805	KJ463152	KJ463036	—
C. hawksworthii	CBS 111870*; CPC 2405; MUCL 30866	FJ918558	DQ190649	GQ267386	AF333407
C. hederiseda	CBS 138102;	—	—	KF815157	JX535308
C. hodgesii	CBS 133609*; LPF 245	KC491225	—	KC491222	KC491228
C. hongkongensis	CBS 114828*; CPC 4670	AY725717	AY725667	AY725755	AY725622
C. humicola	CBS 125251*	GQ267353	GQ267282	GQ267445	GQ267233

Table 4.1 (continued)

Species	Culture collection no.	TEF1	HIS3	CAM	TUB2
C. hurae	CBS 114551, CMW 16720	FJ918548	DQ190728	GQ267387	AF333408
C. ilicicola	CBS 190.50*; CMW 30998*; IMI 299389	AY725726	AY725676	AY725764	AY725631
C. indonesiae	CBS 112823*; CMW 23683; CPC 4508	AY725718	AY725668	AY725756	AY725623
C. indonesiana	CBS 112823*, CMW 23683, CPC 4508	KX784701	—	KX784573	KX784631
C. indusiata	CBS 144.36*	GQ267332	DQ190653	GQ267453	GQ267239
C. insularis	CBS 114558*; CPC 768	FJ918556	—	GQ267389	AF210861
C. kyotensis	CBS 114550; CPC 2351	KX784721	—	KX784587	KX784650
C. lageniformis	CBS 111324*; CPC 1473	KX784702	—	KX784574	KX784632
C. lantauensis	CMW 47252*; CERC 3302; CBS 142888	MF442677	MF442792	MF442907	—
C. lateralis	CBS 136629*; CMW 31412; CERC 1747	KJ462840	KJ463186	KJ463070	KJ462955
C. lauri	CBS 749.70	GQ267312	GQ267250	GQ267388	GQ267210
C. leguminum	CBS 728.68*	FJ918547	DQ190654	GQ267391	AF389837
C. leucothoes	CBS 109166*; CPC 2385; ATCC 64824	FJ918553	FJ918523	GQ267392	FJ918508
C. machaerinae	CBS 123183; CPC 15378	KX784706	—	—	KX784636
C. madagascariensis	CBS 114572*; CPC 2252	GQ267314	DQ190658	GQ267394	DQ190572
C. magnispora	CBS 136249*; CMW 35184; CERC 1860	KJ462841	KJ463187	KJ463071	KJ462956
C. malesiana	CBS 112752*; CPC 4223	AY725722	AY725672	AY725760	AY725627
C. maranhensis	CBS 134811*	KM395861	KM396118	KM396035	KM395948
C. mexicana	CBS 110918*	FJ972526	FJ972460	GQ267396	AF210863
C. microconidialis	CBS 136638*; CMW 31487; CERC 1822	KJ462845	KJ463191	KJ463075	KJ462960
C. monticola	CBS 140645*; CPC 28835	KT964773	—	KT964771	KT964769
C. morganii	CBS 110666	FJ918557	FJ918527	GQ267423	FJ918509
C. mossambicensis	CMW 36327*	JX570718	JX570726	JX570722	—
C. multilateralis	CBS 110932*; CPC 957	KX784712	—	KX784580	KX784642
C. multinaviculata	CBS 134858*; LPF233	KM395898	KM396155	KM396072	KM395985
C. multiphialidica	CBS 112678*	AY725723	AY725673	AY725761	AY725628

Table 4.1 (continued)

Species	Culture collection no.	TEF1	HIS3	CAM	TUB2
C. multiseptata	CBS 112682*	FJ918535	DQ190659	GQ267397	DQ190573
C. naviculata	CBS 101121*	GQ267317	GQ267252	GQ267399	GQ267211
C. nemoricola	CBS 134837*	KM395892	KM396149	KM396066	KM395979
C. nymphaeae	CBS 131802*; HGUP 100003	KC555273	—	—	JN984864
C. orientalis	CBS 125258	GQ267358	GQ267287	GQ267450	GQ267238
C. ovata	CBS 111299	GQ267318	GQ267253	GQ267400	GQ267212
C. pacifica	CBS 109063*; CMW 16726; IMI 354528	AY725724	GQ267255	AY725762	GQ267213
C. papillata	CBS 136097*; CMW 37976; CERC 1939	KJ462849	KJ463195	KJ463079	KJ462964
C. paracolhounii	CBS 114679*;CPC 2445	KX784714	—	KX784582	KX784644
C. paraensis	CBS 134669*; LPF430	KM395837	KM396094	KM396011	KM395924
C. parakyotensis	CBS 136085*; CMW 35169; CERC 1845	KJ462851	KJ463197	KJ463081	—
C. parva	CBS 110798*; CPC 410	KX784716	—	KX784583	KX784646
C. pauciramosa	CMW 5683*; CPC 971	FJ918565	FJ918531	GQ267405	FJ918514
C. penicilloides	CBS 174.55*; IMI 299375	GQ267322	GQ267257	GQ267406	AF333414
C. pentaseptata	CBS 136087; CMW 35177; CERC 1853	KJ462853	KJ463199	KJ463083	KJ462966
C. piauiensis	CBS 134850*	KM395886	KM396143	KM396060	KM395973
C. pini	CBS 123698*	GQ267344	—	GQ267436	GQ267224
C. plurilateralis	CBS 111401*; CPC 1637	KX784719	—	KX784586	KX784648
C. pluriramosa	CBS 136976*; CMW 31440; CERC 1774	KJ462882	KJ463228	KJ463112	KJ462995
C. polizzii	CBS 125270; CMW 7804; CPC 2681	FJ972486	FJ972436	GQ267461	FJ972417
C. propaginicola	CBS 134815*; LPF220	KM395866	KM396129	KM396040	KM395953
C. pseudobrassicae	CBS 134662*; LPF280	KM395849	KM396106	KM396023	KM395936
C. pseudocerciana	CBS 134824*	KM395875	KM396132	KM396049	KM395962
C. pseudocolhounii	CBS 127195*; CMW 27209	HQ285816	HQ285802	—	HQ285788
C. pseudoecuadoriae	CBS 111402*; CPC 1639	KX784723	—	KX784589	KX784652
C. pseudohodgesii	CBS 134818*	KM395817	—	KM395991	KM395905

C. pseudokyotensis	CBS 137332*;	KJ462881	KJ463227	KJ463111	KJ462994

Table 4.1 (continued)

Species	Culture collection no.	TEF1	HIS3	CAM	TUB2
	CMW 31439; CERC 1774				
C. pseudometrosideri	CBS 134845*	KM395821	—	KM395995	KM395909
C. pseudomexicana	CBS 130354*; DISTEF-TCROU1	JN607296	JN607266	—	JN607281
C. pseudonaviculata	CBS 114417*; CPC 10926	GQ267325	—	GQ267409	GQ267214
C. pseudopteridis	CBS 163.28*; IMI 299579 a	KM395902	—	KM396076	—
C. pseudoreteaudii	CBS 123694*; CMW 25310	FJ918541	FJ918519	GQ267411	FJ918504
C. pseudoscoparia	CBS 125255; CMW 15216	GQ267347	GQ267277	GQ267439	GQ267227
C. pseudospathiphylli	CBS 109165*; CPC 1623	FJ918562	AF348241	GQ267412	FJ918513
C. pseudospathulata	CBS 134841*	KM395896	KM396153	KM396070	KM395983
C. pseudoturangicola	CMW 474965*; CERC 7126; CBS 142890	MF442750	MF442865	MF442980	MF443080
C. pseudouxmalensis	CBS 110924*; CPC 942	KX784726	—	—	KX784654
C. pseudovata	CBS 134675*; LPF285	KM395859	KM396116	KM396033	KM395946
C. pseudoyunnanensis	CMW 476555*; CERC 5376; CBS 142892	MF442753	MF442868	MF442983	MF443083
C. pteridis	CBS 111793*; ATCC 34395; CPC 2372	FJ918563	DQ190679	GQ267413	DQ190578
C. putriramosa	CBS 111449*; CPC 1951	KX784728	—	KX784591	KX784656
C. queenslandica	CBS 112146*; CPC 3213	FJ918543	FJ918521	GQ267415	AF389835
C. quinqueramosa	CBS 134654*; LPF065	KM395855	KM396112	KM396029	KM395942
C. reteaudii	CBS 112144*; CMW 30984; CPC 3201	FJ918537	DQ190661	GQ267417	AF389833
C. robigophila	CBS 134652*	KM395850	KM396107	KM396024	KM395937
C. rumohrae	CBS 111431*; CPC 1716	FJ918549	DQ190675	GQ267419	AF232871
C. seminaria	CBS 136632*; CMW 31450; CERC 1785; CPC 23488	KJ462885	KJ463231	KJ463115	KJ462998
C. silvicola	CBS 135237*	KM395891	—	KM396065	KM395978
C. spathiphylli	CBS 114540; ATCC 44730; CPC 2378	GQ267330	—	GQ267424	AF348214
C. spathulata	CBS 555.92*	GQ267331	GQ267261	GQ267427	GQ267215

C. sphaeropedunculata	CBS 136081*; CMW 31390; CERC 1725	KJ462890	KJ463236	KJ463120	KJ463003

Table 4.1 (continued)

Species	Culture collection no.	TEF1	HIS3	CAM	TUB2
C. stipitata	CBS 112513*; CPC 3851	KX784734	—	KX784596	KX784661
C. sulawesiensis	CBS 125277*	GQ267342	—	GQ267434	GQ267222
C. sumatrensis	CBS 112829*; CMW 23698; CPC 4518	AY725733	AY725696	AY725771	AY725649
C. syzygiicola	CBS 112831*; CPC 4511	KX784736	—	—	KX784663
C. telluricola	CBS 134664*; LPF217	KM395843	KM396100	KM396017	KM395930
C. tereticornis	CBS 111301*; CPC 1429	KX784737	—	—	KX784664
C. terrae-reginae	CBS 112151*; CPC 3202	FJ918545	FJ918522	GQ267451	FJ918506
C. terrestris	CBS 136642*; CMW 35180; CERC 1856	KJ462891	KJ463237	KJ463121	KJ463004
C. terricola	CBS 116247; CPC 3583	KX784738	—	—	KX784665
C. tetraramosa	CBS 136635*; CMW 31474; CERC 1809; CPC 23489	KJ462898	KJ463244	KJ463128	KJ463011
C. tropicalis	CBS 116271; CPC 3559	KX784742	—	KX784599	KX784669
C. turangicola	CBS 136077*; CMW 31411; CERC 1746; CPC23479	KJ462900	KJ463246	—	KJ463013
C. uxmalensis	CBS 110925*; CPC 945	KX784708	—	—	KX784638
C. variabilis	CBS 112691; CPC 2506	GQ267335	GQ267264	GQ267458	GQ267240
C. venezuelana	CBS 111052*; CPC 1183	KX784744	—	KX784601	KX784671
C. yunnanensis	CMW 476445*; CERC 5339; CBS 14289	MF442758	MF442873	MF442988	MF443088
C. zuluensis	CBS 125268*; CMW 9188	FJ972483	FJ972433	GQ267459	FJ972414
Curvicladiella cignea	CBS 109167*; CPC 1595; MUCL 40269	KM231867	KM231461	KM231287	KM232002

4.3 Taxonomic Updates and Molecular Phylogeny of *Dactylonectria*

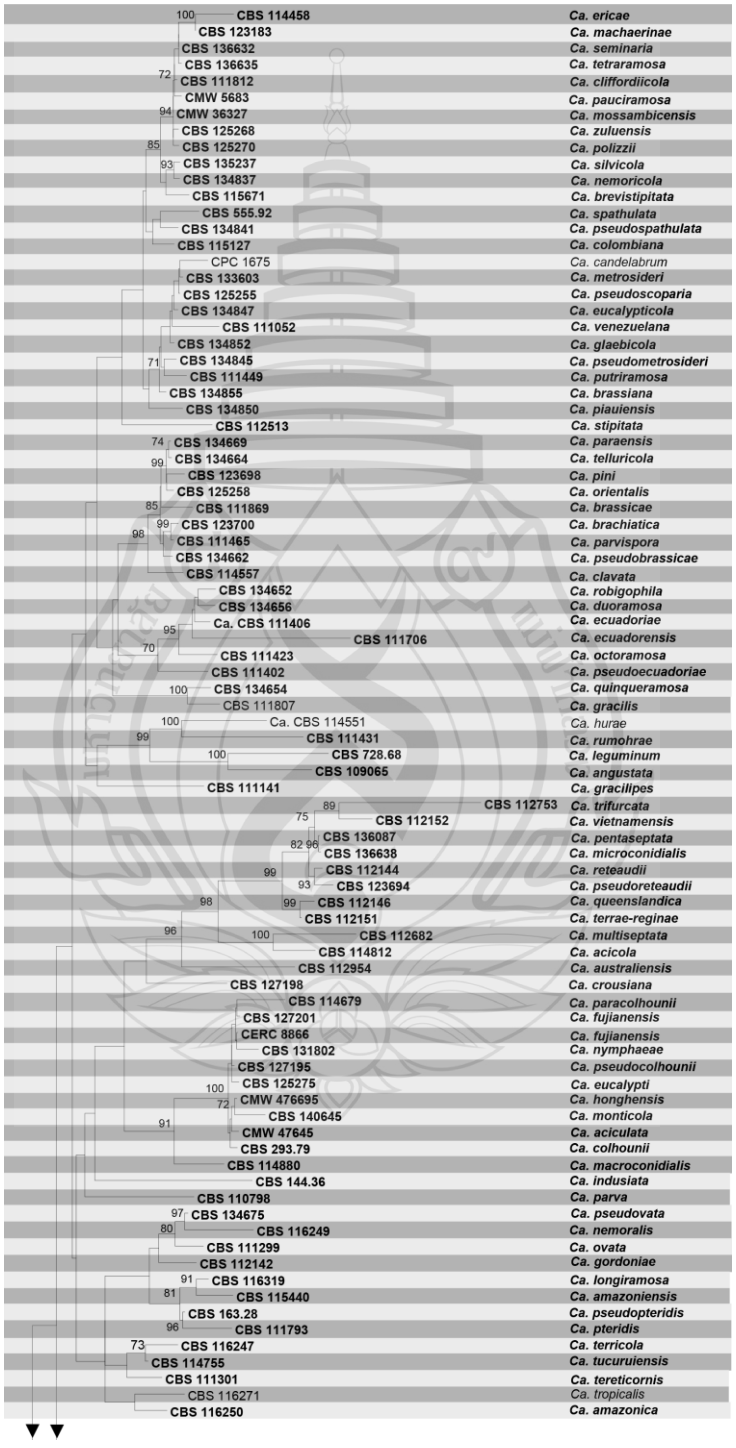
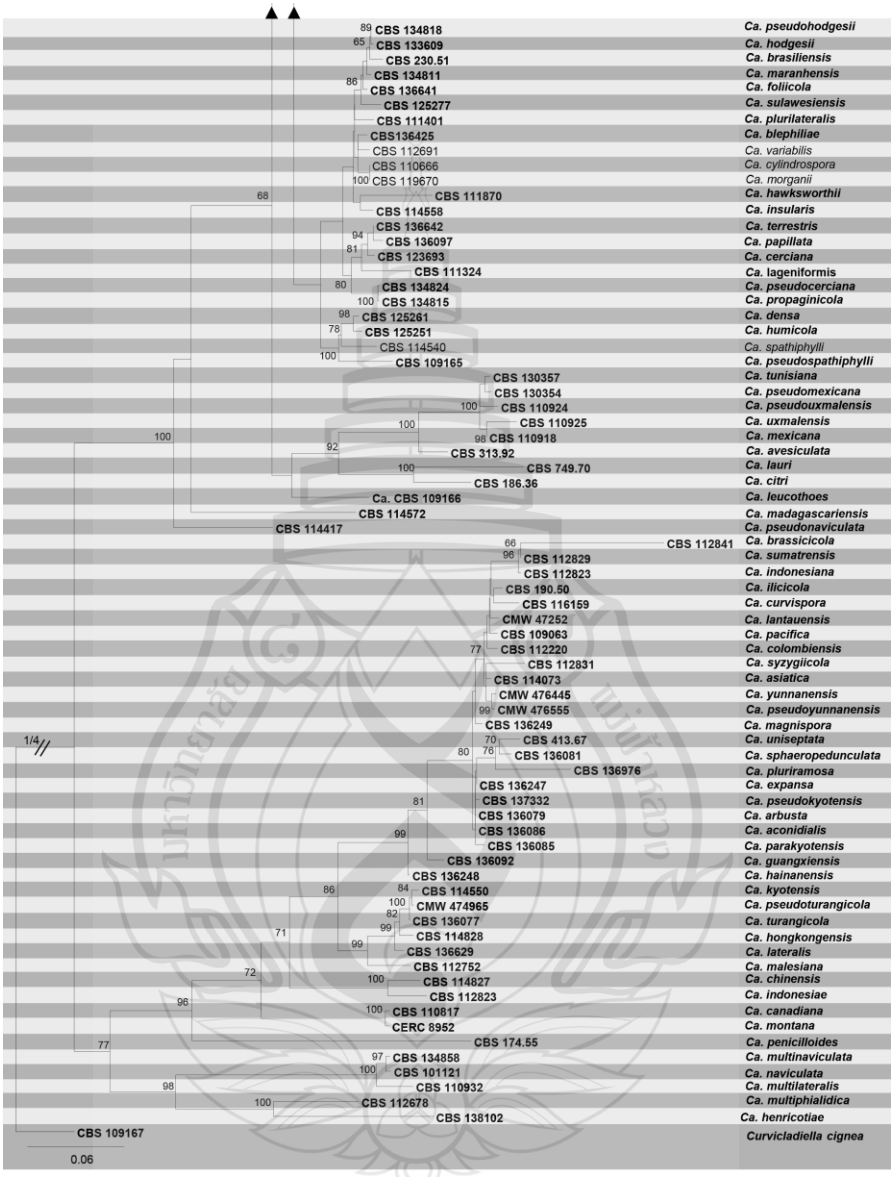


Figure 4.1 Phylogenetic tree generated by maximum likelihood analysis of combined TEF1, TUB2, CAM and His3 sequence data of *Calonectria* species



Note One hundred sixty strains are included in the analyses, which comprise 1946 characters including gaps. Maximum likelihood bootstrap support ≥65% (MLBT) and posterior probabilities ≥0.90 (BYPP) from Bayesian inference analysis are indicated respectively near the nodes. Tree is rooted to *Curvicladiella cignea*. The ex-type strains are in bold and new isolates in blue. The scale bar indicates 0.06 nucleotide changes per site.

Figure 4.1 (continued)

Classification: Sordariomycetes, Hypocreomycetidae, Hypocreales, Nectriaceae

Type species: *Dactylonectria macrodidyma* (Hallen, Schroers & Crous) L. Lombard & Crous, in Lombard et al., Phytopath. Mediterr. 53(3): 527 (2014)

Distribution: Worldwide Disease symptoms—Black foot disease, black root rot

Characteristic symptoms of black foot disease include a reduction in root biomass and root hairs with sunken and necrotic lesions (Halleen et al., 2006). Severe necrosis of the root system results in stunting, wilting, leaf chlorosis, browning and leaf drop prior to death (Parkinson et al., 2017). *Dactylonectria alcacerensis*, *D. estremocensis*, *D. macrodidyma*, *D. novozelandica*, *D. pauciseptata*, *D. pinicola*, *D. torresensis* and *D. vitis* are associated with black foot disease of grapevine (Cabral, Groenewald et al., 2012; Lombard et al., 2014) (Figure 4.2).

Hosts: *Abies* sp., *Annona cherimola*, *Anthrium* sp., *Arbutus unedo*, *Cistus albidus*, *Crataegus azalous*, *Erica melanthera*, *Eriobotrya japonica*, *Ficus* sp., *Fragaria* sp., *Hordeum vulgare*, *Ilex aquifolium*, *Juglans regia*, *Juniperus phoenicea*, *Lonicera* sp., *Myrtus communis*, *Persea americana*, *Picea glauca*, *Pinus* sp., *Pistacia lentiscus*, *Prunus domestica*, *Pyracantha* sp., *Quercus* sp., *Rosmarinus officinalis*, *Santolina chamaecyparissus* and *Vitis* sp.

4.3.1 Morphology Based Identification and Diversity of *Dactylonectria*

Morphological based identification and diversity Lombard et al. (2014) accepted ten species in *Dactylonectria* based on ITS, LSU, TUB2 and TEF1 sequence data and morphological characters. Later, Gordillo and Decock (2018) introduced another four species to the genus based on morphology and sequence data. Fourteen *Dactylonectria* species have been described with DNA sequence data in GenBank. *Dactylonectria* species produce cylindrocarpon-like asexual morphs, several of which were previously treated in *Ilyonectria* (Lombard et al., 2014). *Dactylonectria* species were distinguished mainly by phylogenetic inference and using unique fixed single

nucleotide polymorphisms (SNP's) rather than morphological characters (Lombard et al., 2014; Gordillo & Decock, 2018).

4.3.2 Molecular Based Identification and Diversity of *Dactylonectria*

Lombard et al. (2014) re-evaluated genera with cylindrocarpon-like asexual morphs based on multi-gene phylogeny of ITS, LSU, TUB2 and TEF1 genes. Gordillo and Decock (2018) analysed HIS3 together with latter gene regions, for delimiting the species in *Dactylonectria*. Lombard et al. (2015) also supported the fact that Dactylonectria is monophyletic and distinct from *Ilyonectria*. In this study, we reconstruct the phylogeny of *Dactylonectria* based on analyses of a combined ITS, LSU, TUB2 and TEF1 sequence data (Table 4.2, Figure 4.2). The phylogenetic tree is updated with recently introduced *Dactylonectria* species and corresponds to previous studies (Lombard et al., 2014, 2015; Gordillo & Decock, 2018).

Recommended genetic markers (genus level): ITS, LSU, TUB2, TEF1

Recommended genetic markers (species level): TUB2, TEF1 Accepted number of species: 14 species

References: Cabral, Cecília et al. (2012), Cabral, Groenewald et al. (2012), Halleen et al. (2004), Schroers et al. (2008), Lombard et al. (2014) and Gordillo and Decock (2018) (morphology, phylogeny).

4.4 Taxonomic Updates and Molecular Phylogeny of *Ilyonectria*

Classification: Sordariomycetes, Hypocreomycetidae, Hypocreales, Nectriaceae

Type species: *Ilonectria radicicola* (Gerlach & L. Nilsson) P. Chaverri & Salgado, in Chaverri et al., Stud. Mycol. 68:71 (2011)

Distribution: Worldwide

Disease symptoms: Black foot disease, black root rot Symptoms are given under the genus *Dactylonectria*

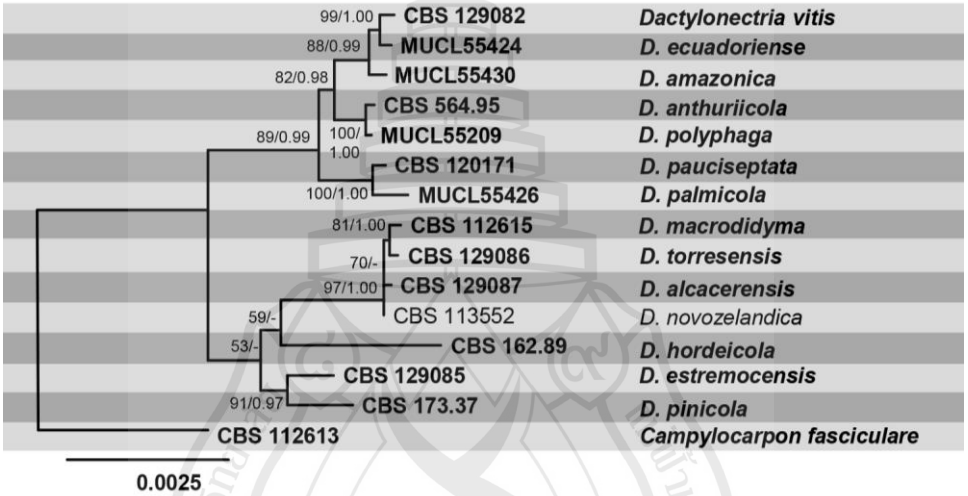
Hosts: Wide host range including plant genera in Amaryllidaceae, Aracaceae, Araliaceae, Cupressaceae, Fagaceae, Liliaceae, Myrtaceae, Pinaceae, Proteaceae, Rosaceae, Strelitziaceae and Vitaceae (Farr & Rossman, 2019).

4.4.1 Morphology Based Identification and Diversity of *Ilyonectria*

Table 4.2 Details of the *Dactylonectria* isolates used in the phylogenetic analyses. Ex-type (or ex-epitype) strains are marked with an asterisk

Species	Culture collection no.	ITS	LSU	TUB2	TEF1
Campylocarpon fasciculare	CBS 112613 (T)	AY677301	HM364313	AY677221	JF735691
Dactylonectria alcacerensis	CBS 129087 (T)	JF735333	KM231629	AM419111	JF735819
D. anthuriicola	CBS 564.95 (T)	JF735302	KM515897	JF735430	JF735768
D. amazonica	MUCL55433(T)	MF683707	MF683727	MF683644	MF683665
D. ecuadoriense	MUCL55424 (T)	MF683704	MF683724	MF683641	MF683662
D. estremocencis	CBS 129085 (T)	JF735320	KM231630	JF735448	JF735806
D. hordeicola	CBS 162.89 (T)	AM419060	KM515898	AM419084	JF735799
D. macrodidyma	CBS 112615 (T)	AY677290	KM515900	AY677233	JF735836
D. novozelandica	CBS 112608	AY677288	KM515901	AY677235	JF735821
D. palmicola	MUCL55426 (T)	MF683708	MF683728	MF683645	MF683666
D. pauciseptata	CBS 120171 (T)	EF607089	KM515903	EF607066	JF735776
D. pinicola	CBS 173.37 (T)	JF735319	KM515905	JF735447	JF735803
D. polyphaga	MUCL55209 (T)	MF683689	MF683710	MF683626	MF683647
D. torresensis	CBS 129086 (T)	JF735362	KM231631	JF735492	JF735870
D. vitis	CBS 129082 (T)	JF735303	KM515907	JF735431	JF735769

The genus *Ilyonectria* was introduced based on *I. radicicola* as the type species, to accommodate *Neonectria* species belonging to the ‘‘*N. radicicola*’’ group (Booth, 1959). This genus has asexual morphs and belonged to Booth’s Group 3 (chlamydospores and microconidia present, Booth, 1966; Chaverri et al., 2011; Lombard et al., 2014). Molecular phylogenetic studies revealed that *Ilyonectria*, as originally conceived, was paraphyletic (Cabral, Cecília et al., 2012; Cabral, Rego et al., 2012; Lombard et al., 2013, 2014).



Note Related sequences were obtained from GenBank. Fifteen taxa are included in the analyses, which comprise 2460 characters including gaps. RAxML and maximum parsimony bootstrap support value ≥50% (MLBT) are shown respectively near the nodes. Bayesian posterior probabilities ≥0.95 (BYPP) indicated as thickened black branches. Ex-type strains are in bold. The scale bar indicates 0.0025 nucleotide changes per site.

Figure 4.2 Phylogram generated from RAxML analysis based on combined sequences of ITS, LSU, TUB2 and TEF1 sequences of all the accepted species of *Dactylonectria*

Conidial size, culture characters and molecular data enabled the separation of *Ilyonectria* species (Cabral, Cecília et al., 2012, Cabral, Rego et al., 2012; Lombard et al., 2013, 2014).

4.4.2 Molecular Based Identification and Diversity of *Ilyonectria*

Delineating between species of *Ilyonectria* can be achieved with histone (His3) gene region. The topologies of the phylogenetic tree (Table 4.3, Figure 4.3) is similar to previous studies done on this genus (Cabral, Cecília et al., 2012; Lombard et al., 2014).

Recommended genetic markers (genus level): ITS, LSU, TEF1, TUB2

Recommended genetic markers (species level): TEF1, TUB2, HIS3

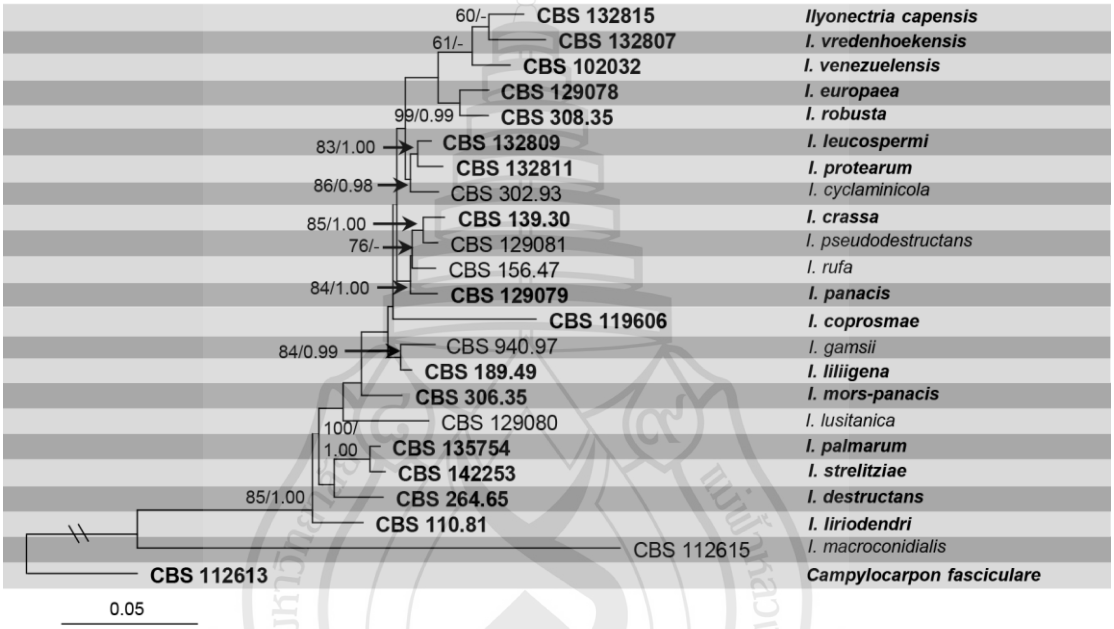
Accepted number of species: 23 species

References: Booth (1959, 1966) (morphology), Cabral, Cecília et al. (2012), Cabral, Groenewald et al. (2012), Cabral, Rego et al. (2012) and Lombard et al. (2013, 2014) (morphology, phylogeny).

Table 4.3 Details of the *Ilyonectria* isolates used in the phylogenetic analyses. Ex-type (or ex-epitype) strains are marked with an asterisk

Species	Culture collection no.	ITS	TEF1	TUB2	HIS3
Campylocarpon fasciculare	CBS 112613	AY677301	JF735691	AY677221	JF735502
Ilyonectria capensis	CBS 132815*	JX231151	JX231119	JX231103	JX231135
I. coprosmae	CBS 119606*	JF735260	JF735694	JF735373	JF735505
I. crassa	CBS 139.30*	JF735275	JF735723	JF735393	JF735534
I. cyclaminicola	CBS 302.93*	JF735304	JF735770	JF735432	JF735581
I. destructans	CBS 264.65*	AY677273	JF735695	AY677256	JF735506
I. europaea	CBS 129078*	JF735294	JF735756	JF735421	JF735567
I. gamsii	CBS 940.97	AM419065	JF735766	AM419089	JF735577
I. leucospermi	CBS 132809*	JX231161	JX231129	JX231113	JX231145
I. liliigena	CBS 189.49*	JF735297	JF735762	JF735425	JF735573
I. liriodendri	CBS 110.81*	DQ178163	JF735696	DQ178170	JF735507
I. lusitanica	CBS 129080	JF735296	JF735759	JF735423	JF735570
I. macroconidialis	CBS 112615	AY677290	JF735836	AY677233	JF735647
I. mors-panacis	CBS 306.35*	JF735288	JF735746	JF735414	JF735557
I. palmarum	CBS 135754*	HF937431	HF922614	HF922608	HF922620

I. panacis	CBS 129079*	AY295316	JF735761	JF735424	JF735572
I. protearum	CBS 132811*	JX231157	JX231125	JX231109	JX231141
I. pseudodestructans	CBS 129081	AJ875330	JF735752	AM419091	JF735563
I. robusta	CBS 308.35*	JF735264	JF735707	JF735377	JF735518
I. rufa	CBS 156.47	AY677272	JF735730	AY677252	JF735541
I. strelitziae	CBS 142253*	KY304649	KY304727	KY304755	KY304621
I. venezuelensis	CBS 102032*	AM419059	JF735760	AY677255	JF735571
I. vredenhoekensis	CBS 132807*	JX231155	JX231123	JX231107	JX231139



Note Twenty-three strains are included in the analyses, which comprise 2242 characters including gaps. Maximum likelihood bootstrap support values C 60% and bayesian posterior probabilities C 95 (BYPP) are indicated above or near the nodes. The tree is rooted in *Campylocarpon fasciculare*. Ex-type strains are in bold. The scale bar indicates 0.05 nucleotide changes per site.

Figure 4.3 Phylogenetic tree generated by maximum likelihood analysis of combined ITS, TEF1, TUB2, and HIS3 sequence data of *Ilyonectria* species

4.5 Taxonomic Updates and Molecular Phylogeny of *Fusarium*

Classification: Sordariomycetes, Hypocreomycetidae, Hypocreales, Nectriaceae

Type species: *Fusarium sambucinum* Fuckel, Hedwigia 2: 135.1863.

Distribution: Worldwide

Disease symptoms: blights, cankers, rots, and wilts

Plant pathogenic species of this genus have the capability to change their lifestyle to saprotrophic and can survive for long periods as chlamydospores in host tissues. Fusarium species damage their hosts by systemically colonizing and occluding the host xylem (Ploetz et al., 2003).

Hosts: Known from many host plant families

4.5.1 Morphology Based Identification and Diversity of *Fusarium*

Fusarium was also known from the sexual morphic fungus name *Gibberella*, which was suppressed in favour of *Fusarium* by Rossman et al. (2013). Variation and mutation in culture and lack of clear morphological characters for separating species are the main problems which make thespecies concept of *Fusarium* much broader (Geiser et al., 2004). It leads to the incorrect and confusing application of species names to toxigenic and pathogenic isolates (Geiser et al., 2004). Species boundaries have been inferred using multi-gene phylogenetic methods, reflecting the species diversity more than morphological treatments (Aoki & O'Donnell, 1999; Geiser et al., 2004; O'Donnell, 2000; O'Donnell et al., 1998a, b; Ward et al., 2002). A combined phylogenetic analysis of LSU, ITS, RPB2 and new phylogenetic marker Acl1 by Gräfenhan et al. (2011), revealed that the early concept of *Fusarium* is not monophyletic. *Fusarium sensu* Wollenweber divided into two large groups, basal 'fusarium-like clades', and the other one terminal '*Fusarium* clade' in the Nectriaceae (Gräfenhan et al., 2011) (Figure 4.4).

4.5.2 Molecular Based Identification and Diversity of *Fusarium*

ITS and LSU are least informative in species-level identification of *Fusarium* (O'Donnell et al., 1998b; Hyde et al., 2014). Moreover, non-orthologous copies of the ITS2, which can lead to wrong phylogenetic inferences, can be detected in many species of *Fusarium* (Geiser et al., 2004; O'Donnell et al., 1998a, b). Generally, for

the species-level identification of fungi intron-rich regions of protein-coding genes are used as the markers (Geiser et al., 2004). The TEF1, which lacks nonorthologous copies of the gene, is highly informative at the species level in *Fusarium* (Geiser et al., 2004). rpb1 and rpb2 are also very informative gene regions for species identification of Fusarium (O'Donnell et al., 2013; Hyde et al., 2014). Lombard et al. (2018) observed that TEF1 and RPB2 genes provide better resolution of the species in the *F. oxysporum* complex than CAM and TUB2 (Figure 4.4, Table 4.4).

Recommended genetic markers (genus level): Acl1, TEF1 and ITS

Recommended genetic markers (species level): CAM, TUB2, TEF1, rpb1 and rpb2

Accepted number of species: There are 1552 species epithets in Index Fungorum (2019) under this genus. More than 175 species have DNA sequence data.

References: Booth (1971), Rossman et al. (1999) (morphology), Rana et al. (2017), Gräfenhan et al. (2011), Laurence et al. (2014), Lombard et al. (2018), Lombard, Sandoval-Denis et al. (2019), Maryani et al. (2018, 2019), Wang et al. (2019) and Nalim et al. (2011) (morphology, phylogeny).

Table 4.4 Details of the *Fusarium* isolates used in the phylogenetic analyses. Ex-type (or ex-epitype) strains are marked with an asterisk

Species	Culture collection no.	RPB1	RPB2	TEF1
Fusarium anguioides	NRRL 25385*; ATCC 66485	JX171511	JX171624	MH742689
F. acaciae-mearnsii	NRRL 26755	KM361640	KM361658	AF212449
F. acuminatum	NRRL 36147; CBS 109232	HM347174	GQ505484	GQ505420
F. agapanthi	NRRL 54463*	KU900620	KU900625	KU900630
F. albidum	NRRL 22152	JX171492	JX171605	—
F. albosuccineum	NRRL 20459	JX171471	JX171585	—
F. algeriense	NRRL 66647*; CBS 142638; IL-79	MF120488	MF120499	—
F. ananatum	CBS 118516*	LT996188	LT996137	KU604416
F. andiyazi	NRRL 31727	LT996189	LT996138	KP662901

F. anthophilum	NRRL 13602; CBS 737.97	LT996190	LT996139	KU711685
F. arcuatisporum	CGMCC3.19493*	MK289799	MK289739	MK289584
F. armeniacum	NRRL 6227	JX171446	JX171560	HM744692
F. asiaticum	NRRL 13818*	JX171459	JX171573	AF212451
F. avenaceum	NRRL 54939	JX171551	JX171663	MH582391
F. aywerte	NRRL 25410	JX171513	JX171626	KU171717

Table 4.4 (continued)

Species	Culture collection no.	RPB1	RPB2	TEF1
F. babinda	NRRL 25539; CBS 396.96	JX171519	JX171632	MH742712
F. begoniae	CBS 403.97*	LT996191	LT996140	AF160293
F. beomiforme	NRRL 25174; CBS 740.97	—	JX171619	—
F. brachygibbosum	NRRL 13829	JX171460	JX171574	—
F. buharicum	NRRL 13371; CBS 796.70	JX171449	JX171563	—
F. bulbicola	NRRL 13618*; CBS 220.76	KF466394	KF466404	KF466415
F. burgessii	CBS 125537*; RBG 5319	KJ716217	HQ646393	HQ667149
F. callistephi	CBS 187.53*	—	MH484905	MH484966
F. carminascens	CBS 144738*; CPC 25800	—	MH484937	MH485028
F. celtidicola	MFLUCC 16-0751*	—	MH576580	—
F. citri	CGMCC3.19467*; LC6896	MK289828	MK289771	MK289617
F. citricola	CBS 142421*; CPC 27805	LT746290	LT746310	LT746197
F. coicis	NRRL 66233*; RBG5368	KP083269	KP083274	KP083251
F. commune	NRRL 28387	—	JX171638	KU171720
F. concentricum	NRRL 25181*; CBS 450.97	LT996192	JF741086	AF160282
F. concolor	NRRL 13459*; CBS 961.87	JX171455	JX171569	MH742681
F. contaminatum	CBS 114899*	—	MH484901	MH484992

F. continuum	F201128	KM520389	KM236780	KM236720
F. convolutans	CBS 144207*; CPC 33733	LT996193	LT996141	LT996094
F. cugenangense	InaCCF984*	LS479560	LS479308	—
F. culmorum	NRRL 25475; CBS 417.86	JX171515	JX171628	KY873384
F. cuneirostrum	NRRL 31104	—	EU329558	EF408413
F. curvatum	CBS 238.94	—	MH484893	MH484984

Table 4.4 (continued)

Species	Culture collection no.	RPB1	RPB2	TEF1
F. cyanostomum	NRRL 53998	JX171546	JX171658	—
F. dactylidis	NRRL 29298*	KM361654	KM361672	DQ459748
F. denticulatum	NRRL 25302; CBS 735.97	LT996195	LT996143	AF160269
F. desaboruense	InaCC F950	LS479870	LS479852	—
F. dlaminii	NRRL 13164*; CBS 119860	KU171681	KU171701	MK639039
F. duoseptatum	InaCC F916*	LS479495	LS479239	—
F. elaeidis	CBS 217.49*; NRRL 36358	—	MH484870	MH484961
F. enterolobii	CPC 27190	—	LT746312	LT746199
F. equiseti	NRRL 13405	—	GQ915491	GQ915507
F. fabacearum	CBS 144743*; CPC 25802	—	MH484939	MH485030
F. ficicrescens	CBS 125178*	—	KT154002	KP662899
F. flocciferum	NRRL 25473	JX171514	JX171627	—
F. foetens	NRRL 38302	JX171540	JX171652	GU170559
F. fracticaudum	CMW 252374	LT996196	LT996144	KJ541059
F. fractiflexum	NRRL 28852*	—	LT575064	AF160288
F. fredkrugeri	CBS 144209*; CPC 33747	LT996199	LT996147	LT996097
F. fujikuroi	NRRL 13566	JX171456	JX171570	—
F. gaditjirrii	NRRL 45417	—	JX171654	KU171724
F. gamsi	CBS 143610*; CPC 30862; OrSaAg4	—	LT970760	LT970788

F. globosum	NRRL 26131*; CBS 428.97	KF466396	KF466406	KF466417
F. glycines	CBS 144746*; CPC 25808	—	MH484942	MH485033
F. gossypinum	CBS 116613*	—	MH484909	MH485000
F. graminearum	CBS 123657	JX171531	JX171644	HM744693
F. grosmichelii	InaCC F833*	LS479548	LS479295	LS479744
F. guilinense	CGMCC3.19495*; LC12160	MK289831	MK289747	MK289594

Table 4.4 (continued)

Species	Culture collection no.	RPB1	RPB2	TEF1
F. guttiforme	NRRL 22945	JX171505	JX171618	—
F. hainanense	CGMCC3.19478*; LC11638	MK289833	MK289735	MK289581
F. heterosporum	NRRL 20693; CBS 720.79	JX171480	JX171594	—
F. hexaseptatum	InaCC F866*	—	LS479359	LS479805
F. hoodiae	CBS 132474*	—	MH484929	MH485020
F. hostae	NRRL 29889	JX171527	JX171640	AY329034
F. inflexum	NRRL 20433	—	JX171583	AF008479
F. ipomoeae	CGMCC3.19496*; LC12165	MK289859	MK289752	MK289599
F. iranicum	CBS 143608*; CPC 30860; OrSaAg2	—	LT970757	LT970785
F. irregulare	CGMCC3.19489*; LC7188	MK289863	MK289783	MK289629
F. kalimantanense	InaCC F917*	LS479497	LS479241	LS479690
F. konzum	CBS 119849*	LT996200	LT996148	LT996098
F. kotabaruense	InaCC F963*	LS479875	LS479859	LS479445
F. kuroshium	CBS 142642*; UCR3641	KX262236	KX262256	KX262216
F. kyushuense	NRRL 25349	—	GQ915492	GQ915508
F. lacertarum	NRRL 20423; CBS 130185	HM347137	JX171581	GQ505593
F. lactis	NRRL 25200*; CBS 411.97	LT996201	LT996149	AF160272
F. langsethiae	NRRL 54940	JX171550	JX171662	—

F. languescens	CBS 645.78*; NRRL 36531	—	MH484880	MH484971
F. lateritium	NRRL 13622	JX171457	JX171571	AY707173
F. libertatis	CBS 144749*; CPC 28465	—	MH484944	MH485035
F. longipes	NRRL 13368	JX171448	JX171562	—
F. luffae	CGMCC3.19497*; LC12167	MK289869	MK289754	MK289601
F. lumajangense	InaCC F872*	—	LS479850	LS479441

Table 4.4 (continued)

Species	Culture collection no.	RPB1	RPB2	TEF1
F. lyarnte	NRRL 54252; CBS 125536	JX171549	JX171661	—
F. mangiferae	NRRL 25226*; BBA 69662	JX171509	JX171622	—
F. miscanthi	NRRL 26231	—	JX171634	KU171725
F. mundagurra	NRR L66235*; RBG5717	KP083272	KP083276	MK639058
F. nanum	CGMCC3.19498*; LC12168	MK289871	MK289755	MK289602
F. napiforme	CBS 748.97*; NRRL 13604	HM347136	EF470117	KU604409
F. nelsonii	NRRL 13338	JX171447	JX171561	GQ505402
F. newnesense	NRRL 66237; RBG5443	KP083271	KP083277	KJ397074
F. nirenbergiae	CBS 840.88*	—	MH484887	MH484978
F. nisikadoi	NRRL 25179; CBS 742.97	JX171507	JX171620	—
F. nurragi	NRRL 36452; CBS 392.96	JX171538	JX171650	—
F. nygamai	NRRL 13448*; CBS 749.97	LT996202	EF470114	AF160273
F. odoratissimum	InaCC F822*	LS479618	LS479386	—
F. oligoseptatum	NRRL 62579*; FRC S-2581; MAFF 246283; CBS 143241	KC691596	KC691656	KC691538
F. oxysporum	CBS 144134*	—	MH484953	MH485044
F. palustre	NRRL 54056*	KT597718	KT597731	—

F. paranaense	CML1830*	—	KF680011	KF597797
F. parvisorum	CBS 137236*; FCC 5407; CMW 25267	—	LT996150	KJ541060
F. pernambucanum	MUM 1862*	MH668869	—	—
F. petersiae	CBS 143231*	MG386139	MG386150	MG386159
F. pharetrum	CBS 144751*; CPC 30824	—	MH484952	MH485042
F. phialophorum	InaCC F971*	LS479545	LS479292	LS479741
F. phyllophilum	NRRL 13617*	KF466399	KF466410	KF466421

Table 4.4 (continued)

Species	Culture collection no.	RPB1	RPB2	TEF1
F. pisi	NRRL 22278	—	EU329501	AF178337
F. poae	NRRL 13714	JX171458	JX171572	—
F. praegraminearum	NRRL 39664*	KX260125	KX260126	KX260120
F. proliferatum	NRRL 22944; CBS 217.76	JX171504	JX171617	—
F. pseudensiforme	NRRL 46517	KC691615	KC691645	KC691555
F. pseudocircinatum	NRRL 22946*; CBS 449.97	LT996204	LT996151	AF160271
F. pseudograminearum	NRRL 28062*; CBS 109956	JX171524	JX171637	AF212468
F. pseudonygamai	NRRL 13592*; CBS 417.97	LT996205	LT996152	AF160263
F. purpurascens	InaCC F886*	—	LS479385	LS479827
F. ramigenum	NRRL 25208*; CBS 418.98	KF466401	KF466412	KF466423
F. redolens	NRRL 22901; CBS 743.97	—	KU171708	KU171728
F. riograndense	HCF3*	—	KX534003	KX534002
F. roseum	NRRL 22187	JX171493	JX171606	—
F. sacchari	NRRL 13999; CBS 223.76	JX171466	JX171580	KU711669
F. salinense	CBS 142420*; CPC 26973	LT746286	LT746306	LT746193
F. sangayamense	InaCC F960*	LS479537	LS479283	—
F. sarcochroum	NRRL 20472; CBS 745.79	JX171472	JX171586	—

F. scirpi	NRRL 13402	JX171452	JX171566	GQ505592
F. sibiricum	NRRL 53430*	—	HQ154472	HM744684
F. siculi	CBS 142422*; CPC 27188	LT746299	LT746327	LT746214
F. sororula	CBS 137242*	LT996206	LT996153	—
F. sporotrichioides	NRRL 3299	JX171444	JX171558	HM744665
F. staphyleae	NRRL 22316	JX171496	JX171609	MH582426
F. stercicola	CBS 142481*; DSM 106211	—	KY556552	KY556524

Table 4.4 (continued)

Species	Culture collection no.	RPB1	RPB2	TEF1
F. stilboides	NRRL 20429	JX171468	JX171582	—
F. subglutinans	NRRL 22016*; CBS 747.97	JX171486	JX171599	HM057336
F. sublunatum	NRRL 13384*; CBS 189.34	JX171451	JX171565	—
F. subtropicale	NRRL 66764*; CBS 144706	MH706972	MH706973	MH706974
F. succisae	NRRL 13613; CBS 219.76	LT996207	LT996154	AF160289
F. sudanense	CBS 454.97*; NRRL 25451	LT996208	LT996155	KU711697
F. sulawesiense	InaCC F940*	—	LS479855	LS479443
F. tanahbumbuense	InaCC F965*	LS479877	LS479863	LS479448
F. tardichlamydosporum	InaCC F958*	—	LS479280	LS479729
F. tardicrescens	NRRL 36113*	LS479474	LS479217	LS479665
F. terricola	CBS 483.94*	LT996209	LT996156	KU711698
F. thapsinum	NRRL 22045; CBS 733.97	JX171487	JX171600	AF160270
F. tjaetaba	NRRL66243*; RBG5361	KP083267	KP083275	KP083263
F. tjaynera	NRRL66246*; RBG5367	KP083268	KP083279	—
F. torreyae	NRRL 54149	JX171548	HM068359	HM068337
F. torulosum	NRRL 22748; NRRL 13919	JX171502	JX171615	—
F. transvaalense	CBS 144211*; CPC	LT996210	LT996157	LT996099

	30923			
F. tricinctum	NRRL 25481*; CBS 393.93	JX171516	HM068327	MH582379
F. triseptatum	CBS 258.50*	—	MH484873	MH484964
F. udum	NRRL 22949; CBS 178.32	LT996220	LT996172	AF160275
F. venenatum	CBS 458.93*	—	KM232382	KM231942
F. verrucosum	NRRL 22566, BBA 64786	—	JX171613	—
F. verticillioides	NRRL 20956	JX171485	JX171598	—

Table 4.4 (continued)

Species	Culture collection no.	RPB1	RPB2	TEF1
F. veterinarium	CBS 109898*; NRRL 36153	—	MH484899	MH484990
F. volatile	CBS 143874*	—	LR596006	LR596007
F. witzenhausenense	CBS 142480*	—	KY556553	KY556525
F. xylarioides	NRRL 25486; CBS 258.52	JX171517	JX171630	AY707136
F. caatingaense	MUM 1859*; URM 6779	MH668845	LS398495	LS398466
F. goolgardi	NRRL 66250*; RBG5411	KP083270	KP083280	KP101123
F. humuli	CGMCC3.19374*; CQ1039	MK289840	MK289724	MK289570
Fusicolla aquaeductuum	NRRL 20686*	JX171476	JX171590	—

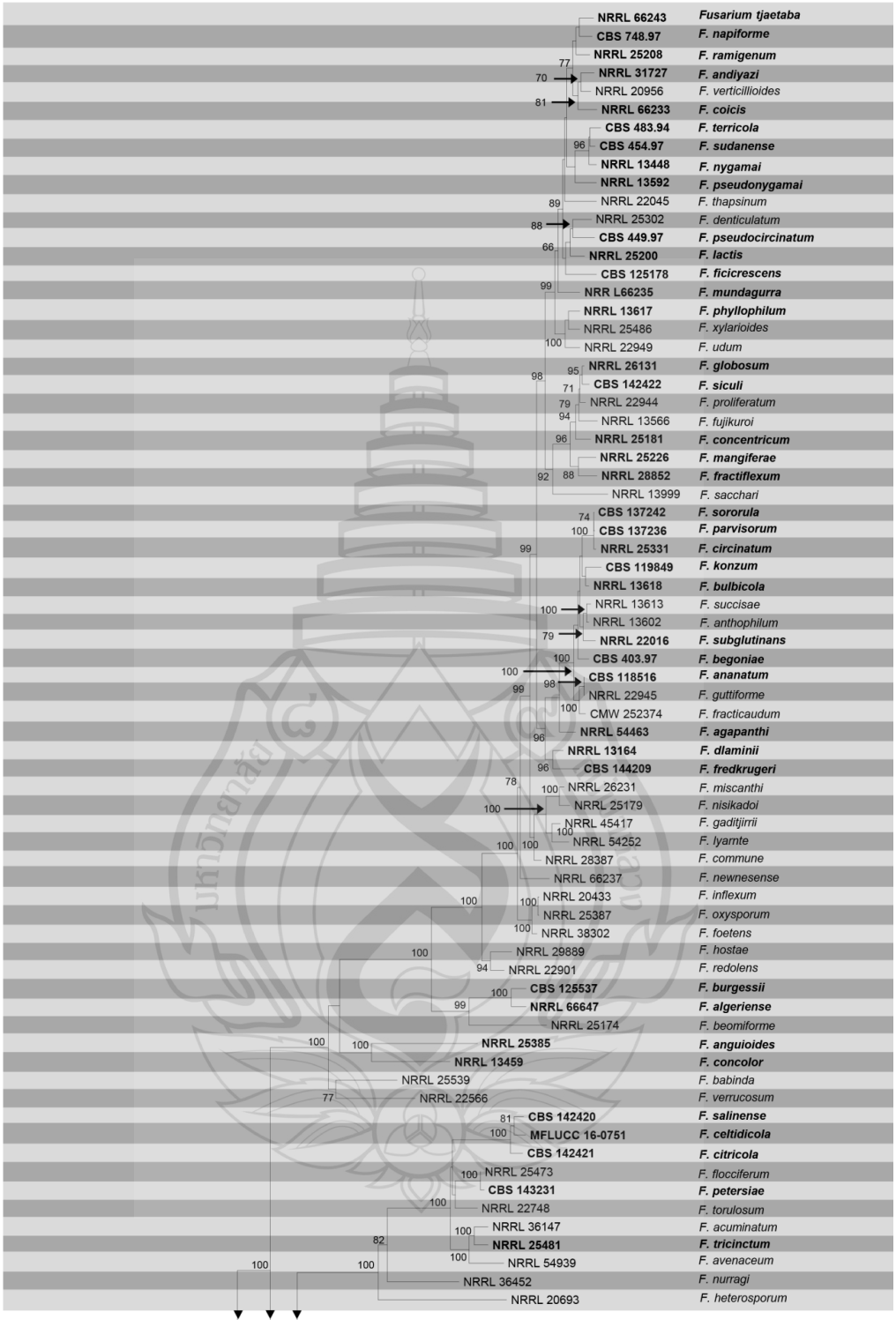
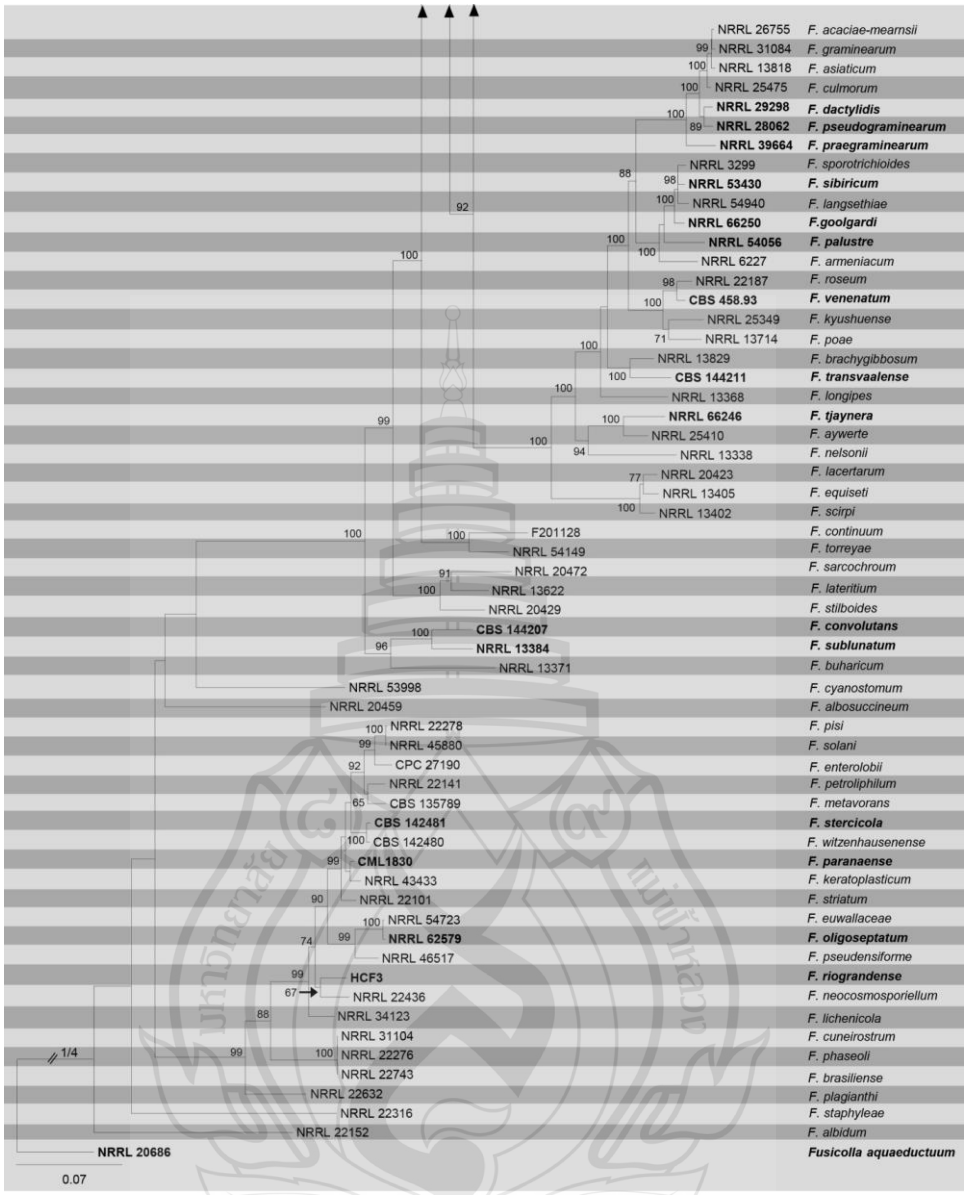


Figure 4.4 Phylogram generated from RAxML analysis based on combined RPB1, RPB2 and TEF1 sequences of accepted species of *Fusarium*



Note Related sequences were obtained from GenBank. One hundred sixty-five taxa are included in the analyses, which comprise 3980 characters including gaps. Maximum likelihood bootstrap support values ≥70% (MLBT) and Bayesian posterior probabilities ≥0.99 (BYPP) are given near the nodes respectively. The tree was rooted in *Fusicolla aquaeductuum*. Ex-type strains are in bold. The scale bar indicates 0.07 nucleotide changes per site.

Figure 4.4 (continued)

4.6 Taxonomic Updates and Molecular Phylogeny of *Neonectria*

Classification: Sordariomycetes, Hypocreomycetidae, Hypocreales, Nectriaceae

Type species: *Neonectria ramulariae* Wollenw., Annls mycol. 15(1/2):52 (1917)

Distribution: Worldwide

Disease symptoms: Canker

Dead shoots can be observed in the lower branches or all over the affected tree. Affected branches or trunks show canker and some may have abundant resin flow. When the canker girdles the affected area, part of the tree above the canker dies. Under humid conditions characteristic small, red fruiting bodies will be formed. Badly affected trees will eventually die (Castlebury et al., 2006).

Beech (Fagus) bark disease is caused by *N. coccinea*, *N. ditissima*, *N. fuckeliana* and *N. faginata*. Cankers of fruit trees are caused by *N. rugulosa* and *N. ditissima*. Shoot dieback of *Abies* species are caused by *N. neomacrospora* (Castlebury et al., 2006; Rossman et al., 2008; Crane et al., 2009; Chaverri et al., 2011; Schmitz et al., 2017; Wenneker et al., 2017).

Hosts: Wide host range including plant genera in Amaryllidaceae, Aracaceae, Araliaceae, Betulaceae, Ericaceae, Fagaceae, Lauraceae, Myrtaceae, Pinaceae, Proteaceae, Rosaceae, Sapindaceae and Vitaceae (Farr & Rossman, 2019).

4.6.1 Morphology Based Identification and Diversity of *Neonectria*

The genus *Neonectria* was established by Wollenweber (1917). The generic concept of *Neonectria* has been revised by different authors (Booth, 1959; Samuels & Brayford, 1994; Rossman et al., 1999). Rossman et al. (1999) accepted only three species (*N. coccinia*, *N. galligena* and *N. ramulariae*) in *Neonectria*. Subsequently, species were added to the genus (Samuels & Brayford, 1994) based on morphology and/or phylogeny (Hirooka et al., 2005; Castlebury et al., 2006; Luo & Zhuang,

2010c; Zhao et al., 2011; Lombard et al., 2014, 2015). However, some unrelated species were transferred to other genera based on molecular analyses and morphological data (Lombard et al., 2014, 2015). There are 31 species recognised in the genus, while 23 species have sequence data in GenBank (4/7/2019). Morphological characters (perithecial morphology, ascospore size, macroconidial morphology, presence or absence of microconidia and chlamydospores) along with DNA sequence analysis are appropriate for identification of *Neonectria* species (Brayford et al., 2004).

4.6.2 Molecular based identification and diversity of *Neonectria*

Since 2001, DNA sequence analysis has been used to clarify the taxonomy of *Neonectria* (Mantiri et al., 2001; Brayford et al., 2004; Halleen et al., 2004; Hirooka et al., 2005; Chaverri et al., 2011). Mantiri et al. (2001) and Brayford et al. (2004) used mtSSU rDNA sequence data to infer intrageneric relationships of some *Neonectria* and *Cylindrocarpon* species. Later, Halleen et al. (2004) used mtLSU rDNA, TUB2 and nrDNA ITS regions to separate some *Cylindrocarpon* species included in the N. mammoidea group. Chaverri et al. (2011) approached a comprehensive treatment of *Cylindrocarpon* and *Neonectria* based on combined loci analyses and morphological data. Chaverri et al. (2011) defined *Neonectria sensu stricto* within Nectriaceae with *Cylindrocarpon sensu stricto* based on multi-gene phylogeny of ITS, LSU, TEF1, TUB2, act, and rpb1. The ITS, TEF1 and TUB2 loci possess highly variable regions (Chaverri et al., 2011) and are important in species delimitation of *Neonectria*. Rossman et al. (2013) proposed to protect generic name Neonectria over *Cylindrocarpon*. Maharachchikumbura et al. (2015) considered *Cylindrodendrum* not to be congeneric with *Neonectria* and accepted *Neonectria* over Cylindrocarpon. This study reconstructs the phylogeny of *Neonectria* based on analyses of a combined ITS, LSU, TEF1 and TUB2 sequence data (Table 4.5, Figure 4.5). The phylogenetic tree is updated with recently introduced *Neonectria* species and corresponds to previous studies (Chaverri et al., 2011; Lombard et al., 2014; Mantiri et al., 2001).

Recommended genetic markers (genus level): LSU, ITS, TEF1 and TUB2

Recommended genetic markers (species level): ITS, TEF1 and TUB2 Accepted number of species: 28 species

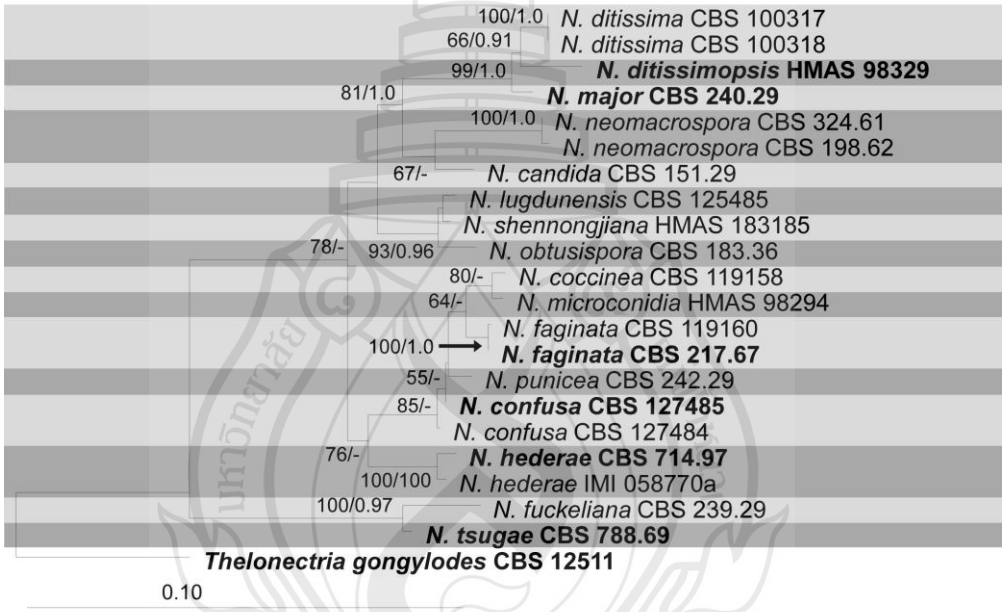
References: Rossman et al. (1999) (morphology), Brayford et al. (2004), Hirooka and Kobayashi (2007), Chaverri et al. (2011) and Lombard et al. (2014) (morphology, phylogeny).

Table 4.5 Details of the *Neonectria* isolates used in the phylogenetic analyses. Ex-type (or ex-epitype) strains are marked with an asterisk

Species	**Culture collection no.**	**ITS**	**LSU**	**TUB2**	**TEF1**
Neonectria austroradicicola	PDD 46334/ G.J.S. 83-154	EF607077	-	-	-
N. candida	CBS 151.29 MUCL 28083	AY677291	AY677333	DQ789863	DQ789723
N. coccinea	CBS 119158/ GJS 98-114	JF268759	KC660620	KC660727	JF268734
N. confusa	CBS 127485/ HMAS 99197*	FJ560437	KM515934	FJ860054	-
N. confusa	CBS 127484/ HMAS 99198	KM515889	KM515933	KM515886	-
N. ditissima	CBS 100318	KM515890	KM515935	DQ789858	KM515944
N. ditissima	CBS 100317	KM515891	KM515936	KM515887	KM515945
N. ditissimopsis	HMAS 98329*	JF268764	-	JF268729	JF268745
N. faginata	CBS 217.67/ IMI 105738/ ATCC 16547*	HQ840385	HQ840382	JF268730	JF268746
N. faginata	CBS 119160/ GJS 04-159	HQ840384	HQ840383	DQ789883	DQ789740
N. fuckeliana	CBS 239.29/ IMI 039700	HQ840386	HQ840377	DQ789871	JF268748
N. hederae	IMI 058770a/ ATCC 16543*	-	KC660617	DQ789895	DQ789752
N. hederae	CBS 714.97	-	KC660616	DQ789878	KC660461
N. lugdunensis	CBS 125485 235831/ TG 2008-07	KM231762	KM231625	KM232019	KM231887
N. major	CBS 240.29/ IMI 113909*	JF735308	KM515942	DQ789872	JF735782
N. microconidia	CBS 198.62	KC660530	KC660587	-	-
N. neomacrospora	BBA 9628/ IMI 113890	AJ009255	HM364316	HM352865	HM364351
N. neomacrospora	CBS 324.61/ DSM 62489	JF735312	HM364318	DQ789875	-

Table 4.5 (continued)

Species	Culture collection no.	ITS	LSU	TUB2	TEF1
N. obtusispora	CBS 183.36; IMI 113895	AM419061	KM515943	AM419085	JF735796
N. punicea	CBS 242.29	KC660522	KC660565	DQ789873	DQ789730
N. shennongjiana	HMAS 183185	FJ560440	-	FJ860057	-
N. tsugae	CBS 788.69*	KM231763	HQ232146	KM232020	-
Thelonectria gongylodes	CBS 12511/ GJS 90-48*	JQ403330	JQ403369	HM352870	HM364357



Note Related sequences were obtained from GenBank. Twentythree strains are included in the analyses, which comprise 2336 characters including gaps. Maximum likelihood bootstrap support ≥ 55% (MLBT) and posterior probabilities ≥0.90 (BYPP) from Bayesian inference analysis are indicated respectively near the nodes. The tree is rooted in *Thelonectria gongylodes*. Ex-type strains are in bold. The scale bar indicates 0.10 nucleotide changes per site.

Figure 4.5 Phylogenetic tree generated by maximum likelihood analysis of combined ITS, LSU, TEF1 and TUB2 sequence data of *Neonectria* species

CHAPTER 5

TAXONOMIC STUDIES OF SOME FUNGI IN DIAPORTHOMYCETIDAE, SORDARIOMYCETIDAE AND XYLARIOMYCETIDAE

5.1 Introduction

We are studying fungi belong to Diaporthomycetidae, Sordariomycetidae and Xylariomycetidae and here report on seven new species, and introduce three new genera *Eriocamporesia Pseudotruncatella* and *Tropohalonectria*, and one host record, two geographical records and first sexual morph records for *Seimatosporium cornii* and *Dissoconium eucalypti*. New species are, *Astrocystis bambusicola, Chaetosphaeria jonesii, Diatrype thailandica, Ditopella biseptata, Eriocamporesia aurantia, Marsupiomyces epidermoidea* and *Pseudotruncatella arezzoensis*. Further we synonymise *Neotruncatella* under *Monochaetinula* and provide notes on *Monochaetinula*.

Chaetosphaeria species were collected from decorticated wood in Chiang Mai province were studied. Phylogenetic analysis of combined LSU, ITS and TUB2 sequence data provides evidence for a new species of and a new record. The new taxon *Chaetosphaeria jonesii* is introduced and compared with closely related species. We provide a morphological and illustrated account of *Chaetosphaeria panamensis* isolated from *Pinus* twigs as the first record for Thailand.

Seimatosporium has been linked to *Discostroma* in several studies (Shoemaker & Müller, 1964; Brockmann, 1976; Nag Raj, 1993; Okane et al., 1996; Hatakeyama & Harada, 2004; Paulus et al., 2006; Hyde et al., 2011). *Discostroma* is characterized by stromatic and/or clypeate, ostiolate ascomata, unitunicate asci, with a J+/ J- apical ring, and usually uniseriate, ellipsoid, transversely septate or muriform, hyaline or pigmented ascospores (Paulus et al., 2006). Species of *Seimatosporium* and *Discostroma* are mainly biotrophic, while some are saprobes (Sutton, 1980; Paulus et

al., 2006; Tanaka et al., 2011). Recent phylogenetic analyses have also confirmed the link between *Discostroma* and *Seimatosporium* (Jeewon et al., 2002; Barber et al., 2011; Tanaka et al., 2011; Norphanphoun et al., 2015). Although the holomorph has not been recorded in nature, *Discostroma* and *Seimatosporium* are recognised as homothallic (culture based) by several authors (Brockmann, 1976; Okane et al., 1996; Hatakeyama & Harada, 2004). However, molecular data are not available to prove the link between the type species of *Discostroma* (*Discostroma rehmii* (Schnabl) Clem.) and *Seimatosporium* (*S. rosae*), hence both genera are treated as distinct genera in Maharachchikumbura et al. (2015) and Senanayake et al. (2015). In the present study we provide phylogenetic data that link the discostroma-like sexual morph with the asexual morph of *Seimatosporium cornii*. However, the type of *Discostroma* which has muriform ascospores, lacks sequence data and should still be maintained as a distinct genus.

Based on phylogeny, molecular clock analysis and morphological data, 12 families are currently included in Amphisphaeriales D. Hawksw. & O.E. Erikss. (Senanayake et al., 2015; Maharachchikumbura et al., 2015, 2016; Hongsanan et al., 2017; Hyde, Maharachchikumbura et al., 2017). Beltraniaceae Nann., Pestalotiopsidaceae Maharachch. & K.D. Hyde, Robillardaceae Crous, and Sporocadaceae Corda were recognized as families with appendage-bearing, brown conidia producing coelomycete fungi in Amphisphaeriales (Senanayake et al., 2015; Maharachchikumbura et al., 2016; Wijayawardene et al., 2016). However, those families were treated as synonymies of Sporocadaceae Corda by Jaklitsch et al. in 2016. Most of the Sporocadaceae members represent asexual morph genera of acervular coelomycetes, with holoblastic conidiogenesis and hyaline, pale or dark brown, phragmo- or didymosporous conidia, with appendages (Nag Raj, 1993; Jeewon et al., 2002; Tanaka et al., 2011; Senanayake et al., 2015; Jaklitsch et al., 2016). Currently, 18 genera producing appendage-bearing conidia: *Adisciso*, *Bartalinia*, *Broomella*, *Ciliochorella*, *Discosia*, *Ellurema*, *Immersidiscosia*, *Monochaetia*, *Morinia*, *Neopestalotiopsis*, *Pestalotiopsis*, *Pseudopestalotiopsis*, *Robillarda*, *Sarcostroma*, *Seimatosporium*, *Seiridium*, *Truncatella*, and *Zetiasplozna*, are accomodated in Sporocadaceae (Senanayake et al., 2015; Jaklitsch et al., 2016; Wijayawardene et al., 2016). Further, 4 coelomycete genera, which lack molecular

data, forming brown conidia were referred to Amphisphaeriales, genera *incertae sedis*. They are *Bleptosporium*, *Griphosphaerioma*, *Hyalotiopsis* and *Monochaetinula* (Senanayake et al., 2015; Jaklitsch et al., 2016; Wijayawardene et al., 2016). Here we introduce undescribed coelomycetes genus *Pseudotruncatella* in Amphisphaeriales based on DNA sequence analysis, together with morphological characterization.

5.2 Materials and Methods

5.2.1 Sample Collection, Morphological Studies and Isolation

Samples were collected from Italy and Thailand and, macroscopic and microscopic characters were observed in the laboratory. Fungal structures were observed using a Motic dissecting microscope (SMZ 168) and a Nikon ECLIPSE 80i compound microscope. Free hand sections of conidiomata were taken and mounted in water for microscopic study. Conidiophores, conidiogenous cells and conidia were mounted in Congo red for detailed observations. Photomicrography was carried out using a Canon 450D digital camera fitted to the microscope. Measurements were taken with the Tarosoft (R) Image Frame Work software. The images used for illustrating the fungi were processed with Adobe Photoshop CS5 v. 12.0 software (Adobe Systems, USA). Single conidial colonies were established as described in Chomnunti et al. (2014). Pure cultures were obtained on Potato Dextrose Agar (PDA) and incubated at room temperature of 28 °C. To induce sporulation, cultures were incubated at 28 °C, in the dark. Conidiomata produced on PDA, were also illustrated following the above procedure.

Herbarium specimens were deposited in the Mae Fah Luang University (MFLU) herbarium, Chiang Rai, Thailand. Living cultures were deposited in the Culture Collection at Mae Fah Luang University (MFLUCC). Facesoffungi and Index Fungorum numbers were registered as explained in Jayasiri et al. (2015) and Index Fungorum. Species delimitated as in Jeewon and Hyde (2016).

5.2.2 DNA Isolationand and Amplification

Genomic DNA was extracted from fungal colonies growing on PDA, using the Biospin Fungus Genomic DNA Extraction Kit-BSC14S1 (BioFlux, P.R. China), following the manufacturer's protocol. Gene regions were amplified using the primer

pairs and PCR protocols mensioned in relavent literature. Amplifications was performed in 25 μl of PCR mixtures containing 9.5 μl ddH2O, 12.5 μl 2 × PCR Master Mix, 1 μl of DNA template and 1 μl of each primer (10 μM). The PCR products were visualized by staining with ethidium bromide after 1% agarose gel electrophoresis. Purification and sequencing of PCR products were done by Shanghai Sangon Biological Engineering Technology & Services Co., China. To ensure the integrity of the sequences, both directions of the PCR products were sequenced using the same primer pairs as used in PCR amplification.

5.2.3 Phylogenetic Analysis

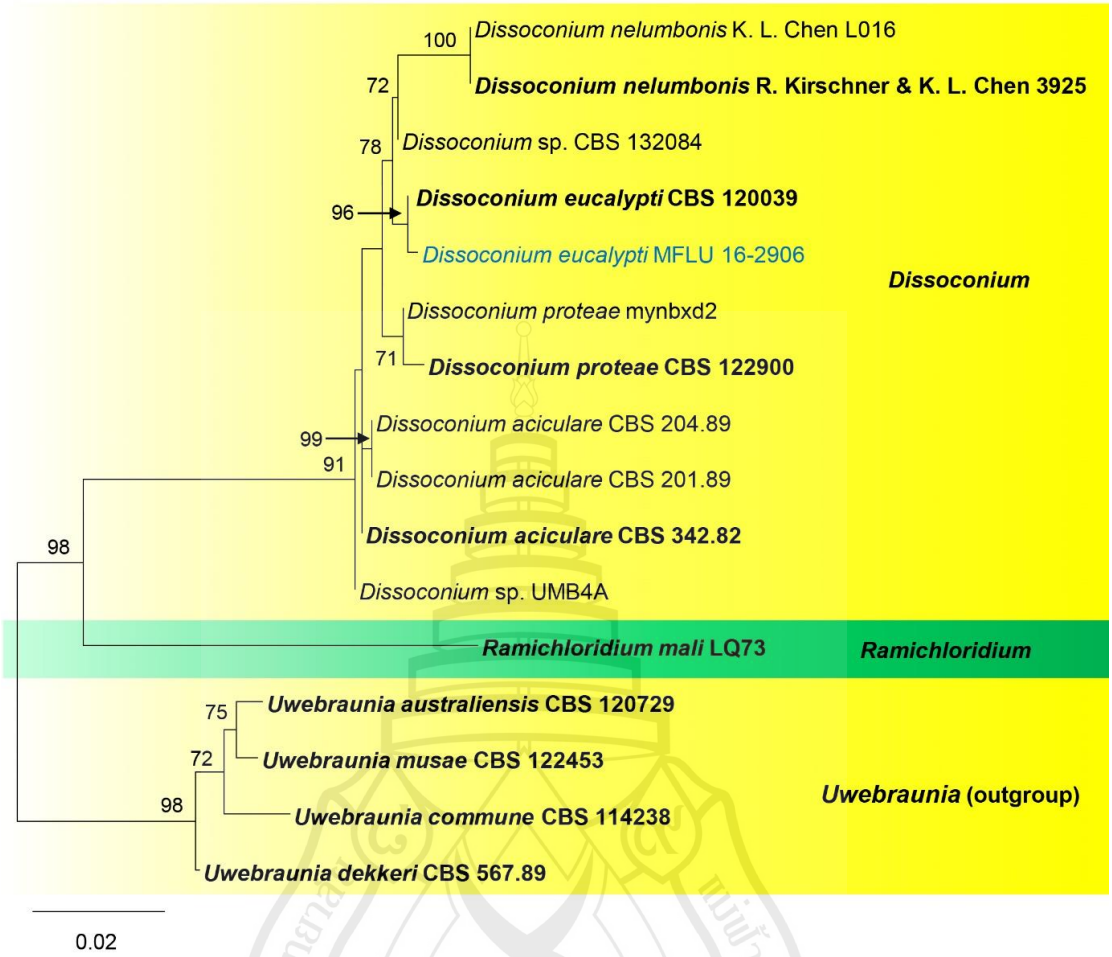
The sequences generated in this study were supplemented with additional sequences obtained from GenBank (Table 2). The sequence data were aligned online with the MAFFT v. 7 server (http://mafft.cbrc.jp/ alignment/server/) and manually adjust using MEGA6 v. 6.0 where necessary (Tamura et al., 2011). Phylogenetic analyses were based on Bayesian inference (BI) and maximum likelihood (ML) methods.

ML analysis was performed using RAxML GUI v. 1.3 (Silvestro & Michalak, 2011). The optimal ML tree search was conducted with 1 000 separate runs, using the default algorithm of the program from a random starting tree for each run. The final tree was selected among suboptimal trees from each run by comparing likelihood scores with the GTRGAMMA nucleotide substitution model. MrBayes version 3.2.0 was used to generate the phylogenetic trees under optimal criteria per data partition (Ronquist & Huelsenbeck, 2003). Bayesian analysis was performed using MrBayes version 3.2.0. The best-fit evolutionary models for phylogenetic analyses were selected separately for each gene regions using MrModeltest v. 2.2 (Nylander, 2004). Trees were viewed by FigTree v1.4 (http://tree.bio.ed.ac.uk/software/figtree/) and edited using Microsoft PowerPoint 2010.

5.3 Results

5.3.1 Phylogeny and taxonomy

Diaporthomycetidae Senan., Maharachch. & K.D. Hyde



Note Related sequences were obtained from GenBank. Sixteen taxa are included in the analyses, which comprise 1290 characters including gaps. Single gene analyses were carried out and compared with each species, to compare the topology of the tree and clade stability. Tree was rooted to *Uwebraunia musae* CBS 122453, *U. dekkeri* CBS 567.89, *U. commune* CBS 114238 and *U. australiensis* CBS 120729. RAxML bootstrap support values ≥ 70% (BT) are given at the nodes. The isolates obtained in this study are in blue and ex-types taxa are in black bold. The scale bar indicates 0.02 changes.

Figure 5.1 Phylogram generated from RAxML analysis based on combined ITS and LSU sequence data of *Dissoconium* isolates

Capnodiales Woron.

Dissoconiaceae Crous & de Hoog

Dissoconium eucalypti Crous & Carnegie, in Crous et al., Fungal Divers 26(1): 157 (2007)

Facesofungi number: FoF06961

Associated with dead branches of *Laurus nobilis*. Appearing as black raised, spots, each surrounded by a thin, yellow border. **Sexual morph:** *Ascomata* up to 180–315 µm high, 240–340 µm wide, pseudothecial, single, globose, immersed becoming erumpent, dark brown, ostiolate. Ostiole 63–90 µm high, papillate, periphysate. *Peridium* 22–36 µm wide, composed of 3–4 layers of thick-walled, medium brown cells of textura angularis, with yellow vacuoles, inner layer of fattened, hyaline cells of textura angularis. *Pseudoparaphyses* lacking. *Asci* 90–105 × 15–28 µm ($\bar{x}$ = 96 × 19.8 µm, n=15), 8-spored, bitunicate, fasciculate, subsessile, cylindrical-clavate to broadly clavate, straight or slightly incurved. *Ascospores* 16.3–28.8 × 7.1– 10.6 µm ($\bar{x}$ = 24.3 × 8.6 µm, n = 35), bi-seriate above, uni-seriate below, flling the ascus almost completely, ellipsoid-fusoid, with subobtuse ends, 1-septate, equilateral or inequilateral, constricted at the septum, with 2 larger guttules and many small guttules, straight to slightly curved, hyaline, with a mucoid sheath. **Asexual morph:** See Crous et al. (2007).

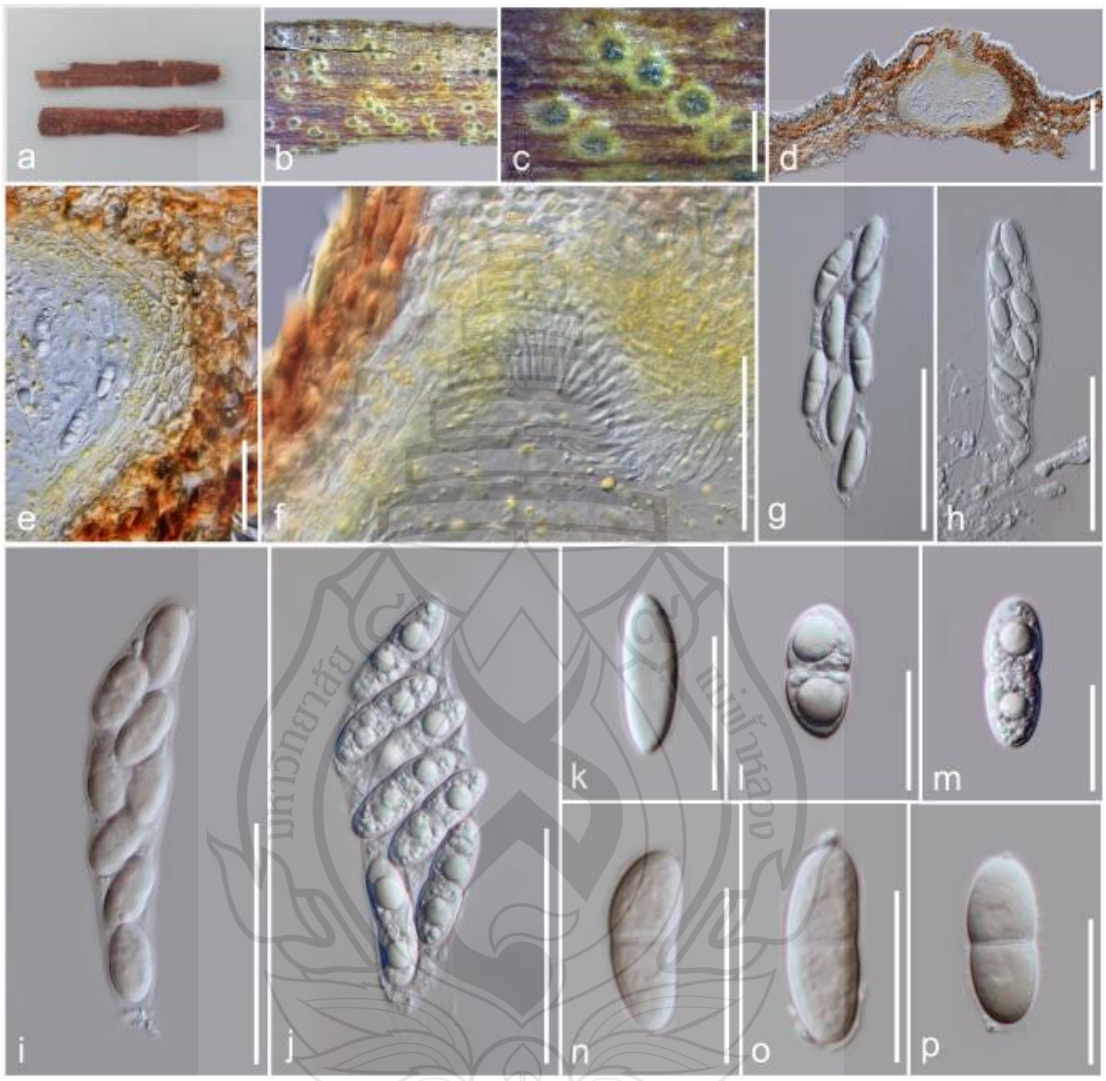
Material examined: ITALY, Province of Forlì-Cesena, Via Lombardini - Forlì, dead aerial branch of *Laurus nobilis* (Lauraceae), 24 November 2016, E. Camporesi, IT3170 (MFLU 16-2906).

Known host and distribution: *Eucalyptus tereticornis* (Australia), *Malus domestica* (United States) (Farr & Rossman, 2020).

GenBank numbers: ITS: MN699134, LSU: MN699129

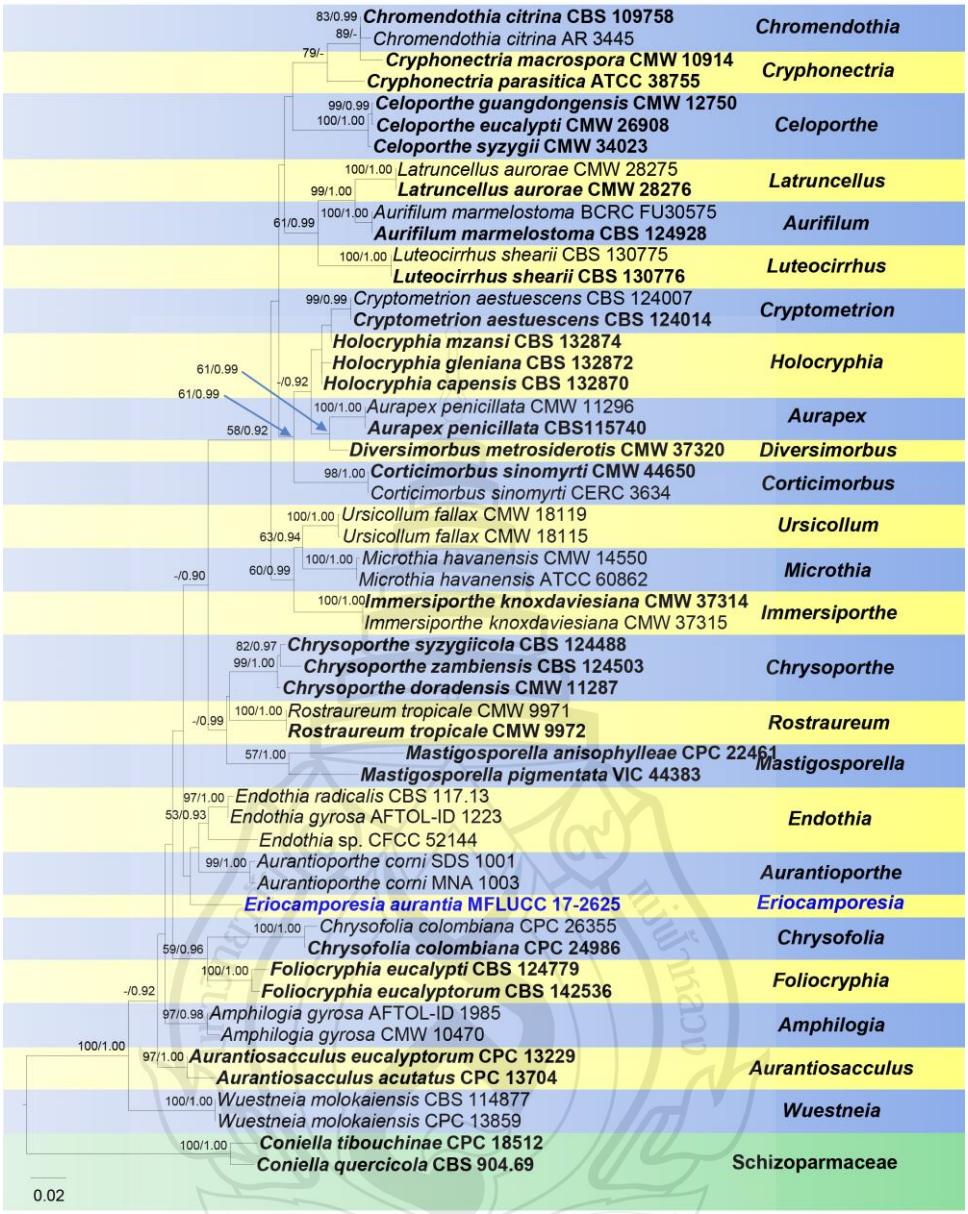
Notes: Our new collection groups with ex-type strain of *Dissoconium eucalypti* (CBS 120039) which was isolated from *Eucalyptus tereticornis* in Australia (Crous et al. 2007), with high statistical support (96% ML; Figure 5.1). However, there were no sexual morphs have been reported for *D. eucalypti* or *Dissoconium* (Crous et al., 2007). Our new fungus resembles Dissoconiaceae in having pseudothecial, immersed, globose, unilocular, papillate ascomata and ellipsoid-fusoid, 1-septate, hyaline ascospores (Crous, Schoch et al., 2009). DNA sequences of *D. eucalypti* strains (MFLU 16-2906 and CBS 120039) difer in 2 nucleotides of the ITS region (0.4%, no gaps), while LSU sequences were

identical. However, molecular data does not provide evidence for delimiting the new collection from *D. eucalypti* (Jeewon & Hyde, 2016). Hence, it is reported here as the sexual morph of *D. eucalypti*.



Note a Herbarium material. b, c Appearance of ascomata on host substrate. d Section through ascoma. e Section through the peridium. f Section through ostiole. g–j Asci. k–p Ascospores. (n–p in 5% KOH). Scale bars: c = 500 µm, d = 200 µm, e–j = 50 µm, k–p = 20 µm

Figure 5.2 *Dissoconium eucalypti* (MFLU 16-2906)



Note *Coniella tibouchinae* (CPC 18512) and *C. quercicola* (CBS 904.69) in Schizoparmaceae is used as the outgroup taxa. Bootstrap values for maximum likelihood ≥50% (ML) and clade credibility values >0.90 (the rounding of values to 2 decimal proportions) from Bayesian inference analysis labelled on the nodes. Ex-type strains are in bold and the new isolate is indicated in blue. The scale bar indicates 0.02 nucleotide changes per site.

Figure 5.3 Phylogram generated from maximum likelihood analysis based on combined LSU, ITS and TUB2 sequence data representing Cryphonectriaceae

Diaporthales Nannf.

Cryphonectriaceae Gryzenh. & M.J. Wingf.

Eriocamporesia R.H. Perera, Samarak., & K.D. Hyde, ***gen. nov.***

Indexfungorum number: IF556791; Faces of fungi number: FoF06959

Etymology: Named after the collector Erio Camporesi

Associated with twigs of dicotyledonous plant. **Sexual morph:** *Ascostromata* on host single, appearing as yellow pustules, pulvinate, semi-immersed in plant tissue, orange, KOH+ purple; ascostromatic tissue pseudoparenchymatous, covering the top of the ascomatal bases. *Ascomata* perithecial, usually valsoid, embedded in stromata at irregular levels, fuscous black, necks emerge at stromatal surface as dark orange brown ostioles covered with orange stromatal tissue to form papillae extending above stromatal surface. *Peridium* of 5–7 layers of flattened, elongate, brown-walled, cells of *textura angularis*. *Paraphyses* absent. *Asci* 8-spored, unitunicate, oblong ellipsoidal to fusoid to ellipsoidal, non-stipitate, floating freely in the perithecial cavity, thin-walled, apex simple. *Ascospores* bi-seriate, cylindrical to allantoid, occasionally ellipsoidal, ends round, curved or sometimes straight, aseptate, hyaline, smooth-walled, without appendages. **Asexual morph:** *Conidiostromata* appearing as yellow pustules on the host, occur as separate structures, pulvinate, semi-immersed, orange. *Conidiomata* multilocular, with locules often convoluted, non-papillate, with 1-ostiolar opening, orange, KOH+ purple; stromatic tissue pseudoparenchymatous. *Paraphyses* absent. *Peridium* of 2–4 layers of flattened, elongate, hyaline, cells of *textura angularis*. *Conidiophores* cylindrical, rarely septate or branching, hyaline. *Conidiogenous cells* phialidic, cylindrical with attenuated apices, hyaline. *Conidia* hyaline, cylindrical or allantoid, ends round, aseptate, hyaline, smooth-walled, without appendages.

Notes: DNA sequence evidence shows new fungus is a member of Cryphonectriaceae and, distinct from other genera in the family (Figure 5.3). *Eriocamporesia* resembles Cryphonectriaceae by orange ascostromata and conidiostromata which turned into purple in 3% KOH, and phialidic conidiogenous cells (Jiang et al, 2019; Gryzenhout et al., 2006). *Eriocamporesia* shares similar morphology with *Holocryphia* in having orange stromata, valsoid, fuscous black ascomata and non-stipitate asci (Chen et al., 2013). However, it can be segregated from *Holocryphia* by absence of paraphyses in conidiomata and allantoid conidia, while *Holocryphia* has

paraphyses and cylindrical conidia. Considering both molecular and morphological data we introduce *Eriocamporesia* as a new genus.

Eriocamporesia aurantia R.H. Perera, Samarak., & K.D. Hyde, ***sp. nov.***

Index fungorum number: IF556792; Faces of fungi number: FoF06960

Etymology: Name reflects orange stromata.

Associated with twigs of dicotyledonous plant. **Sexual morph:** *Ascostromata* on host single, appearing as yellow pustules, 450–670 μm high, 870–1000 μm diam., pulvinate, semi-immersed in plant tissue, orange, KOH+ purple; ascostromatic tissue pseudoparenchymatous, covering the top of the ascomatal bases. *Ascomata* 450–700 μm high, 120–330 μm diam., perithecial, usually valsoid, embedded in stromata at irregular levels, fuscous black, necks emerge at stromatal surface as dark orange brown ostioles covered with orange stromatal tissue to form papillae extending above stromatal surface. *Peridium* 12–24 μm wide, composed of 5–7 layers of flattened, elongate, brown-walled, cells of *textura angularis*. *Paraphyses* absent. *Asci* 30–43 × 6.7–8.7 ($\bar{x}$ = 37.6 × 7.8, n = 14) μm, 8-spored, unitunicate, oblong ellipsoidal to fusoid to ellipsoidal, non-stipitate, floating freely in the perithecial cavity, thin-walled, apex simple. *Ascospores* 9.5–14.5 × 2.5–3.3 ($\bar{x}$ = 11.6 × 2.8, n = 30) μm, bi-seriate, cylindrical to allantoid, occasionally ellipsoidal, ends round, curved or sometimes straight, aseptate, hyaline, smooth-walled, without appendages. **Asexual morph:** *Conidiostromata* 445–630 μm high, 1500–1800 μm diam, appearing as yellow pustules on the host, occur as separate structures, pulvinate, semi-immersed, orange. *Conidiomata* multilocular, with locules often convoluted, non-papillate, with 1-ostiolar opening, orange, KOH+ purple; stromatic tissue pseudoparenchymatous. *Paraphyses* absent. *Peridium* 4–7 μm wide, composed of 2–4 layers of flattened, elongate, hyaline, cells of *textura angularis*. *Conidiophores* 16.3–23.6 μm long, 1.6–2.3 wide, cylindrical, rarely septate or branching, hyaline. *Conidiogenous cells* 8.8–9.7 μm long, 1.1–1.6 wide, phialidic, cylindrical with attenuated apices, hyaline. *Conidia* 3.7–5.7 × 1–1.5 ($\bar{x}$ = 4.9 × 1.2, n = 30) μm, hyaline, cylindrical or allantoid, ends round, aseptate, hyaline, smooth-walled, without appendages.

Culture characters: Ascospores germinated on PDA within 12 hours, colonies on PDA reaching 35–38 mm diam. after 2 weeks at 25 °C, mycelium partly superficial, partly immersed, slightly effuse, with irregular edge, initially white, becoming orangish with time.

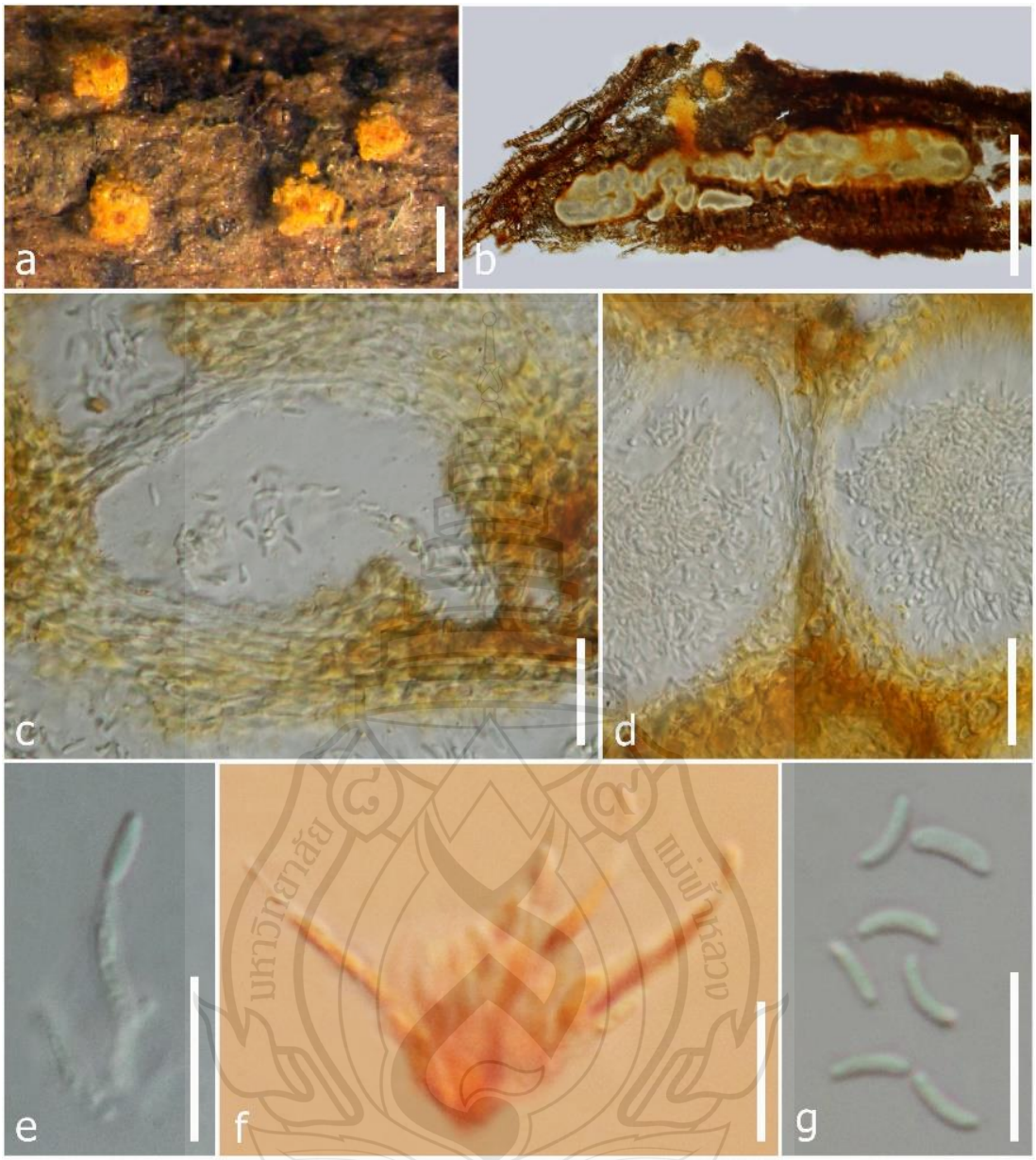
Material examined: THAILAND, Mae Rim Province, on twigs of dicotyledonous plant, R.H. Perera, 09 September 2017, Rim19 (MFLU 19-0943, Holotype), ex-type living culture, MFLUCC 17-2625.

GenBank numbers: ITS: MN699135, LSU: MN699130.

Notes: *Eriocamporesia aurantia* clusters within Cryphonectriaceae as a separate lineage (Figure 5.3). BLAST analysis of the ITS rDNA region of our new isolate showed highest similarity to *Amphilogia gyrosa* 91123101 (94 %, 465/494 bp), *Endothia gyrosa* AFTOL-ID 1223 (94 %, 531/564bp), *E. radicalis* CBS 116.13 (94 %, 549/585 bp), *Chrysoporthe inopina* CMW 12731 (94 %, 549/585 bp), CBS 116.13 (94 %, 543/580 bp), *Aurantiosacculus eucalyptorum* CBS 130826 (93 %, 548/587 bp), *A. eucalyptorum* CPC 13229 (93 %, 548/587 bp) and *Chrysoporthe syzygiicola* CBS 124488 (93 %, 552/593 bp). *Eriocamporesia aurantia* shares similar asexual morph characters to *Amphilogia* (Senanayake et al., 2017; Gryzenhout et al., 2005). However, it can be distinguished from *Amphilogia* species having valsoid perithecia, aseptate, cylindrical to allantoid ascospores, while *Amphilogia* has diatrypoid perithecia, 1–3 septate, fusoid to ellipsoid ascospores (Senanayake et al., 2017; Gryzenhout et al., 2005). Considering both molecular and morphological data we introduce *Eriocamporesia aurantia* as a novel species.

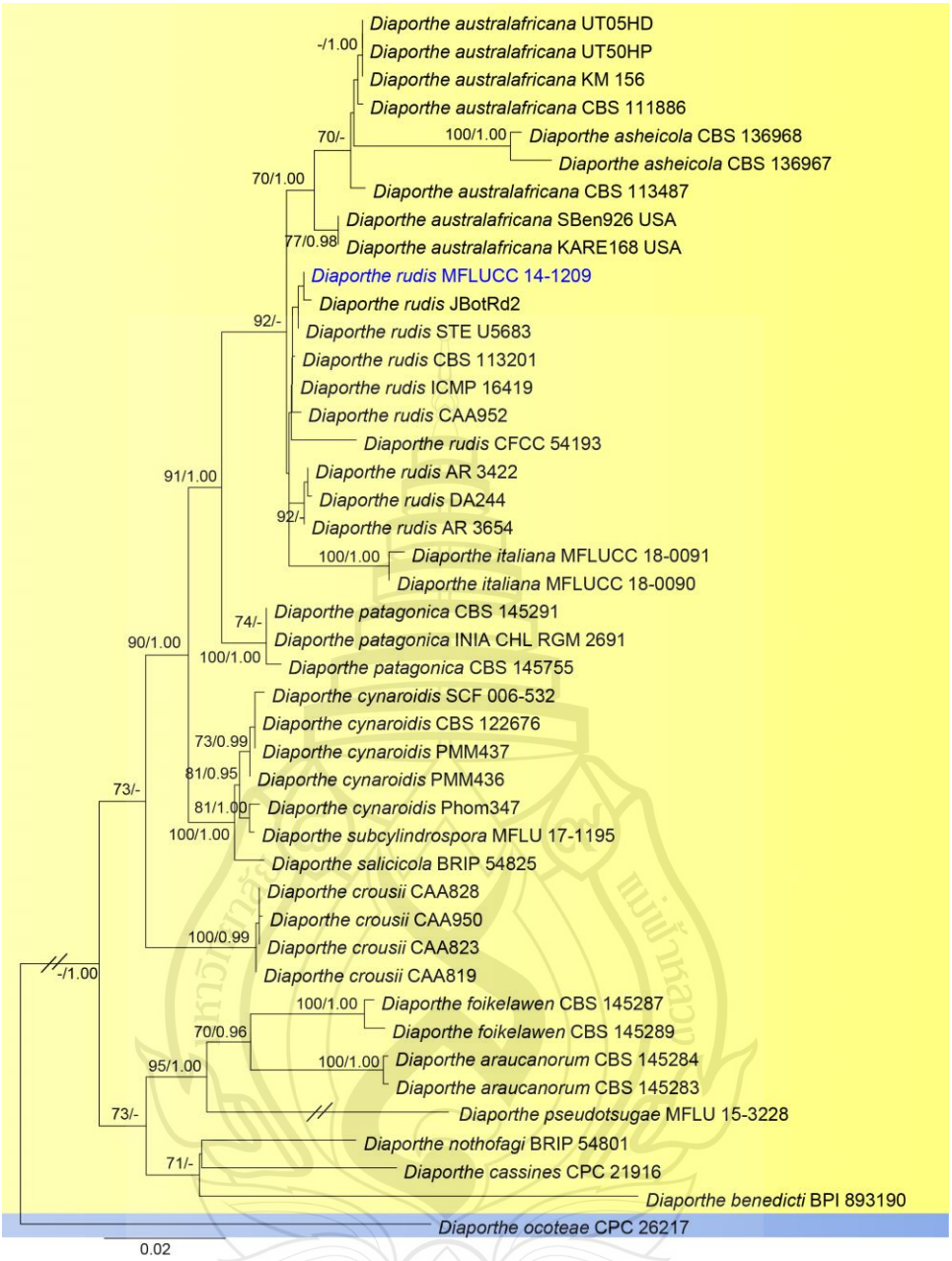
Note (a) Herbarium material. (b) Ascostromata on host. (c) Longitudinal sections of ascostromata. (d) Section of peridium. (e) Peridium in face view. (f–j) Asci. (k–o) Ascospores. (p) Germinating ascospore. Scale bars: b, c = 200 μm, d–j = 20 μm, k–o = 10 μm, p = 20 μm.

Figure 5.4 *Eriocamporesia aurantia* (MFLU 19-0943, holotype)



Note (a) Conidiostromaon host. (b) Longitudinal sections of conidiostroma. (c) Section of conidioma. (d) Section of peridium. (e, f) Conidiophores with conidia (f in Congo red). (g) Conidia. Scale bars: a = 100 μm, b = 500 μm, c, d = 20 μm, e–g = 10 μm.

Figure 5.5 *Eriocamporesia aurantia* (MFLU 19-0943, holotype)



Note *Diaporthe ocoteae* (CPC 26217) is used as the outgroup taxon. Bootstrap support values for ML ≥70% and BYPP ≥0.95 are given near the nodes respectively. Newly generated sequences are in blue.

Figure 5.6 Phylogram generated from maximum likelihood analysis based on combined ITS, TEF1, CAL and TUB2 sequenced data of selected *Diaporthe* species

Diaporthe Nitschke

Diaporthe rudis (Fr.) Nitschke, (Fr.) Nitschke, Pyrenomyc. Germ. 2: 282 (1870)

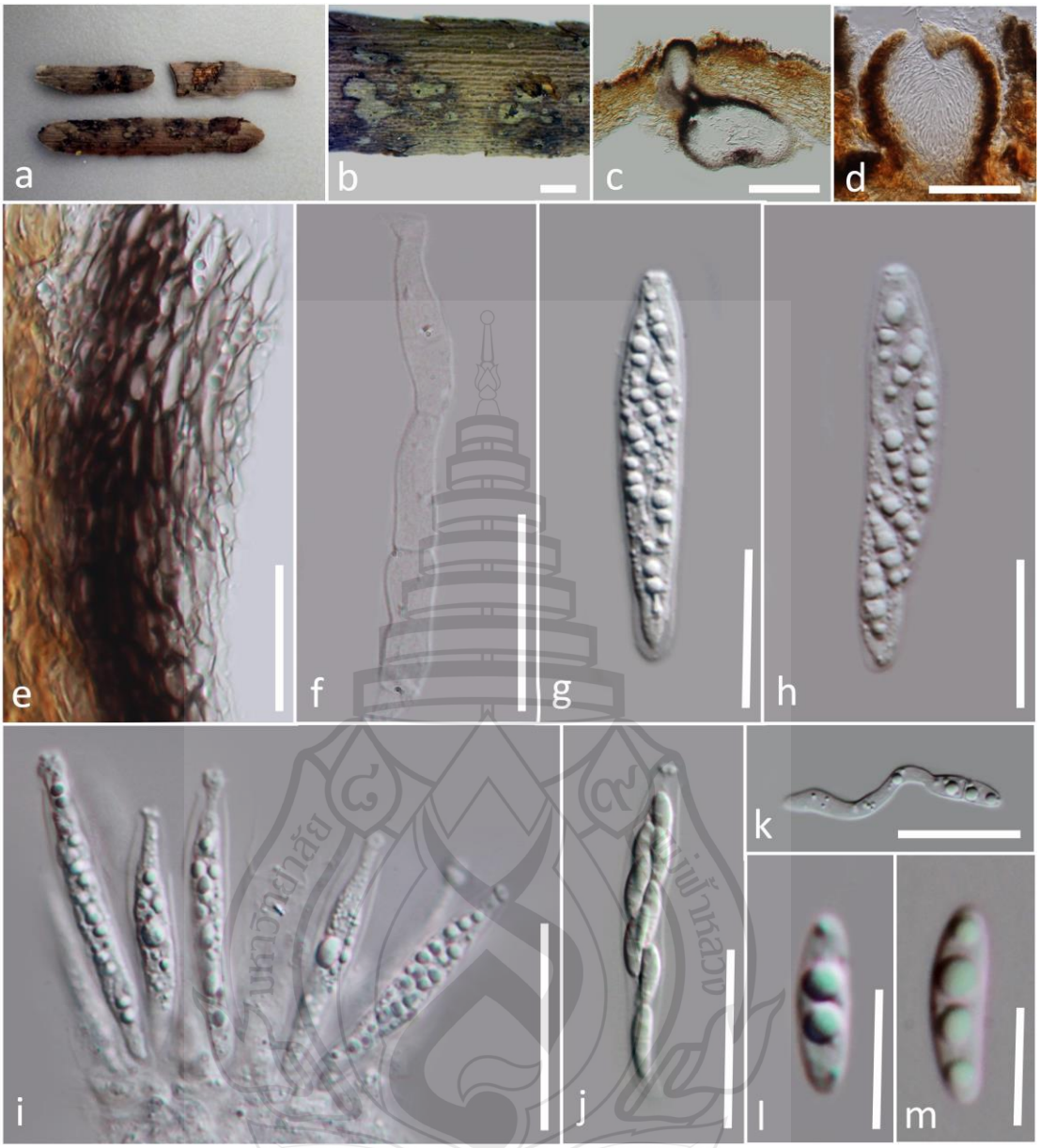
Facesoffungi number: FoF02353

Saprobic on dead branches of *Rosa canina* L. **Sexual morph:** *Ascomata* 200–300 lm high 230–320 µm diam. ($\overline{x}$ = 220 × 227 µm, n = 5, immersed in the ectostroma, erumpent through the host epidermis, visible as raised, pale yellow brown patches on the host surface, globose to flattened globose, solitary or occur in clusters, black brown, with a neck. *Neck* 205 × 99 µm diam. *Ostiole* periphysate. *Peridium* 25–40 µm wide, comprising 10–15 layers, outer layers heavily pigmented, thin-walled, comprising dark brown cells of textura globulosa to textura angularis, inner layers composed of hyaline to brown thin-walled cells of textura angularis. *Paraphyses* 6–9 µm (n = 10) 1–4-septate, wide at base, tapering towards the apex, thin-walled. *Asci* 40–50 × 7–12 µm ($\overline{x}$ = 47.8 9 9.1 µm, n = 20), 8-spored, unitunicate, cylindrical to cylindric clavate, straight to slightly curved, sessile, with a J- apical ring. *Ascospores* 9–12 × 2.5–3.5 µm ($\overline{x}$ = 11.3 × 3.2 µm, n = 30), overlapping uniseriate to biseriate, 1-septate, often tetra-guttulate, with larger guttules at center and smaller ones at the ends, ellipsoidal to clavate, straight to slightly curved, hyaline, without appendages or a mucilaginous sheath. **Asexual morph:** See Udayanga, Castlebury, Rossman et al. (2014).

Material examined: ITALY, Forlì-Cesena Province, near Corniolo, Santa Sofia, dead aerial branches of *Rosa canina* L. (Rosaceae), 20 September 2014, Erio Camporesi, IT 2111 (MFLU 15-3379), living culture MFLUCC 14-1209.

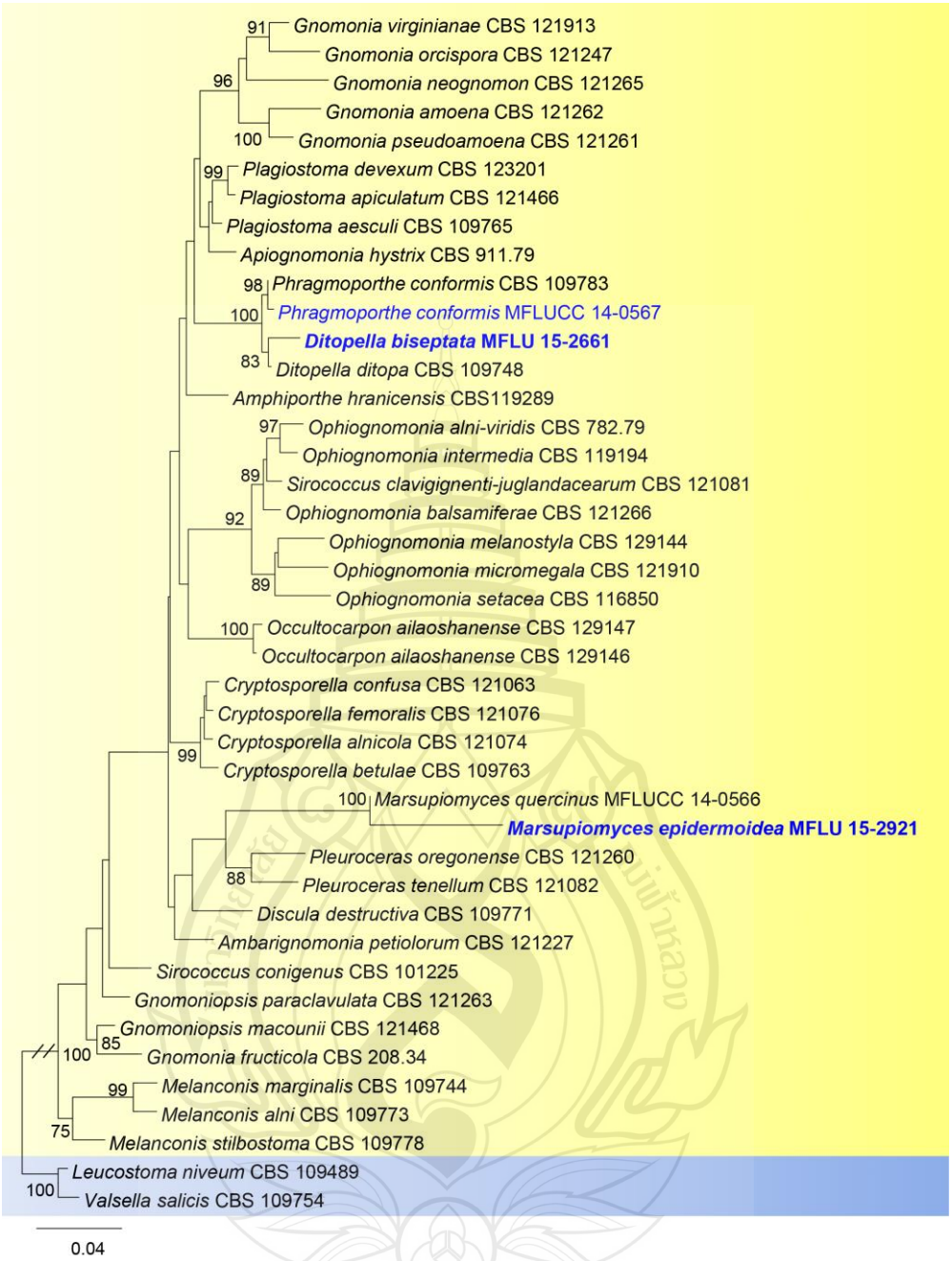
GenBank numbers: TUB2: KX856059, ITS: KX856060, LSU: KX856061, SSU: KX856062, TEF1: KX856063.

Notes: Our new isolate MFLUCC 14–1209 clustered with ex-type strain of *Diaporthe rudis* (AR 3422), which was originally described by Nitschke (1870) from *Laburnum anagyroides* (as *Cytisus laburnum*), but was also recorded from Rosa in Australia (Udayanga, Castlebury, Rossman et al., 2014). However, our collection differs from the type strain of *D. rudis* (Nitschke, 1870; Udayanga, Castlebury, Rossman et al., 2014) in having smaller asci (44–53 × 7.2–11.2 µm vs. 53.5–58.5 × 10.6–12 µm) and ascospores (9.4–12.3 × 2.7–3.5 µm vs. 12–14.2 9 3.5–3.7 µm). By considering the molecular data and the host, we consider our collection as a new record from *Rosa canina* in Italy.



Note (a, b) Appearance of ectostroma and ascomata on host substrate. (c) Vertical section through ectostroma with ascoma. (d) Section through ostiole. (e) Close up of peridium. (f) Paraphyses. (g–i) Immature and mature asci. (j) Ascus in Melzer's reagent. (k) Germinating ascospore. (l, m) Ascospores. Scale bars: b = 1 mm, c–j = 20 µm, k–m =5 µm.

Figure 5.7 *Diaporthe rudis* (MFLU 15-3379)



Note Maximum likelihood bootstrap support values greater than 50 % are shown near the nodes. New taxa are in blue and ex-type strains in bold. The tree is rooted with *Valsella salicis* and *Leucostoma niveum*. The scale bar indicates 0.04 nucleotide changes per site.

Figure 5.8 Maximum Likelihood tree resulting from analysis of combined LSU, ITS and TEF1 sequence data for taxa of the family Gnomoniaceae

Gnomoniaceae G. Winter

Ditopella biseptata R.H. Perera, Senan., Camporesi & K.D. Hyde, ***sp. nov.***

MycoBank number: MB821558; Facesoffungi number FoF03487.

Etymology: Species name refers to the ascospores that have two septa.

Saprobic on dead branch of *Alnus glutinosa*. **Sexual morph:** *Stromata* surrounding the perithecial necks, extending outward beneath the host periderm as a distinct clypeus, composed of dark brown thick-walled angular cells. *Ascomata* 500–900 μm diam, immersed in the ectostroma, situated between the epidermis and the cortex of the host tissue, appearing as solitary swellings of the host epidermis, sometimes epidermis ruptures to expose the rounded apex of the ostiole, perithecial, depressed globose to oval, ostiolate. *Ostiolar neck* lined with thin-walled hyaline, septate periphyses. *Peridium* 44 μm thick, 2-layered, outer layer composed of angular, sometimes slightly compressed, dark brown, thick-walled cells of *textura angularis*, inner layer of elongate, hyaline, thin-walled, compressed cells of *textura angularis*, wider around the ostiole, composed of dark brown, thick-walled cells of textura angularis. *Asci* 63–90 × 15–19 μm ($\overline{x}$ = 79 × 18.3 μm, n = 10), 16- to 32-spored, elongate-ellipsoidal to clavate, apedicellate, with a J- refractive apical ring, lying without paraphyses. *Ascospores* 18–27 × 3–4 μm ($\overline{x}$ = 23.8 × 3.6 μm, n = 30), multi-seriate, (1) 2(–3)-septate, not constricted at the septum, cylindrical to narrowly ellipsoidal, straight or very slightly curved, tapering slightly to bro2adly rounded ends, hyaline, guttulate, smoothwalled, with 2-polar appendages. **Asexual morph:** Undetermined.

Material examined: Italy, Province of Forlì-Cesena, Bagno di Romagna, near Lago Pontini, on dead branch of *Alnus glutinosa* (Betulaceae), 26 May 2014, E. Camporesi, IT 1891 (holotype, MFLU 15-2661).

Genbank numbers: ITS: MF190148, LSU: MF190090, RPB2: MF377617

Notes: Here we introduce a new species *Ditopella biseptata* based on phylogeny. *Ditopella biseptata* forms a distinct clade which is sister to *Ditopella ditopa* (Figure 5.8). Morphologically *Ditopella biseptata* has 2-septa and minute appendages at both ends. We could not obtain a culture from this fungus and extracted DNA directly from the sporocarps.

Note (a) Herbarium specimen. (b, c) Appearance of ascomata on host substrate. (d) Vertical section through ascoma. (e) Papilla. (f) Peridium. (g–j) Asci (J in Melzer's reagent). (k–m) Ascospores (m in Indian ink). Scale bars: c = 1 mm, d = 200 mm, e = 100 mm, f = 50 mm, g–j = 20 mm, k–m = 10 mm.

Figure 5.9 *Ditopella biseptata* (MFLU 15-2661)

Phragmoporthe Petr.

Phragmoporthe conformis (Berk. & Broome) Petr., Annls mycol. 39(4/6): 285 (1941)

Facesoffungi number: FoF01794

Basionym: *Sphaeria conformis* Berk. & Broome, Ann. Mag. nat. Hist., Ser. 2 9: 325 (1852)

Saprobic on *Alnus glutinosa* L. **Sexual morph:** Appearing as conical, pustules on the host surface. *Ascomata* perithecial, minutely stromatic, immersed, erumpent. *Perithecia* 700– 770μm diam. (n = 20), solitary, immersed in or directly below the host epidermis, globose, membranous, dark brown to black, with a periphysate ostiole. *Peridium* 14–38 μm ($\bar{x}$ = 22 μm, n = 10) wide, comprising 7–15 cell layers, outer layers heavily pigmented, thin-walled, comprising dark brown cells of textura angularis, inner layers composed of hyaline to brown, thin-walled, flat cells of textura angularis. *Hamathecium* lacking paraphyses. *Asci* 60–80 × 17–24 μm ($\bar{x}$ = 72 × 19.5 μm, n = 30), 8-spored, unitunicate, clavate, straight, short pedicellate, apically rounded or truncate, with a refractive, J- apical ring. *Ascospores* 19–24 × 6.5– 8 μm ($\bar{x}$ = 22 × 7 μm, n = 50), multi-seriate, fusiform, mainly with 3 transverse septa, occasionally constricted at septum, hyaline, smooth and thick-walled, without a mucilaginous sheath or appendages. **Asexual morph:** Undetermined.

Culture characteristics: Colonies growing on MEA, slow growing, reaching 4 cm diam. in 21d at 16 °C on MEA, white, dense, moderate aerial mycelium on the surface, underneath similar in colour, margins even.

Material examined: ITALY, Forlì-Cesena Province, Lago Pontini-Bagno di Romagna, dead branches of *Alnus glutinosa* (L.) Gaertn. (Betulaceae), 26 May 2014, Erio Camporesi, IT 1892 (MFLU 15-2662 reference specimen designated here), also in HKAS 92498, living culture, MFLUCC 14-0567.

Genbank numbers: ITS: KU315388, LSU: KU315389, TEF1: KU315391

Notes: The putatively named strain of *Phragmoporthe conformis* (CBS 109793) clustered with our newly collected strain (MFLU 14-0567), collected from Italy, on a dead a stem of *Alnus glutinosa*. Berkeley and Broome (1852) originally described *Phragmoporthe conformis* as Sphaeria conformis on Alnus spp. from the UK. Later Petrak (1941) synonymized *Sphaeria conformis* under *Phragmoporthe conformis*. The ascomata, size of asci and ascospores of our strain are typical of *P. conformis* (Petrak, 1941) and the molecular data is identical to CBS 109793. We therefore designate our collection as a reference specimen of *P. conformis* to stabilize the taxonomy of the genus.

Marsupiomyces Senan. & K.D. Hyde

Marsupiomyces epidermoidea R.H. Perera, Senan., Bulgakov & K.D. Hyde, ***sp. nov.***

MycoBank number: MB821557; *Facesoffungi number*: FoF03486

Etymology: Fungal peridium comprising cells of textura epidermoidea.

Saprobic on dead leaves of *Quercus robur*. **Sexual morph:** Appearing on the surface as black solitary swellings on the leaf surface. *Ascomatal cavity* pale in colour, tightly packed cells, forming a thin, coating around ascomata. Ascomata 200–310 μm diam, depressed globose to irregular. *Peridium* 11–36 μm thick, comprising 3–8 layers of brown to hyaline cells of textura epidermoidea, outer cell layer brown to pale brown, inner cells hyaline, elongate. *Asci* 54–83 × 11–15 μm ($\bar{x}$ = 71 × 14 μm, n = 25), 8-spored, unitunicate, clavate, apedicellate, with a J- refractive apical ring, lying without paraphyses. *Ascospores* 18–21 × 3–3.6 μm ($\bar{x}$ = 19 × 3.4 μm, n = 30), uni- to tri-seriate, 1-septate, not constricted at the septum, broadly fusiform, rounded at both ends, straight or very slightly curved, hyaline, guttulate, smooth-walled. **Asexual morph:** Undetermined.

Material examined: Russia, Rostov region, Shakhty city, Maisky, Cemetery Park, (47.6922302° E, 40.0925446° N), on dried leaf of *Quercus robur* (Fagaceae), 21 Jun. 2015, T.S. Bulgakov, T 776 (MFLU 15-2921, **holotype**, BBH 42451 **isotype**).

Genbank numbers: LSU: MF190058

Notes: Our new taxon, *Marsupiomyces epidermoidea* is a sister taxon to *Marsupiomyces quercina*, but sufficiently distinct. In addition, it is different from *Marsupiomyces epidermoidea* in having a distinct peridium comprising cells of *textura epidermoidea*.

Note (a) Herbarium specimen. (b, c) Appearance of ascoma on the leaf surface. (d) Vertical section through ascoma. (e) Peridium in surface view. (f) Peridium. (g–k) Asci. (l–o) Ascospores. Scale bars: b = 1 mm, c = 500 mm, d = 100 mm, e = 50 mm, f–k = 20 mm, l–o = 10 mm.

Figure 5.10 *Marsupiomyces epidermoidea* (MFLU 15-2921, holotype)

Diaporthomycetidae families *incertae sedis*

Barbatosphaeriaceae Huang Zhang, K.D. Hyde & Maharachch.

Barbatosphaeria Réblová 2009

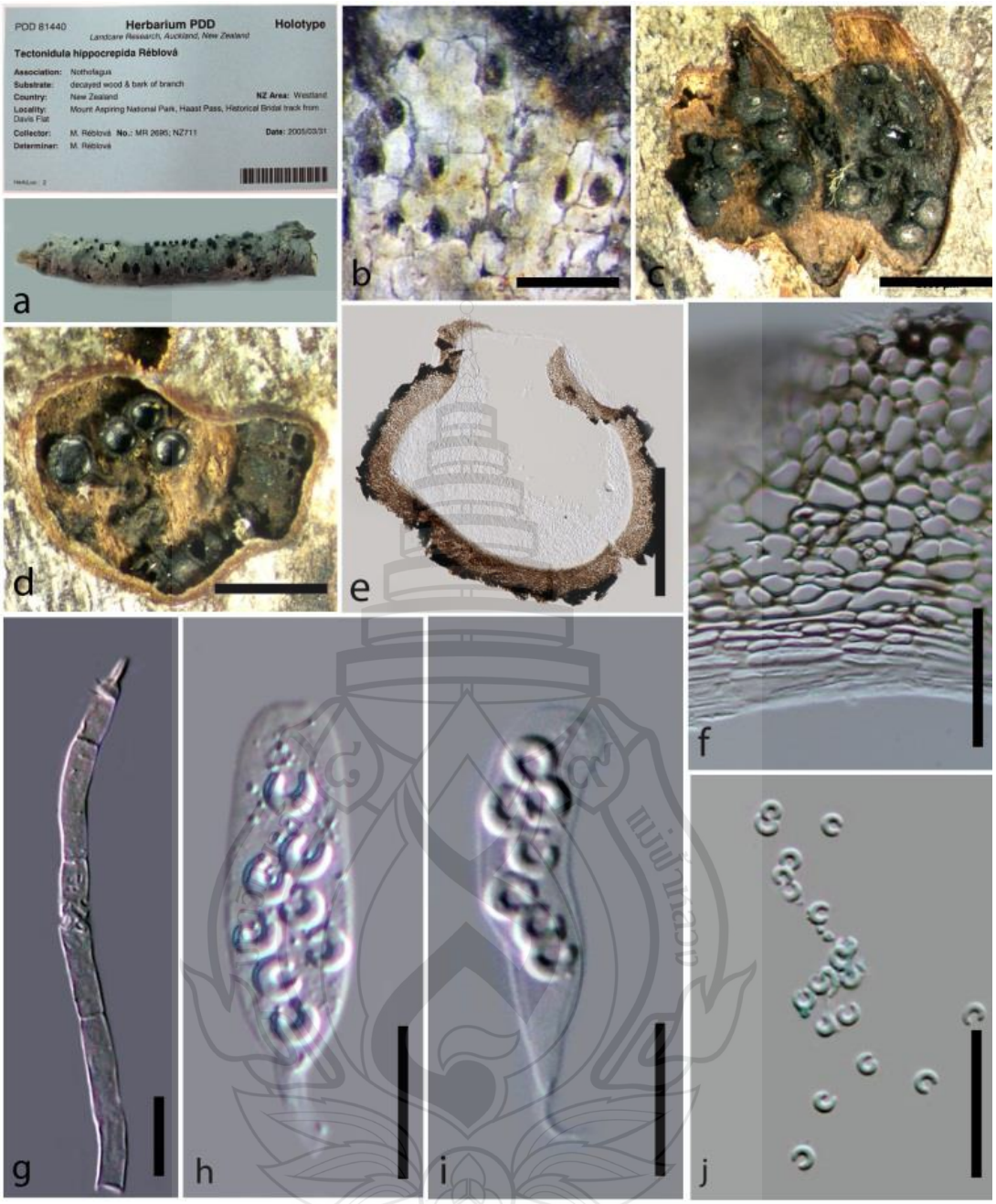
Barbatosphaeria hippocrepida (Réblová) Réblová, Persoonia 35: 32 (2015)

Synonymy: *Tectonidula hippocrepida* Réblová, Mycol. Res. 113(9): 998 (2009)

Sexual morph: *Ascomata* 326–500 µm high, × 370–550 µm diam., growing on decayed wood beneath the peridium, non-stromatic, arrange in circular groups of 5–11, slightly flattened, globose to subglobose, slightly flattened, dark brown to black. *Neck* 310–870 µm long, 100–115 µm wide, forming laterally, cylindrical, slightly flexuous, rounded-truncate at the apex. *Peridium* 30–50 µm wide, 3-layered, external layer with dark brown to black, opaque cells; middle layer composed of 10–15 cells of brown polyhedral *textura prismatica* or *t. globulosa*; inner layer composed of 3–5 cells of hyaline, thin walled, elongated, *textura prismatica*. *Paraphyses* 2.2–5.3 µm wide, septate, slightly constricted at the septa, tapering towards the tip, wider near the base, longer than the asci. *Asci* 17–20 × 3–5 µm ($\overline{x}$ = 18 × 4 µm) diam., unitunicate, cylindrical-clavate, with truncate apex, short stipe, mature asci with a septum near the bottom. *Ascospores* 2.8–4.6 × 0.65–0.83 µm ($\overline{x}$ = 3 × 0.7 µm) diam., one celled, U- to horseshoe shaped or 3⁄4 circular, allantoid, aseptate, hyaline, smooth, arrange as a group in the middle of the ascus.

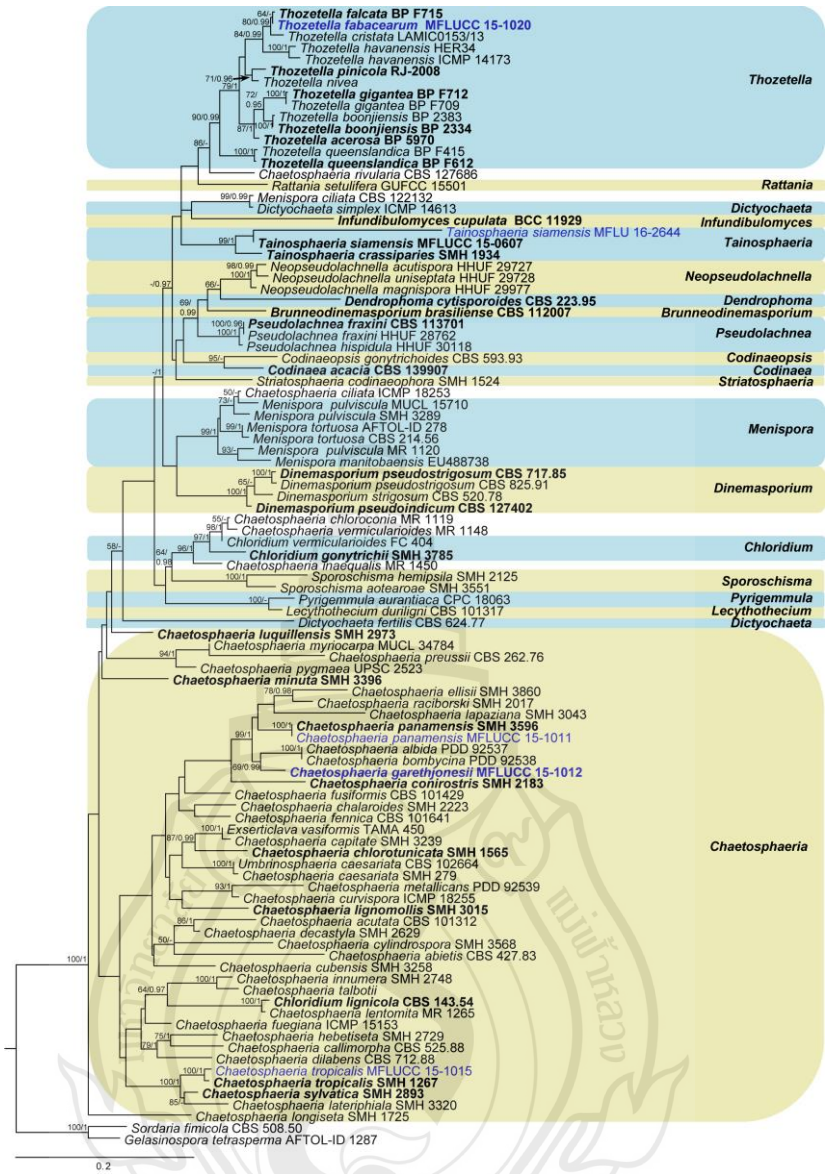
Material examined: NEW ZEALAND, Westlands, Mount Aspiring National Park, Haast Pass, Historical Bridal Track, decayed wood of the branch of *Nothofagus* sp., 31 Mar. 2005, M. Réblová ´ NZ 711, PDD 81440, **holotype**.

Notes: The genus *Barbatosphaeria* is described for *Calosphaeria barbirostris* occurring on decayed wood beneath the periderm (Réblová, 2007). Currently there are 8 species were described for this genus based on molecular data (Réblová, 2007; Réblová & Stepanek, 2009; Réblová et al., 2015). This genus was accommodated in the Sordariomycetes *incertae sedis* based on SSU sequences (Réblová, 2007), and later by multigene phylogenetic analysis of the SSU, LSU and RPB2 sequences (Réblová et al., 2015). Ascomata are non-stromatic perithecial with a long neck, and ascospores usually group in the middle of the sporiferous part of ascus, forming an empty apex. Asexual morph of *Barbatosphaeria* are ramichloridium- and sporothrix-like.



Note (a) Herbarium material with the label. (b) Perithecial necks protruding in the cortex. (c, d) Perithecia growing on wood beneath the cortex; cortex peeled off with a razor blade. (e) Longitudinal section of the peridium. (f) Longitudinal section of the perithecial wall. (g) Paraphyses. (h, i) Asci (j) Ascospores in cotton blue. Scale bars: b = 500 µm, c, d = 2 mm, e = 100 µm, f = 20 µm, g–i = 10 µm, j = 20 µm.

Figure 5.11 *Barbatosphaeria hippocrepida* (PDD 81440, holotype)



Note Maximum likelihood bootstrap support values greater than 50% and Bayesian posterior probabilities (PP) above 90% are shown near the nodes. The new isolates are in blue and ex-type strains in bold. The tree is rooted with *Gelasinospora tetrasperma* and *Sordaria fimicola*. The scale bar indicates 0.2 nucleotide changes per site.

Figure 5.12 Phylogram generated from maximum likelihood analysis of combined LSU, ITS and TUB2 sequence data from species of Chaetosphaeriaceae

Sordariomycetidae O.E. Erikss. & Winka

Chaetosphaeria panamensis Huhndorf & F.A. Fernández

Facesoffungi number: FoF02657, Figurs 5.13, 5.14

Saprobic on dead wood. **Sexual morph:** *Ascomata* 180–230 µm diameter, 195–285 µm high, scattered, sparse, superficial, not collapsing when dry, reddish-brown to dark brown, setose, rough-walled, papillate. *Setae* scattered over entire ascomata, dark brown, stiff, pointed, 60–85 µm long. *Peridium* 28–45 µm thick, with cells of *textura globosa* in surface view, 2-layerd in longitudinal section, inner layer 6–10 cells thick, comprising small, brown to dark brown, elongate to polygonal cells, with setae arising from inner layer, outer layer 4–6 cells thick, composed of large isodiametric to polygonal, brown to dark brown cells. *Paraphyses* 4–4.8 µm wide at the base, tapering towards the apex, numerous, septate. *Asci* 120–140 × 10–11.3 ($\bar{x}$ = 130.8 × 10.6, n = 10) µm, 8-spored, unitunicate, arising from the basal hymenium, cylindrical, rounded at the apex, with a J-, apical ring. *Ascospores* 60–73 × 3–4.1 ($\bar{x}$ = 68.2 × 3.5, n = 20) µm, filiform, loosely fasciculate, straight or slightly curved, 7-septate, without constrictions at the septum, rounded at both ends, apical end broader than the basal end, hyaline, smooth walled. **Asexual morph from the culture:** colonies on MEA cream coloured to light brown. *Conidiophores* macronematous, mononematous, flexuous, septate, branched, smooth, pale to moderately brown. *Conidiogenous cells* 4.3–5.3×1.5–2.1 µm, phialidic, flask-shaped to clavate, arising on septate, brown conidiophores, hyaline to light brown, guttulate, terminating with a flared conspicuous, cup-shaped collarette. *Conidia* 14.6–17×10–14.8 ($\bar{x}$ = 15.6 × 12.3, n = 20) µm, enteroblastic, hyaline, 1-celled, globose to subglobose or ellipsoid, guttulate. *Aleuriospore-like cells* absent.

Culture characters: Twenty-one day old colonies on MEA, 55–58 mm diameter, mostly immersed, with floccose superficial hyphae, margins effuse, light brown from above, reverse dark brown, producing asexual morph after 60 days of incubation in the dark at 28 °C.

Material examined: THAILAND, Chiang Mai Province, garden of Mushroom Research Center, on decorticated twig of *Pinus* (*Pinaceae* Spreng. ex F. Rudolphi), 12 July 2015, R.H. Perera, RHP 116 (MFLU 16-1014), living culture, MFLUCC 15-1011.

GenBank numbers: LSU: KY212760, ITS: KY212752, TUB2: KY212756

Notes: Our newly collected strain (MFLUCC 15-1011) clustered with the ex-type strain of *Chaetosphaeria panamensis* (SMH 3596), collected from wood fragment in Panama. The ascomata, size of asci, ascospores and asexual morph of our strain is typical of *C. panamensis* in the shape and size (Fernández & Huhndorf, 2005) and the ITS molecular data is identical to SMH3596, which is the only gene available for the ex-type. Here, we provide additional LSU, ITS and TUB2 sequence data for the species. This is the first record of *C. panamensis* for Thailand.

Chaetosphaeria jonesii R.H. Perera, Maharachch. & K.D. Hyde, ***sp. nov.***

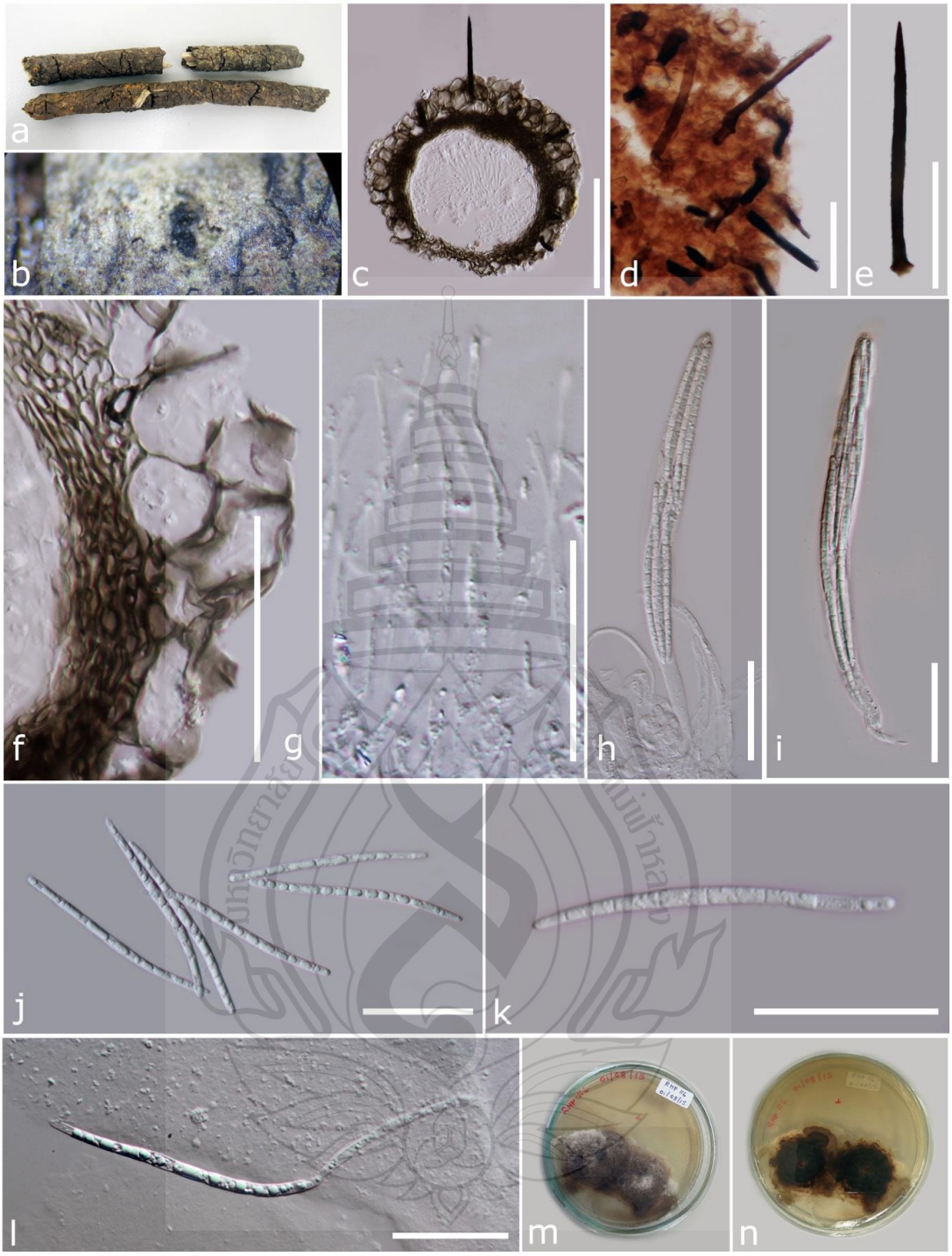
Index Fungorum number: IF552574; Facesoffungi number: FoF02659, Figure 5.15

Etymology: In honour of E.B.G. Jones for his work on tropical mycology.

Saprobic on wood. **Sexual morph:** *Ascomata* 102–250 µm diameter, 142–263 µm high, superficial, arranged in clusters, subglobose to globose, dark brown, surface rough, ostiolate, surrounded by setae. *Ostiole* periphysate. *Setae* brown, multi-septate, sinuous, cylindrical, with a rounded apex, arising from base of ascomata and abundant on the substrate. *Peridium* composed of dark brown cells of *textura angularis* in surface view, 11–16 µm thick in longitudinal section, 2 layered, inner layer 3–5 cells thick, composed of hyaline elongate cells of *textura angularis*, with outer layer 4–7 cells thick, composed of brown to dark brown, globose to polygonal cells. *Paraphyses* 3.9–4.6 µm wide, sparse, simple, septate. *Asci* 69–90 × 8.5–11 ($\bar{x}$ = 80×10 µm, n = 20) µm, 8-spored, unitunicate, cylindrical-clavate, short-pedicellate, with a thin, J-, apical ring. *Ascospores* 16.2–17.7 × 2.8–3.6 ($\bar{x}$ = 19.5 × 3.6 µm, n = 20) µm, overlapping biseriate, hyaline to pale brown, fusiform, 3-septate, curved, smooth-walled. **Asexual morph:** Undetermined.

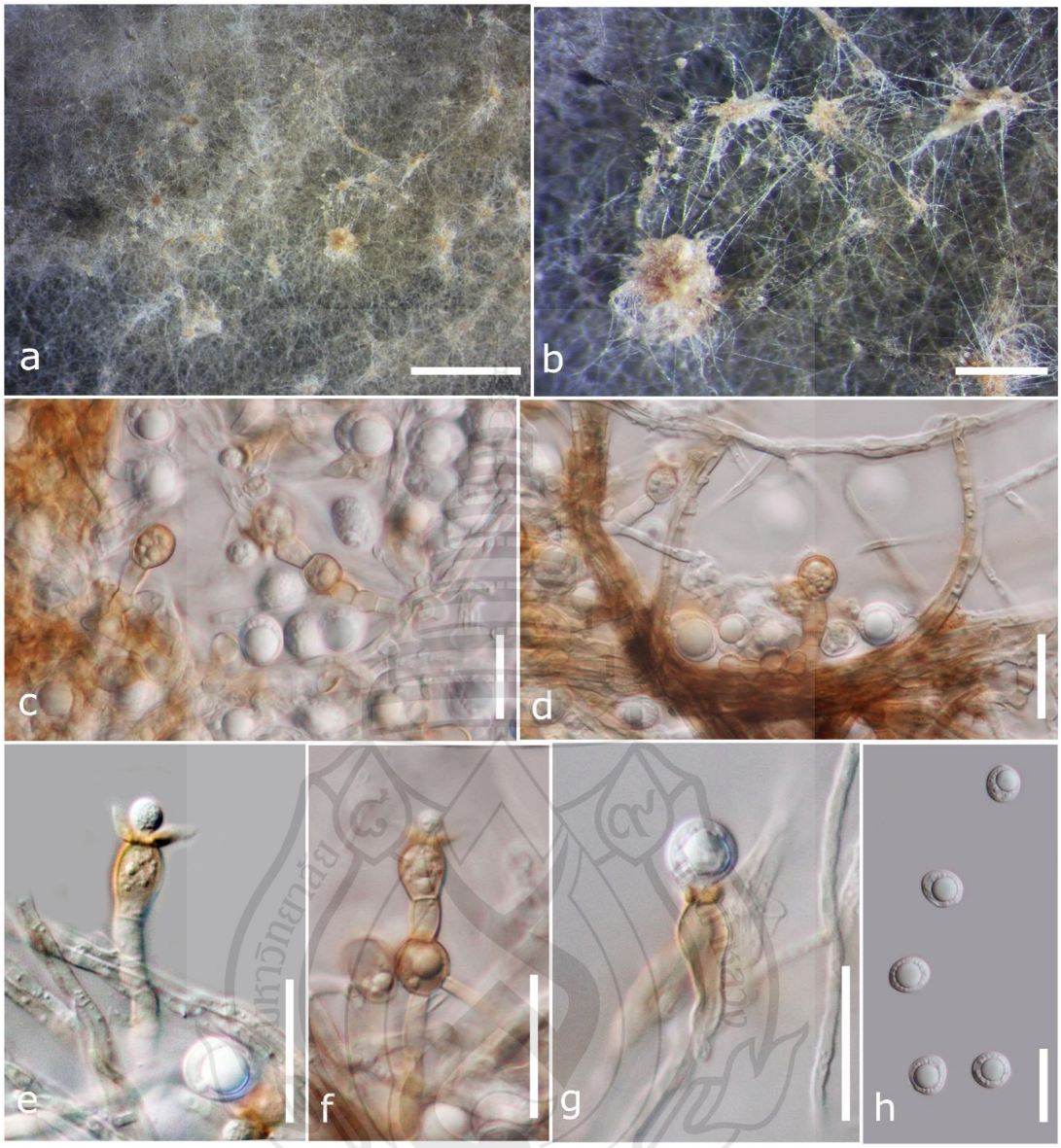
Material examined: THAILAND, Chiang Mai, on decorticated wood, 5 August 2015, S. Boonmee, RHP 121 (MFLU 16-1020, holotype), ex-type living culture, MFLUCC 15-1015.

GenBank numbers: LSU: KY212761, ITS: KY212753, TUB2: KY212757



Note (a, b) Appearance of ascomata on host substrate. (c) Section of ascoma. (d) Paraphyses. (h, i) Asci. (j) Ascospores. (k) Germinating ascospore. (m, n) Colony on MEA (above and below). Scale bars: c = 100 µm, d, e = 50 µm, f–l = 20 µm.

Figure 5.13 *Chaetosphaeria panamensis* (MFLU 16-1014)



Note (a, b) Sporulation in MEA. (c–g) Conidiophores with conidia. (h) Conidia. Scale bars: a = 2 mm, b = 500 µm, c–h = 20 µm.

Figure 5.14 *Chaetosphaeria panamensis* (asexual morph, MFLUCC 15-1011)

Notes: Maximum likelihood and Bayesian analyses of combined LSU, ITS and TUB2 sequence data shows, *Chaetosphaeria jonesii* (MFLUCC 15-1015) clustered with the ex-type strain of *C. tropicalis* F.A. Fernández & Huhndorf (SMH 1267) which was earlier collected from Puerto Rico, on a wood fragment. We observed that the asci (69–90×8.5–11 vs. 100–138 × 10–12.5 µm; Fernández & Huhndorf 2005) and ascospores

(16.2–17.7 × 2.8–3.6 vs. 19–26 × 3.2–6.3 µm; Fernández & Huhndorf, 2005) of our strain are smaller than *C. tropicalis. Chaetosphaeria jonesii* is also phylogenetically and morphologically close to *C. lateriphiala* F.A. Fernández & Huhndorf and *C. sylvatica* F.A. Fernández & Huhndorf. However, the ascomata (102–250×142–263 µm), asci (69–90×8.5–11 µm) and ascospores (16.2–17.7 × 2.8–3.6 µm) of *C. jonesii* are smaller than those of *C. lateriphiala* (ascomata: 200–248 × 234–307 µm, asci: 95–113 × 10–12.5 µm, ascospores: 18–24 × 4.5–6 µm; Fernández & Huhndorf, 2005). *Chaetosphaeria jonesii* also can be distinguished from *C. sylvatica* by its smaller ascomatal size (102–250 × 142–263 µm vs. 264–302 × 269–292 µm; Fernández & Huhndorf, 2005), smaller asci (69–90 µm vs. 95–115 µm; Fernández & Huhndorf, 2005) and thinner ascospores (2.8–3.6 vs. 4–5.5; Fernández & Huhndorf, 2005). By taking into account the morphological and molecular data we introduce *Chaetosphaeria jonesii* as a new species.

Tropohalonectria R.H. Perera, E.B.G. Jones & K.D. Hyde, ***gen. nov.***

Index Fungorum: IF552163, Facesoffungi number: FoF02234

Saprobic on dead leaves of Magnolia. **Sexual morph:** *Ascomata* immersed beneath raised surface under several layers of tissue which are not discoloured, solitary or in small clusters, globose to ellipsoidal, dark brown, non-membranous. *Neck* composed of several layers of long, cylindrical, compressed cells, yellow to light orange. *Peridium* of 2–3 strata of pale brown cells, inner layer comprising compressed angular cells, outer layer cell less distinct and fusing with the host at the outside. *Paraphyses* numerous, filamentous, acute at the apex, rounded at the base, tapering, septate, unbranched, hyaline, longer than the asci. *Asci* 8-spored, cylindrical, apedicellate, apex rounded to slightly acute, with J-, cylindrical apical ring. *Ascospores* filiform, 4–7 septate, slightly acute at the apex, rounded at the base, hyaline, yellow to light orange in mass, without sheath or appendages. **Asexual morph:** Hyphomycetous. *Phialides* flaskshaped, pale brown at base, with hyaline apex, collarette. *Conidia* allantoid, aseptate, hyaline (description modified from Promputtha et al., 2004).

Note (a) Herbarium specimen. (b, c) Appearance of ascomata on host substrate. (d) Section of ascoma. (e) Peridium. (f) Peridium in surface view. (g) Setae. (h) Paraphyses. (i, j) Immature and mature asci. (k) Close up of apical asci in Melzer's reagent. (l) Ascospores. (m) Germinating ascospore. Scale bars: b, c = 2 mm, d = 100 µm, e = 50 µm, f–o = 20 µm.

Figure 5.15 *Chaetosphaeria jonesii* (MFLU 16-1020, holotype)

Type species: ***Tropohalonectria suthepensis*** (Promp.) R.H. Perera, E.B.G. Jones & K.D. Hyde.

Notes: The terrestrial genus *Tropohalonectria* is introduced here to accommodate *Tropohalonectria suthepensis* previously treated as a member of the genus *Pseudohalonectria* (Promputtha et al., 2004). In this study, the ex-type strain of *P. suthepensis* Promp. (PDD 76762) forms a separate clade distinct to species of *Pseudohalonectria sensu stricto*, in a basal position in the phylogenetic tree within the Magnaporthales, Furthermore, differences from *Pseudohalonectria* can be observed in ascomata and ascospore characters in *P. suthepensis*. Therefore, a new combination is required to accommodate *P. suthepensis* in *Tropohalonectria*.

Tropohalonectria suthepensis (Promp.) R.H. Perera, E.B.G. Jones & K.D. Hyde, ***comb. nov.***

Basionym: *Pseudohalonectria suthepensis* Promp., in Promputtha, Lumyong, Lumyong, McKenzie & Hyde, Cryptog. Mycol. 25(1): 44 (2004).

Index Fungorum: IF552164, Facesoffungi number: FoF02233

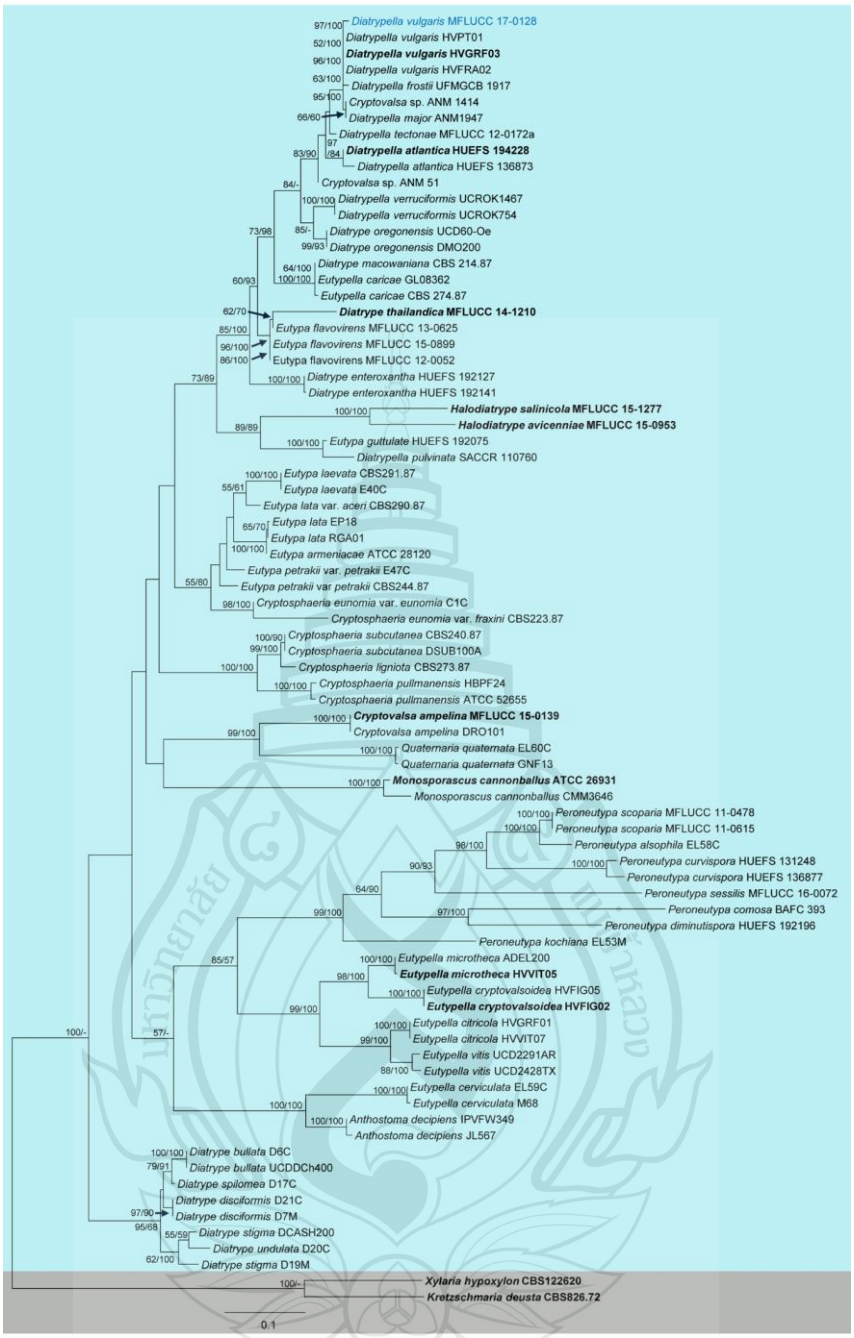
Descriptions and illustrations: see Promputtha et al. (2004)

Xylariomycetidae O.E. Erikss. & Winka

Xylariales Nannf.

Diatrypaceae Nitschke

Diatrypella (Ces. & De Not.) De Not.



Note Maximum likelihood/parsimony bootstrap support values similar or greater than 55% are shown at the nodes. The ex-type strains are in bold and new isolates are in blue. The tree is rooted with *Kretzschmaria deusta* and *Xylaria hypoxylon*.

Figure 5.16 Phylogram generated from Maximum likelihood analysis based on ITS and TUB2 sequence data of the family Diatrypaceae

Diatrype thailandica R.H. Perera, J.K. Liu & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF 552008, Facesoffungi number: FoF01797

Etymology: The specific epithet thailandica refer to the country in which the fungus was first collected.

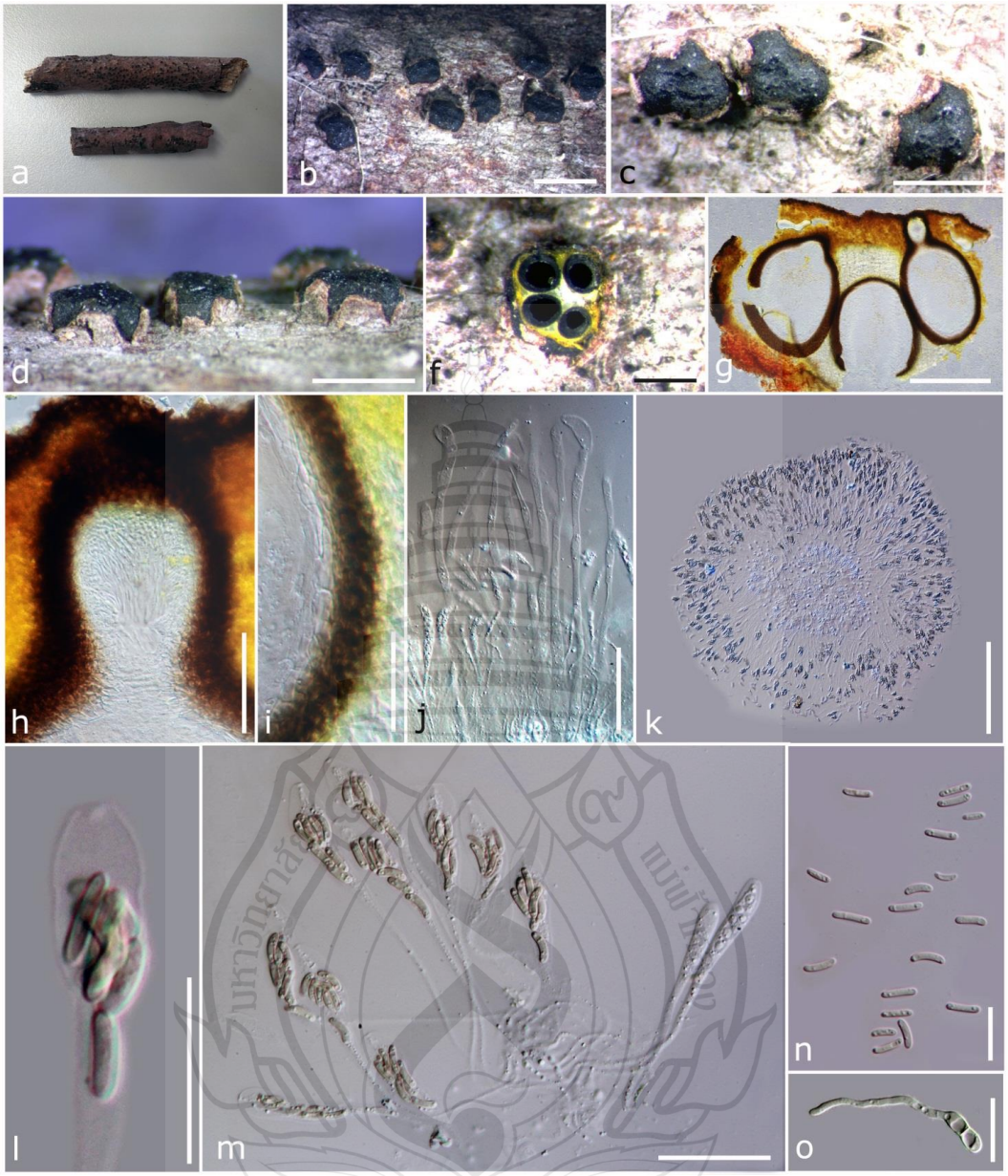
Saprobic on wood. **Sexual morph:** *Stromata* 1–1.2 mm wide, scattered on host, erumpent, arising through the cracks in bark epidermis, with 4 ascomata immersed in a single stroma, comprising an outer, dark brown to black, small, tightly packed, thin parenchymatous cell layer, inner layer yellowish, loosely packed, with parenchymatous cells, with ostioles opening to outer surface, appearing as black spots. *Ascomata* 226–336 μm high, 177–235 μm diam., ($\bar{x}$ = 282 × 209 μm, n = 20), perithecial, immersed in stromatic tissues, aggregated, globose to subglobose, narrowing towards the apex, pale brown, ostiolate. *Ostiolar necks* emerging separately, short, immersed in only dark outer layer of stromata, conical, periphysate. *Peridium* 6.5–15μm wide ($\bar{x}$ = 11 μm, n = 20), comprising strata of 4–8 layers of cells of hyaline to dark brown cells of textura angularis. *Hamathecium* comprising 2.2–4.5μm wide ($\bar{x}$ = 3μm, n = 20), aseptate, paraphyses, longer than the asci, wider at the apex. Asci 55–80 × 5–7μm ($\bar{x}$ = 67 × 6μm, n= 25), 8-spored, unitunicate, with narrow, long, thin-walled pedicel, with cylindrical, thick-walled, swollen upper portion, apex flat, with J-, conspicuous apical apparatus. *Ascospores* 3.8–6.9 × 1–1.4 μm ($\bar{x}$ = 5.4 × 1.2 μm, n = 20), multi-seriate to overlapping pale brown, allantoid to cylindrical, unicellular, with small, fat globules at the ends, smooth walled. **Asexual morph:** Coelomycetous, libertella-like, *Mycelial clumps* white. *Conidiomata* pycnidial, 0.4–1 mm diam., brownish yellow, becoming dark brown when mature, watery, bubble-like, rounded, conidial masses forming from mycelial clumps. *Pycnidia* superficial, solitary or aggregated, subconical, globose to subglobose, shiny, with smooth surface, yellow, dark brown, comprising brown, thick-walled cells of textura angularis. Conidiophores 12–16 μm high, 1.8–2.3μm wide ($\bar{x}$ = 14 × 2.1μm, n = 20) branched, arising from pseudoparenchymatous cells or interwoven hyphae. *Conidiogenous cells* 5.9–10 μm high, 1.1–1.8 μm wide ($\bar{x}$ = 8.4 × 1.6μm, n = 20), cylindrical, in dense palisades, straight or curved, apically distorted or bearing annellations. *Conidia* 14.2–18 × 0.7–1 μm ($\bar{x}$ = 16.7 × 0.9 μm, n = 20), filiform, curved or rarely straight, with flattened base and blunt apex, hyaline.

Culture characteristics: Fast growing, reaching 6.7 cm within 14 days on PDA, at 25 °C, circular, flat, with diffuse margin, white, and becoming yellowish-white, dull yellow to brownish with age.

Material examined: THAILAND, Doi Mae Salong, on stems of unidentified plant, 12 March 2015, R.H. Perera, RHP 27 (MFLU 15-3662, holotype); *ibid*., HKAS 92497, isotype), ex-type living culture, MFLUCC 14-1210, CUMCC 15-0019.

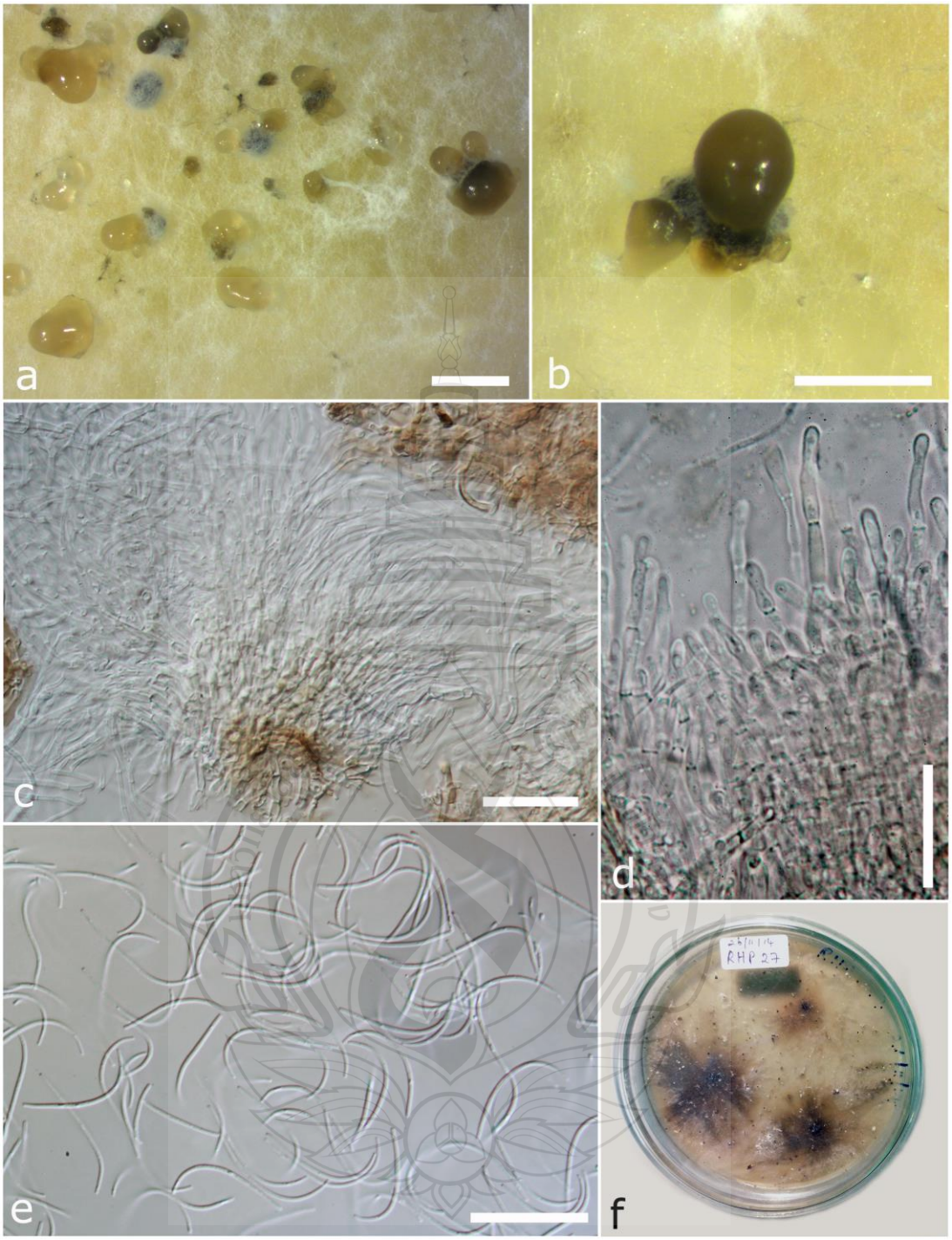
GenBank numbers: ITS: KU315392

Notes: Based on the phylogenetic analysis of ITS sequence data, *Diatrype* thailandica form a separate branch as a sister group with *Diatrypella* and *Diatrype* species. Previous studies by Trouillas et al. (2011) and Acero et al. (2004) suggested that both *Diatrypella* and *Diatrype* are polyphyletic within the family. However, *Diatrype thailandica* is morphologically similar to the members of the genus *Diatrype* in both sexual and asexual morph characteristics. In the phylogenetic analysis it has a close relationship with *D. macowaniana* which was isolated from dead branches of *Cassina capensis* in South Africa. *Diatrype thailandica* is different from *D. macowaniana* in having yellow inner cells in the stromata, with smaller, pale brown, mostly allantoid ascospores, and longer asci, while *D. macowaniana* is characterized by stromata with white inner cells, larger, cylindrical ascospores and smaller asci. Diatrypaceae is a taxonomically confused family and it is presently difficult to segregate genera (Trouillas et al., 2011; Vasilyeva et al., 2006; Liu et al., 2015). Therefore, the placement of this isolate into the genus *Diatrype* may require reconsideration in the future together with a revision for the entire family.



Note (a) Herbarium material. (b–d) Appearance of stromata on host substrate. (e) Longitudinal section through stroma. (f) Vertical section through stroma showing ascomata. (g) Close up of the ostiole. (h) Close up of the peridium. (i) Paraphyses. (j) Arrangement of asci. (k) Ascus in Melzer's reagent. (l) Immature and mature asci. (m) Ascospores. (n) Germinating ascospore. Scale bars: b = 2 mm, c–e = 500 µm, f = 50 µm, g–j = 20 µm, k = 100 µm, l = 10 µm, m = 20 µm, n, o = 10 µm

Figure 5.17 *Diatrype thailandica* (holotype)



Note (a, b) Conidiomata on PDA. (c) Cross section of conidioma. (d) Conidia attached to conidiophores. (e) Conidia. f Sporulation on one-month old culture on PDA, 25 °C. Scale bars: a, b = 1 mm, c–e = 20 μm.

Figure 5.18 *Diatrype thailandica* (holotype)

Diatrypella vulgaris Trouillas, W.M. Pitt & Gubler 2011

Facesoffungi number: FoF03591; Figure 5.19

Saprobic on decaying wood. **Sexual morph** *Stromata* 780–1500 *μm* wide, well developed, in pustules, solitary or gregarious on host, semi-immersed, erumpent through host epidermis, with 3–6 ascomata immersed in a single stroma, comprising of outer, dark brown to black, small, tightly packed, thin parenchymatous cell layer, inner white, loosely packed, parenchymatous cells. *Ascomata* 255–450 *μm* diam., ($\bar{x}$ = 598 × 343 *μm*, n = 20), perithecial, immersed in stromatic tissues, aggregated, globose to subglobose, sometimes with flattened base, pale to dark brown, ostioles sulcate, only slightly prominent. *Peridium* 20–44 *μm* wide ($\bar{x}$ = 30 *μm*, n=20), 2 layered, inner 4–6 layers of hyaline, flattened, elongate, thin walled cells of *textura angularis*, outer 6–13 layers of pale to dark brown, flattened, thick walled cells of *textura angularis*. *Hamathecium* comprising 4–7.8 μm wide ($\bar{x}$ = 5.6 *μm*, n = 20), septate, paraphyses, tapering towards the apex, wider at the base. *Asci* 90–130 × 14–19 *μm* ($\bar{x}$ = 134 × 16 *μm*, n = 25), multi-spored, unitunicate, clavate, with long, thin-walled pedicel, with swollen upper portion, apex rounded, without an apical apparatus. *Ascospores* 4.5–7.5 × 1.0–2.0 *μm* ($\bar{x}$= 5.5 × 1.4 *μm*, n=20), overlapping, subhyaline, allantoid to cylindrical, unicellular, with small, fat globules at ends, smooth-walled, without sheet or appendages.

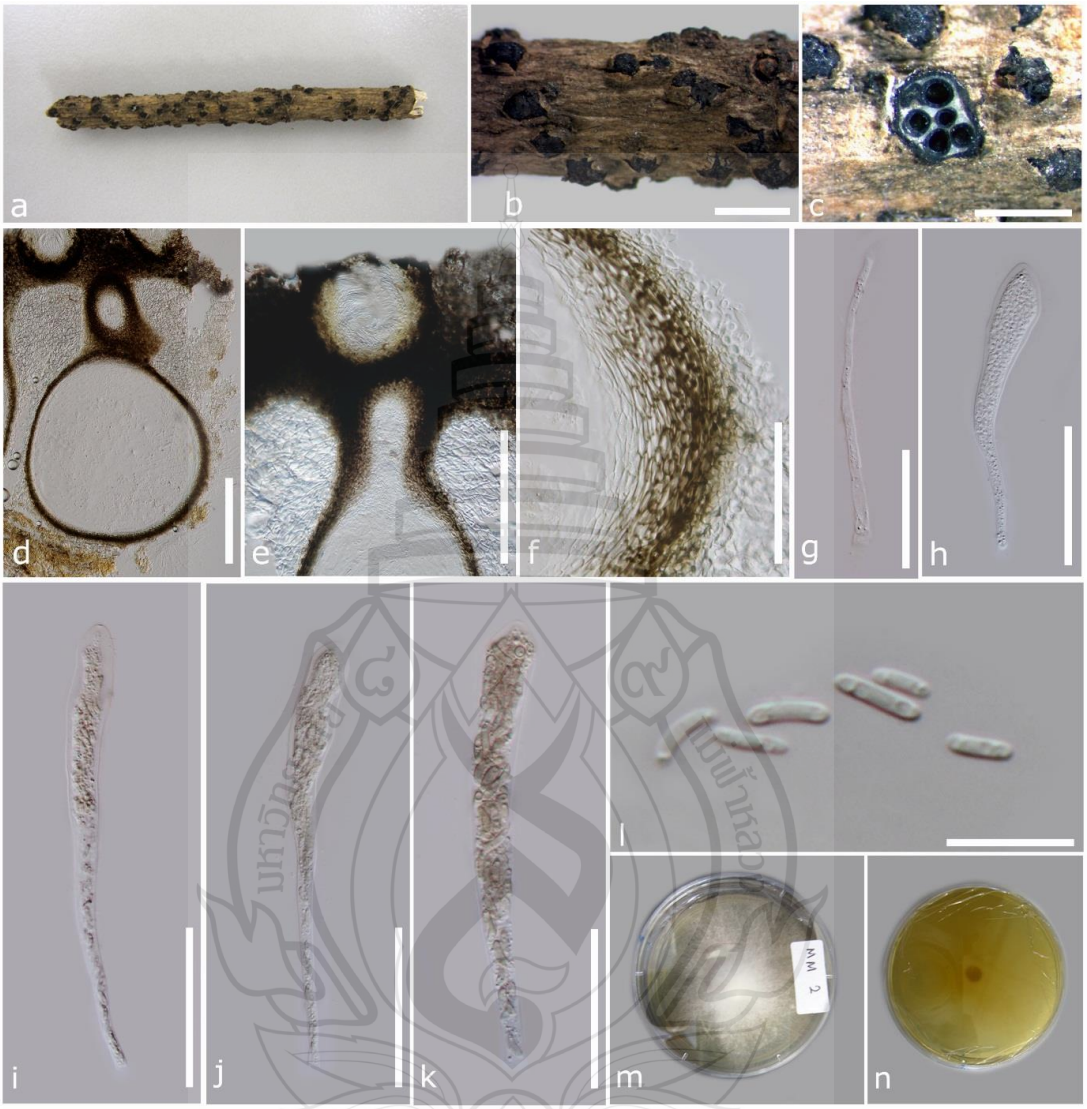
Culture characteristics: Colonies reaching 6.5 cm within 14 days on PDA, at 25 °C, circular, flat, with diffuse margin, white become light brown with age, reverse similar in colour, not zonate.

Material examined: THAILAND, Chiang Rai, on stems of unidentified plant, 01 Jan 2015, R.H. Perera, MM-2 (MFLU 17-0737), living culture, MFLUCC 17-0128.

GenBank numbers: LSU: MF467945, ITS: MF467943, TUB2: MF467947

Notes: In the phylogenetic analysis, new strain MFLUCC 17-0128 is closely related to ex-type strain of *D. vulgaris* (HVGRF03) and other two strains of *D. vulgaris* (Figure 5.16). The comparisons of ITS and TUB2 sequence data from both strains show 100 % similarity for each gene. Morphologically, strain MFLUCC 17-0128 has similar ascomatal, asci and colony characteristics to those of *D. vulgaris*, and the only different character is the dimension of the ascospores. Strain MFLUCC 17-0128 has smaller ascospores (4.5–7.5 × 1.0–2.0 vs. 8−10 × 2–2.5 *μm*) than *D. vulgaris* (Trouillas et al., 2011). *Diatrypella vulgaris*, has been reported from *Citrus paradise* and *Fraxinus*

angustifolia in Austria (Trouillas et al., 2011), and this is first record of the species in Thailand.



Note (a) Herbarium material. (b) Appearance of ascomata on host substrate. (c) Longitudinal section through stroma. (d) Vertical section through ascoma. (e) Close up of the ostiole (f) Close up of the peridium (g) Paraphyses (h–k) Immature and mature asci. (l) Ascospore. (m, n) Colony on MEA. Scale bars: b = 2 *mm*, c = 1 *mm*, d = 200 *µm*, e–k = 50 *µm*, l = 20 *µm*.

Figure 5.19 *Diatrypella vulgaris* (MFLU 17-0737)

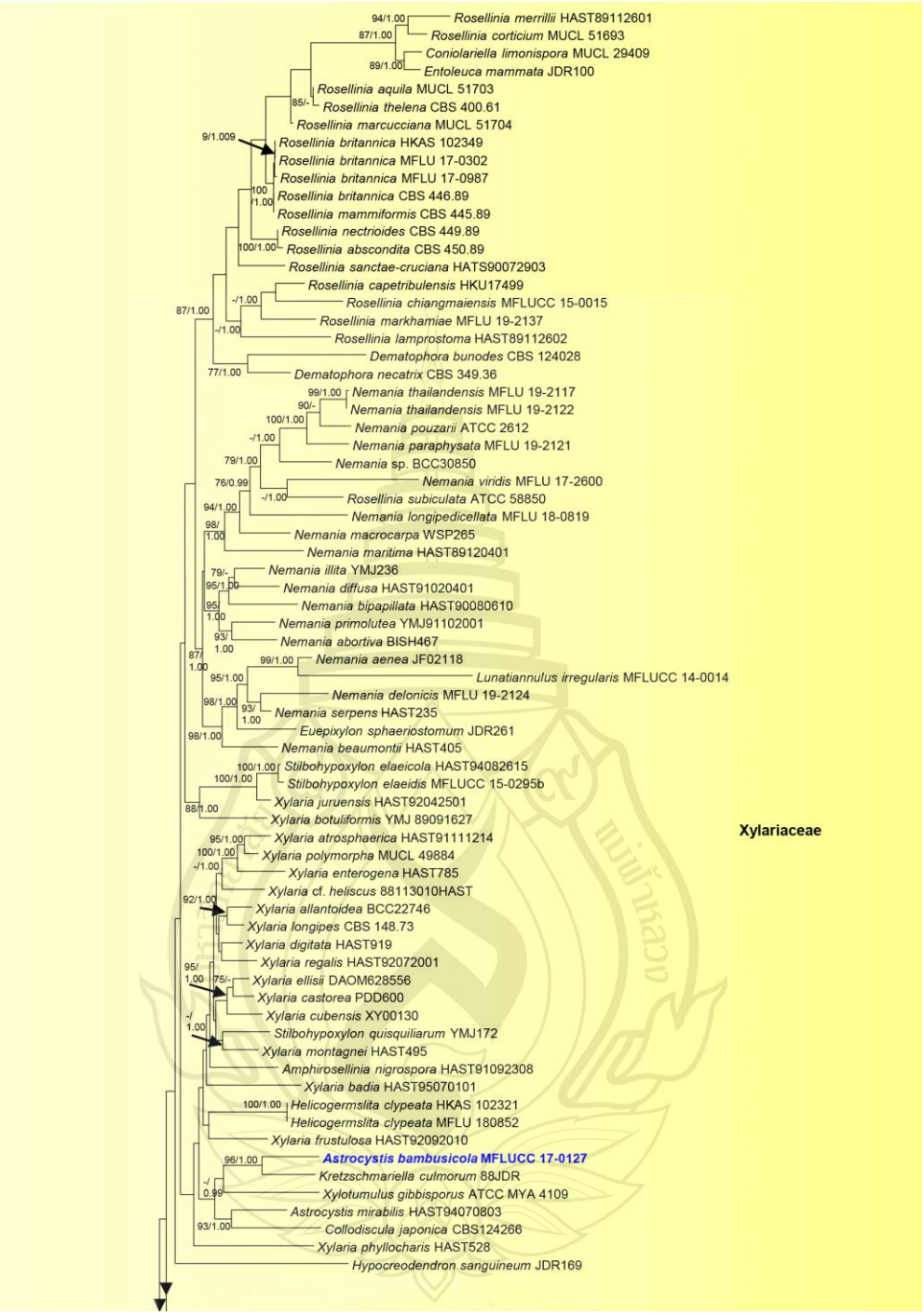
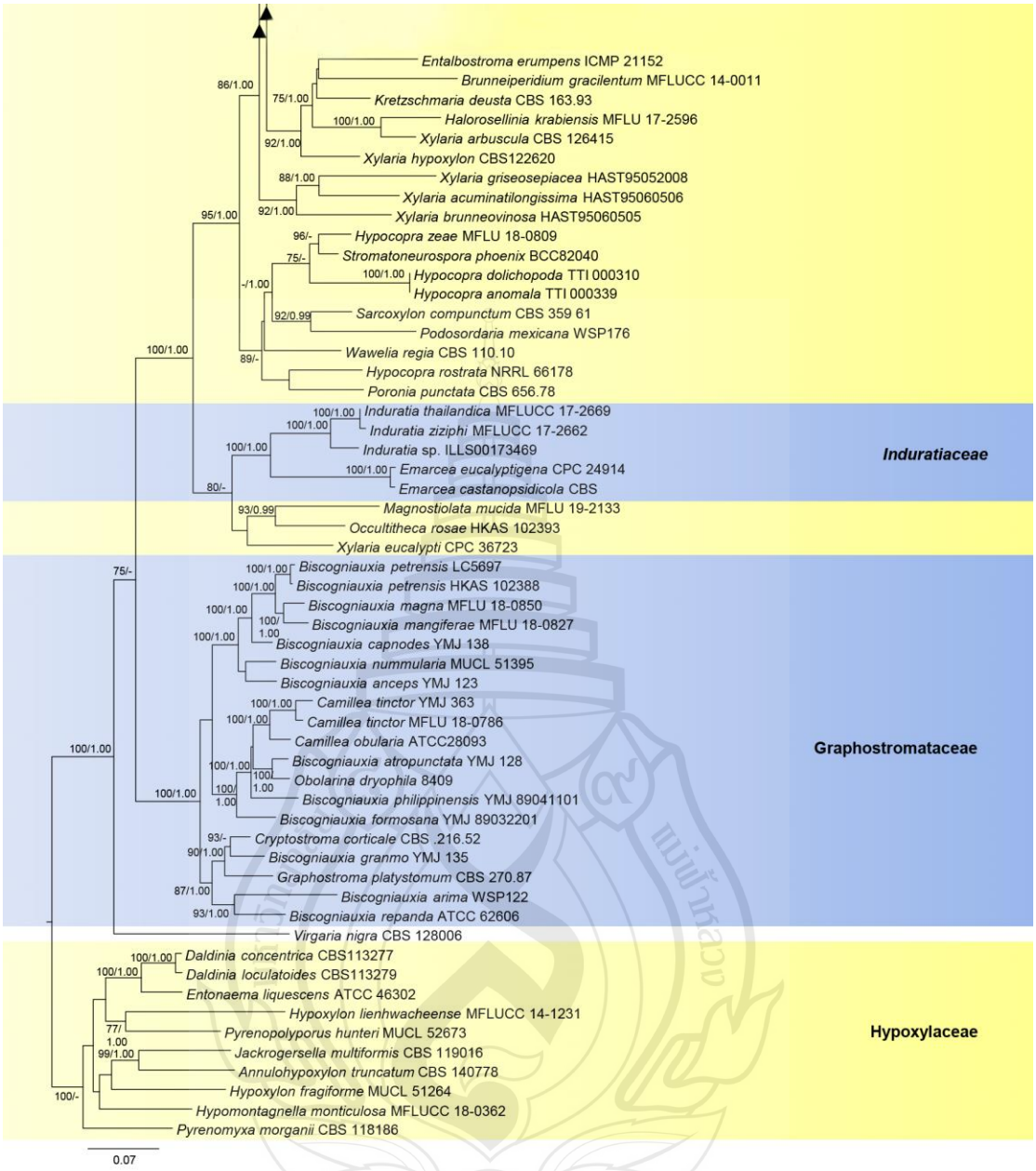


Figure 5.20 Phylogram generated from maximum likelihood analysis based on combined ITS, LSU, RPB2, and TUB2 sequence data of Xylariales



Note Bootstrap support values for ML greater than 75% and Bayesian posterior probabilities greater than 0.99 are given near nodes, respectively. The tree is rooted to Hypoxylaceae. The newly generated sequences are indicated in blue. The scale bar indicates 0.07 nucleotide changes per site.

Figure 5.20 (continued)

Xylariaceae Tul. & C. Tul.

Astrocystis Berk. & Broome

Astrocystis bambusicola R.H. Perera & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF553799; Facesoffungi number: FoF03592, Figure 5.21

Etymology: Referring to the host name.

Saprobic on dead bamboo twig. Appearing as black raised spots on the host. *Pseudostromata* black, erumpent, minutely flanged. **Sexual morph** *Ascomata* 200–600 μm diameter, 150–200 μm high, perithecial, solitary to gregarious, immersed becoming raised and superficial, globose to hemisphaerical, black, carbonaceous, with flattened top, surrounding by pseudostromatal tissue, each pseudostroma containing one or two single perithecium with papillate ostioles, lacking periphyses. *Peridium* 30–50 μm thick, comprising black, fragile, carbonaceous tissue. *Hamathecium* comprising 5.5–6 μm wide, septate, branched paraphyses. *Asci* 85–110 × 7.5–10 μm ($\bar{x}$ = 96 × 8.6 μm, n = 20), 8-spored, unitunicate, cylindrical, with a short pedicel, with a 3–4.5 high × 1.5–2.5 diameter, J+, apical ring. *Ascospores* 12–16 × 6.1–7 μm ($\bar{x}$ = 15 × 6.8 μm, n = 20), uniseriate, ellipsoid, slightly pointed at the ends, aseptate, brown to dark brown, guttulate, smooth-walled, with a germ-slit slightly less than full length, without a gelatinous sheath. **Asexual morph** Undetermined.

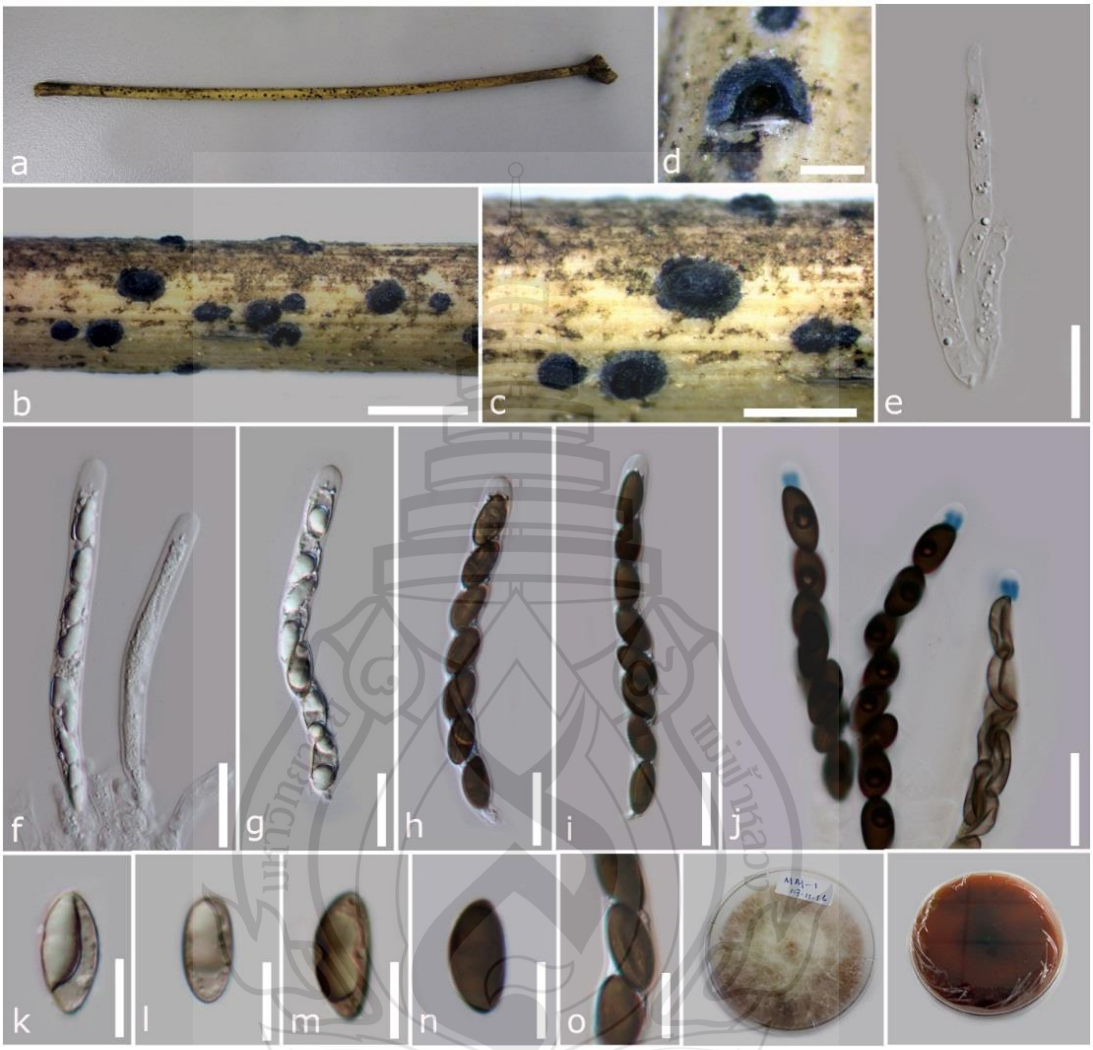
Culture characteristics: Ascospores germinating on MEA within 18 hrs, at 25°C. Colonies reaching 80 *mm* in 2 weeks at 25°C, cottony, mycelium superficial to immersed in media, circular, edge irregular, white from above, reverse similar in colour.

Material examined: THAILAND, Doi Mae Salong, on twigs of bamboo, February 2016, R.H. Perera, MM-1 (MFLU 17-0738, holotype), ex-type living culture, MFLUCC 17-0127.

GenBank numbers LSU: MF467944; ITS: MF467942; RPB2: MF467946.

Notes: Our new strain, *Astrocystis bambusicola* forms a robust clade closer to other *Astrocystis* species, with good statistical support (83% BT) (Figure 5.20). It was isolated from a bamboo twig, while *Astrocystis mirabilis* and *A. bambusae* were originally described from bamboo (Berkeley & Broome, 1874; Læssøe & Spooner, 1994). However, *Astrocystis bambusicola* can be distinguished from *A. mirabilis* by superficial stromata (vs. erumpent), larger ascospores (12–16 × 6.1–7 vs. 85–110 × 7.5–

10 µm) and smaller asci (10–12 × 6–7.5 vs. 110–190 × 8.5–12 µm) (Ju & Rogers, 1990; Dai et al., 2017).



Note (a) Herbarium specimen. (b, c) Appearance of ascomata on host substrate. (d) Vertical section through stromata. (e) Paraphyses. (f–i) Asci. (j) Asci with J+ apical ring. (k–n) Ascospores (o) Ascospore with the germ slit. (p, q) Colony on MEA. Scale bars: b = 200 µm, c = 1 mm, d = 500 µm, e–j = 20 µm, k–o = 10 µm.

Figure 5.21 *Astrocystis bambusicola* (holotype, MFLU 17-0738)

Astrocystis bambusicola differs from *A. bambusae* by superficial stromata (vs. erumpent), larger ascospores (12–16 × 6.1–7 vs. 10.5–15 × 4–6 µm) and smaller asci (10–

12 × 6–7.5 vs. 100–130 × 5–7 μm) (Læssøe & Spooner, 1994). Furthermore, *A. bambusae* similar to *A. thailandica* which was collected from Thailand, by having superficial stromata with black, stellate stromatic material encircling the base. However, *A. bambusicola* is characterized by smaller ascomata (200–600 × 150–200 vs. 650–1075 × 250–375 μm), ascospores (12–16 × 6.1–7 vs. 17–24 × 6. 2 – 7 .5 μm) and asci (10–12 × 6–7.5 vs. 88–125 × 8.2–12.2 μm) than *A. thailandica* (Li et al., 2016).

Monochaetinula Muthumary, Abbas & B. Sutton, Trans. Br. mycol. Soc. 87(1): 104 (1986)

≡ *Neotruncatella* Hyang B. Lee & T.T.T. Nguyen, in Hyde et al., Fungal Diversity 80: 198 (2016)

Monochaetinula terminaliae (Bat. & J.L. Bezerra) Muthumary, Abbas & B. Sutton [as 'terminialiae'], Trans. Br. mycol. Soc. 87(1): 106 (1986)

≡ *Neotruncatella endophytica* Hyang B. Lee, P.M. Kirk, K.D. Hyde, Maharachch. & T.T.T. Nguyen, in Hyde et al., Fungal Diversity 80: 198 (2016)

≡ *Monochaetia terminaliae* Bat. & J.L. Bezerra, Publicações Inst. Micol. Recife 298: 13 (1960)

The endophytic genus *Neotruncatella* Hyang B. Lee & T.T.T. Nguyen was introduced based on *N. endophytica* Hyang B. Lee et al. (Hyde et al., 2016). The genus is characterized by globose to subglobose conidiomata, ampulliform to subcylindrical, hyaline conidiogenous cells, and fusiform, mostly 3-septate, yellow to yellowish-brown conidia with apical and basal appendages (Hyde et al., 2016). Based on ITS data, its phylogenetic position was confirmed as basal to *Bartalinia* Tassi, in Sporocadaceae, Amphisphaeriales (Hyde et al., 2016). However, the type species of *Neotruncatella*, *N. endophytica* is morphologically similar to *Monochaetinula terminaliae* (table 2). Muthumary et al. (1986) synonymised *Monochaetia terminaliae* Bat. & J.L. Bezerra under *Monochaetinula terminaliae* with new genus *Monochaetinula*. Later another 5 species were added to the genus based on phenotypic characters (Bianchinotti, 1990; Nag Raj, 1993; Matsushima, 1996). *Monochaetinula* species are mainly endophytes: caulicolous, foliicolous, or corticolous, on various plants (Muthumary et al., 1986; Bianchinotti, 1990; Nag Raj, 1993; Matsushima, 1996). Members of *Monochaetinula* are unified by globose to subglobose conidiomata, fusiform and curved, holoblastic, usually 3 to 4(-7) septate conidia, with colorless to olivaceous brown or olivaceous median cells,

and apical and basal appendages (Muthumary et al., 1986; Bianchinotti, 1990; Nag Raj, 1993; Matsushima, 1996). Species of *Monochaetinula* lack molecular data to confirm its phylogenetic placement. Hence, this genus was reffered to Amphisphaeriales, genera *incertae sedis* (Senanayake et al., 2015; Wijayawardene et al., 2016). By considering phenotypic similarities and lifestyle, here we synonymize *Neotruncatella endophytica* under *Monochaetinula terminaliae*. Hence, the genus *Neotruncatella* becomes a synonym of *Monochaetinula*.

Table 5.1 Comparison between *"Neotruncatella endophytica*" and *Monochaetinula terminaliae*

Characters	***"Neotruncatella endophytica"***	***Monochaetinula terminaliae***	
	Hyde et al. (2016)	**Muthumary et al. (1986)**	**Nag Raj (1993)**
Lifestyle and host	Endophyte of plants (*Abies firma* leaf)	Endophyte of plants	Caulicolous, foliicolous, corticolous
Conidiomata	Globose to sub-globose	Globose to sub-globose	Globose to sub-globose, picnioid
Conidiomata dimension (µm)	75–190 × 75–215	120–240	70–120 × 120–360
Conidiophore	-	Absent or present	Absent or present
Conidiogenous cells	Ampulliform to subcylindrical, phialidic, hyaline	Cylindrical, occasionally annellidic, hyaline 4–10 µm long × 2–3 µm wide	Cylindrical, legeniform, ampulliform or irregular colorless
Conidia	Fusiform with rounded ends, yellow to yellowish-brown at maturity, mostly 3-septate	Fusiform and curved	Fusiform and slightly curved
Conidia dimension (µm)	25–34 × 3–5	22–28.3(34) × (2.5)3–4	18-)22.5–33(-34)× (2.5-)3.5–4.5

Table 5.1 (continued)

Characters	*"Neotruncatella endophytica"*	*Monochaetinula terminaliae*	
	Hyde et al. (2016)	**Muthumary et al. (1986)**	**Nag Raj (1993)**
Number of septa	3	3(-4)	3(-4)
Apical cell	Slightly yellow, 3–5 (av. 4) µm long	Long conic, hyaline,	Conic, hyaline, 3–5(-6) µm long
Color of median cell	Yellow to yellowish-brown at maturity	Olivaceous or very pale brown	Olivaceous to pale olivaceous
Second cell from the base (length, µm)	7.5–11.5	6–11.5	5.5–11
Third cell from the base (length, µm)	6.5–10.5	6–11.5	5–12
Apical appendage	4.5–6.5 µm long, simple	(3-)4–7(-11) µm long, simple	(3-)4–7(-11) µm long, simple
Basal cell	Conic or with a truncate base, slightly yellowish-white, 5–7 µm long	Hyaline	-
Basal appendage	Single, present or absent, if appendages present, very shorty at base, 1–3.5 µm long	Produced occasionally, central, short, simple, unbranched, 2–7 µm long	Single, often lacking, 1–6(-7) µm long

Seimatosporium cornii Wijayawardene, Camporesi & K.D. Hyde, in Senanayake et al. (2015)

Facesoffunginumber: FoF00662

Saprobic on *Cornus sanguinea* L. **Sexual morph**: *Ascomata* perithecial, minutely stromatic, appearing on the bark surface as flat or depressed, dark brown to black circular patches, 150–230 µm high, 185–350 µm diam. (n = 20), solitary, immersed or directly below the host epidermis, depressed globose, membranous, dark brown to brown, with a periphysate ostiole. *Peridium* 15–43 µm ($\bar{x}$ = 26 µm, n = 10) wide, comprising 6–11 cell layers, outer layers heavily pigmented, fusing outwardly with the host cells, thin-walled, comprising dark brown cells of *textura angularis* to *textura intricata*, inner layers composed of hyaline to brown, thin-walled, flat cells of *textura angularis*. *Hamathecium* comprising numerous, 3–6 µm ($\bar{x}$ = 4 µm, n = 30) wide, hypha-like, septate, branched, apically free paraphyses, rounded at the apex, not embedded in a gelatinous matrix. *Asci*

75–148 × 9–16 µm ($\bar{x}$ = 110 × 12 µm, n = 30), 8-spored, unitunicate, basal, in small numbers in the perithecium, cylindrical to clavate, straight or slightly curved, short pedicellate, apically rounded or truncate, with a refractive, J+ apical ring. *Ascospores* 10–21 × 4–8.5 µm ($\bar{x}$ = 16 × 7 µm, n = 80), uniseriate or overlapping uniseriate, hyaline, fusiform or ellipsoidal, mainly 3 transversely septate, sometimes 1- or 2-septate, occasionally 4-septate, primary septum median, occasionally constricted at the septa, smooth, thick-walled, without a mucilaginous sheath or appendages. **Asexual morph:** see Senanayake et al. (2015).

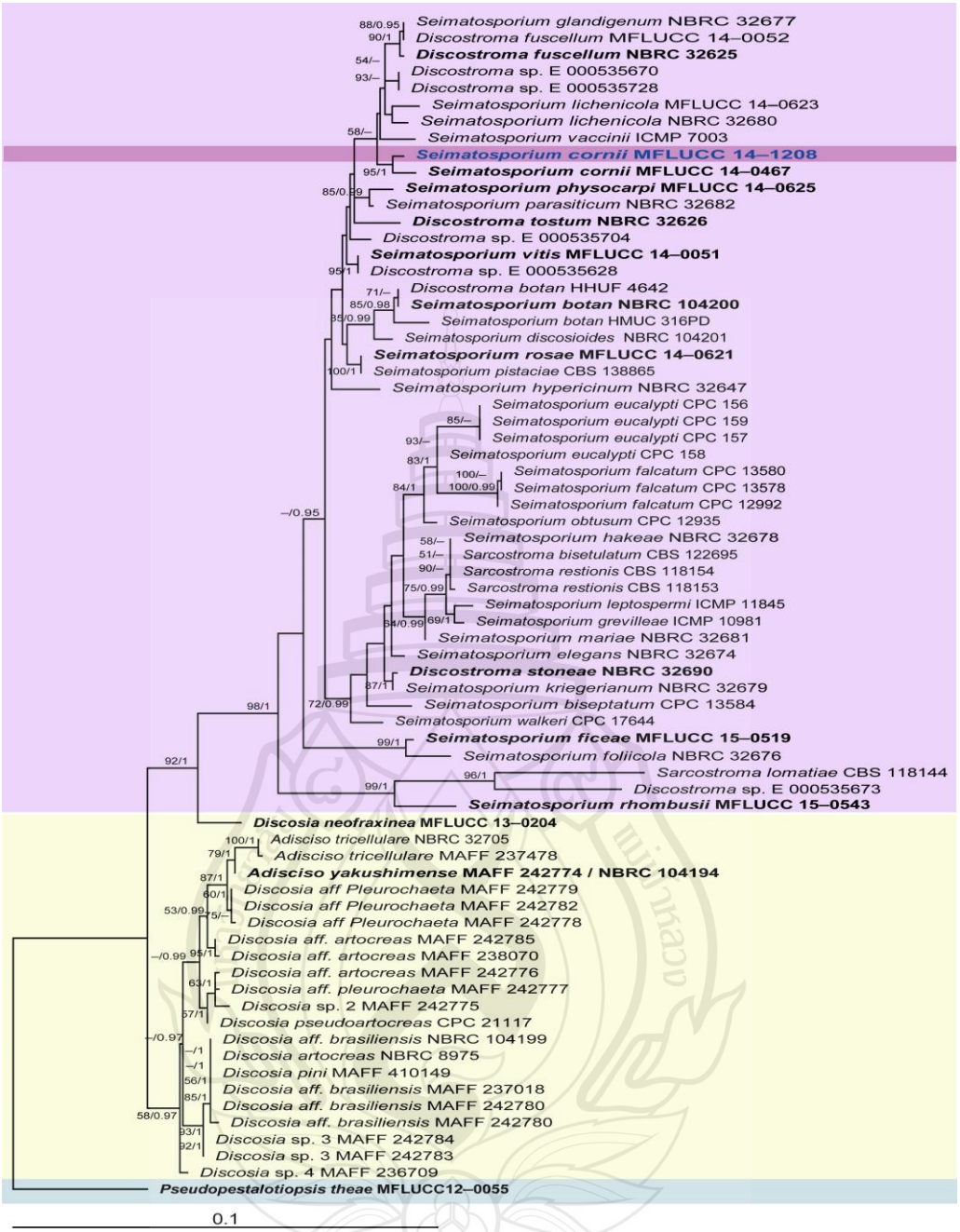
Culture characters: Colonies growing on MEA, reaching 8 cm diam. in 21d at 16 °C, white, dense, moderate aerial mycelium on the surface, below similar in colour, margins uneven, not zonate.

Material examined: ITALY, Arezzo Province [AR], Badia Tega - Ortignano Raggiolo, on dead stem of *Cornus sanguinea* (*Cornaceae*), 26 March 2013, Erio Camporesi, IT 1147 (MFLU 15-2526, *ibid.*, MFLU 15-2527), culture MFLUCC 14-1208 = KUMCC 15-0017.

GenBank numbers: LSU: KT868531, ITS: KT868532, SSU: KU519575, RPB2: KU519576, TEF1: KU519577

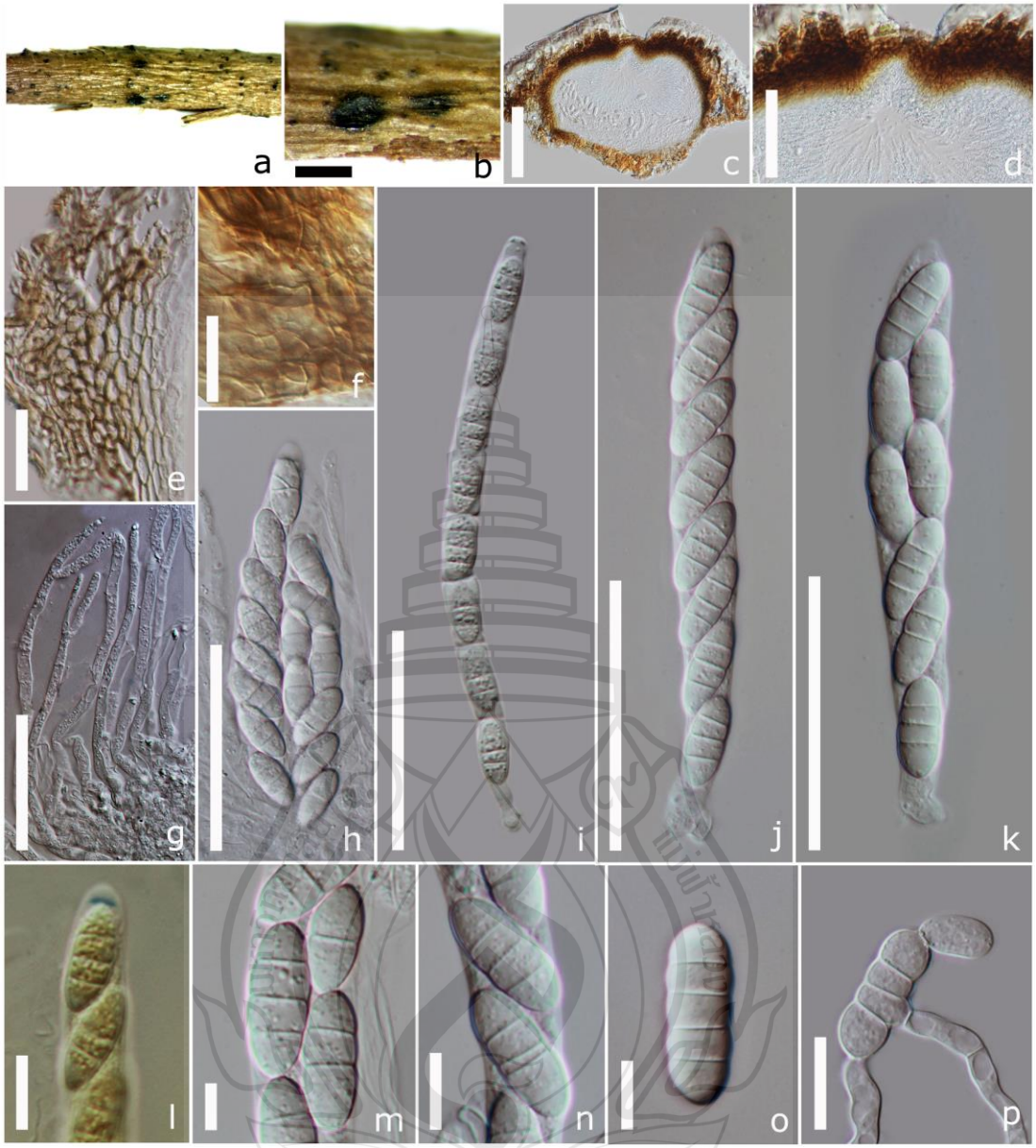
Notes: *Seimatosporium cornii* is morphologically similar to *Discostroma fuscellum*, especially in the characters of its asci and ascospores. However, it differs from *D. fuscellum* in having a peridium of *textura angularis* (in surface view) and ascospores are mostly fusiform and have a different septation range; (1–)3(–4)-septate. In *D. fuscellum* the peridium is a *textura prismatica* (in surface view) and ascospores are ellipsoidal, 3–(4–7)-septate and occasionally constricted at the medium septum (Huhndorf, 1992). The asexual morph of *D. fuscellum* (*Seimatosporium lichenicola* forms fusiform conidia, while *S. cornii* is characterized by having clavate or obovoid conidia larger than *S. lichenicola* (Tanaka et al., 2011; Norphanphoun et al., 2015).

In the phylogenetic analysis, *S. cornii* is related to *D. botan* Sat. Hatak. & Y. Harada and *D. tostum* (Berk. & Broome) Brockmann. *Seimatosporium cornii* is also morphologically similar, with ascomata, asci and ascospores having a similar size range (Brockmann, 1976; Hatakeyama & Harada, 2004), but *S. cornii* has the largest asci and ascospores of these species. *Seimatosporium cornii* can also be distinguished from *D. tostum* in having 3-septate ascospores, while in *D. tostum* the ascospores are 1-septate.



Note Maximum Likelihood bootstrap support values greater than 50% and Bayesian posterior probabilities (PP) above 95% are shown near the nodes. The new isolate is in blue bold and ex-type sequences in bold. The tree is rooted with *Pseudopestalotiopsis theae* (MFLUCC 12–0055).

Figure 5.22 Maximum Likelihood tree resulting from analysis of combined LSU and ITS sequence data of the family Discosiaceae



Note (a, b) Ascomata on dead branch of *Cornus sanguinea*. (c) Vertical section through ascoma. (d) Close up of the ostiole. (e) Close up of the peridium. (f) Peridium in face view. (g) Paraphyses. (h–k) Immature and mature asci. (l) Ascus in Melzer's reagent. (m–o) Ascospores. (p) Germinating ascospore. Bars: b = 500 µm c = 200 µm, d = 100 µm, e = 20 µm, f–k = 50 µm, l–n = 20 µm, o, p = 10 µm.

Figure 5.23 *Seimatosporium cornii* (sexual morph, MFLU 15–2526)

Discostroma sanguineae Brockmann has been recorded from *Cornus sanguinea* (Brockmann, 1976). Although molecular data are not available for *D. sanguineae* it can be distinguished from *D. cornii* based on morphology. *Seimatosporium cornii* has (1–)3(–4)-septate, hyaline ascospores, while *D. sanguineae* is characterised by 3–5-septate, hyaline to yellow ascospores. Ascus and ascospore shapes are also different in the two species (Table 2).

Table 5.2 Morphological comparison between *Seimatosporium cornii* and related species

Species	**Ascomat-a size (µm)**	**Asci (µm)**	**Apical ring**	**Ascospores**			**Host**	**Locality**
				Size (µm)	**Colour**	**No. of septa**		
Discostroma botan	200–250 × 300–360	70–111 × 6–10	J+	12–18 × 4–6	Hyaline	3	*Paeonia suffrutico-sa*	Japan
D. caninum	280–360 × 150–200	85–120×6–9	J+	12–15 × 5.3–6.5	Hyaline to yellowi-sh	1(–2)	*Rosa*	Switzerl-and
D. fruticosum	200 × 250	90–130 × 9–11	J+	18–26 × 6–8	Hyaline	(1–) 3 (–5)	*Pentaphy-lloides fruticosa*	China
D. fuscellum	150–250 × 300–500	115–132 × 7–12	J+	15–21 × 5–9.5	Hyaline	3– (4–7) Somet-imes vertical septa in central cells or in every cell	*Rosa, Cornus, Prunus, Rubus*	UK
D. muricatum	550 × 385	100–110 × 12–17	J–	18–20 × 8–10	Brown	3– (4–6)	tree	California, USA
D. osyridis	160–220 × 150-175	75–80 × 5–6	J–	11.5–13.8 × 4–4.5	Brown	3	*Osyris alba*	Portugal

Table 5.2 (continued)

Species	Ascomata size (µm)	Asci (µm)	Apical ring	Ascospores			Host	Locality
				Size (µm)	Colour	No. of septa		
D. polymorphum	230–370 × 150–240	85–110 × 7–10	J+	11–16.7 × 5.6–7.3	Brown	1–3	*Rosa pendulina*	Switzerland
D. propendulum	350–400 × 350-450	110–140 × 18–20	J+	19–22 × 10–13	Hyaline	3 with 1 longitudinal septum in each segment	*Arctostaphylos alpina*, *A. rubra*	North America, Europe
D. rosae	260–370 × 150–300	75–100 × 5.3–7.4	J+	10–12 × 4–5	Hyaline	1(–3)	*Rosa pendulina*	Switzerland
D. rubicola	300–500 × 250–459	100–160 × 9–13	J+	15.5–24 × 6.5–9	Hyaline	(1–) 3–(4)	*Rubus deliciosus*	USA
D. saccardoanum	400–600 × 210-400	117–150 × 8–10	J+	15–18 × 5.5–7.5	Light brown	3, rarely with 1 longitudinal septum	*Ribes*	Switzerland
D. sanguineae	330–430 × 250–370	105–130 × 8.5–13.3	J+	16.5–20 × 7.5–9	Hyaline to yellow	3–5 rarely 1 longitudinal septum	*Cornus sanguinea*	Switzerland
D. stoneae	110–120 × 80–100	70–80 × 9–19	J–	19–21 × 4–6	Hyaline	3	*Melaleuca squarrosa*	Australia
D. strobiligenum	150–250	55–70 × 5–7	J+	7–11 × 3–4	Hyaline	1 sometimes with further transverse septa	*Pinus sylvestris*	France

Table 5.2 (continued)

Species	Ascomata size (µm)	Asci (µm)	Apical ring	Ascospores			Host	Locality
				Size (µm)	Colour	No. of septa		
D. tostum	150–200 × 250–370	62–85 × 5–7	J+	8–13.5 × 3–4.5	Hyaline	1	*Epilobe hirsute*	UK
Seimatosporium cornii	150–230 × 180–350	75–148 × 9–16	J+	10–21 × 4–8.5	Hyaline	(1–)3(–4)	*Cornus sanguinea*	Italy

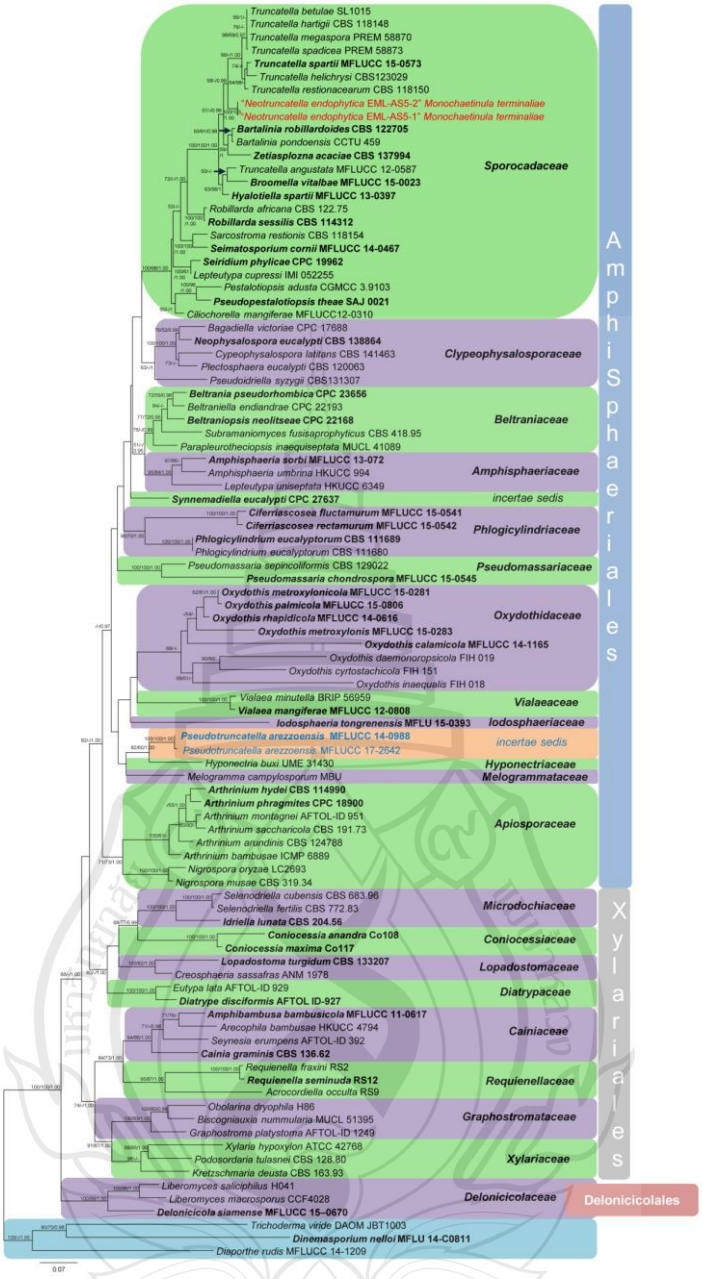
Seimatosporium cornii is also morphologically distinct from the other species of *Discostroma* reported from the same host and locality (Table 2).

Pseudotruncatella R.H. Perera, Camporesi, Maharachch. & K.D. Hyde, ***gen. nov.***

Index fungorum number: IF553932, Facesoffungi number: FoF03838

Etymology: Morphologically resembling the genus *Truncatella*, but phylogenetically distinct.

Saprobic on dead branches of *Cytisus* and *Helichrysum* species. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* acervular to pycnidioid, scattered or gregarious, rounded to oval in outline, unilocular, immersed to semi-immersed, epidermal to sub-epidermal in origin. *Peridium* comprising hyaline to pale brown, thick-walled cells of *textura angularis*. *Conidiophores* arising from basal and lateral cavity-surface of conidioma, cylindrical, septate, branched, sometimes unbranched or reduced to conidiogenous cells, smooth, hyaline. *Conidiogenous cells* cylindrical, occasionally ampulliform, holoblastic, phialidic, annellidic, with a few percurrent proliferations, indeterminate, integrated, hyaline, smooth, thick-walled, with several percurrent proliferations. *Conidia* fusiform to clavate, straight, 3-septate, not constricted at septa, with dark brown median cells and hyaline apical and basal cells, bearing 3 apical appendages; narrowly obconic and truncate base, guttulate, thick-walled, smooth-walled; 2-median cells large, thick-walled, smooth-walled, upper median cell subcylindrical to conic, lower median cell narrowly obconic; apical cell conic, smooth, thick-walled; apical appendages simple, tubular, hyaline, smooth-walled.



Note Values above the branches indicate maximum parsimony and maximum likelihood bootstrap ≥ 70%, (ML/MP). Values at the third position, respectively, above or below the branches represent posterior probabilities (PP ≥ 0.95). The ex-types strains are in bold, the new isolates are in red. The tree is rooted to *Diaporthe rudis*, *Dinemasporium nelloi* and *Trichoderma viride*.

Figure 5.24 The ML consensus tree inferred from the combined LSU, SSU and ITS sequence data of selected taxa of Xylariomycetidae

Type species: ***Pseudotruncatella arezzoensis*** R.H. Perera, Camporesi, Maharachch. & K.D. Hyde

Pseudotruncatella arezzoensis R.H. Perera, Camporesi, Maharachch. & K.D. Hyde, ***sp. nov.***

Index fungorum number: IF553933, Facesoffungi number: FoF03839, Figure 5.25

Etymology: Refers to the name of the Province in Italy where the fungus was collected

Saprobic on dead branches of *Cytisus* and *Helichrysum* species. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* 230–275 μm high, 255–280 μm wide, pycnidioid, scattered or gregarious, rounded to oval in outline, unilocular, immersed to semi-immersed, epidermal to sub-epidermal in origin. *Peridium* 3.6–6.5 μm wide, comprising hyaline to pale brown, thick-walled cells of *textura angularis*. *Conidiophores* 11–35 × 1.5–3.3 μm ($\bar{x}$ = 21.6 × 2.3 μm, n = 20) diam., arising basal and lateral cavity-surface of conidioma, cylindrical, septate, branched, sometimes unbranched or reduced to conidiogenous cells, smooth, hyaline. *Conidiogenous cells* 5.7–28 × 1.4–3 μm ($\bar{x}$ = 16.6 × 2 μm, n = 25) diam., cylindrical, occasionally ampulliform, holoblastic, annelledic, with a few percurrent proliferations, indeterminate, integrated, hyaline, smooth, thick-walled, with several percurrent proliferations. *Conidia* 20–25 × 5.4–6.5 μm diam. ($\bar{x}$ = 22.1 × 5.8 μm, n = 50), fusiform to clavate, straight, 3-septate, not constricted at septa, bearing 3 apical appendages, guttulate; basal cell 4.5–7.1 × 2.5–3.4 ($\bar{x}$ = 5.9 × 2.8 μm) diam., narrowly obconic with a truncate base, hyaline, smooth, thick-walled; 2-median cells together 6.7–8.9 × 4.3–6.5 ($\bar{x}$ = 7.7 × 5.2 μm) diam., large, dark brown, thick, smooth-walled; upper median cell subcylindrical to conic, lower median cell narrowly obconic, thick-walled; apical cell conic, hyaline, smooth-walled 1.6–2.8 × 1.4–2.6 ($\bar{x}$ = 2.1 × 2.7 μm); apical appendages 20–26 μm ($\bar{x}$ = 23.7 μm) long, simple, tubular, hyaline, smooth-walled.

Culture characters: Conidia germinating on PDA within 18 hours. Colonies on PDA reaching 35 mm within 14 days when incubated at 25 °C. Margins effuse, white, flat, lacking aerial mycelium reverse pinkish white.

Material examined: ITALY, Croce di Pratomagno (province of Arezzo [AR]), on dead aerial branch of *Cytisus scoparius* (L.) Link (Fabaceae), Camporesi Erio, 26 October

2013, IT 1491 (MFLU 15-2285, holotype); *ibid*., dead aerial stem of *Helichrysum italicum* (Roth) G. Don fil. (Asteraceae), 18 July 2013, IT 1322E (MFLU 17-1776, **paratype**); extype living culture MFLUCC 14-0988; ex-paratype living culture MFLUCC 17-2642.

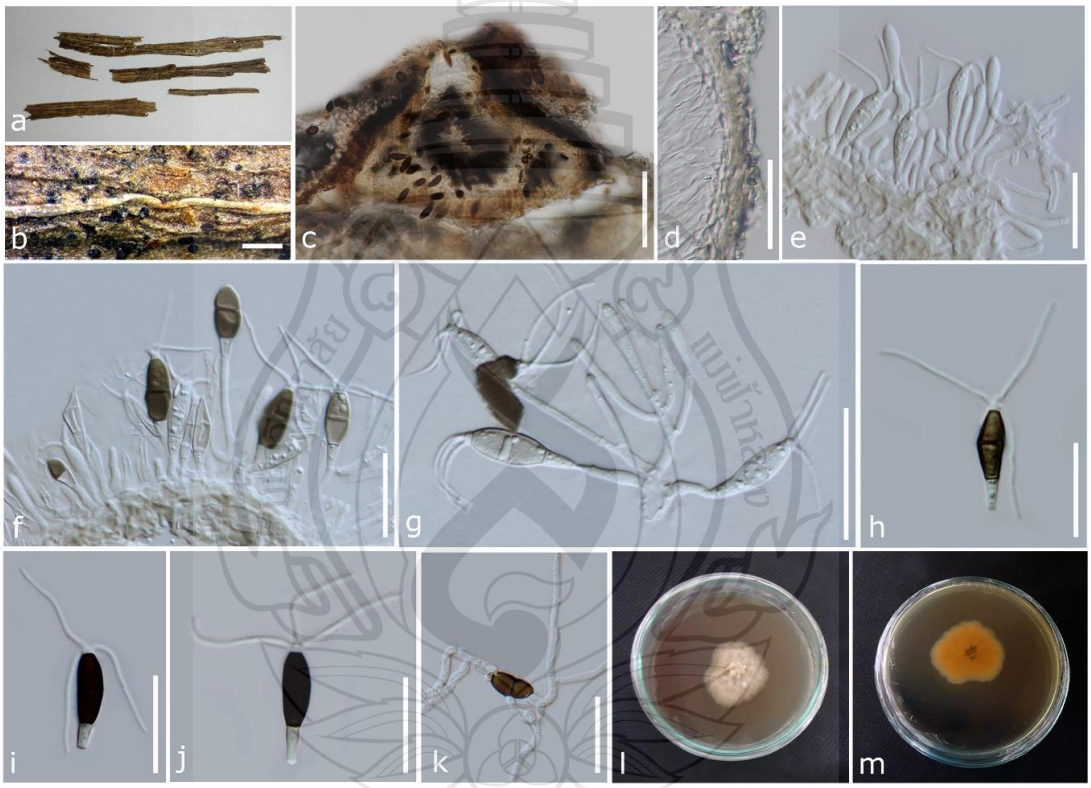
GenBank numbers: LSU: MG192317, ITS: MG192320, SSU: MG192319

Notes: Phylogenetic analysis of combined LSU, ITS and SSU sequence data confirms that *Pseudotruncatella* is phylogenetically distant from members of Sporocadaceae. *Pseudotruncatella* is similar to *Truncatella* Steyaert in forming 3- septate conidia, with pigmented median cells and hyaline apical and basal cells, with apical appendages. However, *Pseudotruncatella* can be distinguished from *Truncatella* by dark brown, subcylindrical to conic upper median cell (vs. pale brown to brown, subcylindrical to doliiform) and dark brown, narrowly obconic lower median cell (vs. pale brown to brown, subcylindrical to doliiform) (Steyaert, 1949; Nag Raj, 1993; Sutton, 1996; Lee et al., 2006; Senanayake et al., 2015). Further, *Pseudotruncatella* forms fusiform to clavate conidia with a thick-walled basal cell, while *Truncatella* species form fusiform conidia, with thin-walled, sometimes deciduous basal cell (Steyaert, 1949; Nag Raj, 1993; Lee et al., 2006).

Mycohypallage B. Sutton, another somewhat similar coelomycetous genus, which was classified in Phyllachoraceae, lacks molecular data (Sutton, 1963; Maharachchikumbura et al., 2015, 2016). This genus shows some morphological similarities to *Pseudotruncatella* by producing brown conidia with appendages. However, *M. margaretae* Marinc., Gryzenh. & M.J. Wingf. is distinct from *N. arezzoensis* by possessing 1-septate conidia, with both apical and basal appendages (Marincowitz et al., 2010). The conidiophores of *M. congesta* (Berk. & Broome) B. Sutton and *M. northeae* Melnik produce 1-septate conidia with an apical cell modified into a branched appendage (Nag Raj, 1993; Marincowitz et al., 2010; Wijayawardene et al., 2106), while our new taxon produces 3-septate conidia.

Bleptosporium, *Griphosphaerioma*, *Hyalotiopsis* and *Monochaetinula*, which were maintained in Amphisphaeriales, genera *incertae sedis*, are also distinct from *Pseudotruncatella* in morphology. *Bleptosporium* differs from *Pseudotruncatella* by forming distoseptate, single appendage-bearing conidia (Morgan-Jones, 1974; Nag Raj, 1993; Wijayawardene et al., 2016). *Griphosphaerioma* produces 5-septate conidia, with

dichotomously or irregularly branched appendages, which are unrelated to *Pseudotruncatella* (Morgan-Jones et al., 1972; Sutton, 1980; Nag Raj, 1993; Wijayawardene et al., 2016). Conidia of *Pseudotruncatella* resemble those of *Hyalotiopsis* in color and septation, but differ by broader basal cell and cylindrical or obclavate conidia, and a single apical appendage with 2–4 branches (Sutton, 1980; Nag Raj & Kendrick, 1985; Nag Raj, 1993; Wijayawardene et al., 2016). *Monochaetinula* is distinct from *Pseudotruncatella* with 3–4-septate, conidia with a single appendaged apical cell and olivaceous to pale brown median cells (Muthumary et al., 1986; Nag Raj, 1993; Wijayawardene et al., 2016).



Note (a, b) Conidiomata on host substrate. (c) Vertical section of conidioma. (d) Section through peridium. (e–g) Conidiogenous cells with mature and immature conidia. (h–k) Mature conidia. (k) Germinating conidium. (m, n) Cultures on PDA. Scale bars: b = 500 μm, c = 100 μm, d–k = 20 μm.

Figure 5.25 *Pseudotruncatella arezzoensis* (MFLU 15-2285, holotype)

5.4 Discussion

In this study, we introduce a new species of *Chaetosphaeria*, and one new record of *Chaetosphaeria* for Thailand. *Chaetosphaeria* species seems to be polyphyletic within the family, and these finding are similar to those obtained by Jeewon et al. (2009) and Crous et al. (2012) using ITS and LSU sequence data. The generic type strain of *Chaetosphaeria* (*C. innumera*) lacks ex-type sequence data. Therefore, it is essential to re-collect, epitypify (*sensu* Ariyawansa et al., 2014) and sequence the types of genera to resolve the phylogenetic confusion.

The sexual morph of *Seimatosporium cornii* was introduced based on analysis of combined LSU and ITS sequence data together with morphological characters following Tanaka et al. (2011) and Norphanphoun et al. (2015). Our isolate did not produce an asexual morph in culture. However, the ex-type strain of *Seimatosporium cornii* (MFLUCC 14-0467), which was collected on a dead stem of *Cornus sanguinea* from Italy, clustered with our strain (MFLUCC 14-1208). The type of *Seimatosporium cornii*, was collected from dead branches of *Cornus* sp. in Italy (Senanayake et al., 2015). It was described as a coelomycetous fungus, producing 3-transversely septate, clavate or obovoid conidia without appendages (Senanayake et al., 2015). Moreover, the ITS and LSU sequence data of our collection are almost (ITS: 100%, LSU: only 2 base pairs difference) identical to the type strain of *S. cornii*. We therefore conclude that our isolate is the sexual morph of *S. cornii*.

Seimatosporium (Corda, 1833) and *Discostroma* (Clements, 1909) have been commonly linked (Jeewon et al., 2002; Barber et al., 2011; Tanaka et al., 2011; Norphanphoun et al., 2015). The former genus is the earliest name and is also the commonest morph found in nature; *Seimatosporium* has 79 records in Index Fungorum (2015), while *Discostroma* has 30 records. These three factors suggest that if these genera can be proven to be unequivocally linked then *Seimatosporium* should be chosen over *Discostroma*. The type species of *Discostroma, D. rehmii* has not been recollected and sequenced and is described as having muriform ascospores. Therefore, both genera should be maintained until *D. rehmii* has been linked to *Seimatosporium* or the genus might be used for a segregate of *Seimatosporium,* which appears to be polyphyletic. The

type species of *Discostroma, D. rehmii* has not been recollected and sequenced and is described as having muriform ascospores. Therefore, *Seimatosporium* and *Discostroma* should be maintained as distinct genera, until *D. rehmii* has been linked to a *Seimatosporium* species, or *Discostroma* might be used for a segregate of *Seimatosporium* which appears to be polyphyletic. *Discostroma* was introduced by Clements (1909) based on *D. rehmii* (Schnabl) Clem. Von Arx (1974) considered *D. rehmii* as synonym of *Metasphaeria massarina* Sacc., and introduced a new combination, *Discostroma massarina* (Sacc.) Arx (Paulus et al., 2006) and listed *D. rehmii* as a synonym. This was followed by Brockmann (1976). Barr (1994), Paulus et al. (2006) and Tanaka et al. (2011) who used the name *D. massarinum* for the type of *Discostroma*. Index Fungorum (2015) list *D. rehmii* as the type of *Discostroma*, and this should be followed, at least until *D. massarinum* is shown to be synonymous with *D. rehmii* using molecular data. Colour and septation of the ascospores and amyloid or non-amyloid apical rings, appear to be important characters to distinguish species within the genus *Discostroma.* Ascospore and ascus dimensions are difficult to use as criterion to separate species because of overlap between most species (Hatakeyama & Harada, 2004; Paulus et al., 2006).

CHAPTER 6

FUNGI OCCURRING ON WILD SEEDS AND FRUITS, AND THEIR DIVERSITY

6.1 Introduction

Seeds are produced by spermatophytes of both angiosperms and gymnosperms. Angiosperm seeds originate from a hard or fleshy structure known as a fruit which also encloses the seeds. However, in gymnosperms, there is no specific biological structure developed to enclose the seeds (http://pediaa.com/ difference-between-fruit-and-seed/). Plants have evolved various mechanisms for the dispersal of mature seeds, which have the potential to produce new individuals (Bewle and Black, 1994).

There is a great diversity in the form and structure of seed and fruits, such as, grains, cones, acorns, berries, drupes, capsules, seed pods, nuts, nut cupules, caryopses, and nutlets (fruits of restiads or sedges). Fruit cases, such as nut cupules are considered as fruits in this paper. Cupules of beech (*Fagus* spp.) are a woody substrate, containing lignocellulose and similar to lignocellulose composition of coarse woody debris (Fukasawa et al., 2012). Leguminous pods also are rich in cellulose, hemicelluloses and lignin (Paula et al., 2011). Cones, which protect the seeds during development, are the reproductive organs of coniferous plants (Kilic et al., 2010). They consist of an axis with surrounding scales, which are rich in cellulose, hemicellulose (mannose, galactose, xylose) and lignin (Fogel and Cromack, 1977 and Kilic et al., 2010). Nuts, kernels of chestnut, hazelnut, walnut and oak are diverse in their protein, carbohydrate and fat content, while some are rich in phosphorus (eg. hazelnut, hickory nut, and black walnut) (Wainio and Forbes, 1941). Nut shells are rich in lignin, cellulose and hemicelluloses (Vellingiri et al., 2014 and Zhai et al., 2015). Fruits (achenes, pomes, berries and drupes) comprise mostly carbohydrates,

some are high in lignin and cellulose, and others are rich in protein and fat, mainly because of their seeds (Wainio and Forbes, 1941). Acorns such as red oak, rock chestnut oak, and scrub oak and, some edible wild fruits (eg. chokeberries, sumac berries, blackhaw and mountain ash berries) are high in tannin content (Wainio and Forbes, 1941). Moreover, seeds such as those of legumes and cereals are major food sources and contain storage reserves of protein, starch and oil (Bewle and Black, 1994 and Shimada, 2001 and Ragaee et al., 2006).

6.1.1 History of studies of Wild Seed/Fruit Fungi

Around the world the forest floor is seasonally covered by a carpet of native seeds and fruits, which are colonised by a wide range of endophytic, saprobic and pathogenic fungi (Rogerson and Samuels, 1992 and Morais et al., 1995 and Rogers et al., 2002 and Somrithipol, Chatmala et al., 2002 and Somrithipol, Jones et al., 2002 and Udayanga et al., 2013 and Perera, Hyde, Dissanayake et al., 2018).

Note (a) *Cassia fistula*. b Fabaceae sp. (c) *Delonix regia*. (d) *Samanea saman*. (e) *Adenocalymma pterocarpus*. (f) *Cassia grandis*. (g) *Entada* sp. (h) *Mucuna macrocarpa*.

Figure 6.1 Fabaceae fruits on the forest floor in Thailand (a–g) and Taiwan (h)

Note (a) Seed of *Lithocarpus* sp. (b) Immature fruits of *Couroupita guianensis* (cannonball tree). (c) Fruits of *Magnolia champaca*. (d–f) *Swietenia mahagoni*. (d) placenta with seeds. (e) fruit. (f) fruit outer carpels). (g) Unidentified fruits. (h) Unidentified seeds.

Figure 6.2 Seeds and fruits on the forest floor in Thailand (a–f) and China (g, h)

Note (a) *Xylaria* sp. on an undetermined fruit. (b, e) *Xylaria xanthinovelutina* on a Fabaceae fruit. (c) *Xylaria* sp. on a *Swietenia mahagoni* fruit. (d) *Xylaria* sp. on a *Swietenia macrophylla* fruit. (f, g) *Xylaria arbuscula* on *Swietenia mahagoni* fruits. (h, i) *Xylaria* spp. on *Swietenia mahagoni* fruits.

Figure 6.3 *Xylaria* species associated with forest fruits

Note (a, b) *Thozetella lithocarpi* on seed of *Lithocarpus* sp. (c, d) *Parascedosporium*-like fungus on fruiting rachis of *Lithocarpus* sp. (e, f) *Thozetella fabacearum* on a Fabaceae seed pod. (g, h) *Diplodia* sp. on a Fabaceae pod. (i) Discomycete on a *Pseudotsuga menziesii* cone. (j, k) Basidiomycete on *Pseudotsuga menziesii* cones. (l) Basidiomycete on *Dipterocarpus* fruit. m Basidiomycete on a *Cassia grandis* pod.

Figure 6.4 a–m Fungi associated with forest fruits

Few studies have been undertaken to document fungal groups from wild seeds and fruits, when compared to other plant substrates, e.g. wood, culms, leaves and commercial seeds and fruits (Kasai et al., 1995 and Nirenberg and Aoki, 1997 and Vujanovic et al., 2000 and Yli-Mattila et al., 2009 and Weir et al., 2012 and Udayanga et al., 2013 and Rashmi et al., 2019). Hyde et al. (2015) acknowledged that the taxonomy, ecology, and distribution of fruit and seed inhabiting fungi are poorly studied in both temperate and tropical areas. Previous research has mainly targeted postharvest fungi, those responsible for economic losses of cereals and edible fruits (Tang, Hyde et al., 2003 and Neergaard, 2017). However, seed and fruit inhabiting fungi of conifers and eucalyptus species has been investigated broadly as they have been widely introduced as exotic timber trees in plantations (Kasai et al., 1995 and Vujanovic et al., 2000 and Lupo et al., 2001 and Palm, 2001, Wingfield et al., 2001 and Desprez-Loustau, 890 2009). Most of the early research focused on endophytic isolations and identification of seed-borne pathogens (Anderson, 1986a and Mittal et al., 1990). Hence, wild seed and fruit fungi are not a well-studied group.

An extensive study of dothideomycetous fungi associated with wild seeds and fruits in selected areas of Thailand, UK and China was carried out by Jayasiri et al. (2019), who introduced 58 new taxa. Fukasawa et al. (2012) and Carré (1964) surveyed fungi on beech cupule litter in Japan and the UK. Tang, Hyde et al. (2003) examined fruit samples from 18 native plant species yielding 101 fungal taxa in Hong Kong. Another survey in Thailand by Somrithipol, Jones et al. (2002) investigated fungi on tropical forest fruit of *Delonix regia* and identified 70 fungi. Ten fungal species belonging to Ascomycota were isolated from cone scales and seeds of 28 *Pinus* hosts in East Asia, Europe and North America, and Canada (Vujanovic et al. 2000). In their study, *Sphaeropsis sapinea*, *Herpotrichia juniperi*, '*Phomopsis' conorum*, *Truncatella hartigii*, *Tubercularia* sp. and *Valsa* spp. were recognised as dominant pathogens of *Pinus* (Vujanovic et al., 2000). A fungal succession study on *Pinus densiflora* cones on a forest floor investigated the early decomposition process in Japan, and identified 31 taxa (Kasai et al., 1995). Pandey and Nimmi (1990) isolated 48 fungal species from *Pinus roxburghii* seeds collected from a forest in India and observed that the predominant species in ungerminated seeds are *Alternaria* and *Fusarium* spp. Anita et al. (1999) and Anita and Sridhar (1999) reported a number of

endophytic fungi from seeds and pods of mangrove wild legumes (*Canavalia cathartica* and *Sesbania bispinosa*) in Southwest coast of India. Lupo et al. (2001) studied endophytic fungi in capsules and seeds of *Eucalyptus globulus* in Uruguay and found 18 taxa from unopened capsules (cut off from the tree) and ten from seeds. Seed-borne fungi associated with *Podocarpus falcatus* and *Prunus africana* in Afromontane rain forests of Ethiopia were investigated by Gure (2004), and identified four Botryosphaeriaceae taxa with one new species, *Diplodia rosulata*. Yeasts (*Candida* spp., *Debaryomyces* spp., *Kloeckera* spp., *Pichia* spp.) colonizing the fallen ripe fruits of Amapa (*Parahancornia amapa*) and *Clusia grandiflora* in tropical forests were examined by Morais et al. (1995). They found 44 yeasts including one new species. Rogers (1979b) described a new saprobic *Xylaria* species, *X. magnolia* on decaying fruits of *Magnolia* sp. and discussed several other fruit inhabiting *Xylaria* species. Ju et al. (2018) studied 25 *Xylaria* species inhabiting fallen seeds and fruits and introduced three new species namely: *Xylaria reevesiae, X. rossmanae* and *X. vivantii*. Jankowiak (2008) investigated fungi occurring on acorns of *Quercus robur*, which were infested by insects in Poland. He identified 45 fungi with *Alternaria alternata* and yeasts as the most frequently isolated fungi (Jankowiak, 2008). Although there is great diversity in fruit and seed-bearing plants, few studies been carried out especially in temperate regions (Table 6.2). Accordingly, the present work on fungal diversity found on seeds and fruits was undertaken.

Anderson (1986a) and Mittal et al. (1990) provided checklists of micro-organisms associated with tree seeds and primarily focused on forestry trees. Seed-borne diseases of 12 host tree species namely: *Acer* spp., *Alnus* spp. *Araucaria excelsa, Betula* spp., *Chamaecyparis* sp., *Fraxinus* spp., *Larix* spp., *Picea sitchensis, Pinus* spp., *Quercus* spp., *Thuja* spp., *Ulmus americana* and *U. pumila* were listed by Noble et al. (1958). Watanabe (2010) listed a number of culturable seed fungi with illustrations and provided a key to species in wild and crop plants in Japan. Previous studies and check lists revealed that the fungi colonising seeds and fruits are dominated by asexual morphic fungi (Carré, 1964, Anderson, 1986a and Mittal et al., 1990 and Kasai et al., 1995 and Amusa et al., 2002 and Somrithipol, Jones et al., 2002 and Tang, Hyde et al., 2003 and Fukasawa et al., 2012). However, a comprehensive literature review or a checklist on fungi that occur on wild seeds and fruits is lacking.

Our approach is to provide a checklist of fungi described from seeds and fruits of non-commercial trees, shrubs and weedy plants or grasses. However, there are no details of substrates such as wood, leaves, seeds, fruits provided in most of the previous fungal lists. In Petrak's lists, fungi were listed under host names but did not mention the substrates. We also looked in the USDA host database for search by substrates, but it lists only host details. It supports for fungal host-search but not for other substrate details. Since 1981, Index of Fungi series and the website provided substrate details, such as wood, leaves, seeds and fruits. Our list of new fungi therefore was mainly based on Index of Fungi. Here we also list fungi reported from wild seeds and fruits based on available literature. The aim of the present study is to give an idea of the different groups of fungi occurring on wild seeds and fruits, document, discuss their role and importance, and illustrate some Sordariomycetes taxa. We also provide a brief account on fossil fungi described from seed fruit substrates.

6.1.2 Where Do These Seed/Fruit Fungi Come From?

There are three different ways fungi can infect or colonise wild seeds or fruits: (1) seeds become infected with endophytic fungi while in the canopy during fruit development, (2) within the soil after dispersal, and (3) by animal vectors such as fruit flies (Gallery, 2007 and Morais et al., 1995 and Somrithipol, Jones et al., 2002). Plant seeds carry spores of different fungi on the seed surface or inside tissues of the seed (Anderson, 1986b). Seed surfaces are mostly contaminated with fungal spores as they easily stick to the outer seed coat, while fungi mostly occur as mycelia inside the seed (Anderson, 1986b). Seeds/fruits inhabiting fungi may include endophytic, saprophytic, and pathogenic fungal species (Gallery et al., 2007). *Diaporthe*, *Fusarium*, *Penicillium*, *Trichoderma* and *Xylaria*-like fungi initially can occur as endophytes, but become pathogenic or saprobic under favorable conditions (Somrithipol, Jones et al., 2002 and Udayanga et al., 2013 and Fukasawa et al., 2012). However, pathogenicity of most fungi associated with wild seeds/fruits has been much debated (Mittal et al., 1990). Somrithipol, Jones et al. (2002) studied pods of *Delonix regia* and observed *Aspergillus*, *Chaetomium*, *Penicillium*, and *Rhizopus* species mainly occurring on the dry fruits when still attached to the tree. A different

fungal community developed once seeds and fruits had been shed from the host plant (Somrithipol, Jones et al., 2002). Lupo et al. (2001) observed *Eucalyptus globulus* capsules attached to the tree and shared the same endophytic fungal species with flowers, but in higher numbers. Clavicipitaceous fungi are parasitic on Poaceae hosts, and can also occur as endophytes (Rodriguez et al., 2009). During flowering of grasses, endophytic species such as *Acremonium* species grow into ovules and become incorporated into the seeds (Neill, 1941, Clay, 1990). Endophytes can be transmitted horizontally (among individuals of the same generation) or vertically (from maternal plants to offspring through seed infections) to other plants/ generations (Chung and Schardl, 1997 and Saikkonen et al., 2002). Animal vectors such as common flies and fruit flies are partially responsible for fungal contamination of fruits (Morais et al., 1995), for example, *Drosophila* spp. are known to be the major vectors of yeasts (Morais et al., 1995). Morais et al. (1995) and Miller and Phaff (1962) observed the coexistence of different *Drosophila* species in different stages of deterioration of *Parahancornia amapa* fruits and *Ficus* figs. Some studies reveal seeds infected by endophytic fungi contain higher concentrations of alkaloids than the normal seeds, thus they may protect seeds from vertebrate and invertebrate predators (Cheplick and Clay, 1988 and Clay, 1990).

6.2 Materials and Methods

6.2.1 Sample Collection, Specimen Examination and Isolation

Specimens were collected from seeds and fruits in Thailand and United Kingdom during 2014 to 2018. Macroscopic and microscopic characters of the specimens were observed in the laboratory. Specimens were examined using a Motic dissecting microscope (SMZ 168). Free-hand sections of fungal fruiting bodies were mounted in water, KOH and Melzer's reagents for microscopic studies and photomicrography. Fungal characters were observed with a Nikon Eclipse E600 DIC microscope and images recorded with a Nikon DS-U2 camera. Measurements were made with Tarosoft (R) Image Frame Work software. The images used for photo plates were processed with Adobe Photoshop CS6 portable version software (Adobe

Systems, USA). Single ascospore isolations were carried out following the method described in Chomnunti et al. (2014). Germinated ascospores were transferred individually to PDA or MEA and incubated at 16°C, 25°C or 28°C. Colony characters were observed and colony diameters were recorded.

Herbarium material was preserved in the Mae Fah Luang University (MFLU) herbarium, Chiang Rai, Thailand. Living cultures were stored in the Culture Collection at Mae Fah Luang University (MFLUCC). Facesoffungi and Index Fungorum numbers were registered as outlined in Jayasiri et al. (2015) and Index Fungorum.

6.2.2 DNA Isolation, Amplification and Analyses

Genomic DNA was extracted from colonies growing on PDA or MEA or directly from the fruiting bodie using the Biospin Fungus Genomic DNA Extraction Kit-BSC14S1 (BioFlux®, P.R. China) following the manufacturer's protocol. PCR was performed in a 25 µl reaction volume containing, 12.5 µl of 2 × PCR Master Mix (TIANGEN Co., China), 9.5 µl ddH_2O, 5–10 ng DNA and 1 µl of each primer (10 µM). PCR products were purified and sequenced at Shanghai Sangon Biological Engineering Technology and Services Co., China. Both directions of the PCR products were sequenced using the same primer pairs as used in PCR amplification. DNA amplifications were performed by polymerase chain reaction (PCR). Part of the large subunit nuclear rRNA gene (LSU) was amplified with primer pairs LR0R (Rehner and Samuels 1994) and LR5 (Vilgalys and Hester 1990). The small subunit nuclear rRNA gene (SSU) was amplified with primer pairs NS1 and NS4 (White et al., 1990). Primer pairs ITS4 and ITS5 were used to amplify the 5.8S rDNA region and flanking internal transcribed spacers (ITS) (White et al., 1990). The translation elongation factor 1-alpha gene (TEF1) was amplified by using primers EF1-983F and EF1-2218R (Rehner, 2001 and Currie et al., 2003) or the primers EF1-728F and EF1-986R (Carbone and Kohn, 1999) or EF2 (O'Donnell et al., 1998). The RNA polymerase II second largest subunit (rpb2) gene was amplified with primers fRPB2 and fRPB2-7cR (Liu et al., 1999). The beta-tubulin (TUB2) gene was amplified by using primers T1 (O'Donnell and Cigelnik, 1997), Bt2b (Glass and Donaldson, 1995), CYLTUB1R (Crous et al., 2004) or T22 (Cigelnik, 1997). Histone H3 (HIS3) region

was amplified with the primers CYLH3F and CYLH3R (Lombard et al., 2012). PCR was performed following the protocols in Perera, Maharachchikumbura, Bhat et al. (2016). Assemblage of consensus sequences were done in ContigExpress (Vector NTI Suite 6.0). Newly generated sequences were deposited in NCBI GenBank and accession numbers are given at the end of the protologue.

6.2.3 Phylogenetic Analysis

The sequences obtained in this study were supplemented with the additional sequences retrieved from GenBank. The sequences were aligned using MAFFT v. 7 online server (http://mafft.cbrc.jp/alignment/server/) and, rechecked visually and improved manually using BioEdit v. 7.0.5.2 (Hall, 1999). Ambiguous regions were excluded from the analyses and gaps were treated as missing data.

Phylogenetic analyses were based on Bayesian inference (BI), maximum likelihood (ML) and maximum parsimony (MP) methods. ML analysis was performed at the CIPRES web portal (Miller et al., 2010) using RAxML v. 8.2.12 as part of the "RAxML-HPC2 on TG" tool (Stamatakis, 2006). BI was performed in MrBayes v. 3.2.0 (Ronquist and Huelsenbeck, 2003). MP analysis was performed using PAUP (Phylogenetic Analysis Using Parsimony) v.4.0b10 (Swofford, 2002). The trees were inferred using the heuristic search option with 1000 random taxa additions and tree bisection and reconnection (TBR) as the branch-swapping algorithm.

Alignments related to MFLUCC 17-2574 and MFLUCC 18-0354 were integrated in ARB program package (v. 6.0.6) (Ludwig et al., 2004), checked and refined where necessary. Maximum likelihood analyses of single gene regions: ITS, TEF1 and TUB2 were carried out for selected *Diaporthe* species to compare the topology of the trees and clade stability. Only reliably alignable positions were used for phylogenetic analyses. This included those corresponding to base pairs 25–51, 58–63, 72–104, 105–194, 197–209, and 212–306 of sequence KJ590747 (*D. ueckerae*) for TEF1. Of the TUB2 alignment, positions 75–174, 180–322, and 328–436 according to sequence KJ610881 were considered. ITS gene trees were based on positions 17–64, 67–92, 98–170, 172–387, and 390–506 according to KJ590726. A

combined gene analysis was carried out for concatenated alignment of TEF1 and TUB2 sequences.

All phylogenetic trees were viewed in FigTree version 1.4.0 and modified using Microsoft PowerPoint. Before combining, single gene phylogenetic analyses were conducted for each locus to compare the tree topology and clade stability. The names of the isolates obtained in this study are printed in blue font and names of ex-type and ex-epitype taxa are printed in black bold font in the trees. Maximum likelihood bootstrap support values and Bayesian posterior probabilities are given at the nodes respectively.

6.3 Results

Phylogeny and Taxonomy

The classification of Sordariomycetes has been detailed in Hyde et al. (2020) and provided in the Outline of fungi and fungus-like taxa by Wijayawardene et al. (2020) and is followed here.

Amphisphaeriales D. Hawksw. and O.E. Erikss.

Beltraniaceae Nann. Beltraniella Subram.

Beltraniella fertilis Heredia, R.M. Arias, M. Reyes and R.F. Castañeda, Fungal Diversity 11: 100 (2002), Figure 6.6

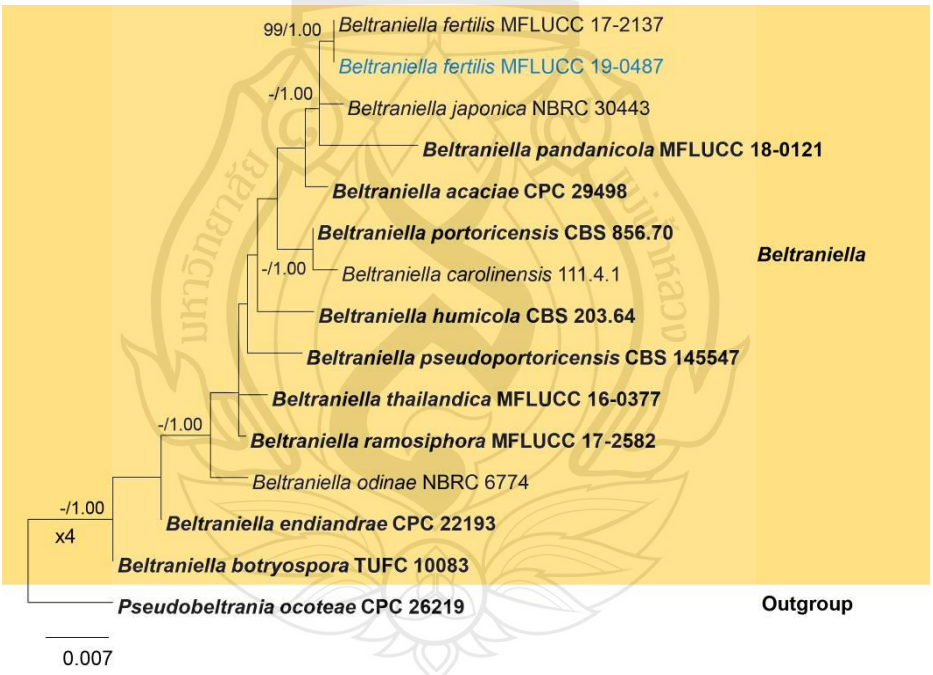
Saprobic on dried fruit of *Lithocarpus* sp. **Sexual morph**: Undetermined. **Asexual morph**: Hyphomycetous. Colony on the host greenish. *Setae* 115–185 × 3.5–4.5 µm (n = 10), erect, dark brown, thick-walled, indistinctly septate, with prominent warts, straight or flexuous, unbranched, tapering to an acute apex, arising from radially lobed basal foot cell. *Long setiform conidiophores* not observed. *Short conidiophores* 33–50 × 3.5–5 µm ($\bar{x}$ = 41.8 × 4.1 µm, n = 15), macronematous, mononematous, single or arranged in groups around the setae, erect, straight or slightly curved, simple or branched, septate, subhyaline to pale brown, thin-walled, smooth-walled. *Conidiogenous cells* 6–20 × 4–6 µm ($\bar{x}$ = 10.4 × 3.5 µm, n = 15), terminal and intercalary, subcylindrical, polyblastic, apex with several flat-tipped denticles, pale brown, smooth-walled. *Separating cells* 7.5–10 × 3–4.1 µm ($\bar{x}$ = 8.6 ×

3.5 µm, n = 10), ovoid or obovoid, fusiform, hyaline to subhyaline, thin-walled, smooth-walled, with a single flat-tipped denticle. *Conidia* 20–22 × 4.3–5.5 µm ($\bar{x}$ = 20.8 × 4.8 µm, n = 20), solitary, turbinate to pyriform, distal end truncate, subhyaline, smooth, aseptate, with median transverse band of lighter pigment, base tapering to an acutely rounded tip.

Culture characteristics: Conidia germinating on PDA within 12 hours. Colonies on PDA reaching 7.5 cm wthin 14 days at 28°C, medium dense, circular, flat, even margin, with sparse aerial mycelium, white from above, reverse dark brown.

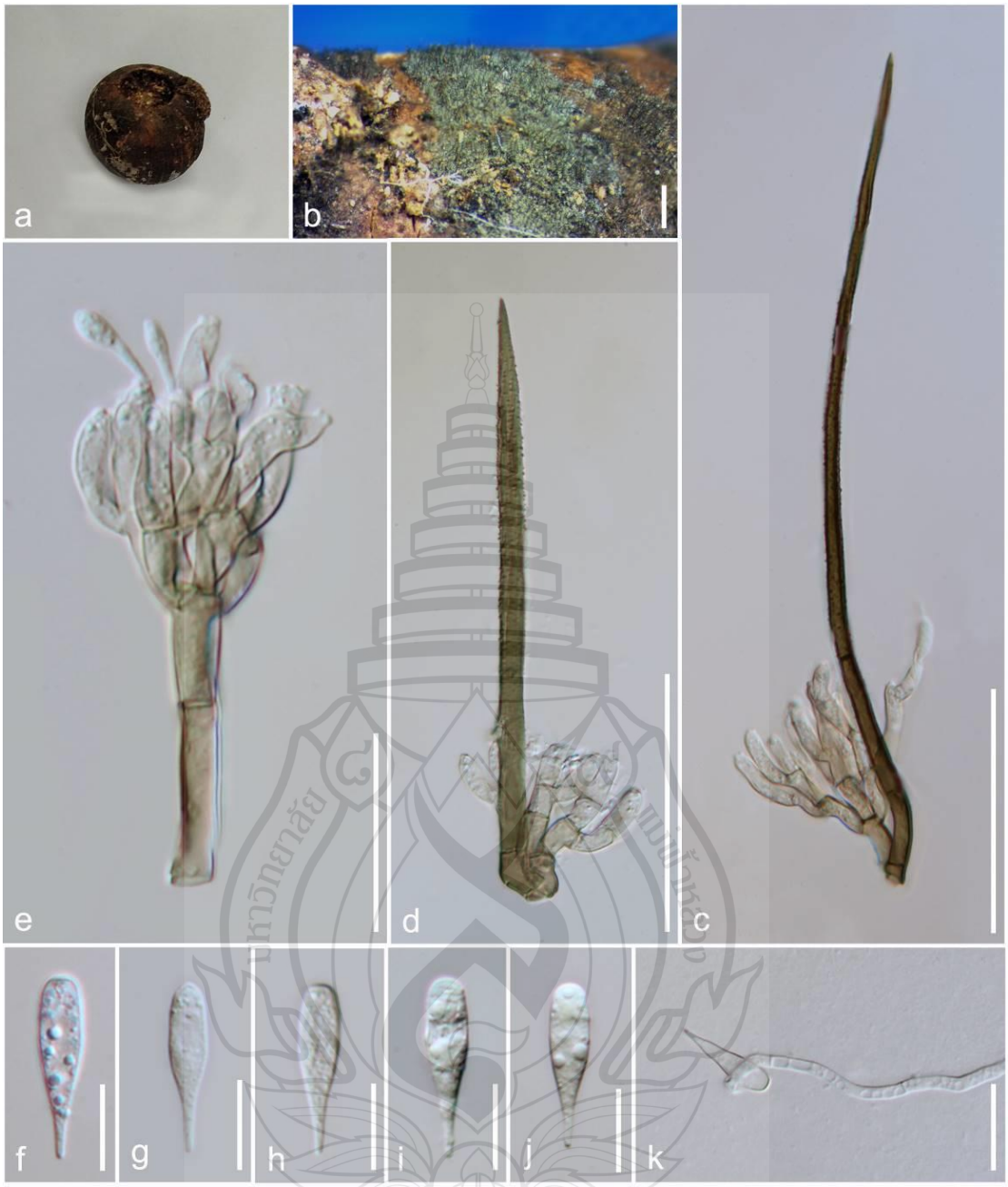
Material examined: THAILAND, Chiang Mai Province, on dried fruit of *Lithocarpus* sp. (Fagaceae), 22 December 2017, R.H. Perera, Seed 06 (MFLU 19-0982), living culture MFLUCC 19-0487.

GenBank numbers: ITS: MT215489, LSU: MT215539.



Note Sequences from fifteen taxa, which comprise 1311 characters including gaps, are included in the analyses. The tree was rooted to *Pseudobeltrania ocoteae* (CPC 26219). The scale bar indicates 0.007 nucleotide changes per site.

Figure 6.5 Phylogram generated from RAxML analysis based on combined ITS and LSU sequence data of *Beltraniella* isolates



Notes (a) Herbarium material. (b) Colony on natural substrate. (c, d) Setae with conidiogenous apparatus. (e) Conidiophores, conidiogenous cells with conidia. (f–j) Conidia. (k) Germinating conidium. Scale bars: b = 500 µm, c, d = 50 µm, e = 20 µm, f–j = 10 µm, k = 20 µm.

Figure 6.6 *Beltraniella fertilis* (MFLU 19-0982)

Notes: In the phylogenetic analysis our new isolate clustered with *Beltraniella fertilis* (MFLUCC 17-2137) with high statistical support (99% MLBT, 1.00 BYPP and Figure 6.5). A comparison of nucleotides shows ITS and LSU loci of our isolate are identical to *B. fertilis* (MFLUCC 17-2137). Our collection is similar to *B. fertilis* by its setae, conidiophore and conidial morphology and dimensions (Heredia et al., 2002 and Lin et al., 2017). Therefore, our collection is a new host record for *B. fertilis*.

Chaetosphaeriales Huhndorf, A.N. Mill. and F.A. Fernández

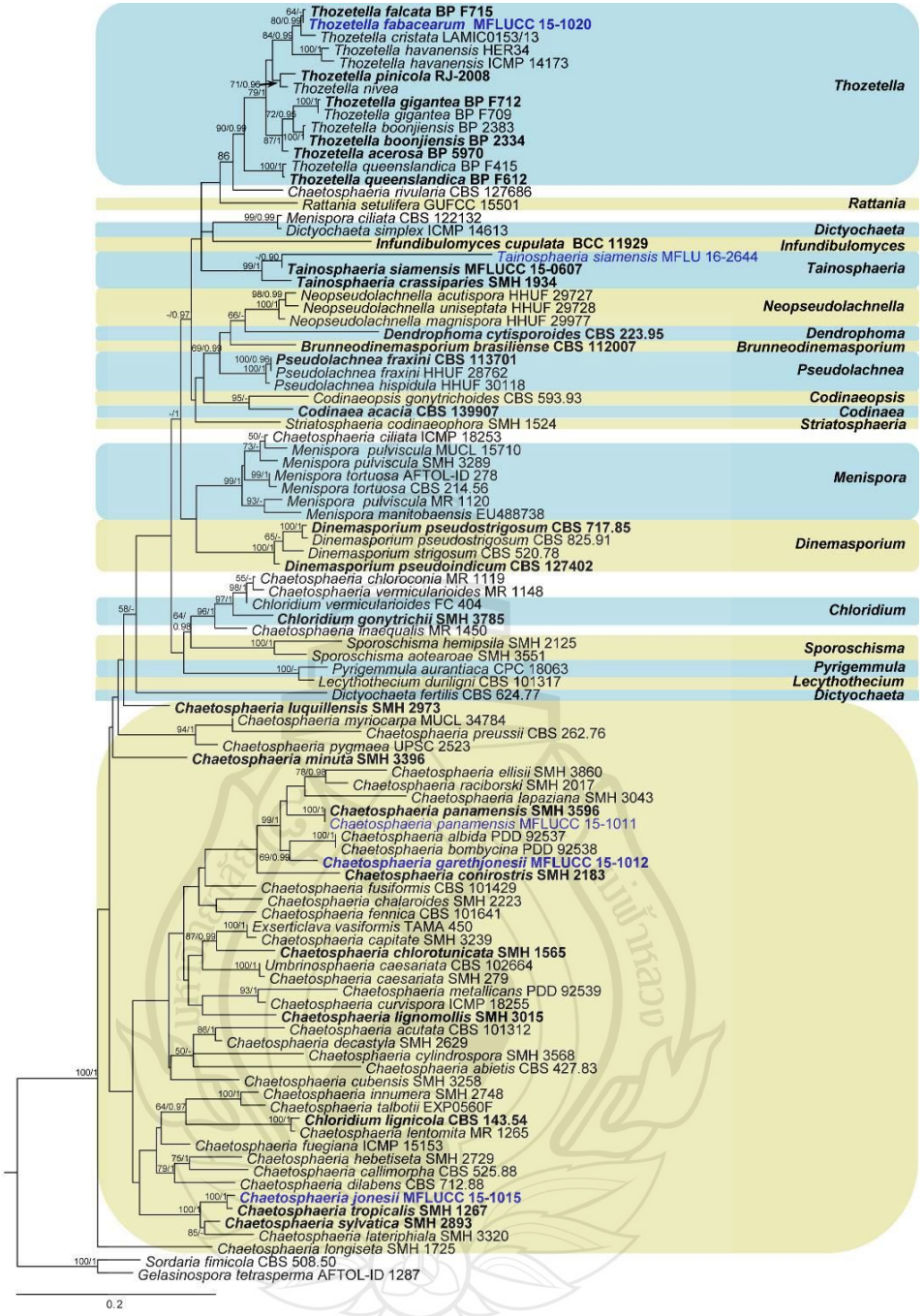
Chaetosphaeriaceae Locq.

Chaetosphaeria garethjonesii R.H. Perera, Maharachch. and K.D. Hyde, ***sp. nov.***

Index Fungorum: IF552536 and Faceoffungi number: FoF02658, Figure 6.8

Etymology: In honor of E.B.G. Jones for his work on marine fungi.

Saprobic on a *Fabaceae* seed pod. **Sexual morph**: *Ascomata* brown to dark brown, not collapsing when dry, ovoid to broadly obpyriform, 191–250 µm diameter, 240–257 µm high, superficial, scattered to gregarious, setose, slightly papillate. *Setae* scattered over entire ascomata, dark brown, stiff, pointed, 38–47 µm. *Peridium* cells 21–59 µm thick, with cells *textura globosa* in surface view, 3-layered in longitudinal section, with inner layer 2–3 cells thick, composed of light brown to hyaline elongate cells, with middle layer 4–6 cells thick, composed of small, brown to dark brown, elongate to polygonal cells, with outer layer 2–3 cells thick, composed of large isodiametric to polygonal, brown cells. *Paraphyses* 5.6–8.6 *µm* wide, of variable length, simple, sparse, hyaline, unbranched, tapering towards the apex, septate. *Asci* 120–152×10.7–13.3 ($\bar{x}$ =137 × 12 µm, n = 20) µm, 8-spored, unitunicate, cylindrical, pedicellate, with rounded apex, with a thin, J-, apical ring. *Ascospores* 63.3–75 × 2.3–3.7 ($\bar{x}$ = 69.5 × 3.1 µm, n = 30) µm, fasciculate, straight to gently curved, with rounded ends, slightly tapering to base, 7-septate, sometimes slightly constricted at septa, hyaline, smooth-walled, without a gelatinous sheath. **Asexual morph**: Undetermined.



Note Maximum likelihood bootstrap support values greater than 50% and Bayesian posterior probabilities (PP) above 90% are shown near the nodes. The new isolates are in blue and ex-type strains in bold. The tree is rooted with *Gelasinospora tetrasperma* and *Sordaria fimicola.*

Figure 6.7 Phylogram generated from maximum likelihood analysis of combined LSU, ITS and TUB2 sequence data from species of Chaetosphaeriaceae

Culture characters: Twenty-one day old colonies on MEA 60–76 mm diameter, flat, lacking aerial mycelium, margins effuse, dark brown at margins, gray to white at the center from above, reverse dark brown.

Material examined: THAILAND, Chiang Mai Province, on a *Fabaceae* seed pod, 19 July 2015, R.H. Perera, RHP 115 (MFLU 16-1019, holotype), ex-type living culture, MFLUCC 15-1012.

GenBank numbers: LSU: KY212759, ITS: KY212751, TUB2: KY212755

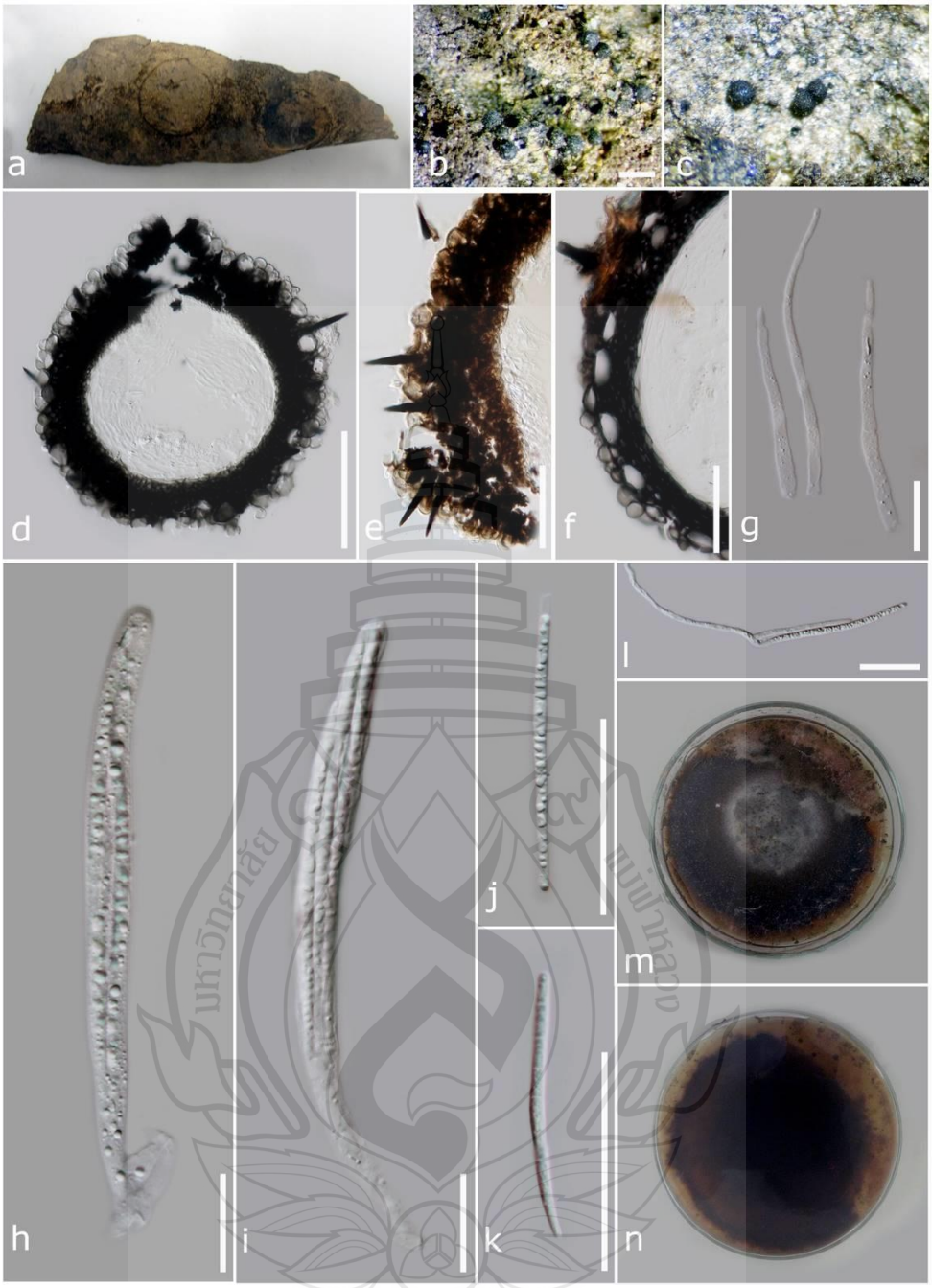
Notes: *Chaetosphaeria garethjonesii* is a distinct species in the genus as supported by molecular and morphological characters. In the phylogenetic tree, *C. garethjonesii* is sister to *C. albida* T.J. Atk. et al. and *C. bombycina* T.J. Atk. et al. (Figure 6.7). *Chaetosphaeria garethjonesii* differs from *C. albida* and *C. bombycina* in ascomatal morphology. *Chaetosphaeria albida* and *C. bombycina* are characterized by almost white or light fawn-grey, translucent or reflective ascomatal with walls lacking setae, while *C. garethjonesii* has brown to dark brown ascomata with setose, rough walls (Atkinson et al., 2007). Ascospore septation in *C. albida* is also less than that in *C. bombycina* (7 vs. 11 and Atkinson et al., 2007).

Dictyochaeta coryli R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556867 and Facesoffungi number: FoF07752, Figure 6.10

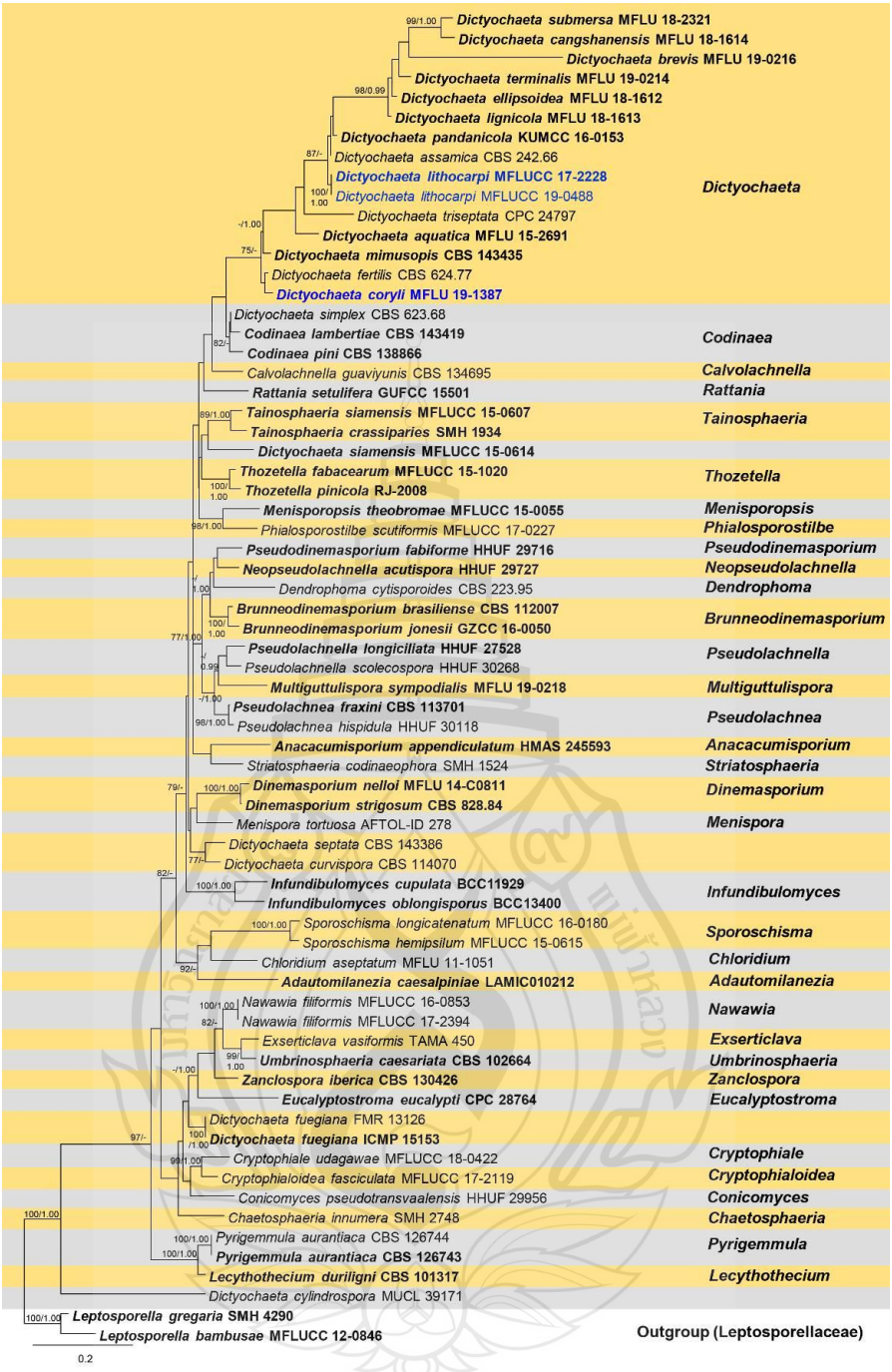
Etymology: Named after the host genus *Corylus.*

Saprobic on dried *Corylus avellana* fruits. **Sexual morph**: Undetermined. **Asexual morph**: Hyphomycetous. *Colonies* on natural substrate, effuse, hairy, pale brown, with glistering white conidial masses. *Setae* 115–135 × 3.5–4.8 µm, straight or flexuous, septate, unbranched, pale brown to brown, paler towards the apex, apex fertile with persistent collarettes, smooth-walled. *Conidiophores* 55–70 × 3.3–4 µm ($\overline{x}$ = 62.3 × 3.8 µm, n = 15), macronematous, mononematous, solitary or in small groups often associated with setae, straight or flexuous, cylindrical, unbranched, septate, smooth, brown to pale brown, almost hyaline at apex, smooth-walled.



Note (a–c) Appearance of ascomata on host substrate. (d) Section of ascoma. € Peridium with ascomatal setae. (f) Peridium. (g) Paraphyses. (h, i) Asci. (j, k) Ascospores. (l) Germinating ascospore. (m, n) Colony on MEA (above and below views). Bars – b = 500 µm, d = 100 µm, e = 50 µm, f–i = 20 µm, j, k = 50 µm, l = 20 µm.

Figure 6.8 *Chaetosphaeria garethjonesii* (MFLU 16-1019, holotype)



Note Sequences from sixty-eight taxa, which comprise 1438 characters including gaps, are included in the analyses. The tree was rooted to *Leptosporella bambusae* (MFLUCC 12-846) and *L. gregaria* (SMH 4290). The scale bar indicates 0.2 nucleotide changes per site.

Figure 6.9 Phylogram generated from RAxML analysis based on combined ITS and LSU sequence data of selected Chaetosphaeriaceae isolates

Conidiogenous cells 10–22 × 2.7–3.8 µm ($\bar{x}$ = 15.7 × 3.3 µm, n = 15), monophialidic, integrated, terminal, sympodially proliferating, determinate, sub-cylindrical, pale brown, with distinct, funnel-shaped collarettes, 1.2−1.6 µm high, 2.2−3 µm wide. *Conidia* 12−19.5 × 2.3−3.5 µm ($\bar{x}$ = 17.4 × 3 µm, n = 30), solitary, aseptate, fusiform, curved, sometimes guttulate, hyaline, smooth-walled, in slimy mass, single setula at each end, 4.7−8.4 µm long, 0.5−0.8 µm wide, filiform, hyaline.

Culture characteristics: Conidia germinating on PDA within 12 hours. Colonies on PDA reaching up to 30 cm diameter after 21 days at 28°C, circular or irregularly circular, medium dense, effuse, aerial mycelium forming concentric rings with cottony texture, edge entire, white from above, reverse brown.

Material examined: UK, Hampshire, Bishop Waltham, standing water, on dried fruits of *Corylus avellana* L. (Betulaceae), 8 December 2017, E.B.G. Jones, GJ 406 (MFLU 19-1387, holotype).

GenBank numbers: ITS: MT215494, LSU: MT215545.

Notes: *Dictyochaeta coryli* groups with *D. fertilis* (S. Hughes and W.B. Kendr.) Hol.-Jech. (CBS 624.77) in our phylogenetic analysis, with low statistical support (Figure 6.9). *Dictyochaeta coryli* differs from *D. fertilis* in having aseptae conidia, while those of *D. fertilis* are 6–11 septate (Whitton et al., 2000). *Dictyochaeta coryli* can be distinguished from *D. mimusopis* Crous and M.J. Wingf by having fertile setae, while *D. assamica* (Agnihothr.) Aramb., Cabello and Mengasc. does not have setae (Arambarri et al., 1987). *Dictyochaeta coryli* resembles *D. intermedia* Gusmão and S.M. Leão, but differs in having shorter and wider conidia (12−19.5 × 2.3−3.5 vs. 18–21 × 1.5–2.5) and fertile setae, while *D. intermedia* forms non-fertile setae (Cruz et al. 2009). *Dictyochaeta coryli* also cannot be assigned to any known *Dictyochaeta* species which lack sequence data (Kuthubutheen and Nawawi, 1991 and Whitton et al., 2000 and Cruz et al., 2009). We therefore identify *D. coryli* as a new species of *Dictyochaeta*.

Note (a) Herbarium material. (b) Colony on fruit. (c) Seta. (d, e) Conidiophores and conidiogenous cells. (f–k) Conidia (l) Germinating conidium. (m, n) Colony on MEA. Scale bars: b = 200 µm, c–e = 100 µm, f–l = 10 µm.

Figure 6.10 *Dictyochaeta coryli* (MFLU 19-1387, holotype)

Dictyochaeta lithocarpi R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556868 and Facesoffungi number: FoF07753, Figure 6.11

Etymology: Named after the host genus *Lithocarpus*.

Saprobic on decaying *Lithocarpus* fruits. Sexual morph: Undetermined. Asexual morph: Hyphomycetous. *Colonies* on natural substrate, effuse, hairy, brown, with white conidial masses. *Setae* 170–275 × 4–5 µm ($\bar{x}$ = 209 × 4.3 µm, n = 10), solitary or in groups of 2–3, straight or flexuous, septate, unbranched, apex fertile with persistent collarettes, dark brown and robust at the base, paler towards the apex, smooth-walled. *Conidiophores* 55–110 × 3.2–4 µm ($\bar{x}$ = 86 × 3.7 µm, n = 20), macronematous, mononematous, aggregated, in small groups often associated with setae, rarely solitary, straight or flexuous, cylindrical, unbranched, septate, smooth, dark brown to pale brown, paler at apex, smooth-walled. *Conidiogenous cells* 12–22 × 3.5–5.3 µm ($\bar{x}$ = 16.6 × 4.2 µm, n = 20), monophialidic, integrated, terminal, determinate, hyaline or pale brown, with distinct, sub-cylindrical, funnel-shaped collarettes, 1.8−2.1 µm high, 2.8−3.6 µm wide. *Conidia* 14−17 × 1.5−2.8 µm ($\bar{x}$ = 15.2 × 2.3 µm, n = 30), solitary, aseptate, fusiform, curved, in slimy mass, hyaline, smooth-walled, single setula at each end, 6.8−10.5 µm long, 0.4−0.6 µm wide, filiform, hyaline.

Culture characteristics: Conidia germinated on PDA within 12 hours. Colonies on PDA reaching up to 35 cm diameter after 15 days at 28°C, circular or irregularly circular, medium dense, flat or effuse, edge entire, white from above, reverse yellow brown.

Material examined: THAILAND, Chiang Mai Province, on dried fruits of *Lithocarpus* sp. (Fagaceae), 20 July 2017, R.H. Perera, Doi 05 (MFLU 19-1173, holotype), ex-type living culture MFLUCC 17-2228 and *ibid.*, 22 December 2017, Seed 08 (MFLU 18-2772), living culture MFLUCC 19-0488.

GenBank numbers: ITS: MT215492, LSU: MT215543 (MFLUCC 17-2228) and ITS: MT215493, LSU: MT215544 (MFLUCC 19-0488).

Notes: *Dictyochaeta lithocarpi* is well separated from other *Dictyochaeta* species in the phylogenetic analysis (Figure 6.9). Our isolate is related to *D. pandanicola* (KUMCC 16-0153) and *D. assamica* (CBS 242.66) (87% MLBT). *Dictyochaeta lithocarpi* differs from *D. pandanicola* by having smaller conidia (14−17 × 1.5−2.8 vs. 16–26 × 4–6 µm) and presence of setae (Tibpromma et al., 2018). *Dictyochaeta lithocarpi* can be distinguished from *D. assamica* by having monophialidic conidiogenous cells, while *D. assamica* has polyphialidic

conidiogenous cells (Arambarri et al., 1987). *Dictyochaeta lithocarpi* also cannot be assigned to any known *Dictyochaeta* species, which lack sequence data (Kuthubutheen and Nawawi, 1991 and Whitton et al., 2000 and Cruz et al., 2009). Therefore, we identify *D. lithocarpi* as a novel species of *Dictyochaeta*.

Note (a) Herbarium material. (b) Colony on natural substrate. (c–e) Setae, conidiophores and conidiogenous cells. (f–k) Conidia. (l) Germinating conidium. Scale bars: b = 200 µm, c, d = 100 µm, e = 50 µm, f–l = 20 µm.

Figure 6.11 *Dictyochaeta lithocarpi* (MFLU 19-1173, holotype)

Menisporopsis theobromae S. Hughes, Mycol. Pap. 48: 59 (1952), Figure 6.12

Colonies on decaying Fabaceae seed pod, scattered, superficial, effuse, white. **Sexual morph**: Undetermined. **Asexual morph**: *Setae* 230–280 × 5.1–6.2 μm, central, solitary, erect, septate, thick-walled, lower part encased tightly by compact conidiophores and obviously wider than each conidiophore, brown. *Conidiophores* up to 128 μm long, synnematous, macronematous, brown, cylindrical, septate, unbranched, lower part narrow, upper part wider, erect, straight or slightly flexuous, smooth, thin to thick-walled. *Conidiogenous cells* terminal, monophialidic, integrated, pale brown, with visible collarettes. *Conidia* (11–)15.7–21.6 × 2.1–3.8 μm ($\bar{x}$ = 18.6 × 2.6 μm, n = 30), aggregated in slimy masses at the apex of the synnemata, acrogenous, lunate to falcate, gently curved or straight, aseptate, hyaline, thin- and smooth-walled and with a single, unbranched, flexuous, tubular, hyaline setula at each end, 7.3–9.4 μm long.

Material examined: THAILAND, Chiang Mai Province, on decaying seed pods of Fabaceae plant, 5 July 2015, R.H. Perera, RHP 128 (MFLU 16-1055).

Notes: We were unable to get a culture of this fungus. However, our collection resembles the genus *Menisporopsis* by its synnematous conidiophores, central, simple, dark brown setae, phialidic conidiogenous cells and lunate to falcate, 0–1-septate conidia, with setulae at ends (Cruz et al., 2014). The newly collected fungus is morphologically similar to *M. theobromae*, which was collected in Ghana and Thailand (Hughes, 1952 and Liu et al., 2016). Based on morphological features we regard our fungus as *M. theobromae* (Hughes, 1952 and Cruz, et al. 2014 and Liu et al., 2016). *Menisporopsis theobromae* was previously reported from *Theobroma cacao* and submerged wood, and this is the first record of the fungus from seed pods of a Fabaceae plant (Hughes, 1952 and Liu et al., 2016).

Note (a) Herbarium material. (b, c) Colony on natural substrate. (d, e) Conidiophores and seta. (f) Conidiogenous cells with conidia in Congo red. (g) Conidia. Scale bars: b = 1 mm, c = 500 µm, d, e = 100 µm, f = 50 µm, g = 30 µm.

Figure 6.12 *Menisporopsis theobromae* (MFLU 16-1055)

Thozetella fabacearum R.H. Perera and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF552537 and Facesoffungi number: FoF02660, Figures 6.13, 6.14

Etymology: Referring to the host family, Fabaceae.

Saprobic on a *Fabaceae* seed pods. **Sexual morph**: Undetermined. **Asexual morph from the natural substrate**: *Colonies* effuse, superficial, sporodochial, white. *Sporodochia* cylindrical or subulate, scattered, sessile, superficial, of cream white mass. *Microawns* 33–60 µm long, 3–5.3 µm wide, visible as small hairs in mass on the natural substrate, aseptate, smooth-walled, thick-walled, hyaline, variously-shaped, sigmoid or sickle-shaped, sometimes L-shaped. *Conidia* 13.2–17.2 × 1.9–2.4 ($\overline{x}$ = 15.5×2.1 µm, n = 30) µm, falcate, inequilateral, with rounded apical end, truncate at basal end, hyaline, smooth-walled, with a single filiform setula at each end, 3.6–9 µm long. **Asexual morph from the culture**: *Conidiomata* funnel-shaped, synnematous, abundant, elongated, brown to dark brown, with hyaline to ash apices, branched. *Conidiophores* macronematous, brown, cylindrical, septate, branched, densely compacted along the synnemata axis, smooth-walled. *Conidiogenous* cells 1.7–2.8 µm wide, phialidic, hyaline, smooth-walled, thick-walled. *Microawns* 32.8–56.4 µm long, 1.7–2.7 µm wide, aseptate, smooth-walled, hyaline, variously shaped, predominantly L-shaped, sometimes sigmoid or sickle-shaped. *Conidia* 11.6–14.7 × 2.2–3.4 ($\overline{x}$ = 13.3×2.6 µm, n = 20) µm, naviculate to fusiform or ellipsoid, inequilateral, with rounded apical end, truncate at basal end, hyaline, smooth-walled, with a single filiform setula at each end, 2.1–3.4 µm long.

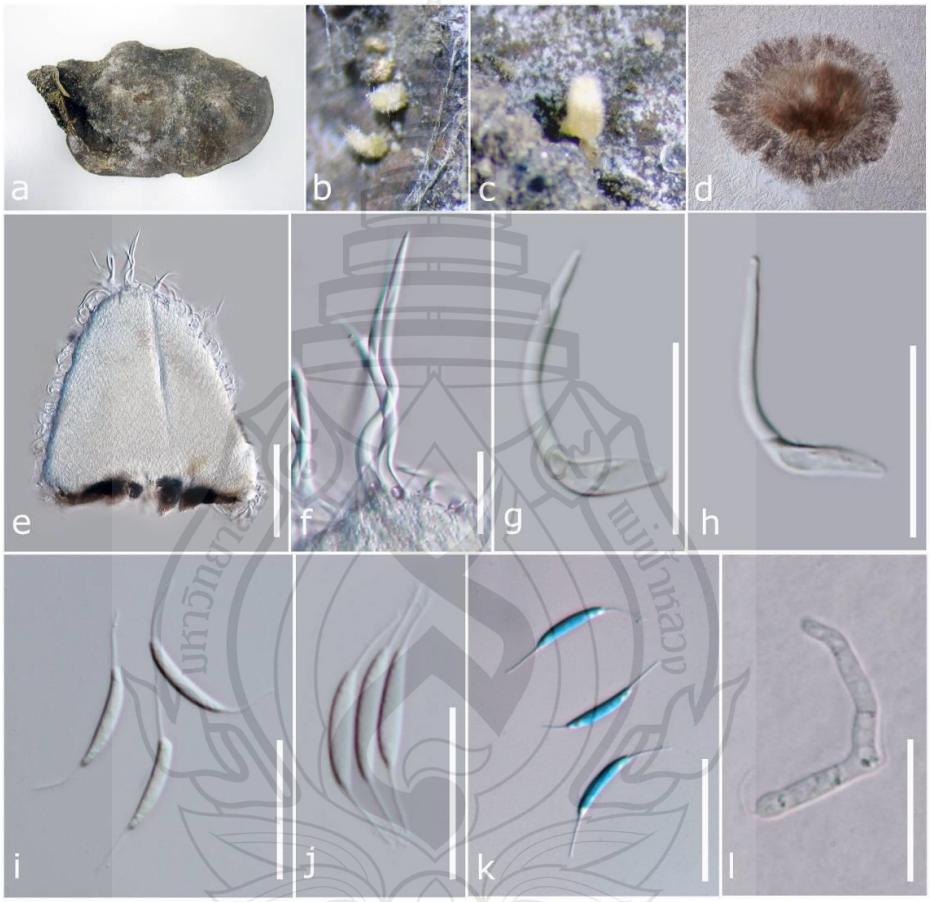
Culture characters: 21 day old colonies on MEA 35 mm, margins effuse, gray to dark-brown, flat, lacking aerial mycelium, producing synnemata after 150 days of incubation in the dark at 28 °C, reverse dark-brown to black.

Material examined: THAILAND, Phang-nga Province, Mueang Phang-nga District, Tham Nam Phut, on a *Fabaceae* seed pod, 7 December 2014, M. Dayarathne RHP 126 (MFLU 16-1021, holotype), ex-type living culture, MFLUCC 15-1020.

LSU: KY212762, ITS: KY212754

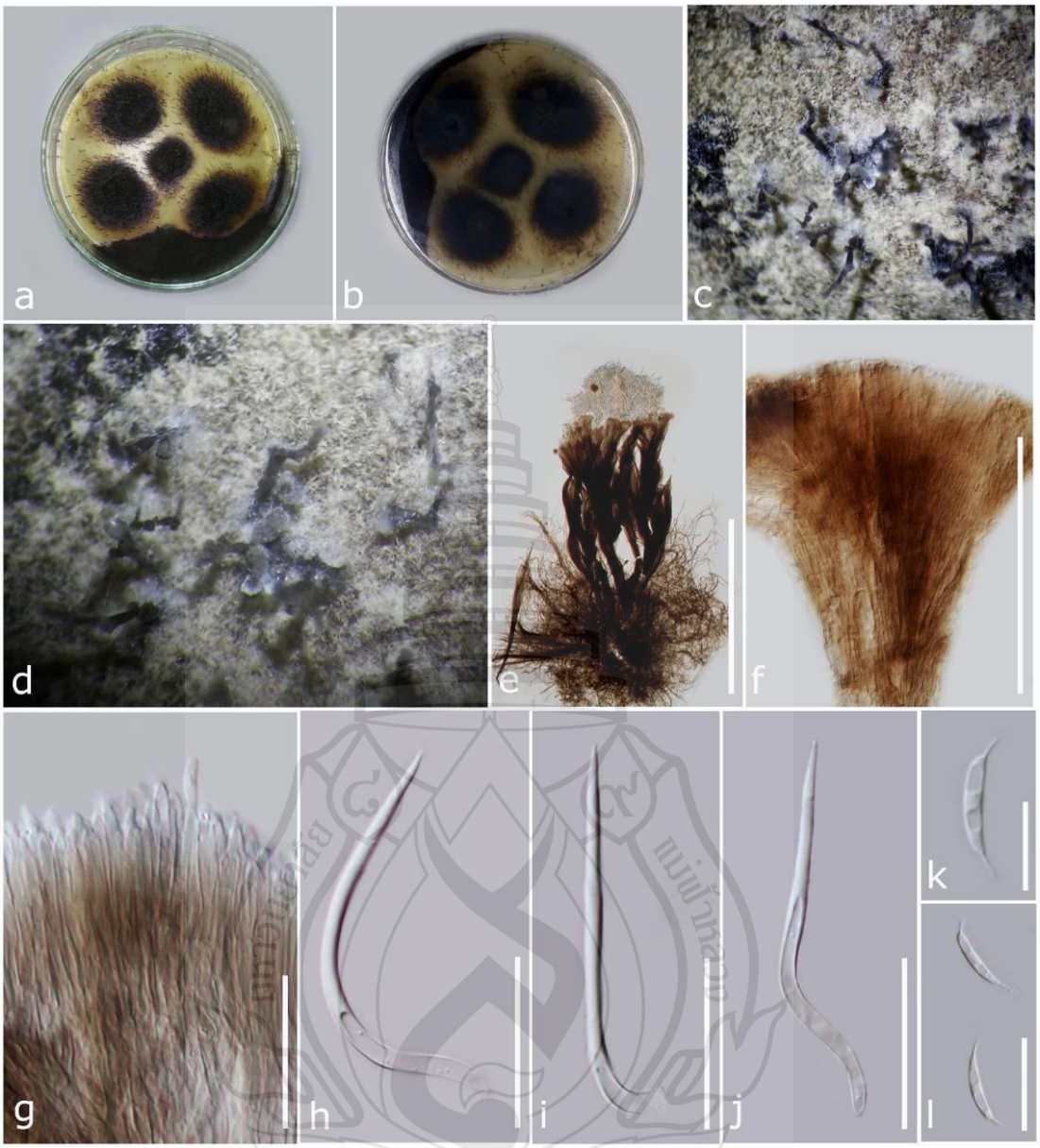
Notes: In this paper, we introduce *Thozetella fabacearum* as a new species which was collected from Phang-nga Province, Thailand. Maximum likelihood and Bayesian analyses of combined LSU, ITS and TUB2 sequence data (Figure 6.7) showed that *T. fabacearum* is closest to *T. falcata* B.C. Paulus et al. and *T. cristata* Piroz. and Hodges with moderate support. *Thozetella falcata* only has ITS sequence data for comparison. Therefore, it is not well-separated from *Thozetella fabacearum* in the phylogeny. However, *T. fabacearum* can easily be distinguished from *T. falcata*

by the conidiomatal morphology and shorter microawns (33–60 vs. 40–95 µm) (Paulus et al., 2004). *Thozetella fabacearum* produce sporodochia on the natural substrate and synnemata in the culture, while *T. falcata* and *T. cristata* produce synnemata on the natural substrate. *Thozetella tocklaiensis* (Agnihothr.) Piroz. and Hodges is the only *Thozetella* species producing sporodochia on the natural substrate and synnemata in culture (Barbosa et al., 2011 and Paulus et al., 2004).



Note (a) Herbarium specimen. (b, c) Appearance of conidiomata on host substrate. (d) Synnemata, circular in shape. (e) Section through synnemata. (f–h) Microawns. (i–k) Conidia (k in Cresol blue). (l) Germinating conidium. Scale bars: d = 100 µm, e–k = 20 µm, l = 10 µm.

Figure 6.13 *Thozetella fabacearum* (MFLU 16-1021, holotype)



Note (a, b) Sporulation on MEA. (c, d) Appearance of conidiomata on MEA. (e) Synnemata. (f) Closely packed conidiophores. (g) Conidiogenous cells. (h–j) Microawns. (k, l) Conidia. Scale bars: e = 500 µm, f = 100 µm, g–j = 10 µm, k = 10 µm, l = 20 µm.

Figure 6.14 *Thozetella fabacearum* in culture (MFLUCC 15-1020, ex-type culture)

However, *T. fabacearum* differs from *T. tocklaiensis* in having larger conidia (13.2–17.2×1.9–2.4 vs. 9–13×1.5–3 µm) and smaller microawns (33–60×3–5.3 vs.

18–38×1.5 µm) (Agnihothrudu, 1958 and Pirozynski and Hodges Jr, 1973). Although, the microawns size in *T. fabacearum* and *T. cristata* overlap, *T. fabacearum* differs in having larger conidia (13.2–17.2×1.9–2.4 µm as compared to 11.5–14.5×2.3–2.7 µm in *T. cristata*) (Barbosa et al., 2011).

Tainosphaeria siamensis J. Yang, K.D. Hyde and J.K. Liu

Figure 6.15

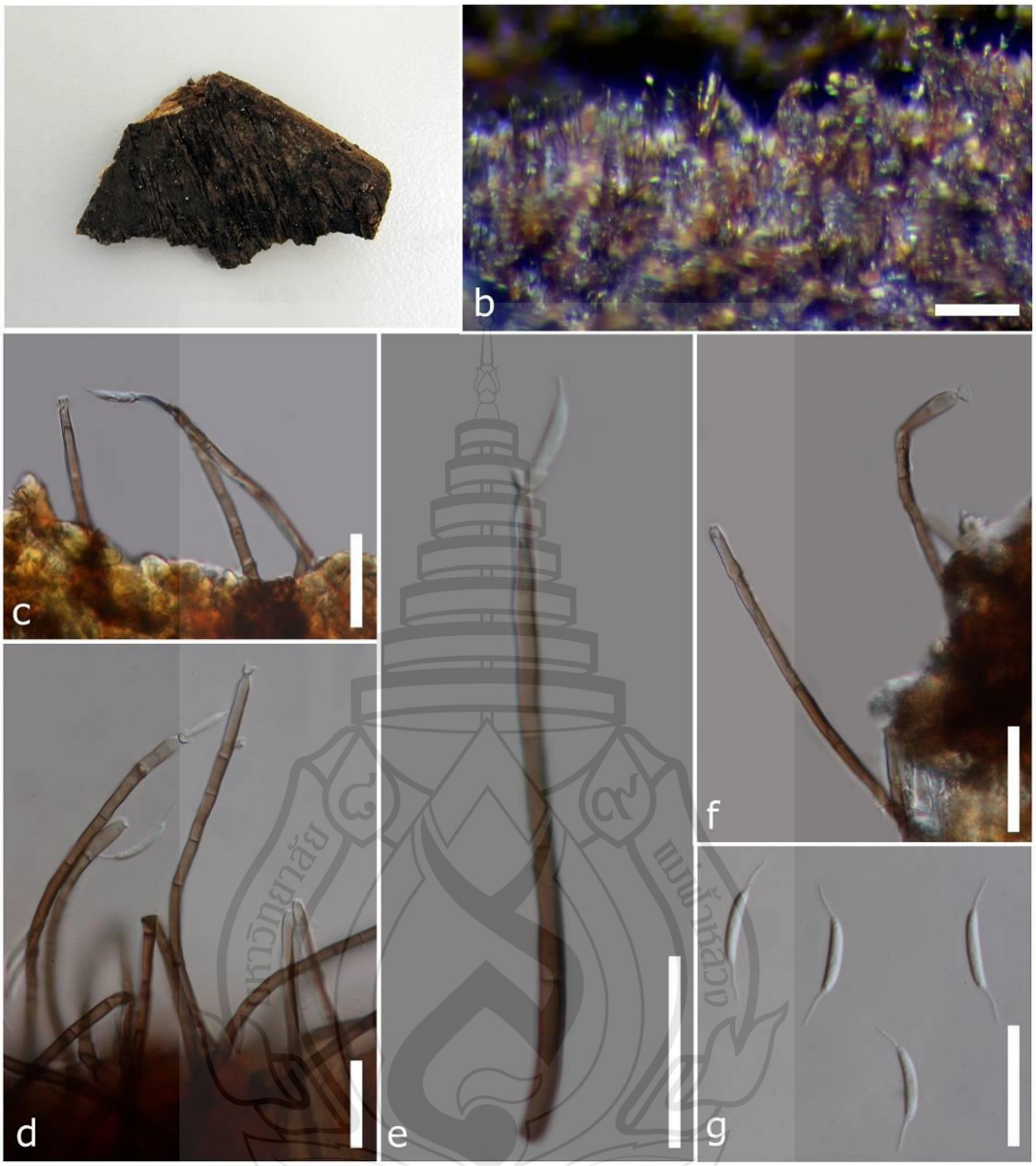
Saprobic on seeds and wood. Sexual morph – Undetermined. Asexual morph – *Colonies* on natural substrate, effuse, superficial, hairy, dark brown, in groups. *Conidiophores* mononematous, macronematous, subcylindrical, flexuous or straight, septate, unbranched, brown, becoming light brown towards the apex, smooth-walled, tapering to a terminal single phialide, 5–6.4 µm at the base. *Conidiogenous cells* phialidic cylindrical to clavate, light brown, smooth walled, with a periclinal thickened, flared, collarette. *Collarette* funnel-shaped, 4–6.2 µm wide at the opening, hyaline. *Conidia* 17.5–20.5×3.2–3.4 (12.5×1.8) µm, enteroblastic, naviculate to fusiform or cylindrical, equilateral, hyaline, both ends obtuse to subobtusely rounded, sometimes basal end truncate, with single setula at both ends, 7.8–9.1 µm long.

Culture characters: Cultures were not obtained.

Material examined: THAILAND, Chiang Mai Province, on a *Fabaceae* seed pod, 20 December 2015, R.H. Perera, DeloL 8 (MFLU 16-2644).

GenBank numbers: LSU: KX609953, ITS: KX609956

Notes: DNA was extracted directly from the colonies growing on the natural substrate. Phylogenetic analysis of combined LSU, ITS and TUB2 sequence data confirms our strain clusters with the ex-type strain of *Tainosphaeria siamensis* which was isolated from Thailand (Liu et al., 2016) (Figure 6.9). It is similar to the ex-type strain of *T. siamensis* in conidiophore morphology, conidial size and shape. *Tainosphaeria siamensis* resembles the asexual morph of *T. crassiparies*, in terms of similar conidiophore morphology and conidial appendages. It can be distinguished from the latter by equilateral (vs. inequilateral) larger conidia (vs. 10.5–14.8×2–3 µm) and conidiogenesis (phialidic vs. percurrent) (Fernández and Huhndorf, 2005 and Liu et al., 2016).



Note (a) Herbarium specimen. (b) Conidiophores on host substrate. (c–e) Conidiophore with developing conidium (f) Apical phialides (g) Conidia. Scale bars: b = 50 µm, c–g = 20 µm.

Figure 6.15 *Tainosphaeria siamensis* (MFLU 16-2644)

Delonicicolales R.H. Perera, Maharachch. and K.D. Hyde

Delonicicolaceae R.H. Perera, Maharachch. and K.D. Hyde

Delonicicola R.H. Perera, Maharachch. and K.D. Hyde

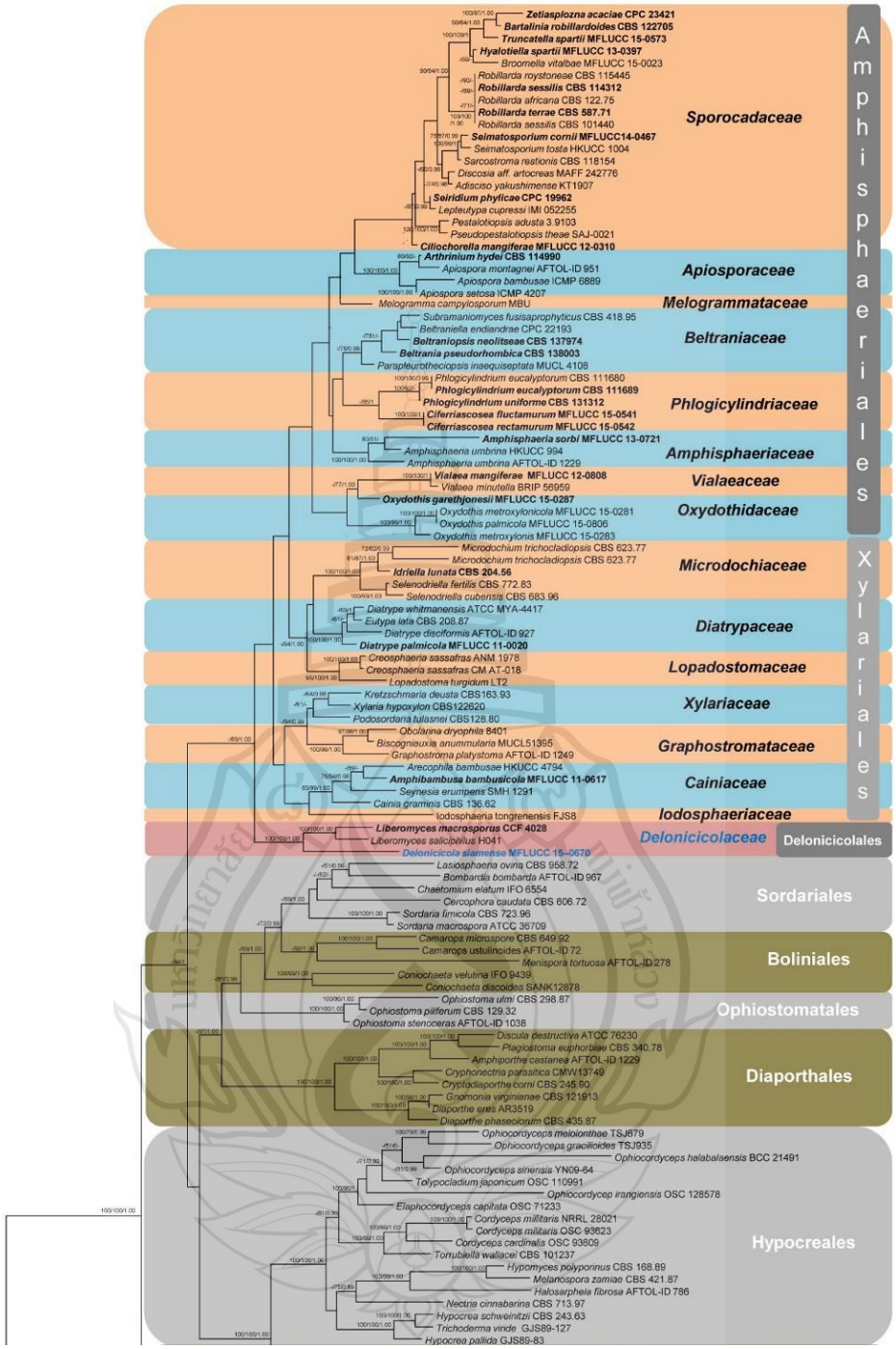
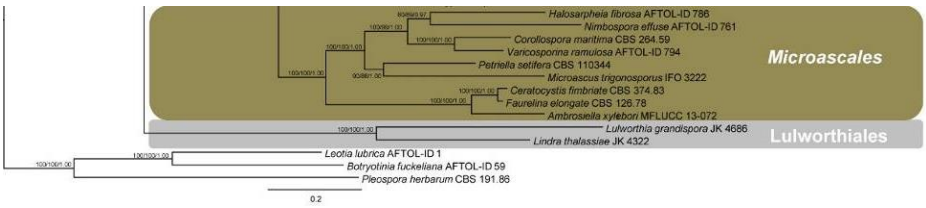


Figure 6.16 Phylogram generated from maximum likelihood analysis of combined LSU, SSU and RPB2 sequence data of selected taxa of Sordariomycetes



Note Values above the branches indicate maximum parsimony and maximum likelihood bootstrap ≥70%, (MP/ML). Values at the third positions, respectively, above or below the branches represent posterior probabilities (PP ≥0.95) from Bayesian inference analysis. The ex-types strains are in bold, the new isolates are in blue. The tree is rooted with *Botryotinia fuckelina*, *Leotia lubrica* and *Pleospora herbarum*.

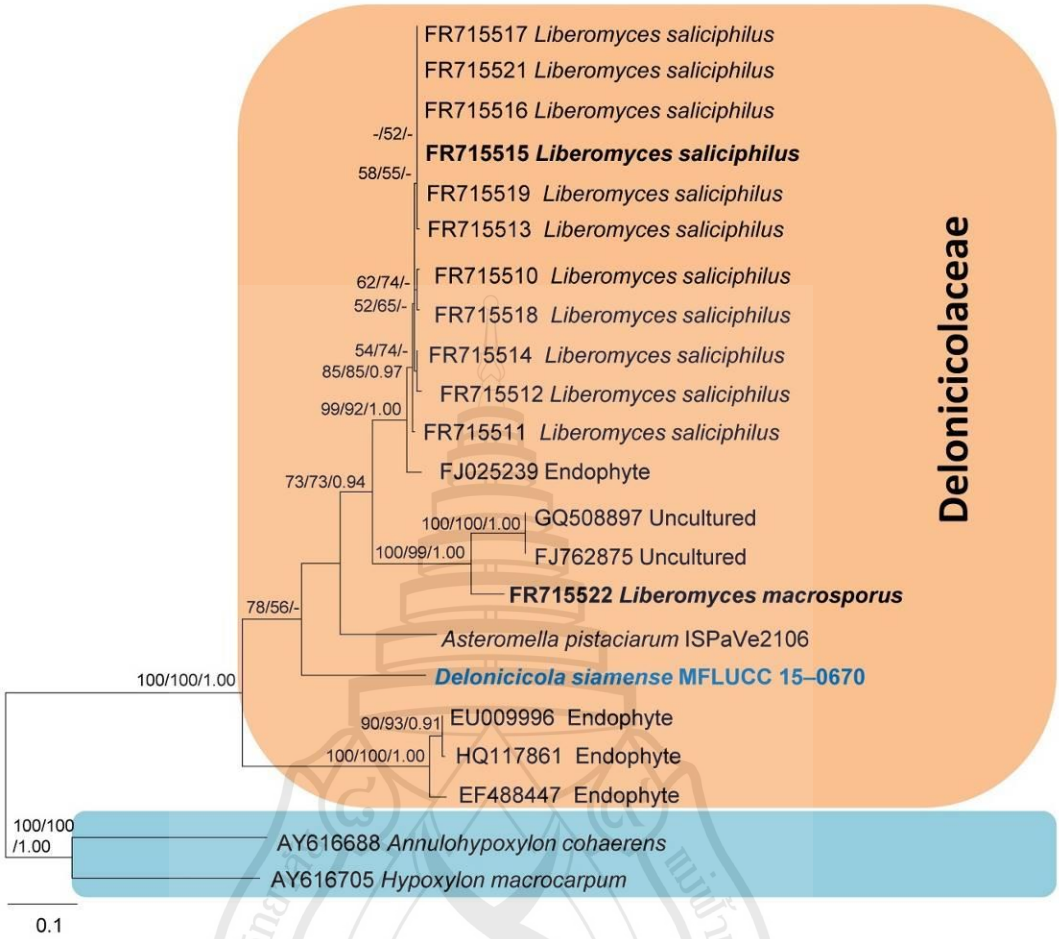
Figure 6.16 (continued)

Delonicicolales R.H. Perera, Maharachch. and K.D. Hyde, ***ord. nov.***

Index fungorum number: IF553775 and Facesoffungi number: FoF03603

Saprobic, *pathogenic* and/or *endophytic* in angiosperms hosts. **Sexual morph**: *Pseudostromata* aggregated, immersed, dark brown to black. *Ascomata*, perithecial, aggregated, immersed in host tissues, ostiolate, papillate. *Peridium*, composed of layers of hyaline cells of *textura angularis*. *Hamathecium* comprising dense filamentous, aseptate, unbranched paraphyses. *Asci* 8-spored, unitunicate, clavate, with short pedicel, apex simple. *Ascospores* uniseriate to biseriate, hyaline, trans-septate. **Asexual morph:** *Conidiomata* pycnidial, single or aggregated, uni- or irregularly multi-locular, ostiolate. *Peridium* composed of several layers, dark brown cells at the outside. *Conidiophores* irregularly branched, simple or more complex, hyaline. *Conidiogenous cells* holoblastic with sympodial proliferation. *Conidia* allantoid or bacilloid, 1-celled, hyaline.

Type family: Delonicicolaceae R. H. Perera, Maharachch. and K.D. Hyde



Note Values above the branches indicate maximum parsimony and maximum likelihood bootstrap ≥50%, (MP/ML). Values at the third positions represent Bayesian inference posterior probabilities (PP ≥ 0.90). The ex-type strains are in bold and the new isolate is in blue. The tree is rooted with *Annulohypoxylon cohaerens* and *Hypoxylon macrocarpum.*

Figure 6.17 Phylogram generated from RAxML based on ITS sequence data of analyzed Delonicicolaceae taxa

Delonicicolaceae R. H. Perera, Maharachch. and K.D. Hyde, ***fam. nov.***

Index fungorum number: IF553776 and Facesoffungi number: FoF03604

Saprobic, *pathogenic* and/or *endophytic* in angiosperms hosts. **Sexual morph**: *Pseudostromata* aggregated, immersed, dark brown to black, visible as raised, dark

spots on the host surface. *Ascomata*, perithecial, aggregated, immersed in host tissues, globose, subglobose to conical or irregular, hyaline, ostiolate, papillate. *Peridium*, composed of 5–8 layers of hyaline cells of *textura angularis*. *Hamathecium* comprising dense filamentous, aseptate, unbranched paraphyses. *Asci* 8-spored, unitunicate, clavate, with short pedicel, apex simple. *Ascospores* uniseriate to biseriate, 1-septate, ellipsoid, equilateral or inequilateral, hyaline, without a mucilaginous sheath. **Asexual morph:** *Conidiomata* pycnidial, rounded to oval, single or aggregated, uni- or irregularly multi-locular, ostiolate. *Peridium* composed of several layers, inner layers consisting of paler cells, outer layers with thick-walled, dark brown cells, basal part sometimes consisting of thin-walled non-melanized cells. *Conidiophores* irregularly branched, simple or more complex, hyaline, arising all around the cavity of the conidioma. *Conidiogenous cells* holoblastic with sympodial proliferation. *Conidia* allantoid or bacilloid, 1-celled, hyaline, sometimes producing synanamorph with filiform, one-celled, hyaline, conidia.

Type genus: *Delonicicola* R.H. Perera, Maharachch. and K.D. Hyde

Notes: In the phylogenetic analyses (Figures 6.16, 6.17), *Delonicicola* groups with *Liberomyces*, *Asteromella pistaciarum* and endophytes from various plants of tropical origin forming a distinct clade in Xylariomycetidae. *Liberomyces* species are endophytic or pathogenic coelomycetes, with sympodial proliferation of conidiogenous cells, allantoid conidia and sometimes produce synanamorph with filiform conidia (Pažoutová et al., 2012). *Asteromella pistaciarum* is a leaf pathogenic coelomycete, with rounded to oval conidiomata (45–90 µm diam) and bacilloid conidia (3–5 × 1 mm), straight or rarely curved, the type of conidial developmental pattern was not mentioned in the original description (Bremer and Petrak, 1947). In the multi-gene analysis, this clade is distinct from the other orders and families in Xylariomycetidae and thus we introduce a new order and family to accommodate these taxa. *Delonicicolaceae* resembles Xylariomycetidae in its life mode, as they are saprobic, pathogenic and/or endophytic (Bremer and Petrak, 1947 and Pažoutová et al., 2012 and Senanayake et al., 2015).

Delonicicola R.H. Perera, Maharachch. and K.D. Hyde, ***gen. nov.***

Index fungorum number: IF553772 and Facesoffungi number: FoF03605

Etymology: Referring to the host genus.

Saprobic on seed pods of *Delonix*. **Sexual morph**: *Pseudostromata* aggregated, immersed, dark brown to black, visible as raised, dark spots on the host surface. *Ascomata* perithecial, aggregated, immersed in host tissues, globose, subglobose to conical or irregular, hyaline, ostiolate, papillate. *Papilla* short, immersed or protruding through the host tissue, conical, periphysate. *Peridium*, composed of 5–8 layers of hyaline cells of *textura angularis*. *Hamathecium* comprising dense filamentous, aseptate, unbranched paraphyses. *Asci* 8-spored, unitunicate, clavate, with short pedicel, apex simple. *Ascospores* uniseriate to biseriate, 1-septate, not constricted at the septum, ellipsoid, equilateral or inequilateral, with narrowly rounded ends, straight, hyaline, smooth-walled, without a mucilaginous sheath. **Asexual morph:** Undetermined.

Type species: *Delonicicola siamense* R. H. Perera, Maharachch. and K.D. Hyde

Notes: *Delonicicola* is introduced as a monotypic genus to accommodate *D. siamense*, saprobic on *Delonix* seed pods based on sequence data and morphology. The ITS phylogeny showed that *Delonicicola* forms a distinct clade sister to *Liberomyces*, *Asteromella pistaciarum* and related sequences of endophytes of angiosperms within the family Delonicicolaceae (Figure 6.17).

Delonicicola siamense R.H. Perera, Maharachch. and K.D. Hyde, ***sp. nov.***

Index fungorum number: IF553771 and Facesoffungi number: FoF03606, Figure 6.18

Etymology: Referring to the country where the fungus was first collected.

Saprobic on seed pods of *Delonix regia*. **Sexual morph**: *Pseudostromata* aggregated, immersed, dark brown to black, visible as raised, dark spots on the host surface. *Ascomata* 112–267 *μm* high, 75–264 *μm* diam. ($\bar{x}$ = 162 × 125 *μm*, n = 20), perithecial, aggregated, immersed in host tissues, globose, subglobose to conical or irregular, hyaline, ostiolate, papillate. *Papilla* short, immersed or protruding through the host tissue, conical, periphysate. *Peridium* 10–16 *μm* wide ($\bar{x}$ = 12 *μm*, n = 20), composed of 5–8 layers of hyaline cells of *textura angularis*. *Hamathecium* comprising dense filamentous, aseptate, unbranched paraphyses, 0.8–1.1 *μm* wide ($\bar{x}$ = 0.9 *μm*, n = 20). *Asci* 29–42 × 3.4–4.9 *μm* ($\bar{x}$ = 35 × 4.2 *μm*, n = 25), 8-spored, unitunicate, clavate, with short pedicel, apex simple. *Ascospores* 3.8–6.9 × 1–1.4 *μm*

($\bar{x}$ = 5.4 × 1.2 μm, n = 20), uniseriate to biseriate, 1-septate, not constricted at the septum, ellipsoid, equilateral or inequilateral, with narrowly rounded ends, straight, hyaline, smooth-walled, without a mucilaginous sheath. **Asexual morph:** Undetermined.

Culture characters: Colonies growing on MEA, reaching 7 cm within 18 days, at 25 °C, circular, white, even margin with zonation, becoming pale yellow with time, flat, lacking aerial mycelium, underneath brown.

Material examined: Thailand, Chiang Rai, Mae Fah Luang University premises, on dried seed pods of *Delonix regia* (Boj. ex Hook.) Raf. (*Fabaceae*), 2 June 2015, R.H. Perera, RHP 92 (MFLU 17-0739, **holotype**) *ibid.* (HKAS, **isotype**), ex-type living culture = MFLUCC 15-0670.

GenBank numbers: LSU: MF158345, ITS: MF167586, SSU: MF158347, RPB2: MF158346

Notes: *Delonicicola siamense* is phylogenetically related to *Asteromella pistaciarum*, *Liberomyces* and endophytes of angiosperms (Fig 6.16). Both *Liberomyces* and *Asteromella* are coelomycetous genera with pycnidial conidiomata and allantoid, bacilloid or filiform, hyaline conidia. *Delonicicola siamense* is the only sexual morph known in *Delonicicolaceae*. The morphology of the sequenced endophytes was not described in the original publications (Vega et al., 2010 and Lin et al., 2010). However, phylogenetic analysis supports that *D. siamense* is distinct from those sequenced endophyte sequences (Figure 6.17).

Diaporthales Nannf.

Cytosporaceae Fr.

Cytospora diopuiensis Q.J. Shang, K.D. Hyde and J.K. Liu, in Shang et al., Mycosphere 11: 203 (2020), Figures 6.20, 6.21

Associated with dried seed pods of *Cassia fistula*. **Sexual morph**: Undetermined. **Asexual morph**: *Stromata* 125–470 µm high, 130–465 µm wide (n = 10), with poorly developed interior, solitary to gregarious, immersed, becoming raised or erumpent through the host tissue, discoid, circular to irregular in shape, dark brown to black, glabrous. *Conidiomata* (excluding necks) 110–210 × 95–325 µm diam. (n = 15), immersed in host tissue, scattered, erumpent, circular, with 1–2 locules, ostiolate, occasionally with yellow conidial exudate. *Ostioles* 120–150 µm diam. *Peridium*

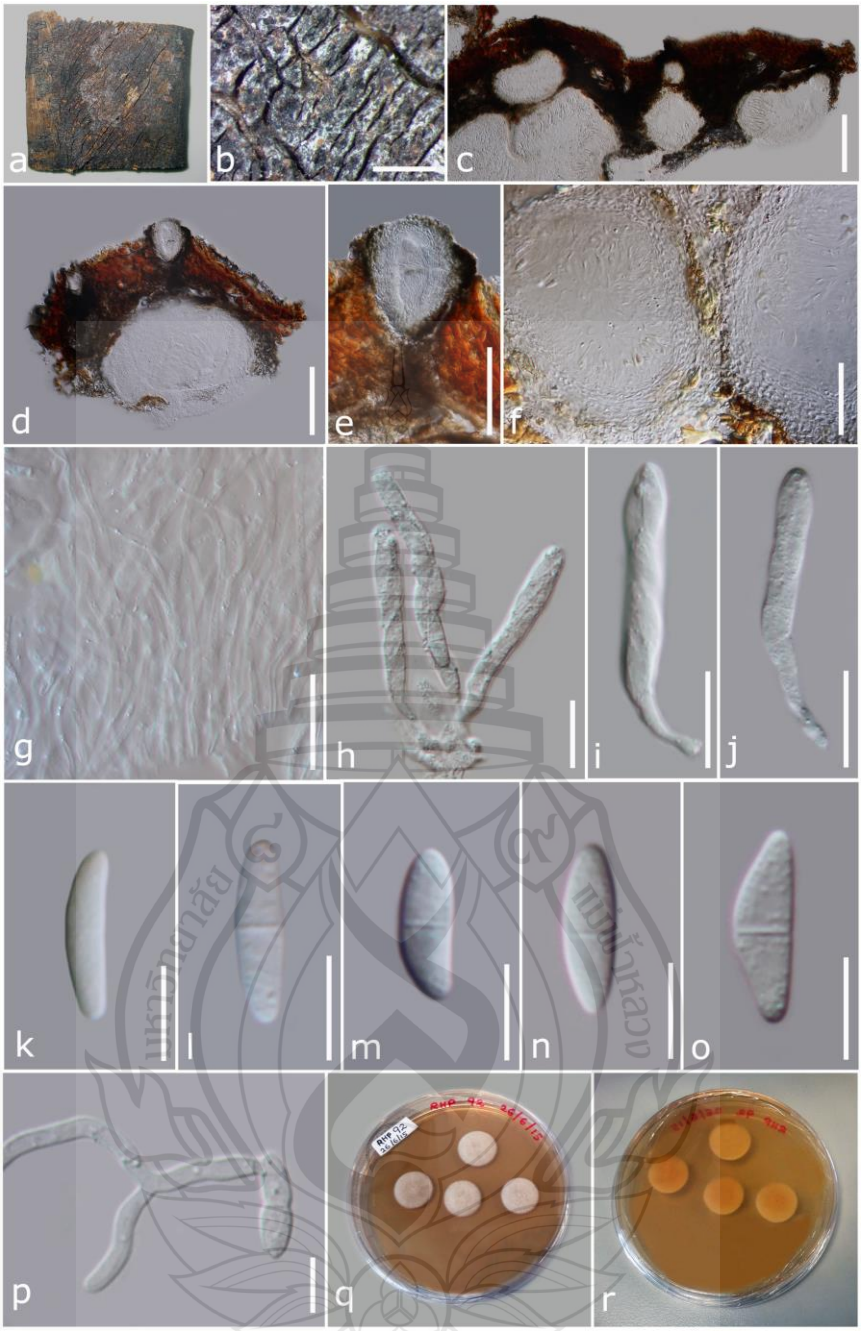
comprising a few to several layers of cells of *textura angularis*, inner layer thick, brown, outer later dark brown. *Conidiophores* branched, reduced to conidiogenous cells. *Conidiogenous cells* 8.4–14 × 1.5–2.4 µm ($\bar{x}$ = 11 × 1.9 µm, n = 20), enteroblastic, phialidic, formed from the inner most layer of pycnidial wall, hyaline, smooth-walled. *Conidia* 4.3–6.7 × 1.4–2.3 µm ($\bar{x}$ = 5.3 × 1.9 µm, n = 50), unicellular, allantoid, sometimes obovoid, guttulate, hyaline, smooth-walled. *Chlamydospores* produced on PDA, hyaline, in chains.

Culture characteristics: Conidia germinated on PDA within 12 hours. Colonies on PDA reaching 40–45 mm diameter after 7 days at 28°C, colonies circular to irregular, medium dense, flat or effuse, with edge fimbriate, white from above and below, pale brown with time, sporulating on PDA within 60 days.

Material examined: Thailand, Phayao Province, dried seed pod of *Cassia fistula* L. (Fabaceae), 4 August 2017, R.H. Perera, PH-CAS 01 (MFLU 18-2749), dry culture MFLU 18-0620, living culture: MFLUCC 18-0598.

GenBank numbers: ITS: MT215491, LSU: MT215540, RPB2: MT212203.

Notes: A modern treatment of *Cytospora* was provided by Norphanphoun et al. (2017) and is followed here. Our new isolate MFLUCC 18-0598 groups with ex-type of *Cytospora diopuiensis* (MFLUCC 18-1419) in our phylogenetic analysis with low statistical support (Figure 6.19). In the combined gene analysis of ITS and LSU, our isolate grouped with *C. diopuiensis* (MFLUCC 18-1419) with high statistical support (99% MLBT) (data not shown). ITS and LSU data of two isolates are identical and, there is no RPB2 gene available for *C. diopuiensis* for comparison. However, only the sexual morph is reported for *C. diopuiensis* (Shang et al., 2020). By considering the similarities in the ITS and LSU loci, we identify our isolate as the first asexual morph record for *C. diopuiensis* and a new host record. *Cytospora diopuiensis* can be distinguished from *C. thailandica* in having larger allantoid conidia (4.3–6.7 × 1.4–2.3 vs. 3.8–4 × 1–1.3 µm) and larger conidiogenous cells (8.4–14 × 1.5–2.4 vs. 6–9.1 × 1–1.3 µm), while conidia of *C. thailandica* are subcylindrical (Shang et al., 2020).



Note (a–b) Appearance of ascomata on host substrate. (c) Vertical section through pseudostroma with ascomata. (d) Vertical section through ascoma. (e) Ostiole. (f) Close up of the peridium. (g) Paraphyses (h–j) Asci. (k–o) Ascospores. (p) Germinating ascospore. (q, r) Colony on MEA. Scale bars: b = 1 mm, c, d = 100 µm, e = 50 µm, f, g = 20 µm, h–j = 10 µm, k–p = 5 µm.

Figure 6.18 *Delonicicola siamense* (MFLU 17-0739, holotype)

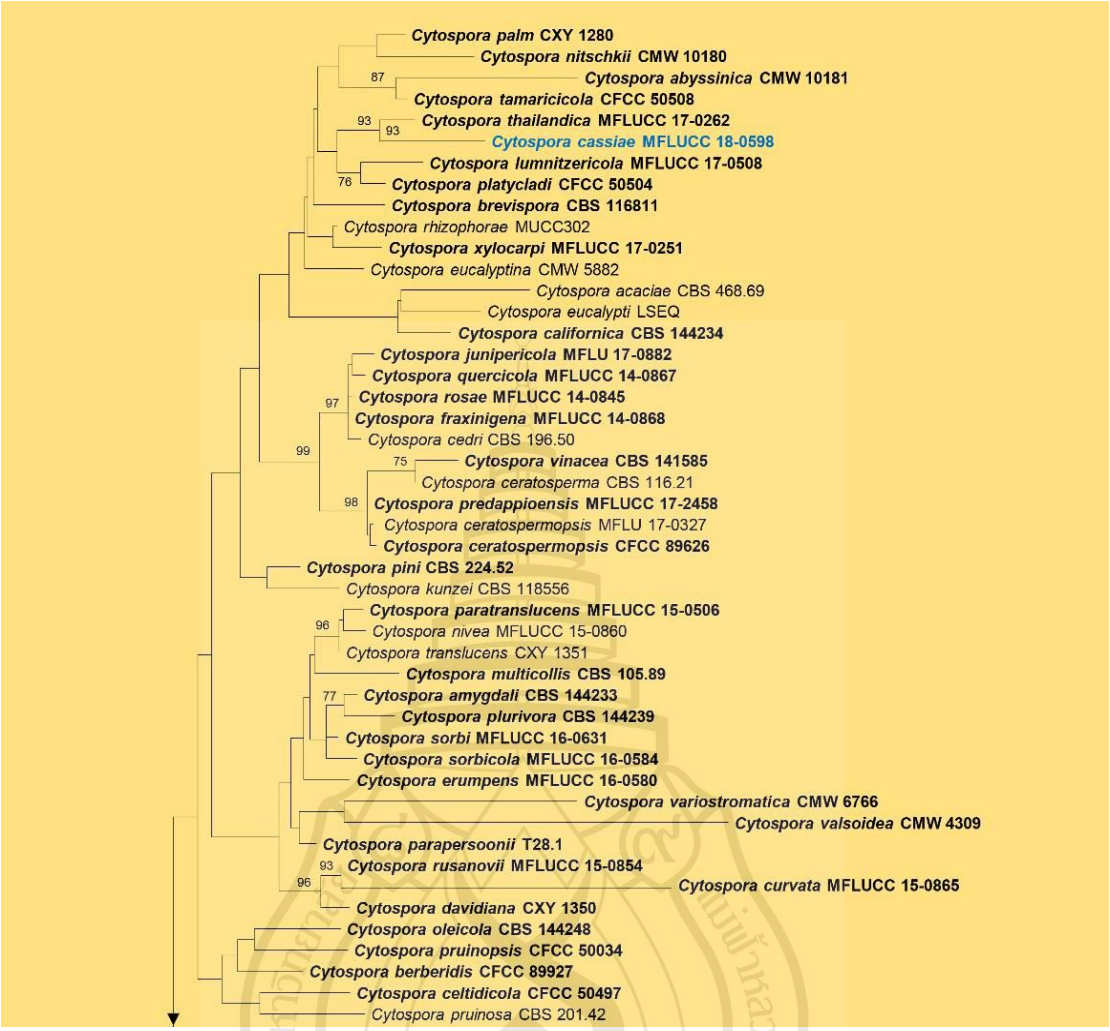
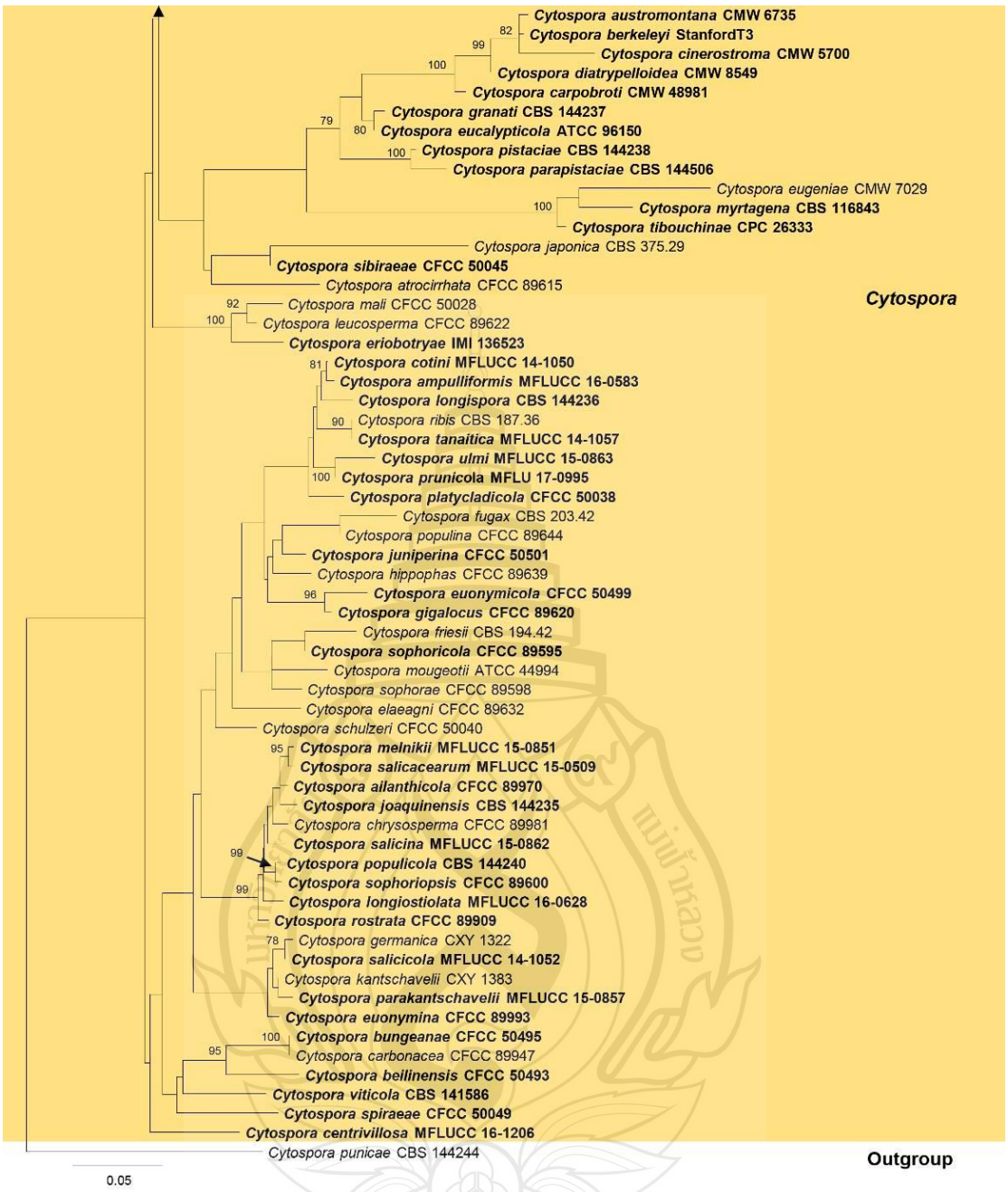
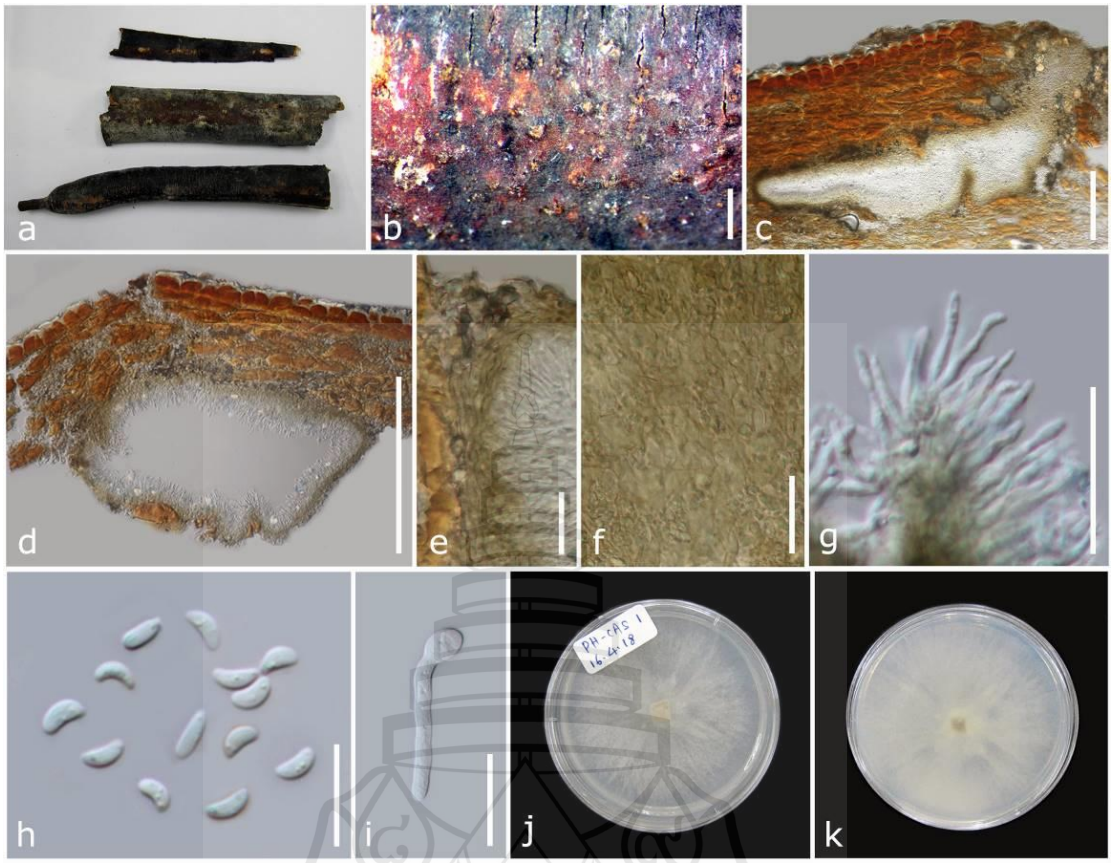


Figure 6.19 Phylogram generated from RAxML analysis based on combined ITS, LSU, RPB2 and ACT sequence data of *Cytospora* isolates



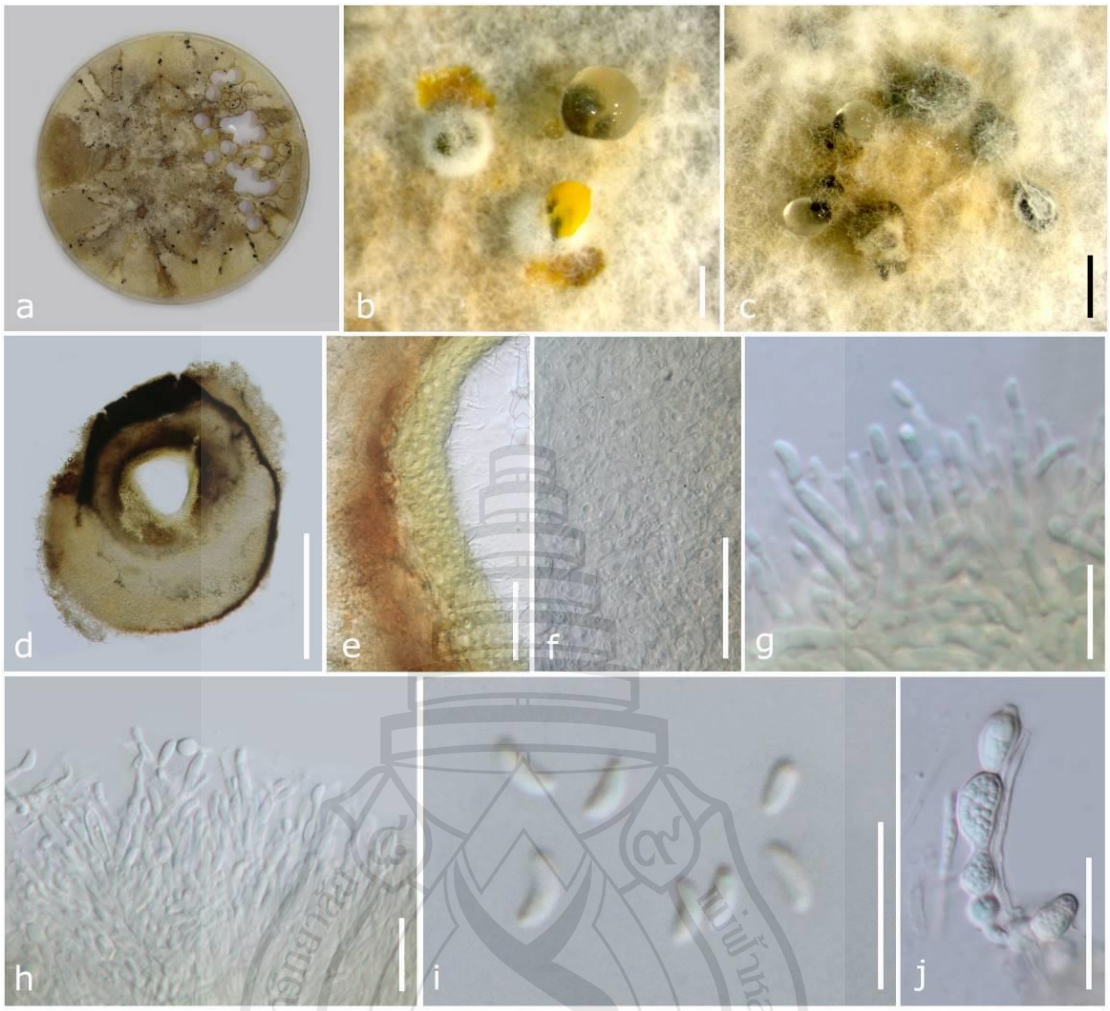
Note Sequences from one hundred thirty taxa, which comprise 3352 characters including gaps, are included in the analyses. The tree was rooted to *Cytospora punicae* CBS 144244. The scale bar indicates 0.04 nucleotide changes per site.

Figure 6.19 (continued)



Note (a) Herbarium material. (b) Conidiomata on host surface. (c, d) Cross section of the stroma showing conidiomata. (e) Peridium. (f) Peridium in face view. (g) Conidia attached to conidiogenous cells. (h) Conidia. (i) Germinating conidium. (j, k) Colony on PDA. Scale bars: b = 500 µm, c = 100 µm, d = 200 µm, e–g = 20 µm, h = 10 µm, i = 20 µm.

Figure 6.20 *Cytospora diopuiensis* (MFLU 18-2749)



Note (a–c) Conidiomata on PDA. (d) Conidioma. (e) Wall of the ostiolar canal. (f) Stromatal tissue. (g, h) Conidia attached to conidiogenous cells. (i) Conidia. (j) Chlamydospores. Scale bars: b, c = 1 mm, d = 500 µm, e, f = 50 µm, g–j = 10 µm, j = 20 µm.

Figure 6.21 *Cytospora diopuiensis* (MFLU 18-0620)

Note Values near the nodes indicate maximum parsimony and maximum likelihood bootstrap ≥ 70%, (MP/ML). Values at the third positions, respectively, represent posterior probabilities (PP ≥ 0.95) from Bayesian inference analysis. The ex-type strains are in bold and new isolates in blue. The scale bar indicates 0.2 changes. The tree is rooted with *Diaporthella corylina* (CBS 121124).

Figure 6.22 Phylogram generated from maximum likelihood analysis based on combined ITS, TEF1, TUB2, and CAM sequenced data of *Diaporthe* species

Diaporthaceae Höhn. ex Wehm.

Diaporthe collariana R. H. Perera and K. D. Hyde ***sp. nov.***

Indexfungorum: IF554061 and Facesoffungi: FoF03909, Figures 6.23, 6.24

Etymology: Named after its prominently flared collarettes.

Saprobic on *Magnolia champaca.* **Asexual morph from the natural substrate**: *Conidiomata* 190–325 µm wide, 310–550 µm high, pycnidial, eustromatic, subepidermal, semi immersed, scattered, globose to ampullifom or irregular, black, outer surface smooth, convoluted to unilocular, singly ostiolate, with prominent necks 150–290 µm long. *Peridium* 18–25 µm thick, 5–9 cells thick, consisting brown to hyaline cells of *textura angularis*. *Conidial mass* globose or sometimes exuding in cirrhi, white to pale-yellow. *Alpha conidiophores* 12.1–20.6 × 2.4–3.2 µm ($\bar{x}$ = 16.6 × 2.8 µm), densely aggregated, ampulliform to subcylindrical, rarely septate and branched, hyaline. *Alpha conidiogenous cells* 10–17 × 1.3–2.4 µm ($\bar{x}$ = 13.7 × 1.8 µm) subcylindrical, tapering towards the apex, hyaline, with visible periclinal thickening, collarette prominent, up to 6 µm long, 5.7 µm wide. *Alpha conidia* 4.2–6.2 × 1.5–2 µm ($\bar{x}$ = 5.2 × 1.7 µm), less common than beta conidia, oblong to ellipsoidal, apex bluntly rounded, base obtuse to subtruncate, aseptate, straight, guttulate, hyaline, smooth-walled. *Beta conidiophores* 10.3–19 × 1.4–3.5 µm ($\bar{x}$ = 14.6 × 2.6 µm), densely aggregated, subcylindrical, filiform or obconical, branched and septate, hyaline. *Beta conidiogenous cells* 3.8–14 × 1.4–2.2 µm ($\bar{x}$ = 7.9 × 1.8 µm) subcylindrical, tapering towards the apex, hyaline, with visible periclinal thickening, collarette prominent, up to 6.6 µm long, 5.7 µm wide. *Beta conidia* 22–31.3 × 0.8–1.6 µm ($\bar{x}$ = 27.7–1.2 µm), commonly found, straight, curved or hamate, hyaline, smooth-walled. *Gamma conidia* not observed. **Asexual morph on PDA**: *Conidiomata* 600–636 µm wide, 1045–1170 µm high, pycnidial, aggregated in small groups, globose to ampullifom, unilocular, black, with a prominent neck. *Peridium* consisting brown cells of *textura angularis*. *Conidial mass* globose or sometimes exuding in cirrhi, white to pale-yellow. *Alpha conidiophores* 12–20 × 2.4–3.2 µm ($\bar{x}$ = 17.2 × 2.8 µm), densely aggregated, ampulliform to subcylindrical, rarely septate and branched, hyaline. *Alpha conidiogenous cells* 11.1–17 × 1.3–2.4 µm ($\bar{x}$ = 14.4 × 1.8 µm) subcylindrical, tapering towards the apex, hyaline, with visible periclinal thickening, collarette prominent, up to 3.5 µm long, 3.2 µm wide. *Alpha conidia* 4.7–

5.6 × 1.7–2.2 μm ($\bar{x}$ = 5.2 × 1.9 μm), less common than beta conidia, oblong to ellipsoidal, apex bluntly rounded, base obtuse to subtruncate, aseptate, straight, bi-guttulate, hyaline, smooth-walled. *Beta conidiophores* 13.2–20.8 × 1.3–4.1 μm ($\bar{x}$ = 17.4 × 3.6 μm), densely aggregated, subcylindrical, filiform or obconical, branched and septate, hyaline. *Beta conidiogenous cells* 8.8–13.4 × 1.7–2.3 μm ($\bar{x}$ = 10.8 × 2.1 μm) subcylindrical, tapering towards the apex, hyaline, with visible periclinal thickening, collarette prominent, up to 3.5 μm long, 3.2 μm wide. *Beta conidia* 22–31.7 × 1.1–1.6 μm ($\bar{x}$ = 28.8–1.3 μm), commonly found, straight, curved or hamate, hyaline, smooth-walled. *Gamma conidia* not observed. **Sexual morph**: Undetermined.

Culture characters: Conidia germinating on WA within 12 h and germ tubes produced from one end. Colonies growing on PDA, reaching 6 cm in 7 days at 25°C, flat, initially white, aerial mycelium forming concentric rings with cottony texture, white to olivaceous, reverse zonate with white and ash-brown rings. Sporulate on PDA after 2 months of incubation period in dark, at 25°C.

Material examined: THAILAND, Chiang Rai, Mae Fah Luang University premises, on dried fruits and pedicels of *Magnolia champaca* (L.) Baill. ex Pierre (Magnoliaceae), 17 August 2017, S. Boonmee, Fruit 3 (MFLU 17-2770, holotype), MFLU 17-2845 dried culture on PDA, ex-type living culture, MFLUCC 17-2636.

GenBank numbers: LSU: MG806114, ITS: MG806115, TUB2: MG783041, TEF1: MG783040, CAM: MG783042.

Notes: Our new fungus *Diaporthe collariana* grouped with a putative strain of *D. subclavata* (ZJUD83), which was collected from fruit of *Citrus maxima* cv. Shatianyou in China (Figure 6.22) (Huang et al., 2015). They showed differences of 26 nucleotides in the concatenated alignment, in which 5 were distinct in the ITS region, 10 in the TEF1 region, 11 in the TUB2 region (Huang et al., 2015). The ex-type strain of *D. subclavata* (ZJUD95) is the next phylogenetically closest isolate to *Diaporthe collariana* (Figure 6.22). They show differences of 71 nucleotides in the concatenated alignment, in which 15 were distinct in the ITS region, 46 in the TEF1 region, 10 in the TUB2 region (Huang et al., 2015). CAL region is not available for *D. subclavata* strains in the GenBank (Huang et al., 2015). *Diaporthe collariana* differs from *D. subclavata* in the presence of beta conidia. Furthermore, *D. collariana*

produces prominent collarettes while collarets are absent in *D. subclavata*. On PDA, *D. collariana* produce smaller alpha conidia, which are oblong to ellipsoidal (4.7–5.6 × 1.7–2.2 μm), while *D. subclavata* produce fusiform to clavate conidia (5.5–7.2 × 2.2–2.9 μm) (Huang et al., 2015). The placement of *D. collariana* in between two isolates of *D. subclavata* seems confusing. However, by comparing available gene sequences of *D. subclavata* strains, we confirm that ZJUD83 is different from its extype ZJUD95. This is further discussed below.

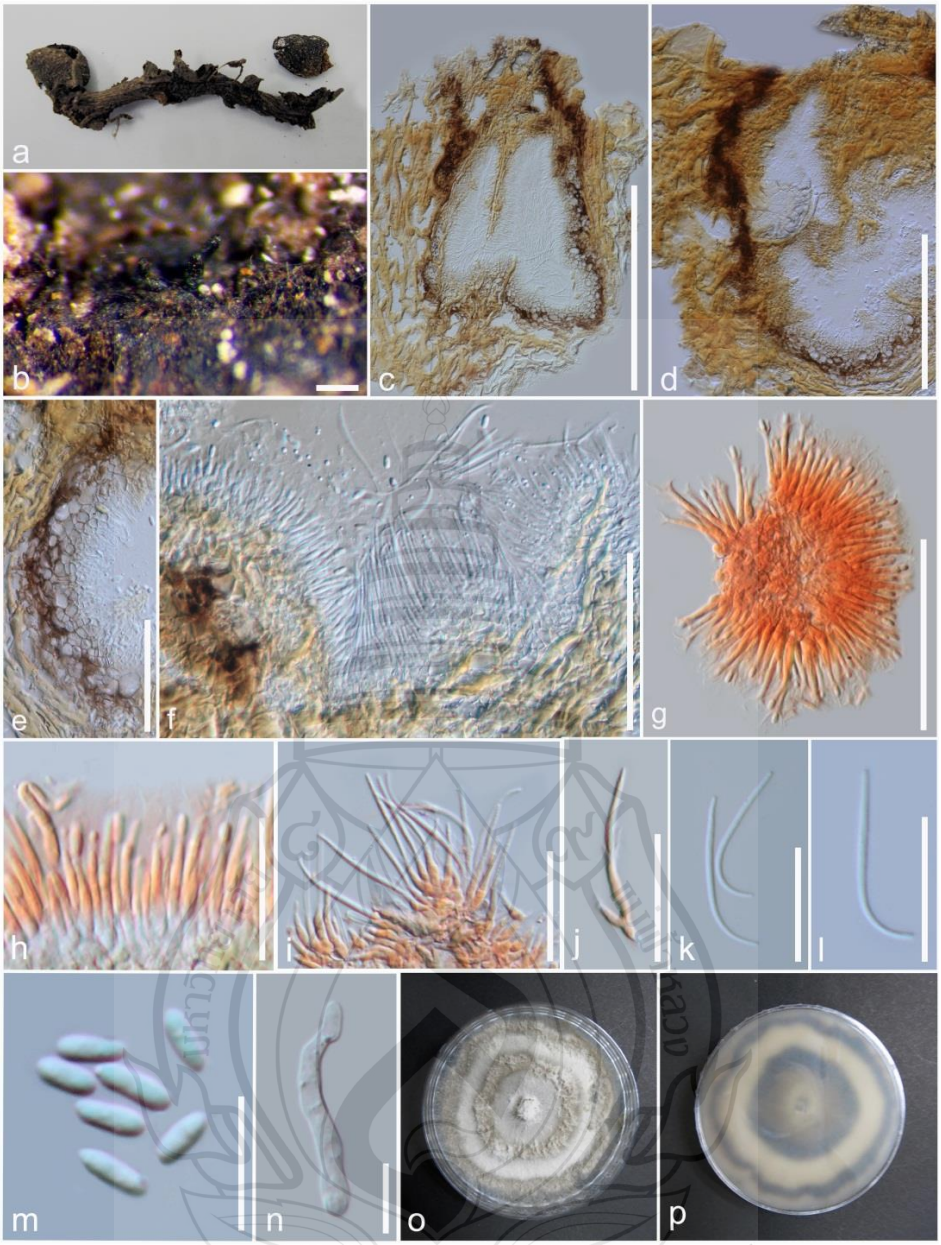
Diaporthe micheliae, is another species which lacks molecular data in the GenBank, and was also isolated from the same host as *D. collariana* (Sankaran et al., 1987). However, *D. collariana* can be distinguished from *D. micheliae* by having prominent collarettes which are absent in *D. micheliae*, branched conidiophores (vs. simple conidiophores), and smaller alpha conidia (4.7–5.6 × 1.7–2.2 vs. 4.6–8.2(-11.5) × 2–2.8 μm) (Sankaran et al., 1987).

Diaporthe delonicis R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556855 and Facesoffungi number: FoF07754, Figure 6.26

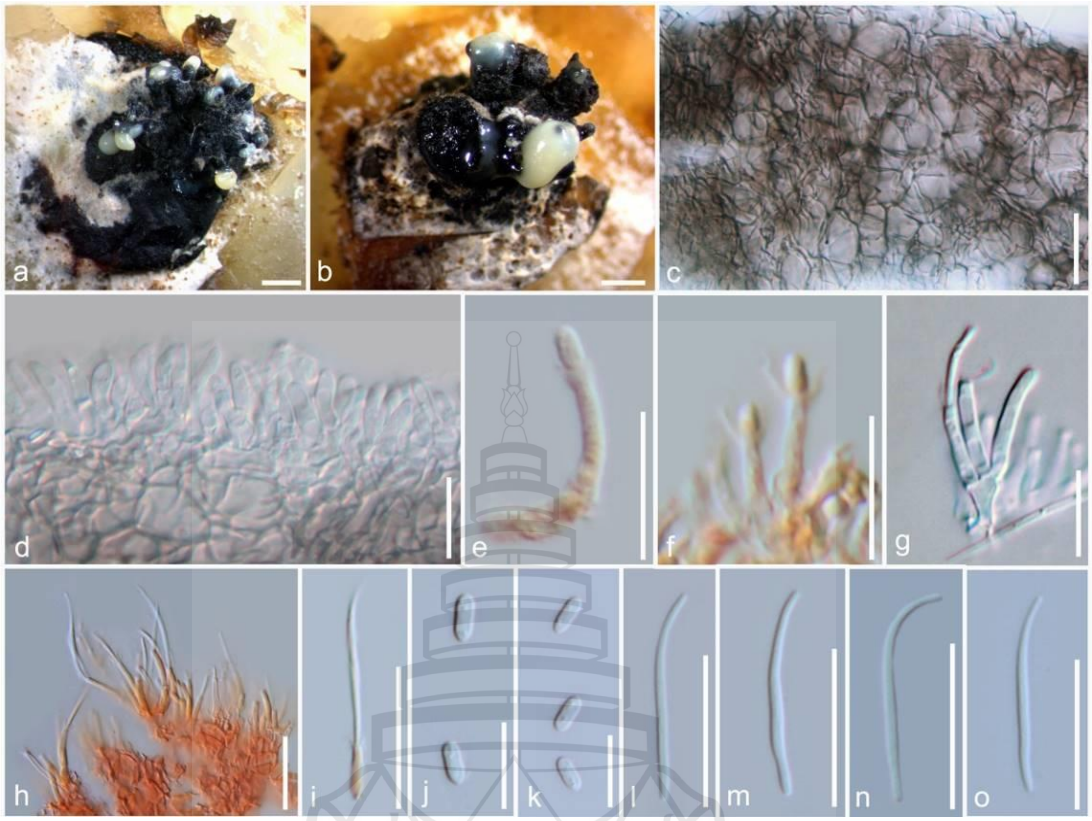
Etymology: Named after the host genus *Delonix*.

Saprobic on seed pods of *Delonix regia*. **Sexual morph**: Undetermined. **Asexual morph**: *Conidiomata* 78–190 μm ($\bar{x}$ = 120 μm) in diam., appearing as black raised spots on the host, scattered, globose or near-globose, brown to dark brown, conidia exuded from conidiomata in white creamy drops. *Peridium* 20 μm thick, composed of 5–8 rows of hyaline to light brown cells of *textura angularis*.



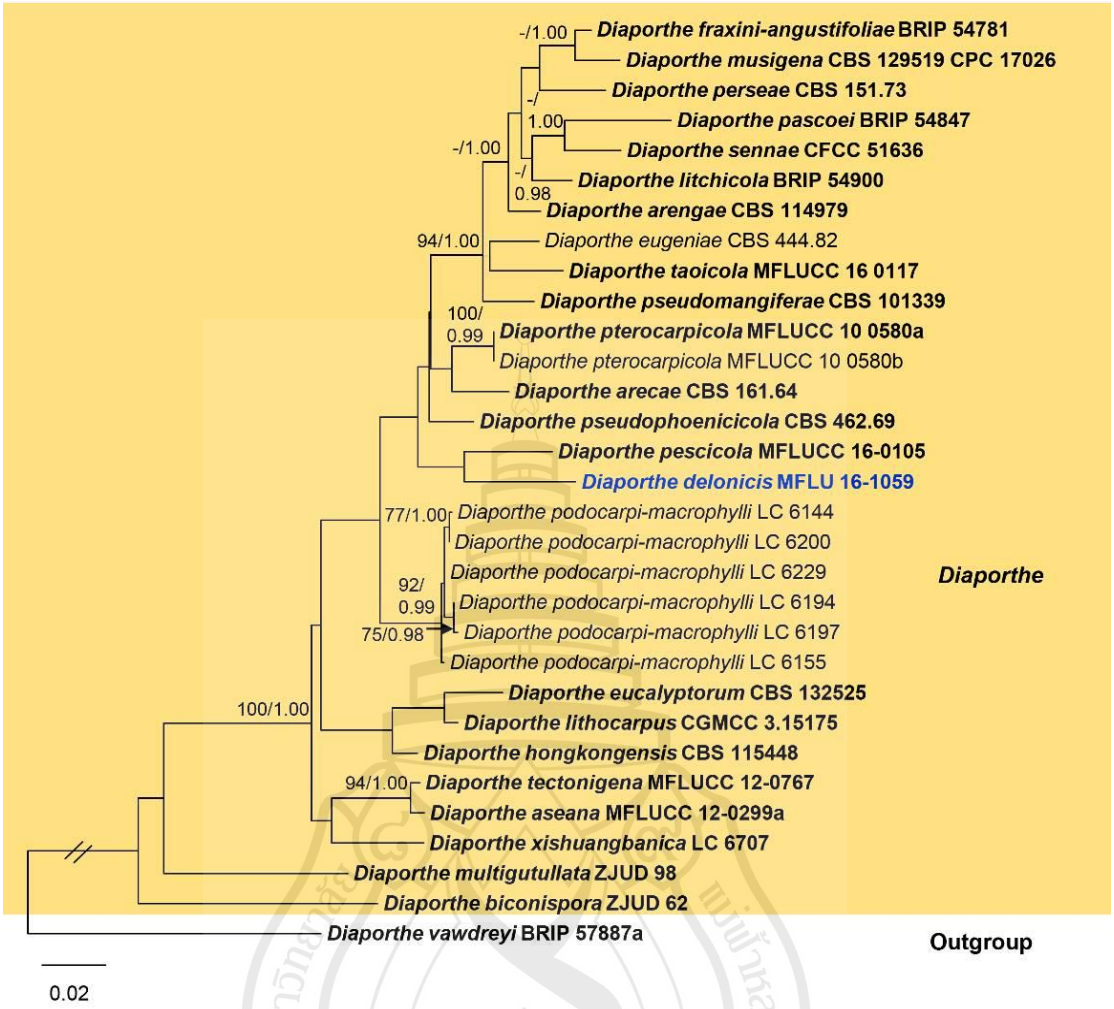
Note (a) Herbarium material. (b) Conidioma on host substrate. (c, d) Section through conidiomata. (e) Peridium. (f) Alpha and beta conidia inside the same conidiomata. (g, h) Conidiophores with alpha conidia (in Congo red). (i, j) Conidiophores with beta conidia (in Congo red). (k, l) Beta conidia. (m) Alpha conidia. (n) Germinating conidia. (o, p) Colony on PDA. Scale bars: b, c = 200 µm, d = 50 µm, e–g = 50 µm, h–l = 20 µm, m, n = 10 µm.

Figure 6.23 *Diaporthe collariana* (MFLU 17-2845, holotype)



Note (a, b) Conidiomata on PDA. (c) Peridium in surface view. (d) Developing conidiophores with conidiogenous cells. (e, f) Conidiogenous cells with alpha conidia (in Congo red). (g–i) Conidiophores with beta conidia (h, i. in Congo red). (j, k) Alpha conidia. (l–o) Beta conidia. Scale bars: a, b = 1 mm, c = 20 µm, d–f = 10 µm, g = 10 µm, h, i = 20 µm, j, k = 10 µm, l–o = 20 µm.

Figure 6.24 *Diaporthe collariana* (MFLU 17-2845)



Note Sequences from thirty-one taxa, which comprise 1578 characters including gaps, are included in the analyses. The tree was rooted to *Diaporthe vawdreyi* (BRIP 57887a). The scale bar indicates 0.02 nucleotide changes per site.

Figure 6.25 Phylogram generated from RAxML analysis based on combined ITS, TEF1 and TUB2 sequence data of *Diaporthe* isolates

Conidiophores 6.4–15.2 × 1.4–2.2 µm ($\bar{x}$ = 11.6 × 1.9 µm), sub-cylindrical, hyaline. *Conidiogenous cells* 5.3–10.5 × 1.3–2.5 µm ($\bar{x}$ = 7.9 × 1.9 µm), phialidic, tapering to the apex, collarette prominent. *Alpha conidia* 4.4–9 × 1.3–2.2 µm ($\bar{x}$ = 7.7 × 1.8 µm), aseptate, fusoid with obtuse ends, 4-guttulate, hyaline, smooth-walled.

Beta conidia 16–23 × 1–1.7 μm ($\bar{x}$ = 19.4 × 1.2 μm), aseptate, filiform, slightly curved at one end and both ends rounded, hyaline, smooth-walled.

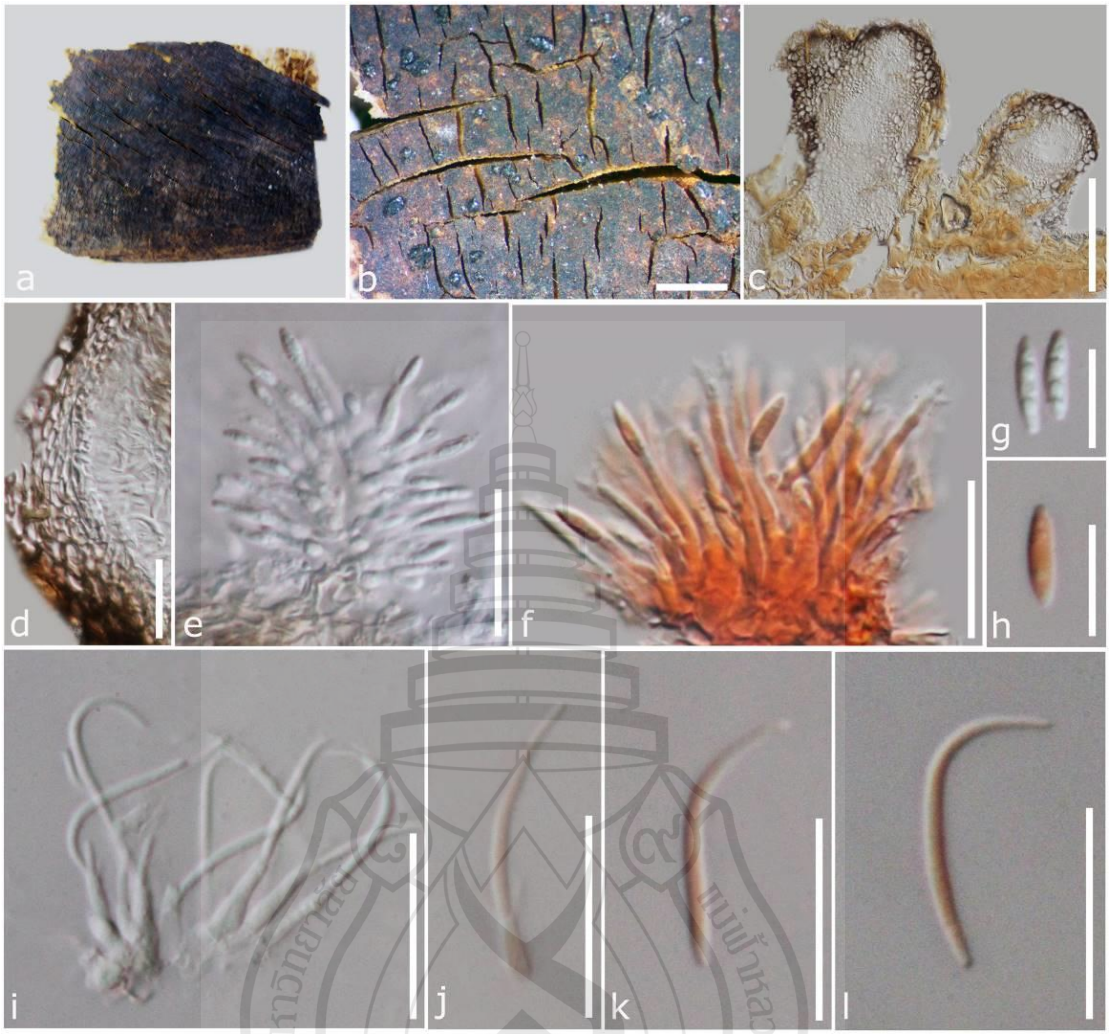
Material examined: Thailand, Chiang Rai Province, Mae Fah Luang University premises, on dried seed pods of *Delonix regia* (Boj. ex Hook.) Raf. (Fabaceae), 7 May 2015, R.H. Perera, RHP 99 (MFLU 16-1059, holotype).

GenBank numbers: ITS: MT215490, TUB2: MT212209.

Notes: The genus has been well-studied and requires ITS, TEF1 and TUB2 sequence data to resolve species (Udayanga, Castlebury, Rossman, Chukeatirote et al., 2014, 2015 and Dissanayake, Camporesi, Hyde, Zhang et al., 2017). DNA was directly extracted from the fruiting bodies of this fungus. *Diaporthe delonicis* (MFLU 16-1059) groups with *D. pescicola* (MFLUCC 16-0105), but is unsupported within *Diaporthe* (Figure 6.25). *Diaporthe pescicola* was identified as a pathogen on *Prunus persica* shoots in China by Dissanayake, Phillips et al. (2017). *Diaporthe delonicis* differs from *D. pescicola* by producing smaller conidiomata (78–190 vs. 300 μm) and conidiophores (6.4–15.2 × 1.4–2.2 vs. 21–35 × 1.5–2.5 μm) (Dissanayake, Phillips et al. and 2017). *Diaporthe delonicis* can also be distinguished from *D. pescicola* by smaller beta conidia (16–23 × 1–1.7 vs. 18–37 × 1–1.5 μm) (Dissanayake, Phillips et al. and 2017). Furthermore, *D. delonicis* produces alpha conidia with 4-guttules, while *D. pescicola* forms bi-guttulate alpha conidia (Dissanayake, Phillips et al. and 2017). We also observed prominent collarettes in conidiophores of *D. delonicis*, and this character was not reported from *D. pescicola* (Dissanayake, Phillips et al. and 2017). We therefore identified *D. delonicis* as a new species.

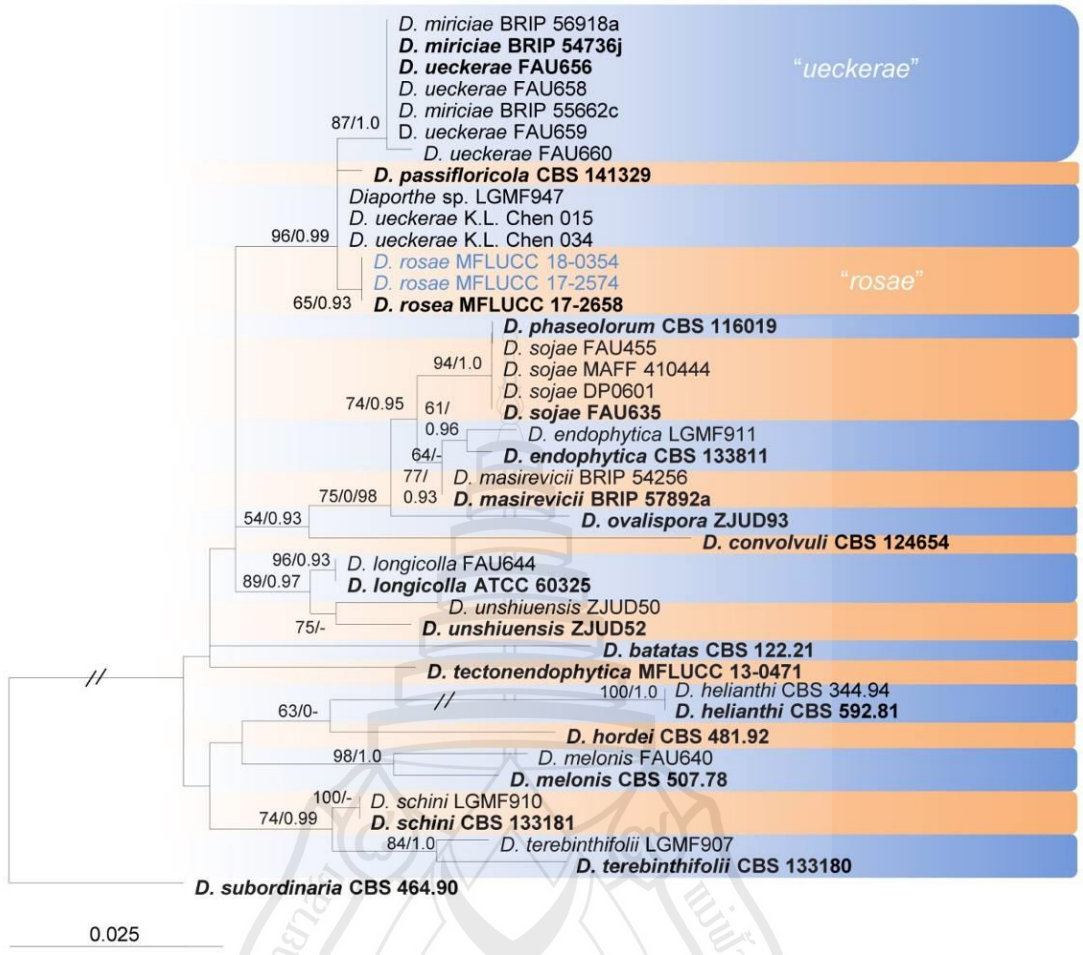
Diaporthe rosae Samarakoon and K.D. Hyde, Figures 6.29, 6.30

Saprobic on *Rosa* sp. and, dried fruits of *Magnolia champaca* and *Senna siamea*. Visible as raised, black spots or, black necks immerging through the host surface. **Sexual morph**: *Ascomata* 260–350 μm high, 210–340 μm diam. ($\bar{x}$ = 260 × 300 μm, n = 6), immersed in the ectostroma, immersed in the host epidermis, globose to sub-globose, solitary or occur in clusters, black, ostiolate, papillate. *Neck* 190 × 435 μm diam. *Ostiole* periphysate. *Peridium* 8–22 μm wide, comprising 4–10 layers, outer layers heavily pigmented, thin-walled, comprising dark brown cells of *textura angularis*, inner layers composed of hyaline to brown thin-walled cells of *textura angularis*.



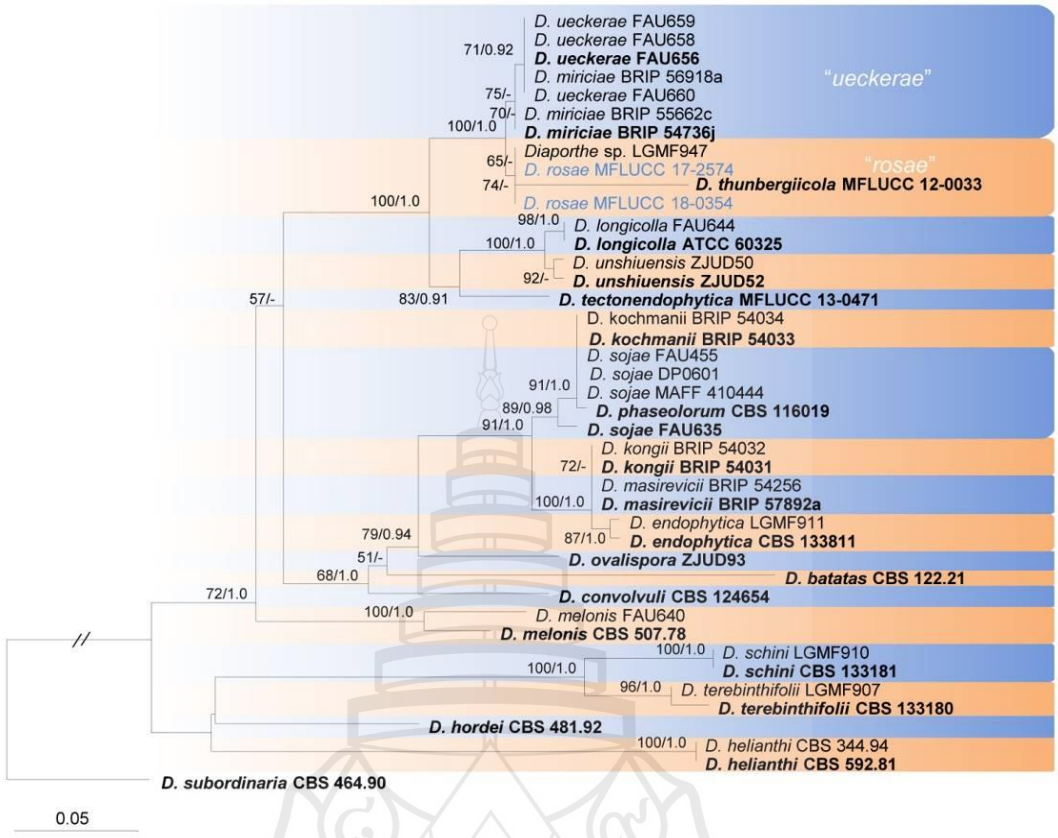
Note (a) Herbarium material. (b) Conidiomata on natural substrate. (c) Section through conidiomata. (d) Peridium. (e, f) Conidiogenous cells with alpha conidia (f in Lugol's solution). (g, h) Alpha conidia (h in Lugol's solution). (i) Conidiogenous cells giving rise to beta conidia. (j–l) Beta conidia in Lugol's solution. Scale bars: b = 1 mm, c = 100 µm, d–f = 20 µm, g, h = 10 µm, i–l = 20 µm.

Figure 6.26 *Diaporthe delonicis* (MFLU 16-1059, holotype)



Note Maximum likelihood bootstrap support (ML≥50%) and posterior probabilities (PP≥0.90) from Bayesian inference analysis are indicated respectively near the nodes. The tree is rooted with *Diaporthella subordinaria*. The ex-type strains are in bold and new isolates in blue. The scale bar indicates 0.025 nucleotide changes per site.

Figure 6.27 Phylogram generated from maximum likelihood analysis based on TUB2 sequences of selected *Diaporthe* species



Note Maximum likelihood bootstrap support (ML≥50%) and posterior probabilities (PP≥0.90) from Bayesian inference analysis are indicated respectively near the nodes. The ex-type strains are in bold and new isolates in blue. The tree is rooted with *Diaporthella subordinaria*. The scale bar indicates 0.05 nucleotide changes per site.

Figure 6.28 Phylogram generated from maximum likelihood analysis based on TEF1 sequence data of selected *Diaporthe* species

Paraphyses 5.4–8 µm (n = 10), 2–4-septate, wide at base, tapering towards the apex, thin walled. *Asci* 34–46 × 6.7–9 µm ($\bar{x}$ = 40.5 × 7.9 µm, n = 20), 8-spored, unitunicate, clavate to subclavate, straight to slightly curved, sessile, with a J- apical ring. *Ascospores* 10–12.5 × 2.8–3.6 µm ($\bar{x}$ = 11.1 × 3.2 µm, n = 30), overlapping uniseriate to biseriate, 1-septate, constricted at the septum, often tetra-guttulate, ellipsoidal, straight, hyaline, without appendages or a mucilaginous sheath. **Asexual**

morph on PDA: *Conidiomata* pycnidial or multiloculate, scattered, globose or irregular, black. *Peridium* consisting brown cells of *textura angularis* in surface view. *Conidial mass* globose, white to pale-yellow. *Paraphyses* absent. *Conidiophores* 10–63 × 1.4–2.7 μm ($\bar{x}$ = 36.4 × 2 μm), 2–3-septate, branched, densely aggregated, cylindrical, straight to sinuous rarely reduced to conidiogenous cells, hyaline, smooth-walled. *Alpha conidiogenous cells* 8–23 × 0.7–3 μm ($\bar{x}$ = 15.4 × 1.8 μm) phialidic, subcylindrical, sometimes ampulliform, slightly tapering towards the apex, hyaline, with visible periclinal thickening, and a flared collarette. *Alpha conidia* 5–7 × 2–3.1 μm ($\bar{x}$ = 5.9 × 2.5 μm), enteroblstic, ovate to ellipsoidal, base obtuse to subtruncate, aseptate, straight, bi-guttulate, hyaline, smooth-walled. *Beta conidiogenous cells* 4.1–22.6 × 1.3–4.2 μm ($\bar{x}$ = 16.6 × 2 μm) phialidic, subcylindrical, tapering towards the apex, hyaline, with periclinal thickening, and a flared collarette. *Beta conidia* 18–28 × 0.9–1.3 μm ($\bar{x}$ = 22.3–1.1 μm), fusiform to hooked, aseptate, hyaline, smooth-walled. *Gamma conidia* not observed.

Culture characteristics: Colonies on PDA, reaching 40 mm diam. after 2 weeks at 25°C, flat, circular, margin entire, white with radially arranged minute mycelium clots later becoming pale yellow, reverse whitish, azonate. Odour not pronounced. Sporulated on PDA after 2 months incubation period in dark, at 25°C.

Material examined: Thailand, Chiang Rai Province, Mae Fah Luang University premises, on dried fruits and pedicels of *Magnolia champaca* (L.) Baill. ex Pierre (Magnoliaceae), 17 August 2017, S. Boonmee, Fruit 5 (MFLU 18-0186) and dry culture, MFLU 18-0515 and living culture, MFLUCC 18-0354 and *ibid*. Phayao Province, Pong, Pha Chang Noi, dried pods of *Senna siamea* (Lam.) Irwin et Barneby (Fabaceae), 04 August 2017, R.H. Perera, PH-FB 1 (MFLU 18-0187), living culture, MFLUCC 17-2574.

Genbank numbers: ITS: MG906793, TUB2: MG968952, TEF1: MG968954

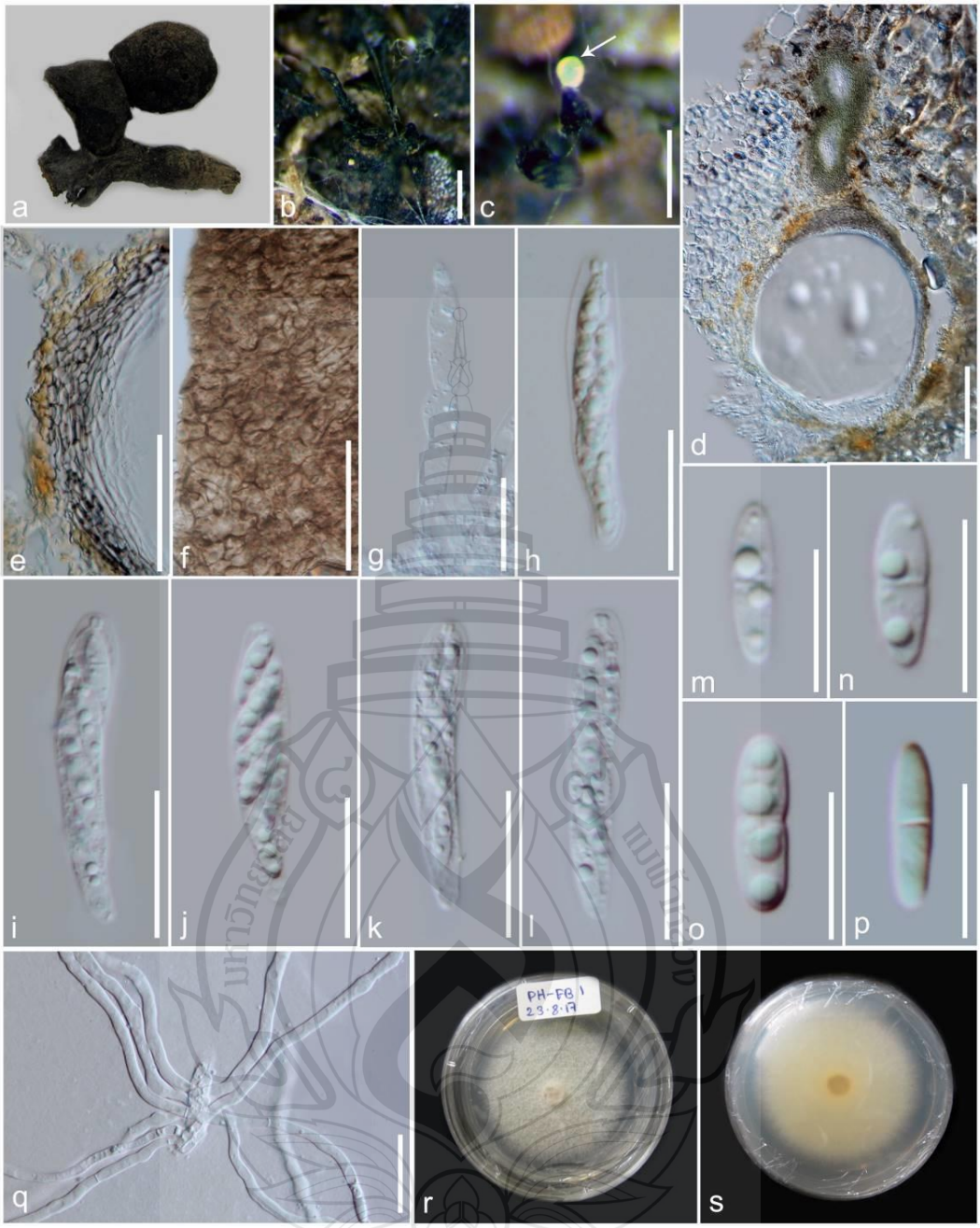
Notes: Our two new isolates grouped with the ex-type strain of *D. rosae* (MFLUCC 17-2658), which was collected from *Rosa* sp. (Rosaceae) in Chiang Rai Province, Thailand (Figures 6.27, 6.27) (Wanasinghe et al., 2018). The asexual morph of one of the new strains (MFLUCC 18-0354) produced on PDA is similar to that of the holotype of *D. rosae* (MFLU 17-1550). DNA sequences of *D rosae* and strains (MFLUCC 18-0354 and MFLUCC 17-2574) differed in 2 positions of the ITS region,

while TUB2 sequences were identical. Sequence data of the TEF1 region were not available for the ex-type of *D. rosae* for the comparison. Neither molecular nor morphological data accordingly allow delimiting the new collection from *D. rosae*. It is therefore reported here as the sexual morph of *D. rosae*.

In this study, we used the ARB software environment to analyze the sequence data related to our collection. Sequence heterogeneity of ITS has been observed earlier within the same species of *Diaporthe*, even within the same geographic region and the same host by different authors (Farr et al., 2002a, b and Santos et al. 2010 and Udayanga, Castlebury, Rossman, Chukeatirote et al., 2014). The difference of 2 nucleotides in the ITS region between our collection and the asexual morph of *D. rosae* is therefore in the range of intraspecific variability within the genus.

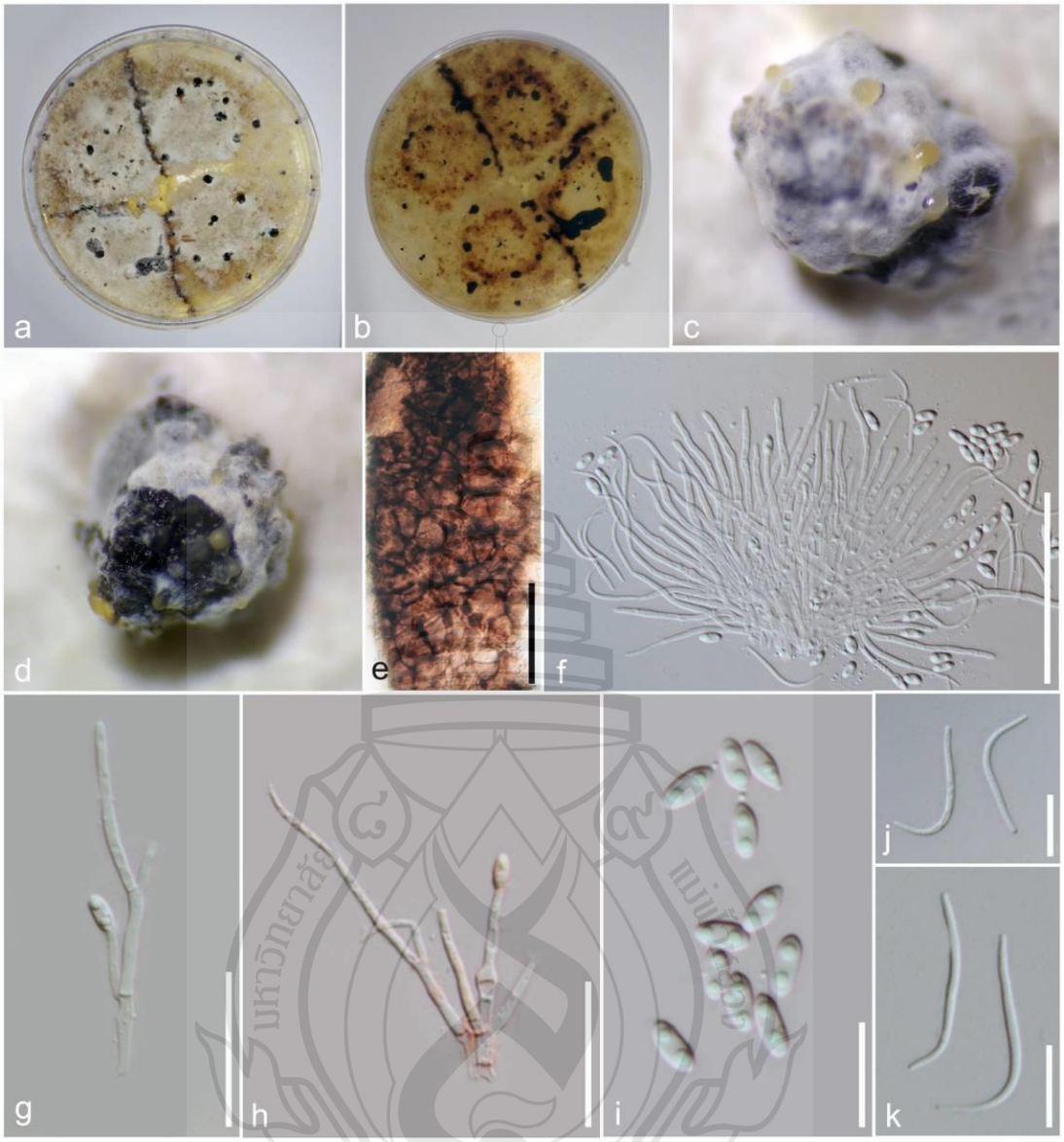
Diaporthe miriciae and *D. ueckerae* strains only form a monophyletic clade together in the TUB2, TEF1 and combined TEF1 and TUB2 analyses (Fig 1, 2, Appendix 2), '*ueckerae*' Clade). Furthermore, ITS, TEF1 and TUB2 sequence data of their ex-types (BRIP 54736j and FAU656) are almost identical except for 1 bp difference in the TEF1 region. When considering other *D. miriciae* (BRIP 56918a, BRIP 55662c) and *D. ueckerae* (FAU660, FAU659, FAU658) strains, a maximum difference of 3 nucleotides is found within the clade. *Diaporthe miriciae* and *D. ueckerae* also share similar morphological characters. Even though those similarities are in the same range as for *D. rosae* and the new collections, we refrain from describing our collection as a new species. We agree with Udayanga, Castlebury, Rossman, Chukeatirote et al. (2014) that such differences most likely represent intraspecific variation. Another two strains putatively named as *D. ueckerae* (K.L. Chen 015 and K.L. Chen 034) are unrelated to the main '*ueckerae'* clade (Figure 6.27). They showed 4 nucleotide substitutions in *tub2* region to the *D. ueckerae* species in the main clade. However, no other gene regions or morphological features are available for comparison.

One problematic sequence of *D. thunbergiicola* (MFLUCC 12-0033) clusters with long branches and its phylogenetic position is conflicting notably between ITS and TEF1 trees (Figure 6.28). Re-sequencing of the isolate of *D. thunbergiicola* would be required to finally confirm its phylogenetic position.



Note (a) Herbarium material. (b, c) Ascomata on host substrate (white arrow: ascospores mass on the neck). (d) Section through ascoma. e Section through the peridium. (f) Surface view of the peridium. (g) Paraphyses. (h–l) Asci. (m–p) Ascospores. (q) Germinating ascospores. Scale bars: b, c = 200 µm, d = 100 µm, e, f = 50 µm, g–l = 20 µm, m–p = 10, q = 20 µm.

Figure 6.29 *Diaporthe rosae* (MFLU 18-0186)



Note (a, b) Sporulation on PDA. (c, d) Conidioma on PDA. (e) Surface view of the peridium. (f) Conidiophores with alpha and beta conidia. (g, h) Conidiophores with alpha conidia. (i) Alpha conidia. (j, k) Beta conidia. Scale bars: b, c = 200 µm, d = 100 µm, e, f = 50 µm, g–l = 20 µm, m–p = 10, q = 20 µm.

Figure 6.30 *Diaporthe rosae* (MFLU 18-0515, asexual morph on PDA)

While we did not exclude *D. thunbergiicola* (MFLUCC 12-0033) from our analysis, we do not consider our results strong evidence for the species being related to the *D. rosae* clade.

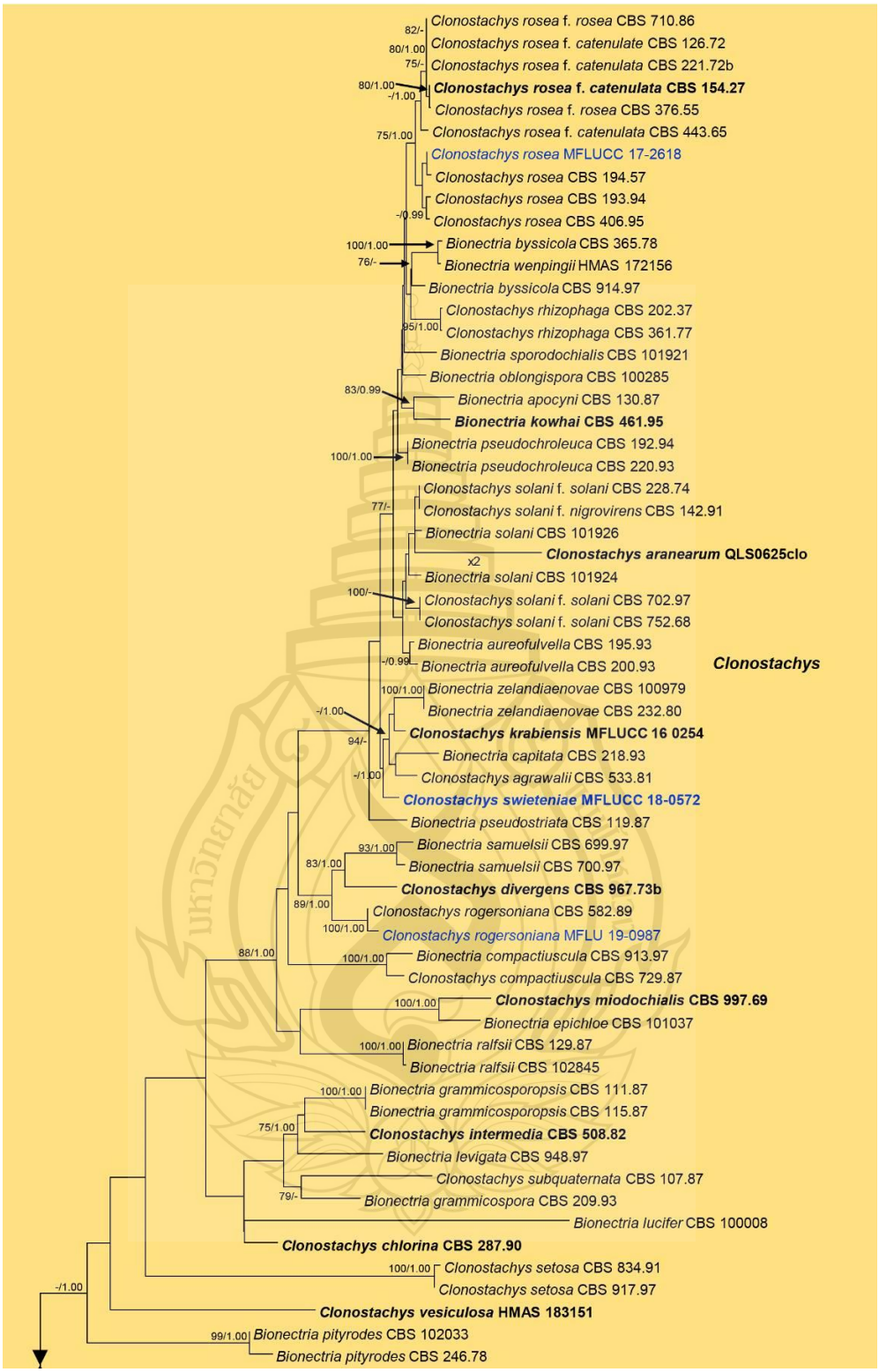
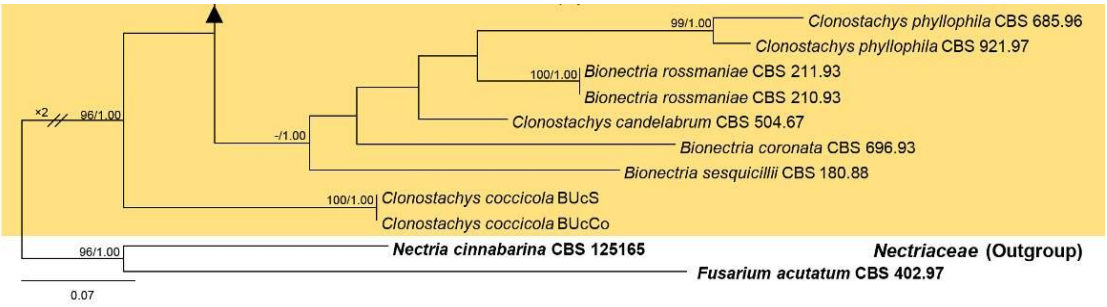


Figure 6.31 Phylogram generated from RAxML analysis based on combined ITS and TUB2 sequence data of *Clonostachys* isolates



Note Sequences from seventy-two taxa, which comprise 1087 characters including gaps, are included in the analyses. The tree was rooted to *Nectria cinnabarina* NRRL 20484 and *Fusarium acutatum* CBS 402.97. The scale bar indicates 0.07 nucleotide changes per site.

Figure 6.31 (continued)

Hypocreales Lindau

Bionectriaceae Samuels and Rossman

Clonostachys rogersoniana Schroers, Stud. Mycol. 46: 109 (2001)

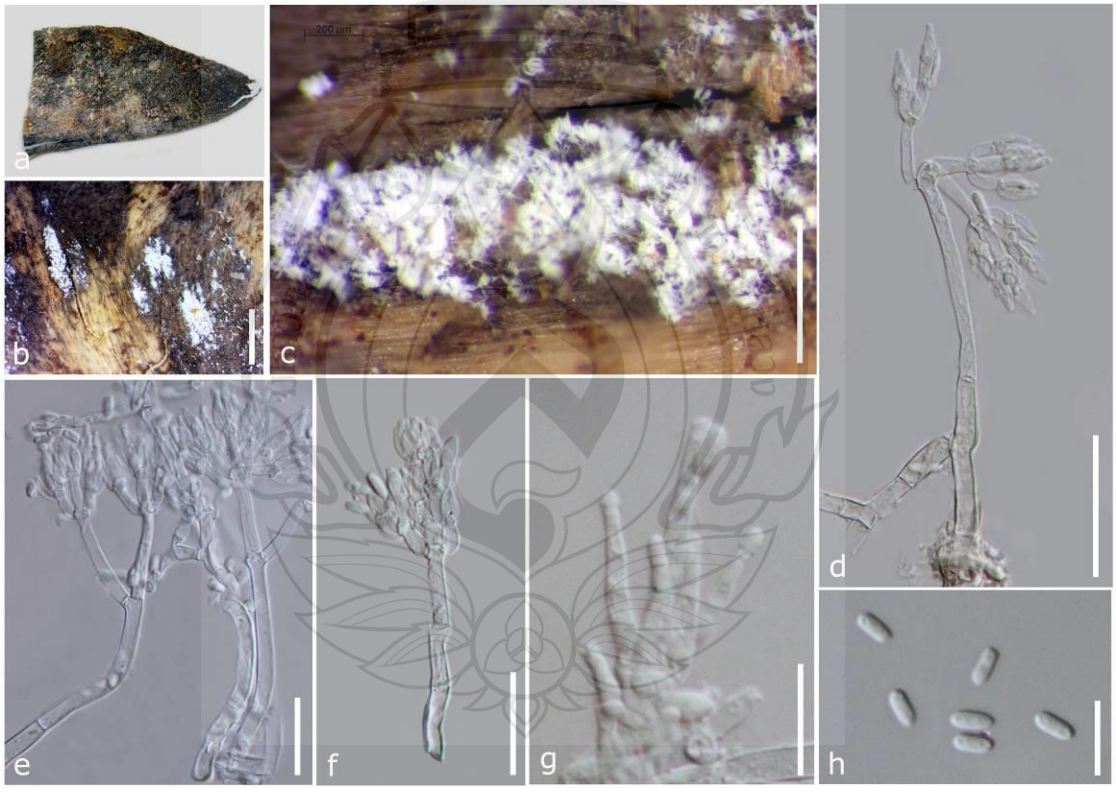
Facesoffungi number: FoF07755, Figure 6.32

Saprobic on decaying seed pods of *Delonix regia*. **Sexual morph**: Undetermined. **Asexual morph**: Hyphomycetous, colonies appearing as white patches on both inner and outer epidermis of the seed pod. *Conidiophores* arising from stroma, monomorphic, hyaline, smooth-walled, penicillate, stipes 70– 100 µm long, 4.2–6.8 µm wide at base. *Penicilli* 58–80 µm high, × 50–100 µm diam. at widest point and solitary to gregarious, not sporodochial, bi- to quaterverticillate and branches of the penicillus divergent, each branch terminating in metulae and adpressed phialides. *Phialides* 7–12.4 µm ($\bar{x}$ = 10 µm) long, 1.8–2.9 µm ($\bar{x}$ = 2.4 µm) wide at widest point, in whorls of up to 6, narrowly flask-shaped, slightly tapering toward the apex. *Intercalary phialides* not observed. *Conidial masses* white. *Conidia* 4.9–9.1 × 1.6–2.3 µm ($\bar{x}$ = 7.2 × 2 µm, n = 30), broadly ellipsoidal to oval, rarely minutely curved, ends broadly rounded, bi-guttulate, hilum laterally displaced, almost median or invisible, hyaline, smooth-walled.

Material examined: Thailand, Chiang Mai Province, on decaying seed pods of *Delonix regia* (Fabaceae), 20 December 2016, R.H. Perera, Delo 01 (MFLU 19-0987).

GenBank numbers: ITS: MT215572, LSU: MT215538, TUB2: MT212208.

Notes: Our new strain clusters with *Clonostachys rogersoniana* (CBS 582.89) with high statistical support (100% MLBT, 1.0 BYPP and Figure 6.31) in phylogenetic analysis of ITS sequence data, and they are morphologically similar in having the same conidiophore characters and conidial dimensions (Schroers, 2001). However, verticillate conidiophores were not observed in our collection (Schroers, 2001). With morphological and DNA molecular analysis support, we report a new host record of *Clonostachys rogersoniana* from *Delonix regia*.



Note (a) Herbarium material. (b, c) Colonies on host. (d–f) Conidiophores with phialides. (g) Phialides with conidia. (h) Conidia. Scale bars: b = 2 mm, c = 1 mm, d–f = 20 μm, g, h = 10 μm.

Figure 6.32 *Clonostachys rogersoniana* (MFLU 19-0987)

Clonostachys rosea (Link) Schroers, Samuels, Seifert and W. Gams, Mycologia 91(2): 369 (1999)

Facesoffungi number: FoF06012 Figure 6.33

Saprobic on decaying fruits of *Swietenia mahagoni*. **Sexual morph**: *Stromata* well developed, erumpent. *Ascomata* 170–215 × 160–218 μm ($\bar{x}$ = 185 × 186 μm, n = 7), perithecial, densely crowded in groups, globose to subglobose to oval, not collapsing or sometimes slightly laterally pinched when dry, light orange to yellowish orange, KOH-, not papillate, surface smooth to slightly roughened, but not distinctly warted. *Ostiole* periphysate. *Peridium* 21–46 μm wide, wider around the ostiole, two strata: outer layer 21–30 μm wide, comprising unevenly thickened brownish yellow cells of *textura angularis* to *textura globosa*, becoming larger towards the periphery, most cells containing a vacuole and inner layer 8–14 μm wide, consists of flat, hyaline cells of *textura angularis*. *Asci* 50.6–62.2 × 6–7.2 μm ($\bar{x}$ = 55.4 × 6.6 μm, n = 18), 8-spored, unitunicate, narrowly clavate, apex flat with somewhat rounded edges, short stalked, apical ring J-. *Ascospores* 8.9–11.9 × 2.9–3.4 μm ($\bar{x}$ = 10.7 × 3.1 μm, n = 25), bi-seriate above and uni-seriate below, 1-septate, equilateral, not constricted at the septum or slightly constricted in mature ascospores, ellipsoidal to oblong ellipsoidal, 4-guttulate, hyaline, spinulose. **Asexual morph**: See Schroers (2001).

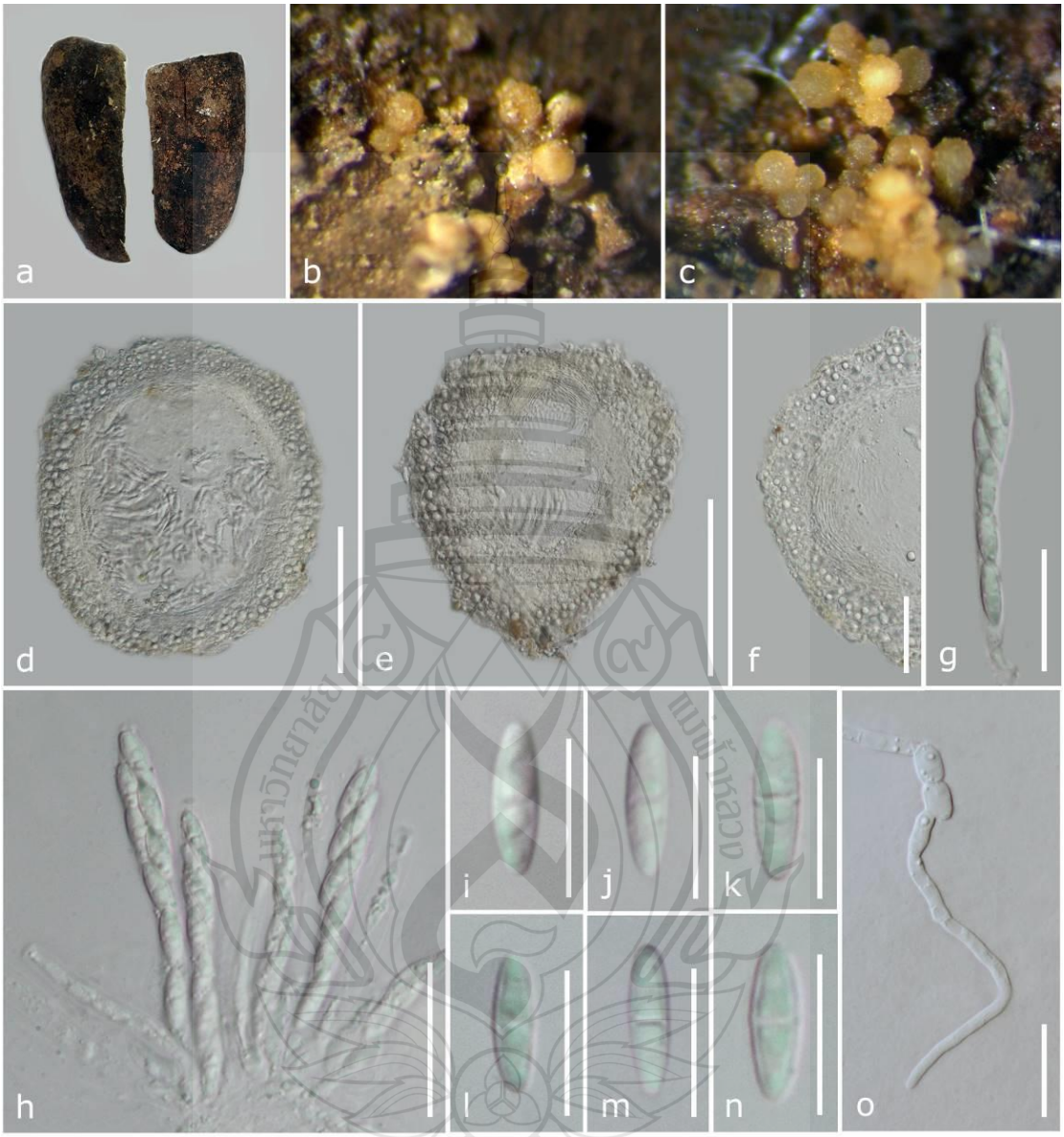
Culture characteristics: Ascospores germinating on PDA within 12 hours. Colonies growing on PDA, reaching up to 4.5 cm in 7 days at 25°C, surface effused, smooth, margin entire to undulate, aerial mycelium rare, initially white, becoming yellowish, reverse yellowish.

Material examined: THAILAND, Chiang Rai Province, Mae Fah Luang University Garden, on decaying fruits of *Swietenia mahagoni* (L.) Jacq. (Meliaceae), 06 September 2017, R.H. Perera, Maho 04 (MFLU 18-2770), living culture MFLUCC 17-2618.

GenBank numbers: ITS: MT215574, LSU: MT396165, TEF1: MT415234.

Notes: Our new isolate (MFLUCC 17-2618) groups with *Clonostachys rosea* isolates of CBS 194.57, CBS 193.94 and CBS 406.95. (Figure 6.31). A comparison of nucleotides shows ITS loci of our isolate identical to *C. rosea* (CBS 194.57, CBS 193.94 and CBS 406.95). Our collection morphologically resembles *C. rosea* in

ascomatal colour, size, asci and ascospore dimensions (Rossman et al., 1999 and Schroers et al., 1999). This collection represents a new host record for *C. rosea.*



Note (a) Herbarium material. (b, c) Ascomata on host. (d, e) Section of ascomata. (f) Section of peridium. (g, h) Asci. (i–n) Ascospores. (o) Germinating ascospore. Scale bars: d, e = 100 µm, f = 50 µm, g, h = 20 µm, i–n = 10 µm, o = 20 µm.

Figure 6.33 *Clonostachys rosea* (MFLU 18-2770)

Clonostachys swieteniae R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556856 and Facesoffungi number: FoF07756, Figure 6.34

Etymology – Named after the host genus *Swietenia*.

Saprobic on decaying fruits of *Swietenia mahagoni*. **Sexual morph**: Undetermined. **Asexual morph**: Hyphomycetous, colonies appearing as white patches on the host. *Conidiophores* arising from stroma, mononematous, monomorphic, hyaline, smooth-walled, penicillate, stipes 130–200 µm long, 5–8 µm wide at base. *Penicilli* 28–66 µm high, × 20–60 µm diam. at widest point and solitary to gregarious, not sporodochial, bi- or quater-verticillate and branches of the penicillus divergent, each branch terminating in metulae and adpressed phialides. *Phialides* 9–14.1(–17) × 2.1–3.2 µm ($\bar{x}$ = 11.4 × 2.6 µm, n = 40), in whorls of 2–6, narrowly flask-shaped, slightly tapering toward the apex, with visible periclinal thickening, collarettes inconspicuous, hyaline, smooth-walled. *Intercalary phialides* not observed. *Conidial masses* white. *Conidia* (4.5–)5.1–6.7 × 1.9–2.6 µm ($\bar{x}$ = 6 × 2.2 µm, n = 40), broadly ellipsoidal to oval, rarely minutely curved, ends broadly rounded, straight, bi-guttulate, hilum laterally displaced, almost median or invisible, hyaline, smooth-walled.

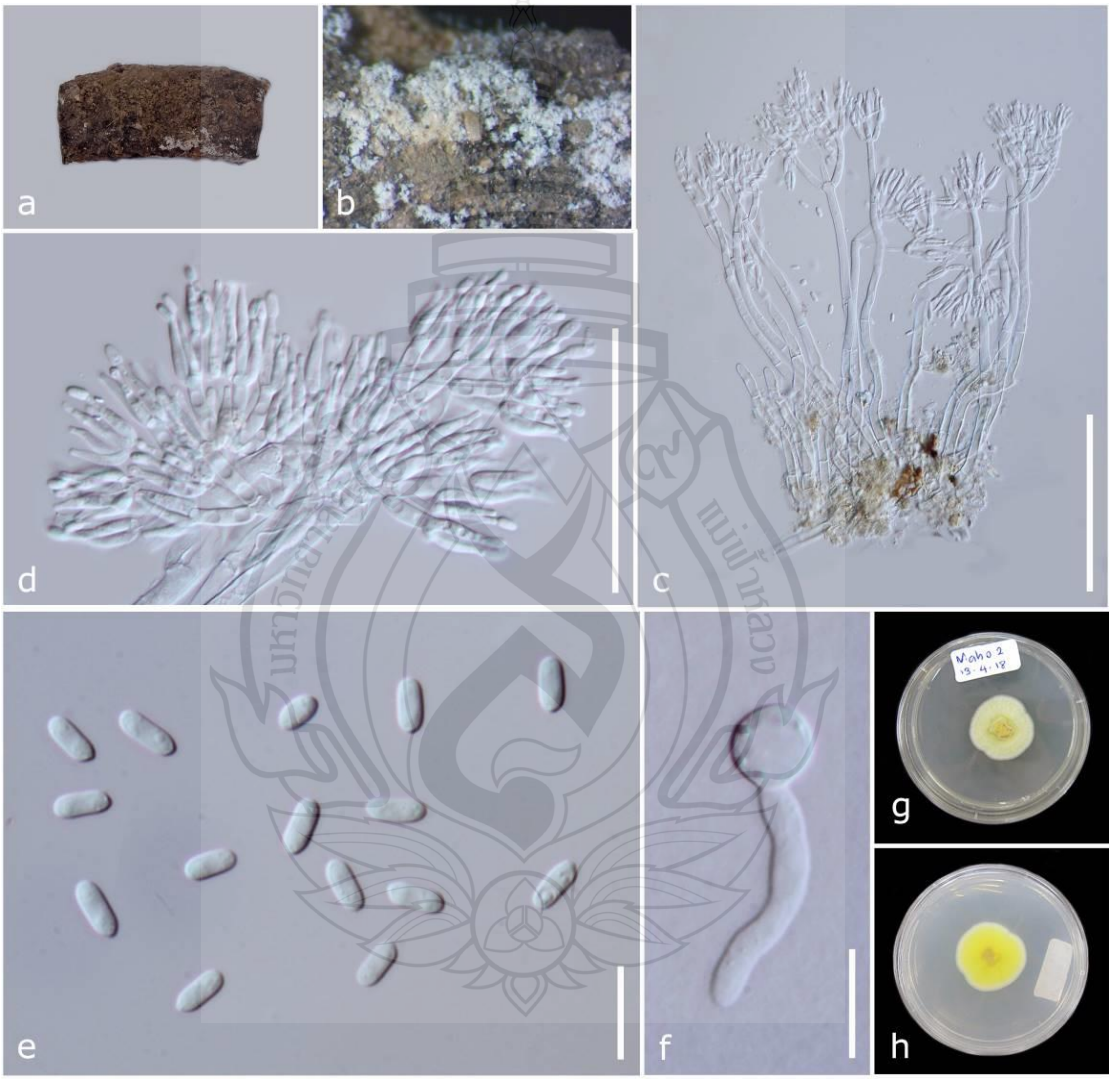
Culture characteristics: Conidia germinating on PDA within 12 hours. Colonies growing on PDA, reaching up to 3.8 cm within 7 days at 25°C, surface slightly raised, smooth, margin entire to undulate, aerial mycelium dense, initially white, becoming yellowish, reverse yellow.

Material examined: Thailand, Chiang Rai Province, Mae Fah Luang University Garden, on decaying fruits of *Swietenia mahagoni* (Meliaceae), 6 September 2017, R.H. Perera, Maho 02 (MFLU 18-2769, holotype), ex-type living culture MFLUCC 18-0572.

GenBank numbers: ITS: MT215573, LSU: MT396164, TEF1: MT212204.

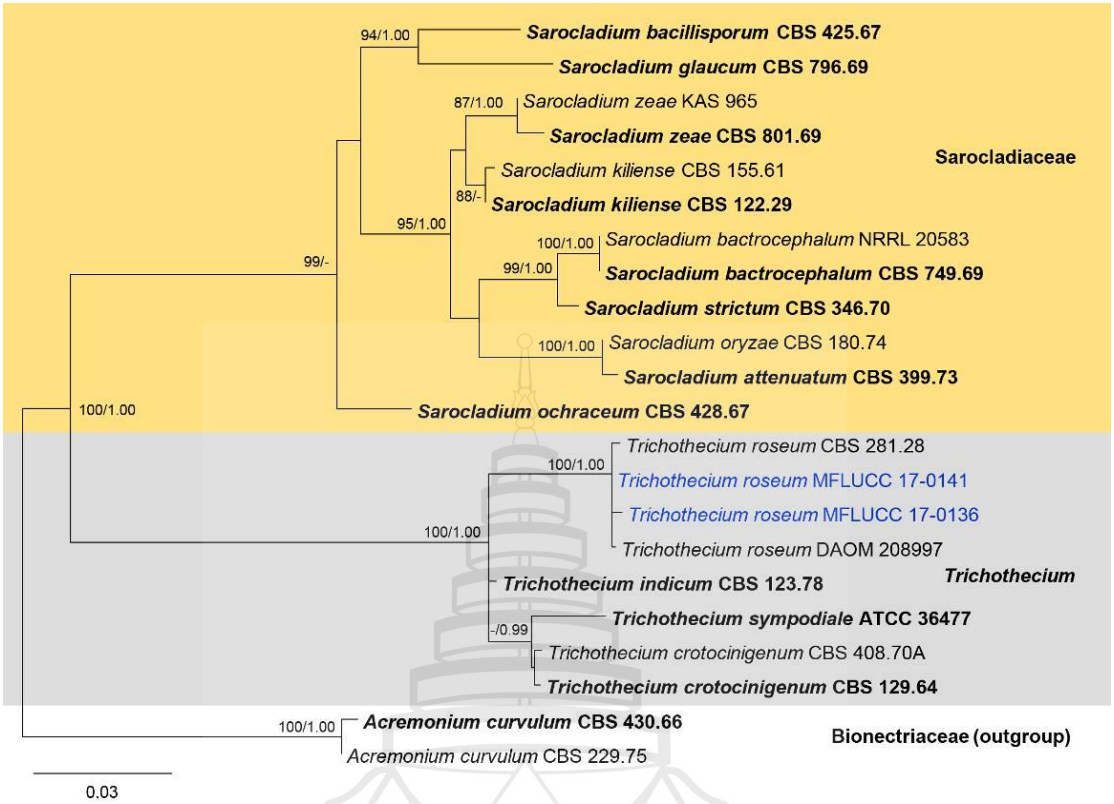
Notes: *Clonostachys swieteniae* constitutes a distinct lineage within *Clonostachys* (Figure 6.31). A comparison of the ITS regions of *C. swieteniae* reveals 11 (2.1%), 10 (2.1%), 7 (1.5%) and 8 (1.7%) nucleotide differences with *C. capitata*, *C. zelandiaenovae*, *C. agrawalii* and *C. krabiensis*, respectively. *Clonostachys swietenia* can be discriminated from *C. capitata* by its longer and wider conidiophore

stipe (130–200 × 5–8 vs.100 × 3.5 μm) and straight, smaller conidia (5.1–6.7 × 1.9–2.6 vs. 6–7.2 × 2.8–3.4 μm), which are curved in *C. capitata* (Schroers, 2001). *Clonostachys swieteniae* is different from *C. krabiensis*, which was also collected from Thailand, by the absence of setae and not forming sporodochial conidiophores (Tibpromma et al., 2018). We therefore identified *Clonostachys swieteniae* as a new taxon.



Note (a) Herbarium material. (b) Colony on host. (c) Conidiophores. (d) Conidiogenous apparatus. (e) Conidia. (f) Germinating conidium. (g, h) Colony on PDA. Scale bars: c = 100 μm, d = 50 μm, e, f = 10 μm.

Figure 6.34 *Clonostachys swieteniae* (MFLU 19-0987, holotype)



Note Sequences from twenty-two taxa, which comprise 1390 characters including gaps, are included in the analyses. The tree was rooted to *Acremonium curvulum* CBS 430.66 and *Acremonium curvulum* CBS 229.75. The scale bar indicates 0.03 nucleotide changes per site.

Figure 6.35 Phylogram generated from RAxML analysis based on combined LSU and ITS, sequence data of *Trichothecium* isolates

Myrotheciomycetaceae Crous

Trichothecium roseum (Pers.) Link, Mag. Gesell. naturf. Freunde, Berlin 3(1-2): 18 (1809)

Facesoffungi number: FoF07768, Figures 6.36, 6.37

On dried pods of *Delonix regia*. **Sexual morph**: Undetermined. **Asexual morph**: Hyphomycetous. *Conidiophores* 215 × 360 µm long, 3.3–5 µm wide ($\bar{x}$ = 270 × 4 µm, n = 20), simple, long, slender, rarely branched, septate, often slightly swollen at the tip, hyaline, smooth-walled. *Conidia* 11.5–25.5 × 8–14.6 µm ($\bar{x}$ = 20 ×

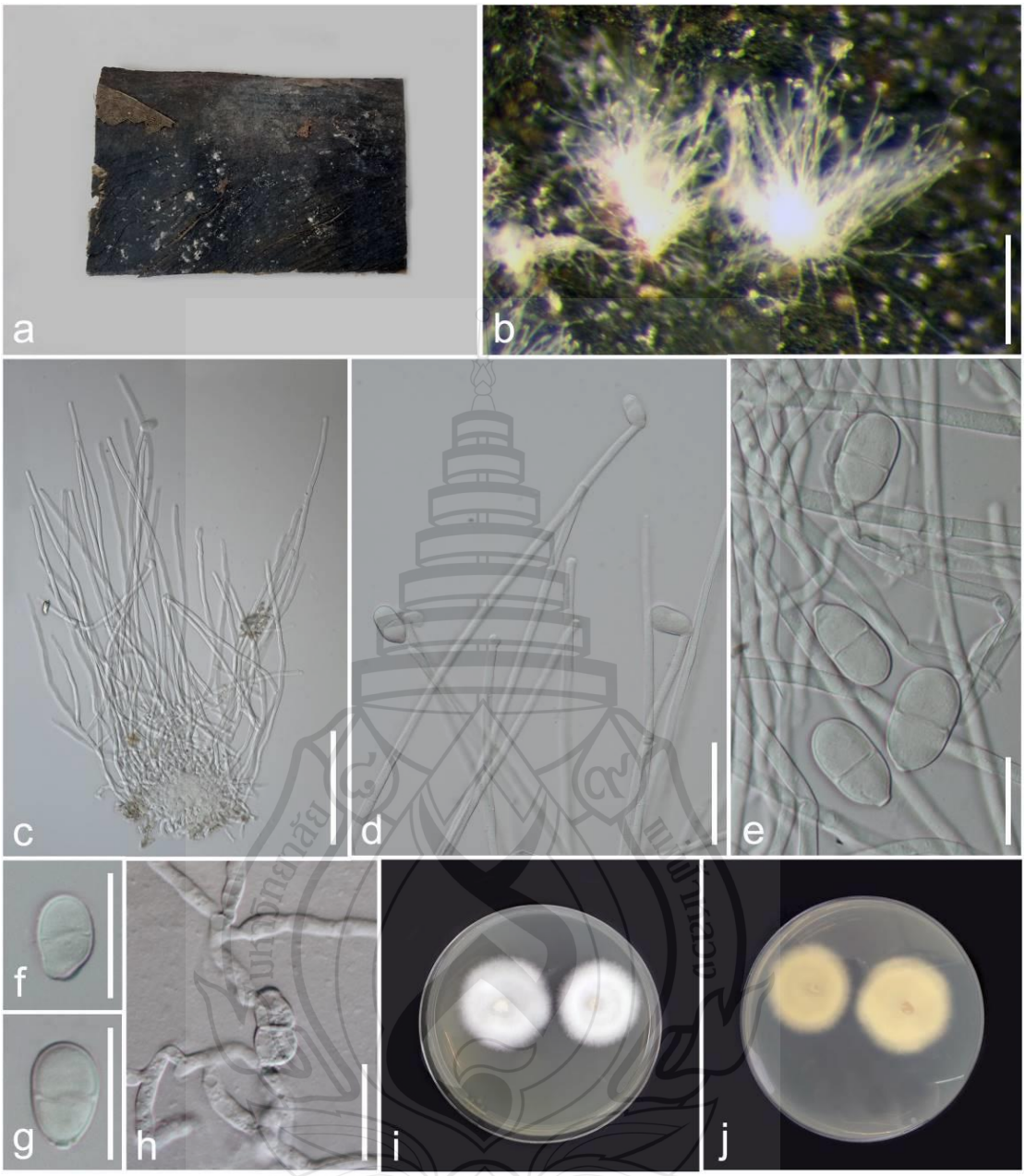
11 µm, n = 30), borne apically and singly, attached in groups or chains, pink in mass, 1-septate, ovate, hyaline, thick-walled, each with a decurved, abruptly narrowed basal hilum terminating in a distinct truncate end, often clustered. *Conidiophores* on MEA retrogressive, with each conidial base subsuming a portion of conidiophore apex. *Conidia* arise from the side of the conidiophore apex. *Chlamydospores* present, 7–8.8 µm wide (n = 10), in intercalary chains, hyaline, smooth-walled.

Culture characteristics: Conidia germinating on PDA within 12 hours. Colonies growing on PDA, reaching up to 4.5 cm within 7 days at 28°C, surface effused, smooth, margin entire, aerial mycelium rare, initially white, turning salmon pink, reverse salmon pink. Colony on MEA reaching up to 3.3 cm in 7 days at 28°C, sporulating within 30 days.

Materials examined: THAILAND, Chiang Rai Province, Mae Fah Luang University garden, on dried pods of *Delonix regia* (Fabaceae) on the ground, 1 December 2017, R.H. Perera, Delo 24 (MFLU 18-2773), living culture: MFLUCC 17-1036 and *ibid*., on dried pods of *Tamarindus indica* L. (Fabaceae) on the ground, 6 December 2016, R.H. Perera, Tam 4 (MFLU 18-2735), sporulated dry culture: MFLU 18-0624, living culture: MFLUCC 17-0141.

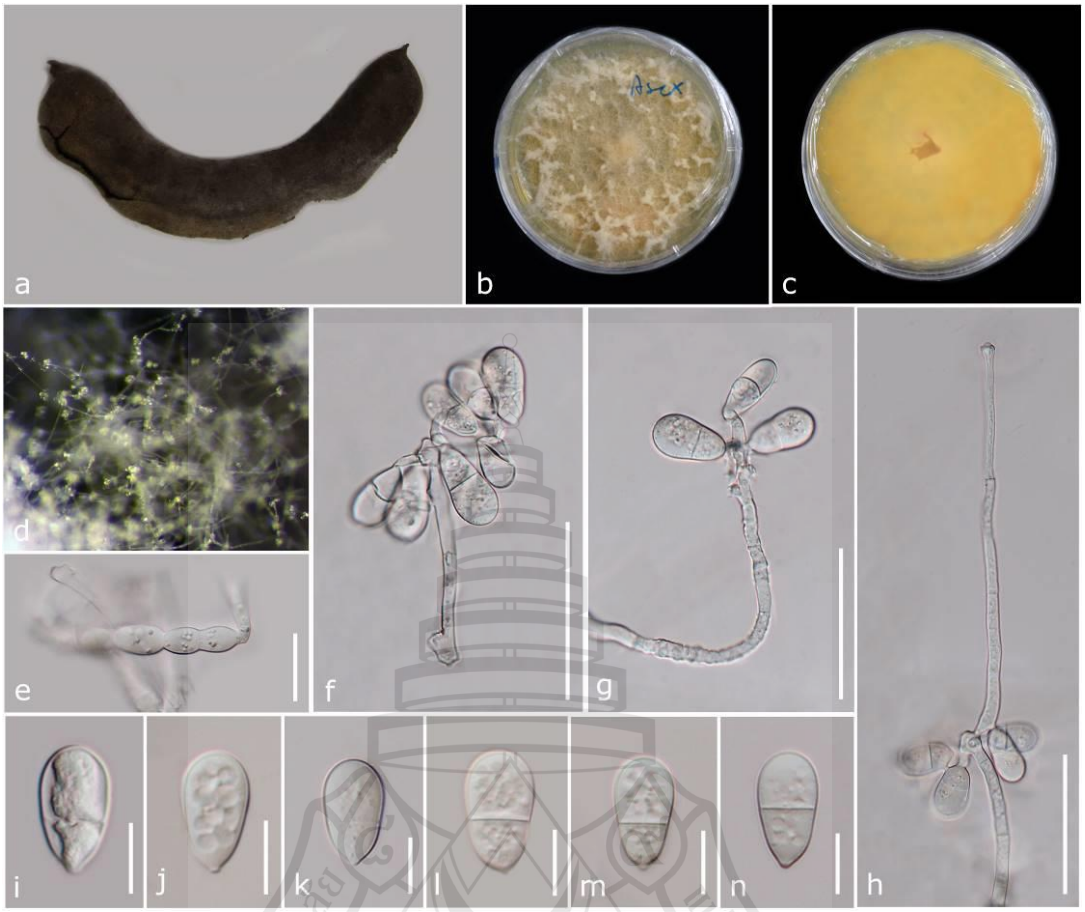
GenBank numbers: ITS: MT215509, LSU: MT215558 (MFLUCC 17-1036) and ITS: MT215510, LSU: MT215559 (MFLUCC 17-0141).

Notes: In the phylogenetic analysis our two isolates grouped within *Trichothecium roseum* isolates CBS 281.28 and DAOM 208997 (Figure 6.35). Based on the phylogenetic analysis and morphological similarities the fungus was identified as *Trichothecium roseum* (Petrak, 1953 and Bello, 2008), and is a new host record.



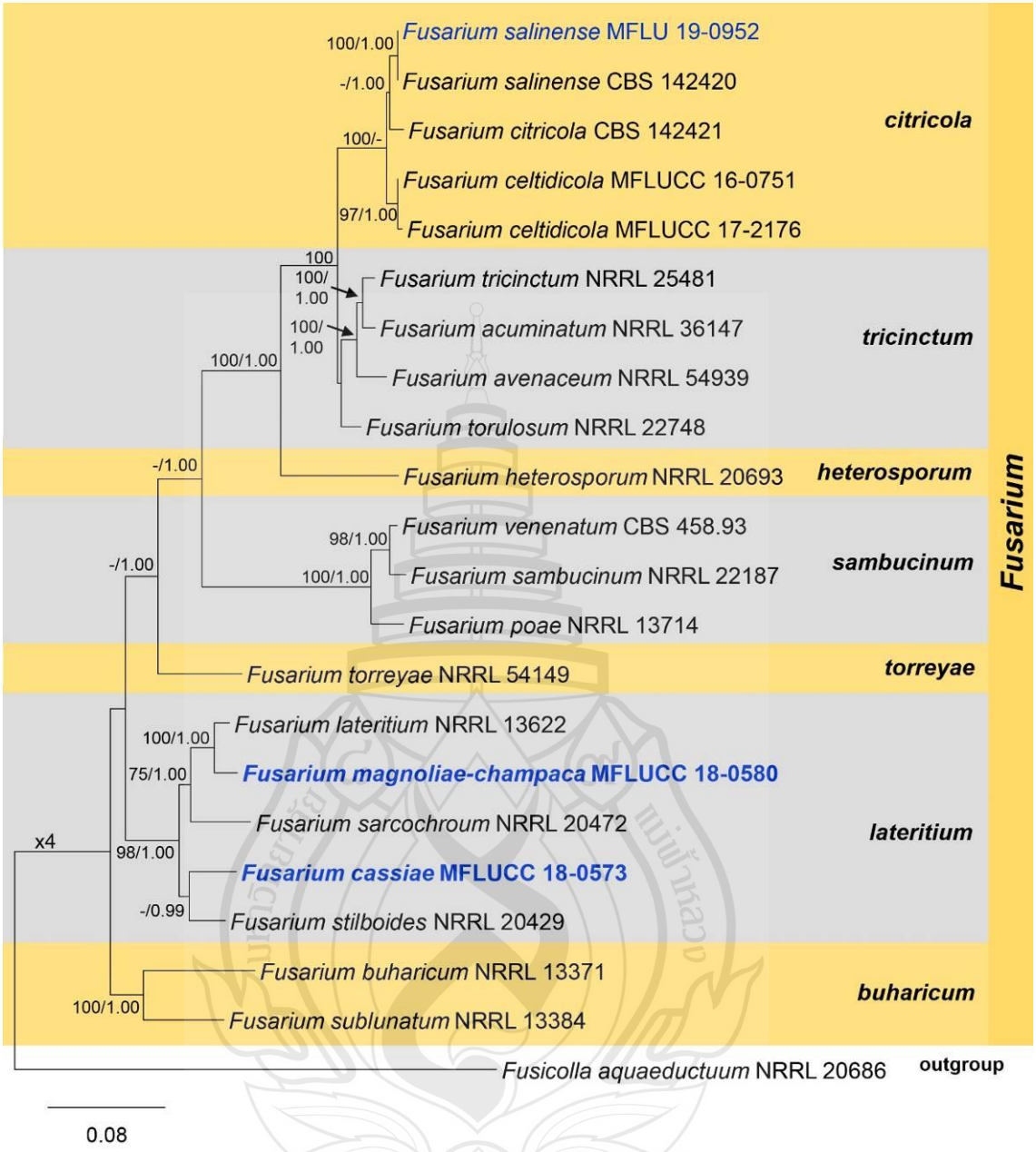
Note (a) Herbarium material. (b) Conidiomata on host. (c, d) Conidiophores with conidia. (e–g) Conidia. (h) Germinating conidium. (i, j) Colony on PDA. Scale bars: b = 200 µm, c = 100 µm, d = 50 µm, e–h = 20 µm.

Figure 6.36 *Trichothecium roseum* (MFLU 18-2773)



Note (a) Herbarium material. (b, c) Sprorulating colony on MEA. (d) Conidiomata on MEA. (e) Chlamydospores. (f–h) Conidiophores with conidia. (i–n) Conidia. Scale bars: e–h = 20 µm, i–n = 10 µm.

Figure 6.37 *Trichothecium roseum* (MFLU 18-0624)



Note Sequences from twenty-two taxa, which comprise 3349 characters including gaps, are included in the analyses. The tree was rooted to *Fusicolla aquaeductuum* (NRRL 20696). The scale bar indicates 0.08 nucleotide changes per site.

Figure 6.38 Phylogram generated from RAxML analysis based on combined RPB2 and RPB1 sequence data of selected *Fusarium* isolates

Nectriaceae Tul. and C. Tul.

Fusarium Link

Fusarium cassiae R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556857 and Facesoffungi number: FoF07757, Figure 6.39

Etymology: Name reflects the host genus *Cassia fistula*.

Saprobic on decaying pods of *Cassia fistula*. **Sexual morph**: *Ascomata* 110–180 μm high × 110–155 μm diam. ($\bar{x}$ = 132 × 128 μm), superficial, solitary to gregarious, blue-black to dark purple, subglobose to ampulliform, or obpyriform, collapsing laterally when dry, with a slightly papillate ostiole. *Peridium* 16–30 μm wide, comprising dark purple to hyaline, thick-walled cells of *textura angularis*. *Catenophyses* absent. *Asci* 59–83 × 9–16 μm ($\bar{x}$ = 70.2 × 11.8 μm, n = 20), 4–8–spored, unitunicate, clavate, with a short pedicel, truncate at the apex, apical ring J-. *Ascospores* 10.3–21.2 × 5.6–8.8 μm ($\bar{x}$ = 15.9 × 7 μm, n = 37), 1–2-seriate, varied in shape, ellipsoidal to oblong, or subglobose to obovoid, or fusiform, with both ends rounded, (0–)1-septate, not or slightly constricted at the septum, hyaline, pale brown when mature, guttulate, smooth-walled. **Asexual morph**: Undetermined.

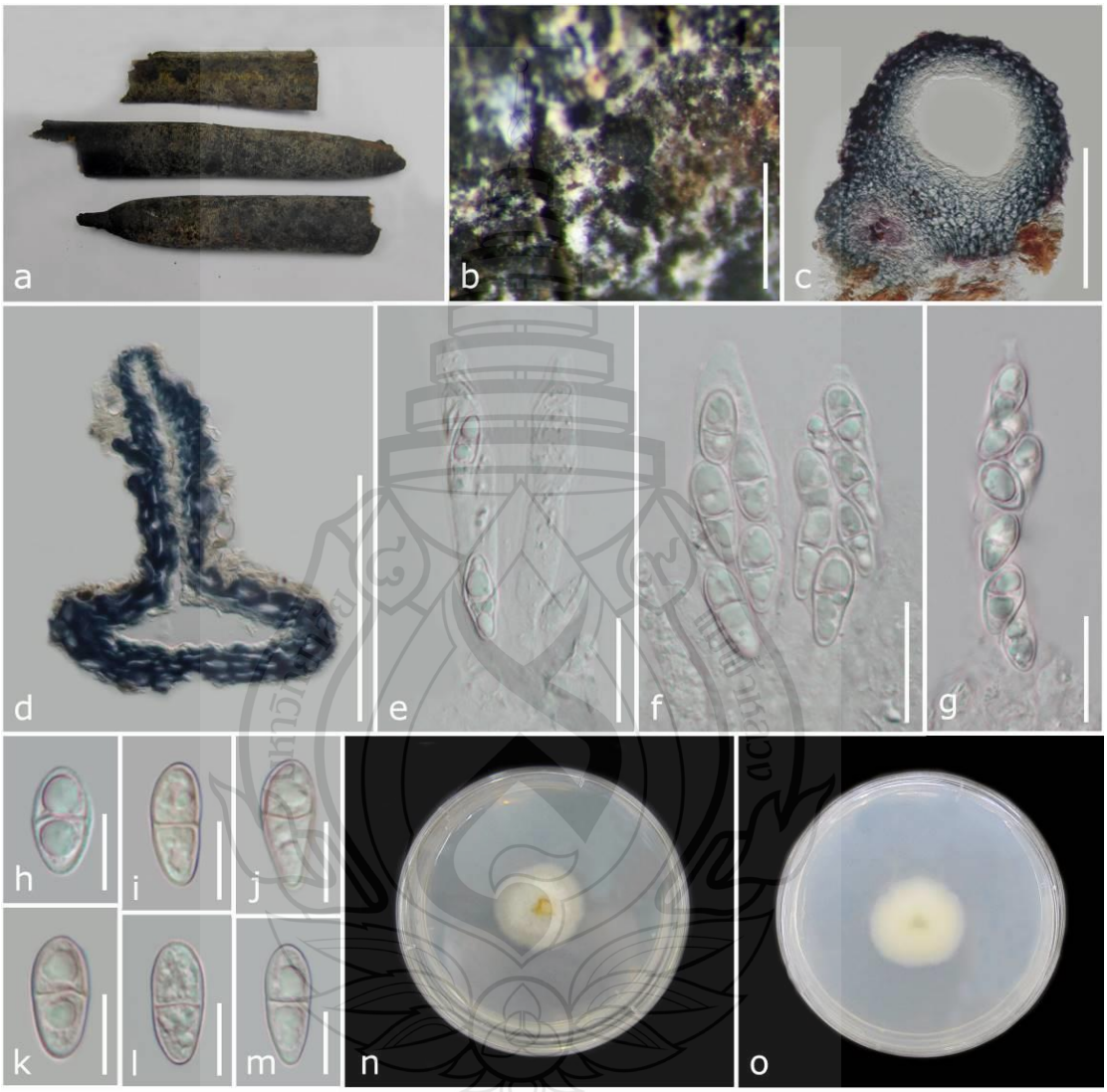
Culture characteristics: Colonies on PDA reach 3–4.5 cm diameter within 7 days at 25℃, circular, flat, smooth, edges crenate, zonate, whitish above, reddish at the center, reverse white.

Material examined: THAILAND, Phayao Province, decaying pods of *Cassia fistula* (Fabaceae) on the ground, R.H. Perera, 4 August 2017, PH-CAS 05 (MFLU 18-2751, holotype), ex-type living culture MFLUCC 18-0573.

GenBank numbers: ITS: MT215495, LSU: MT215546, RPB2: MT212197, TEF1: MT212205.

Notes: In the phylogenetic tree, *Fusarium cassiae* is closely related to *F. stilboides* (NRRL 20429) with low support (70% ML, 0.99 BYPP and Figure 6.38). A comparison of RPB2 gene region of new fungus and *F. stilboides* (NRRL 20429) indicates 53 (5.9%) different nucleotides. *F. cassiae* also can be discriminated from *F. stilboides* in having variously shaped, (0–)1-septate ascospores vs. elliptical, 1–3 septate ascospores in *F. stilboides* (Booth, 1971). The NCBI megablast search of ITS and TEF1 sequences show 99% similarity (476/477) with *F. lateritium* (CF6), and

97% similarity (659/682) with *F. lateritium* (YT2-7), respectively. However, the highest similarity (93%, 801/858) obtained in the megablast search of RPB2 sequences is with *F. lateritium* strain (NRRL 13622). We therefore recognize *F. cassiae* as a novel species.



Note (a) Herbarium material. (b) Ascomata on host. (c, d) Section of ascoma (d laterally collapsed). (e–g) Asci. (h–m) Ascospores. (n, o) Colony on PDA. Scale bars: b = 500 µm, c = 100 µm, e–g = 20 µm, h–m = 10 µm.

Figure 6.39 *Fusarium cassiae* (MFLU 18-2751, holotype)

Fusarium magnoliae-champaca R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556920 and Facesoffungi number: FoF07758, Figure 6.40

Etymology: Name reflects the host plant *Magnolia champaca*.

Holotype: MFLU 18-2736

Saprobic on dried fruits of *Magnolia champaca*. **Sexual morph**: *Ascomata* 75–215 μm high × 70–210 μm diam. ($\bar{x}$ = 147 × 143 μm, n = 10), superficial, solitary to gregarious, blue-black to dark purple, subglobose to ampulliform, or obpyriform, collapsing laterally when dry. *Ostioles* periphysate. *Peridium* 30–40 μm wide, composed of two layers, inner 3–5 layers, comprising hyaline cells of *textura angularis*, outer 3–5 layers, comprising brown to dark purple, thick-walled cells of *textura angularis*. *Hamathecium* comprising hyaline, distinctly septate catenophyses, each cell 12.7–17.5 μm long × 14.2–22.5 μm wide. *Asci* (70–)90–100(–109) × (7–)9–13(–16) μm ($\bar{x}$ = 96.5 × 11 μm, n = 40), 8-spored, unitunicate, clavate, with short pedicel, slightly rounded to truncate at the apex. *Ascospores* (8–)16–20(–25) × (4.5–)6–7.5(–9) μm ($\bar{x}$ = 18 × 6.6 μm, n = 165), 1–2-seriate, pale brown, varied in shape, ellipsoidal to oblong, or subglobose to obovoid, or fusiform, with both ends rounded, (0–)1-septate, not constricted at the septum, smooth-walled. **Asexual morph**: Undetermined.

Material examined: THAILAND, Chiang Rai Province, Mae Fah Luang University garden, on ground, dried fruits of *Magnolia champaca* (L.) Baill. ex Pierre, (Magnoliaceae), 7 August 2017, S. Boonmee, Fruit 1 (MFLU 18-2736, holotype), ex-type living culture MFLUCC 18-0580.

GenBank numbers: ITS: MT215496, LSU: MT215547, RPB2: MT212198.

Culture characteristics: Ascospores germinated on PDA within 12 hours. Colonies on PDA reaching 15–17 mm diameter after 7 days at 28°C, colonies circular, medium dense, flat or effuse, with entire margin, white, becoming yellowish with time, reverse pale yellow.

Notes: In the phylogenetic analysis *Fusarium magnoliae-champaca* (MFLUCC 18-0580) clusters with *F. lateritium* strain (NRRL 13622) with high statistical support (100% MLBT, 1.00 BYPP and Figure 6.38). A comparison of

RPB2 gene region of the new fungus and *F. lateritium* (NRRL 13622) indicates 27 (3.1%) different nucleotides. *Fusarium magnoliae-champaca* also can be delineated from *F. lateritium* in having (0–)1 septate ascospores vs. 1–3 septate ascospores and larger asci 90–100 × 9–13 vs. 65–80 × 8–11 µm (Booth, 1971).

Note (a) Herbarium material. (b) Ascomata on host. c, d Section of ascomata. e Periphyses. f–h Asci. i–o Ascospores.p Germinating ascospore. q, r Colony on PDA. Scale bars: b = 200 µm, c, d = 100 µm, e–h = 20 µm, i–o = 10 µm, p = 20 µm.

Figure 6.40 *Fusarium magnoliae-champaca* (MFLU 18-2736, holotype)

Fusarium salinense Sand.-Den., Guarnaccia and Polizzi, in Sandoval-Denis, Guarnaccia, Polizzi and Crous, Persoonia 40: 15 (2017)

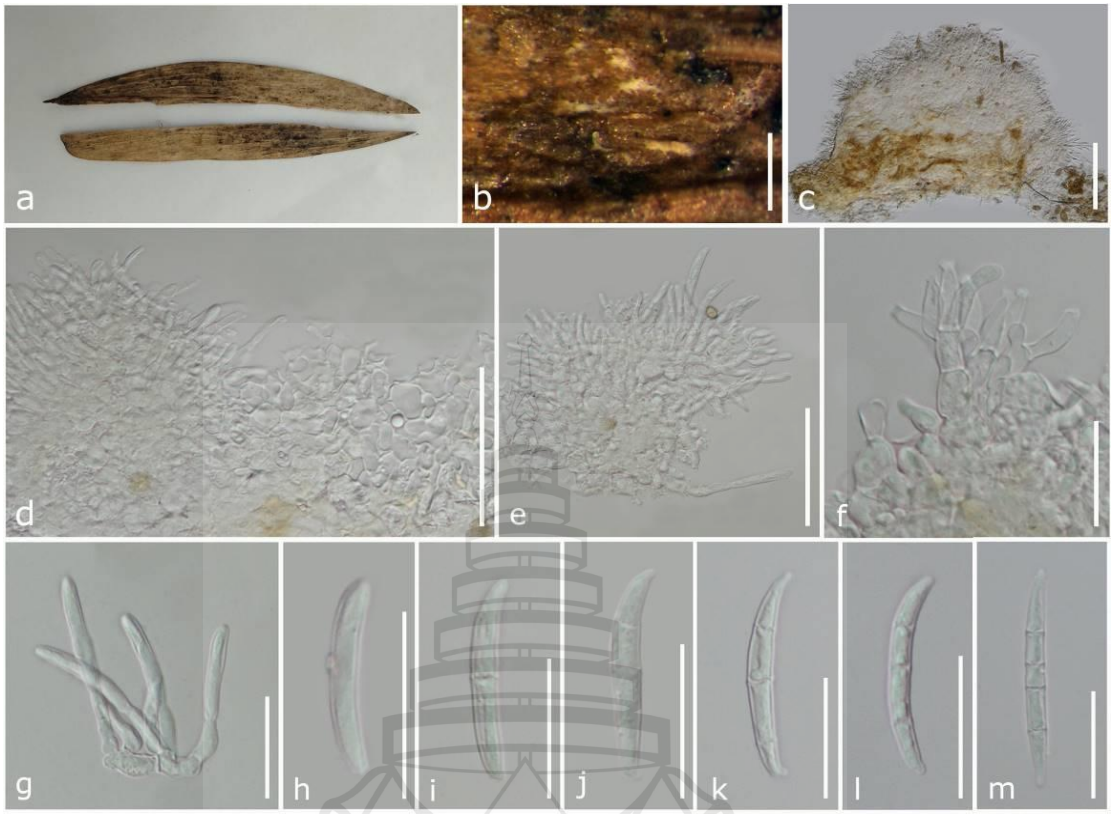
Facesoffungi number: FoF07759, Figure 6.41

On dead samaras of *Fraxinus angustifolia*. **Sexual morph**: Undetermined. **Asexual morph**: *Colonies* on the host appearing as pale orange coloured masses. *Conidiomata* sporodochial, pale orange coloured. *Conidiophores* 33–48 × 5–6.6 µm, densely and irregularly branched, bi- or tri-verticillately, bearing 1–2 terminal phialides, hyaline, smooth-walled. *Phialides* 7.3–12.1 × 2.9–3.6 µm, subulate to subcylindrical, with a minute apical collarette, hyaline, smooth- and thin-walled. *Conidia* 21–42 × 3.4–4.5 µm ($\overline{x}$ = 40 × 3.7 µm, n = 20), (1–)3–4-septate, falcate, slender, curved, curvature more prominent in the upper part of the conidium, slightly tapering towards the basal end, with a foot-like basal cell, hyaline, thin- and smooth-walled.

Material examined: ITALY, Forlì-Cesena Province, Collina – Forlì, dead aerial samaras of *Fraxinus angustifolia* Vahl (Oleaceae), Erio Camporesi, 22 January 2015, IT 2345 (MFLU 19-0952).

GenBank numbers: LSU: MT215548, RPB2: MT212199, TUB2: MT212211.

Notes: Since single spore isolation was unsuccessful, DNA was isolated directly from the fruiting bodies. In the phylogenetic analysis the new isolate (MFLU 19-0952) clusters with the ex-type strain of *Fusarium salinense* (CBS 142420) with high statistical support (100% MLBT, 1.00 BYPP and Figure 6.38). The morphology of the new collection is similar to the holotype of *F. salinense* (Sandoval-Denis et al., 2017). However, microconidia, obtained in the culture in holotype of *F. salinense*, were not observed in our collection. The DNA sequences of new strain (MFLU 19-0952) and *F. salinense* are similar. Hence, we identify our collection as *Fusarium salinense* with a new geographical record and new host for the fungus.



Note (a) Herbarium material. (b) Conidiomata on the host. (c) Conidioma mounted in water. (d–g) Conidiophores with conidia. (h–m) Conidia. Scale bars: b, c = 100 µm, d, e = 50 µm, f–m = 20 µm.

Figure 6.41 *Fusarium salinense* (MFLU 19-0952)

***Fusarium* sp.**

Figure 6.42

Saprobic on decaying seed pods of *Delonix regia*. **Sexual morph**: *Ascomata* 75–215 µm high × 70–210 µm diam. ($\bar{x}$ = 147 × 143 µm, n = 7), superficial, solitary to gregarious, blue-black to dark purple, subglobose to ampulliform, or obpyriform, collapsing laterally when dry. *Ostioles* slightly papillate, periphysate. *Peridium* 30–40 µm wide, composed of two layers, inner 3–5 layers, comprising hyaline cells of *textura angularis*, outer 3–5 layers, comprising brown to dark purple, thick-walled cells of *textura angularis*. *Hamathecium* comprising hyaline, distinctly septate catenophyses, each cell 12.7–17.5 µm long × 14.2–22.5 µm wide. *Asci* (70–)90–100(–

109) × (7–)9–13(–16) µm ($\bar{x}$ = 89 × 11 µm, n = 40), 6–8-spored, unitunicate, clavate, with a short pedicel, truncate at the apex, apical ring J-. *Ascospores* (8–)16–20(–25) × (4.5–)6–7.5(–9) µm ($\bar{x}$ = 18 × 6.6 µm, n = 165), overlapping 1–2-seriate, varied in shape, ellipsoidal to oblong, or subglobose to obovoid, or fusiform, with both ends rounded, 1-septate, slightly constricted at the septum, hyaline, smooth-walled. **Asexual morph**: Undetermined.

Material examined: THAILAND, Chiang Mai Province, on decaying seed pods of *Delonix regia* (Fabaceae), 6 January 2015, R.H. Perera, M-9 (MFLU 16-1075).

GenBank numbers: LSU: MT396166, SSU: MT396180, TUB2: MT415235.

Notes: We were unable to obtain cultures of this fungus using single spore isolation. DNA was extracted from the fruiting bodies. Fungal morphology of this fungus resembles *Fusarium*. Only LSU, SSU and TUB2 sequences are available.

Fusicolla Bonord.

Fusicolla cassiae-fistulae R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556858 and Facesoffungi number: FoF07760, Figure 6.44

Etymology: Name derived from the host plant *Cassia fistula*.

Saprobic on decaying wood and seed pods of *Cassia fistula*. **Sexual morph**: *Ascomata* 150–180 µm high, 130–182 µm diam. ($\bar{x}$ = 173 × 157 µm, n = 10), perithecial, stroma erumpent, scattered or in small groups of 3–8, globose to pyriform sometimes collapsing when dry, yellow, pale yellow to pale orange, not changing colour in 5% KOH, smooth walled. *Ascomatal surface cells* forming a *textura angularis* in face view, with a broadly conical, rounded ostiolar neck 40–55 µm high, 70–85 µm diam. at base. *Ostiole* periphysate. *Peridium* 14–30 µm wide, two strata: outer region composed of 3–4 layers of hyaline to pale brown, thick-walled cells of *textura angularis* to *textura globosa* and inner region composed of 2–3 layers of hyaline cells of *textura angularis*. *Asci* 53–65 × 5.8–8.2 µm ($\bar{x}$ = 57 × 6.7 µm, n = 20), 8-spored, unitunicate, cylindrical to narrowly clavate, short pedicellate, apex flat, apical ring J-, lying without paraphyses. *Ascospores* 6.9–10.2 × 3.6–4 µm ($\bar{x}$ = 8.8 × 3.8 µm, n = 35), uniseriate, 1-septate, not constricted at the septum, ellipsoidal,

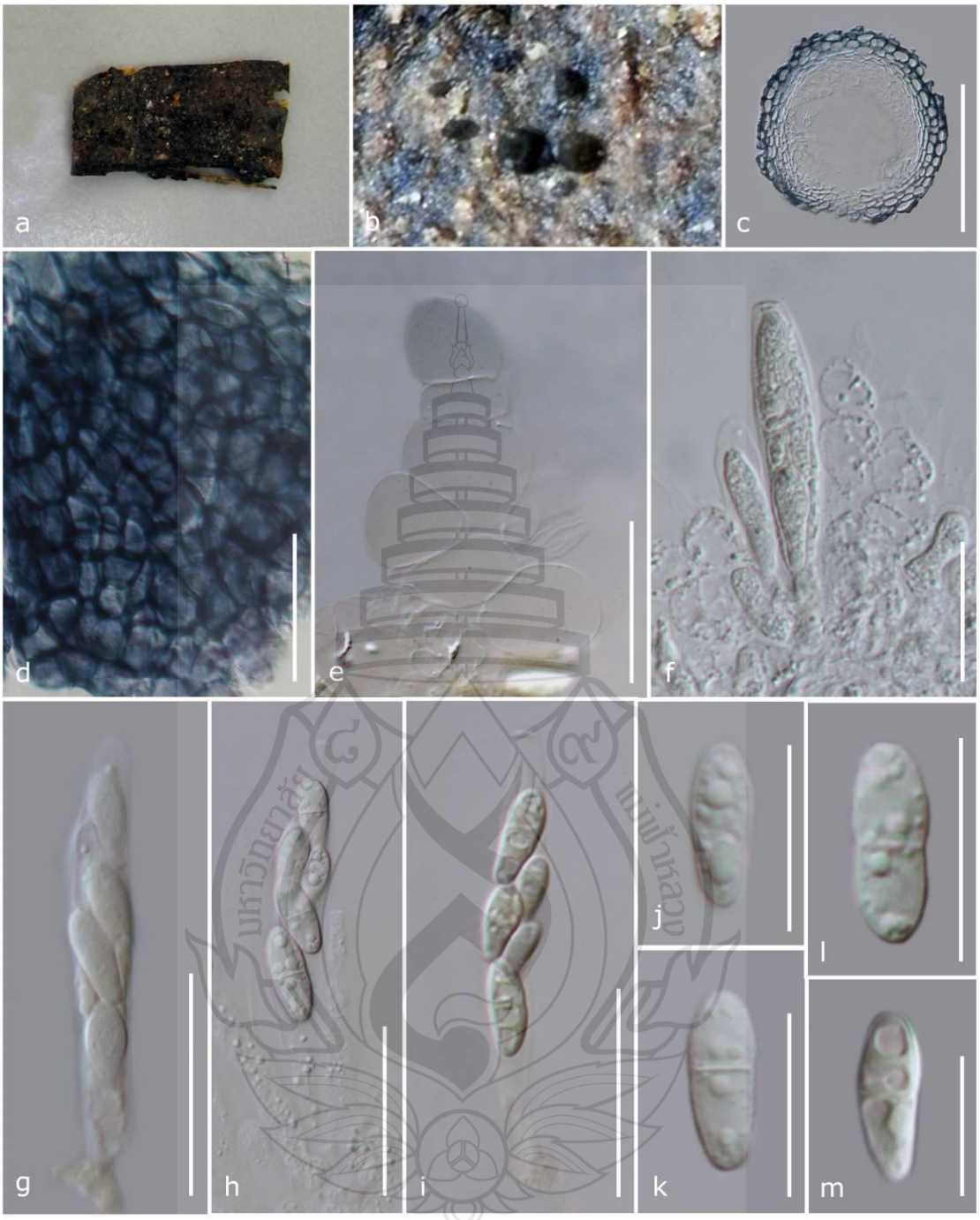
rounded at ends, equilateral or inequilateral, hyaline to very pale brown, thick-walled, smooth and slightly verrucose when mature. **Asexual morph**: Undetermined.

Culture characteristics: Colonies on PDA at 25°C attaining 15–18 mm in 7 days. Aerial mycelium rare to absent, white to cream in centre, white at margin, margin entire, reverse pale luteous.

Material examined: THAILAND, Phayao Province, on decaying seed pods of *Cassia fistula* (Fabaceae), 4 August 2017, R.H. Perera, PH-CAS 08 (MFLU 18-2753, holotype), ex-type living culture MFLUCC 19-0318.

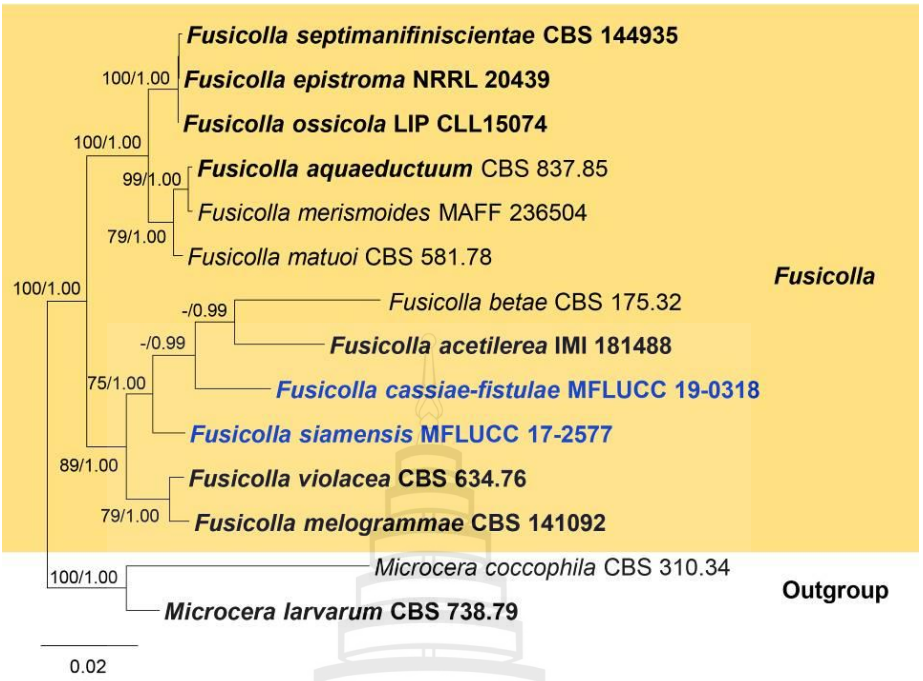
GenBank numbers: ITS: MT215497, LSU: MT215549.

Notes: Based on phylogenetic inference of the LSU and ITS sequences *Fusicolla cassiae-fistulae* forms an unsupported lineage within genus *Fusicolla* (Figure 6.43). *Fusicolla cassiae-fistulae* resembles *F. melogrammae* and *F. ossicola* in having yellow, pale yellow to pale orange ascomata (Crous, Wingfield, Burgess et al., 2016 and Lechat and Rossman, 2017). However, *F. cassiae-fistulae* can be easily distinguished from *F. melogrammae* and *F. ossicola* by having smaller ascomata, asci and ascospores (Table 6.1). *Fusicolla cassiae-fistulae* and ex-type of *F. melogrammae* (CBS 141092) showed 15 (2.9%, 2 gaps) different nucleotides in the ITS region and, 32 (3.8%, 0 gaps) in LSU sequences. Furthermore, ITS region of *F. cassiae-fistulae* and ex-type of *F. ossicola* (LIP CLL15074) showed 24 (4.7%, 1 gap) different nucleotides and 45 (5.3%, 3 gaps) in LSU sequences. Hence, we introduce *F. cassiae-fistulae* as a novel species.



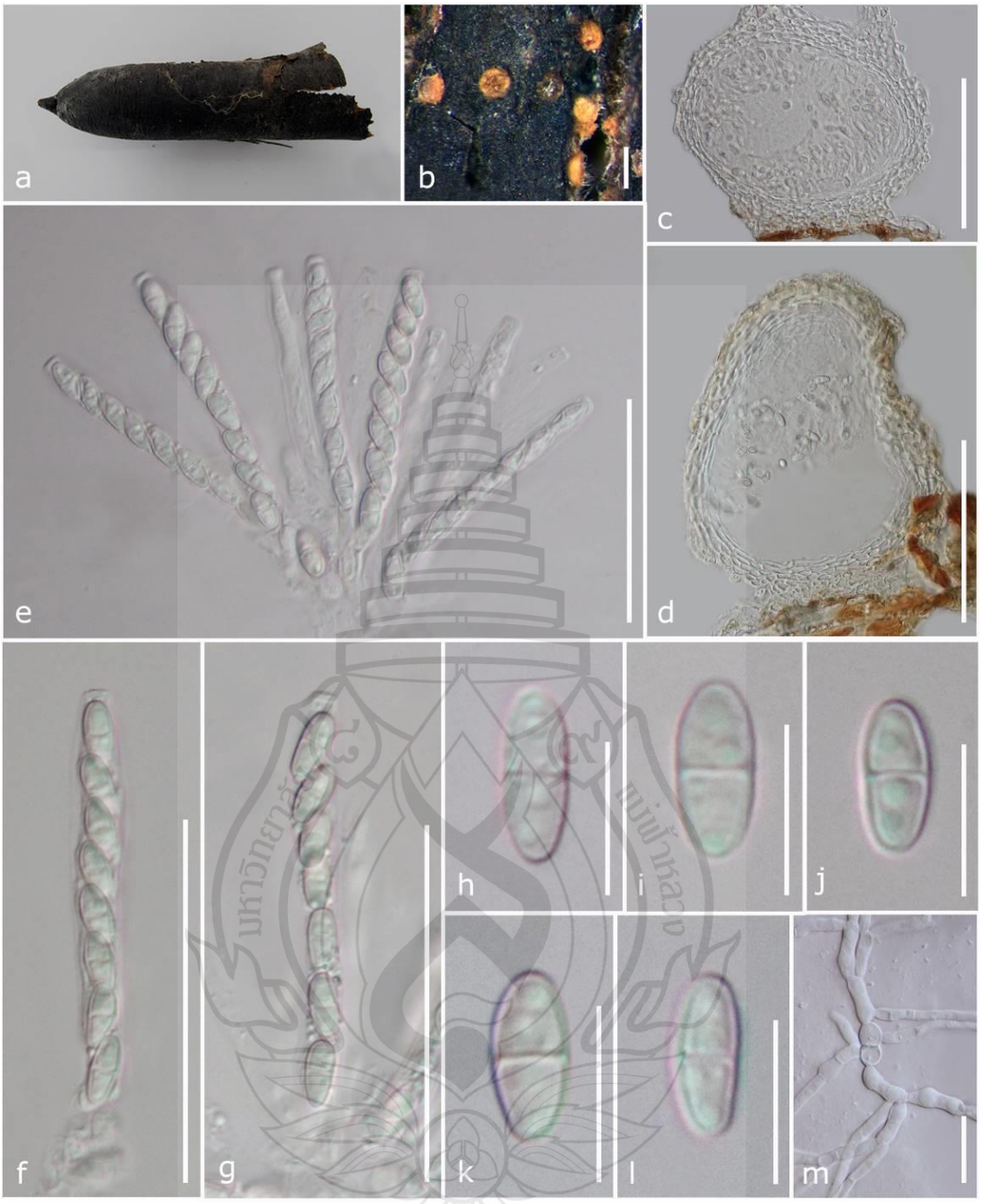
Note (a) Herbarium material. (b) Appearance of ascomata on host substrate. (c) Cross section through ascoma. (d) Peridium in face view. (e, f) Catenophyses. (g–i) Asci (i in Melzer's reagent). (j–m) Ascospores. Scale bars: c = 100 μm, d–i = 20 μm, j–m = 10 μm.

Figure 6.42 *Fusarium* sp. (MFLU 16-1075)



Note Sequences from fourteen taxa, which comprise 1337 characters including gaps, are included in the analyses. The tree was rooted to *Microcera larvarum* (CBS 738.79) and *M. coccophila* (CBS 310.34). The scale bar indicates 0.02 nucleotide changes per site.

Figure 6.43 Phylogram generated from RAxML analysis based on combined ITS and LSU sequence data of *Fusicolla* isolates



Note (a) Herbarium material. (b) Ascomata on host. (c, d) Section of ascomata. (e–g) Asci. (h–l) Ascospores. (m) Germinating ascospore. Scale bars: b = 200 µm, c, d = 100 µm, e–g = 50 µm, h–l = 10 µm, m = 20 µm.

Figure 6.44 *Fusicolla cassiae-fistulae* (MFLU 18-2753, holotype)

Fusicolla siamensis R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556859 and Facesoffungi number: FoF07761, Figure 6.45

Etymology: Name refers to the country Thailand, where the specimen was collected.

Associated with dried seed pods of *Cassia fistula*. **Sexual morph**: Undetermined. **Asexual morph**: *Conidiomata* sporodochial, appearing as flat wart-like, orange masses on the host surface. *Conidiophores* 27–46 µm × 3.7–5.1 µm (n = 10), monochasial, verticillate or penicillate, each branch terminating in one or two phialides, hyaline. *Phialides* 11.5–22.5 × 3.1–5.1 µm ($\bar{x}$ = 14.8 × 4.1 µm, n = 10), monophialidic, cylindrical to subulate, hyaline, with periclinal thickening at the unflared tip. *Microconidia* absent. *Macroconidia* 50.5–70.5 × 5.1–8 µm ($\bar{x}$ = 58.2 × 6.8 µm, n = 25), 3–5(7)-septate, not constricted at the septa, sub-falcate, straight to curved, narrowing towards the ends, apical cell with a flat or sometimes rounded tip, basal cell slightly hooked with a more or less pointed end, hyaline, smooth-walled.

Culture characteristics: Colonies on PDA at 25°C attaining 20–25 mm in 7 days. Aerial mycelium rare to absent, white to cream in centre, white at margin, reverse pale luteous, margin entire.

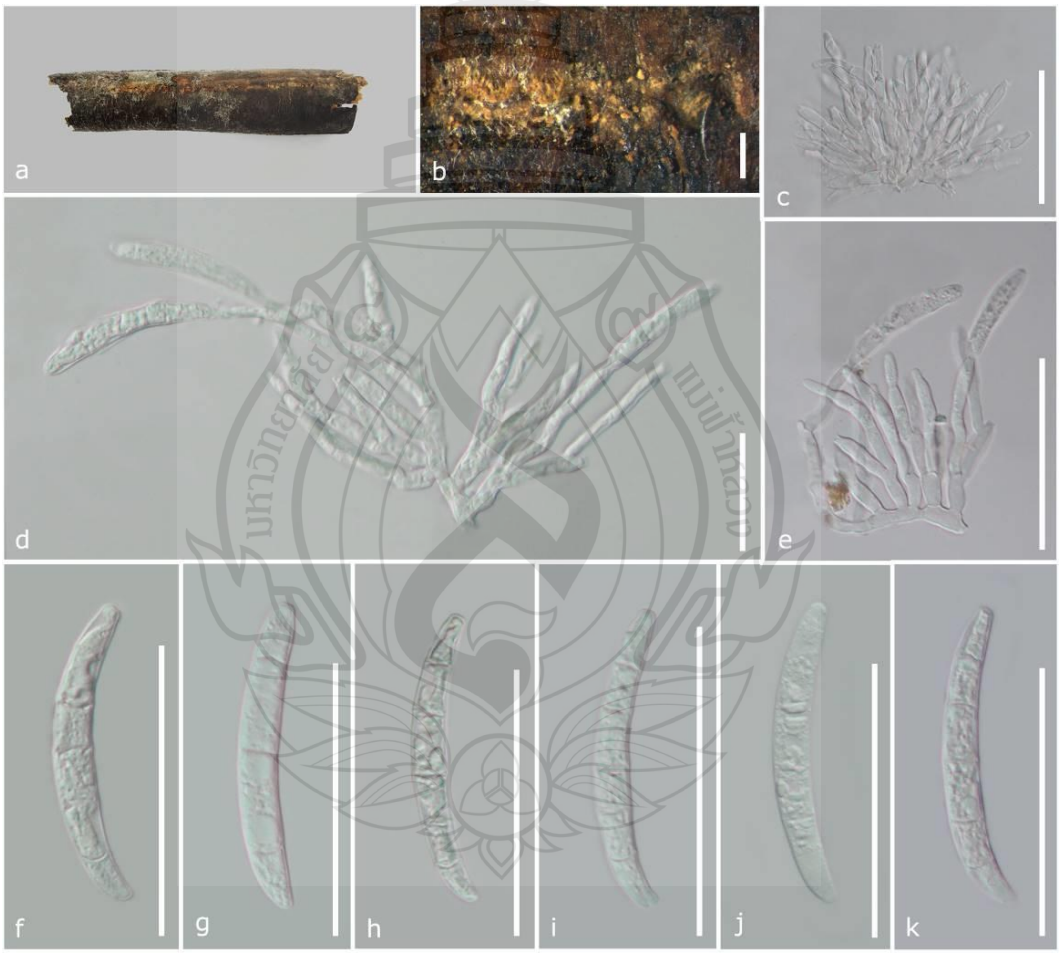
Material examined: THAILAND, Phayao Province, on decaying seed pods of *Cassia fistula* (Fabaceae), 4 August 2017, R.H. Perera, PH-CAS 07 (MFLU 19-1385, holotype), ex-type living culture MFLUCC 17-2577.

GenBank numbers: ITS: MT215498, LSU: MT215550.

Notes: Based on phylogenetic inference of LSU and ITS sequence data *Fusicolla siamensis* is closely related to *F. acetilerea* (Tubaki, C. Booth and T. Harada) Gräfenhan and Seifert, *F. betae* Bonord. and *F. cassiae-fistulae* (Figure 6.43). However, *F. siamensis* produced 3–5(7)-septate macroconidia, with basal cell slightly hooked (50.3–70.4 × 5.1–8 µm), which are larger than the 3(-4) septate conidia of *F. acetilerea* (35–40 × 3–3.5 µm and Tubaki et al. 1976). The conidia of *F. betae* are not falcate and 2–3-septate (Gräfenhan et al., 2011).

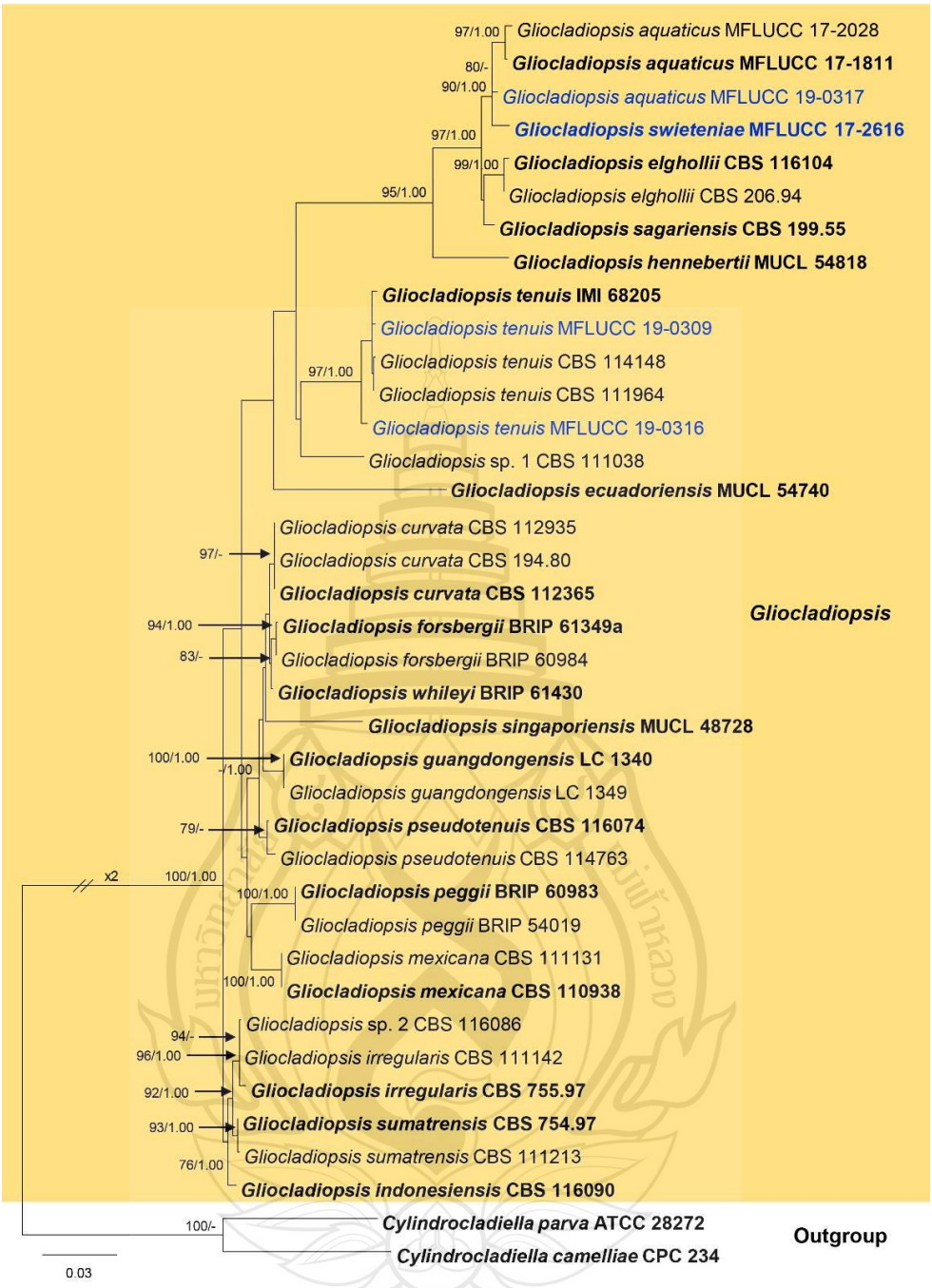
Table 6.1 Morphological comparison of related *Fusicolla* species

Species	Ascomatal size (µm)	Asci size (µm)	Ascospore size (µm)	Reference
Fusicolla cassiae-fistulae	150–180 ×130–182	53–65 × 5.8–8.2	6.9–10.2 × 3.6–4	This study
F. melogrammae	250–290 × 220–250	70–80 × 10–12	12–14 × 4.5–5	Crous, Wingfield, Burgess et al. (2016)
F. ossicola	250–300 × 240–280	80–85 × 8–11	10–12 × 5–5.5	Lechat and Rossman (2017)



Note (a) Herbarium material. (b) Sporodochia on host. (c–e) Conidiogenous apparatus. (f–k) Conidia. Scale bars: b = 500 µm, c = 50 µm, d = 20 µm, e–k = 50 µm.

Figure 6.45 *Fusicolla siamensis* (MFLU 19-1385, holotype)



Note Sequences from thirty-eight taxa, which comprise 1667 characters including gaps, are included in the analyses. The tree was rooted to *Cylindrocladiella parva* (ATCC 28272) and *C. camelliae* (CPS 234). The scale bar indicates 0.03 nucleotide changes per site.

Figure 6.46 Phylogram generated from RAxML analysis based on combined ITS, TUB2 and HIS3 sequence data of *Gliocladiopsis* isolates

Gliocladiopsis S.B. Saksena

Gliocladiopsis aquaticus Y.Z. Lu, R.H. Perera and K.D. Hyde, in Hyde et al., Mycosphere 9(2): 387 (2018)

Figure 6.47

Saprobic on seed pods of *Cassia fistula*. **Sexual morph**: Undetermined. **Asexual morph**: appearing as white masses on the substrate, becoming yellowish with age. *Conidiophores* 90–120 × 5.1–6.5 μm, penicillate, lacking stipe extensions and terminal vesicles, very pale brown. *Conidiogenous apparatus* with several series of hyaline to very pale brown branches and primary branches 22–27 × 3.1–5.6 μm, aseptate or 1-septate and secondary branches 14.5–25 × 3–4.1 μm, aseptate, hyaline and tertiary branches 9.1–15 × 2.2–3.4 μm, aseptate, hyaline. *Phialides* 7.5–13.1 × 1.6–2.6 μm ($\bar{x}$ = 11 × 2.1 μm, n = 30), doliiform to cymbiform to cylindrical, arranged in terminal whorls of 2–5 per branch, with periclinal thickening and minute collarettes, central phialide frequently extending above the rest. *Subverticillate conidiophores* absent. *Conidia* 13.4–20.6 × 1.7–2.6 μm ($\bar{x}$ = 17.3 × 2.2 μm, n = 30 μm), cylindrical, hyaline, smooth with rounded ends, straight, 0–1-septate, lacking a visible abscission scar.

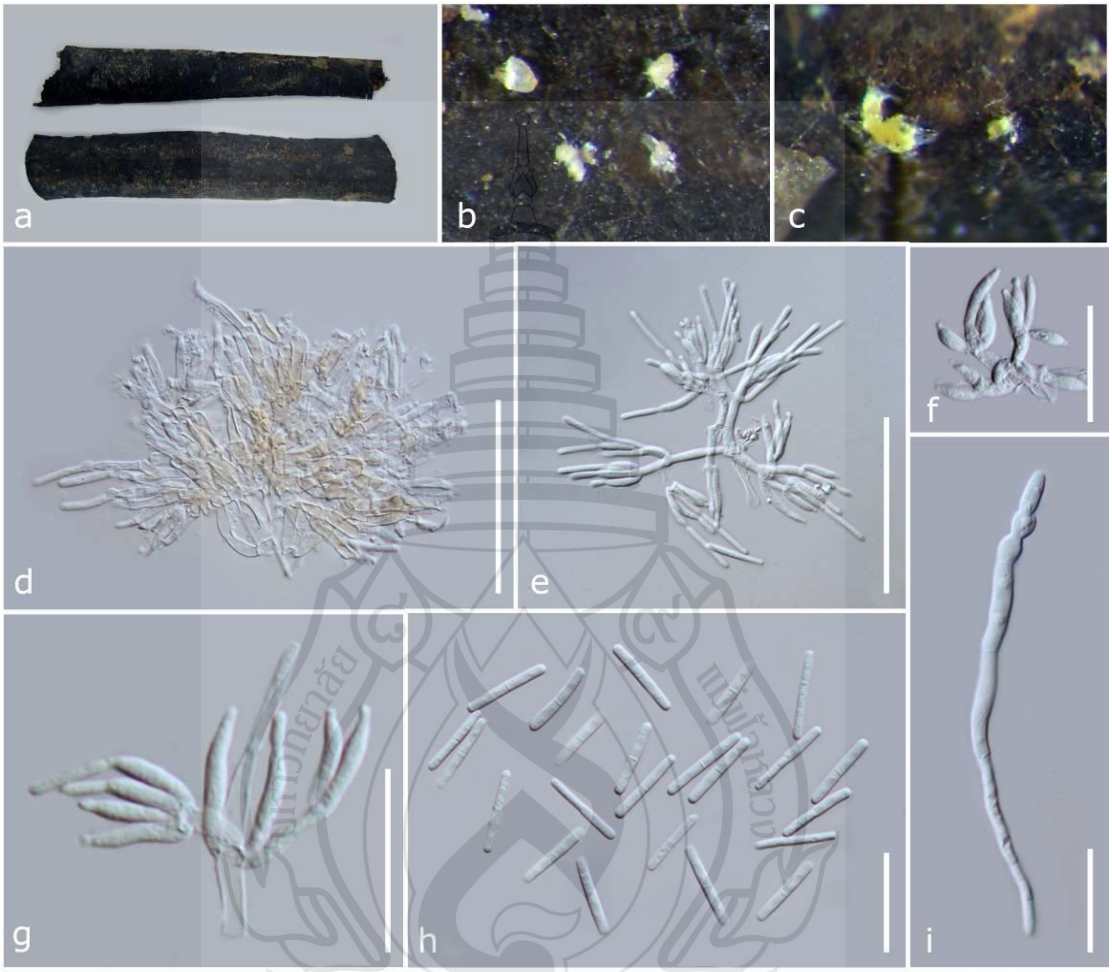
Culture characteristics: Conidia germinating on PDA within 8 hours. Colonies growing on PDA reaching 35 mm within 2 weeks at 28°C, circular, with flat to effuse surface, edge entire, aerial mycelium dense, pale brown from above and below.

Material examined: THAILAND, Phayao Province, on decaying seed pods of *Cassia fistula* (Fabaceae), 4 August 2017, R.H. Perera, PH-CAS 04 (MFLU 18-2750), living culture MFLUCC 19-0317).

GenBank numbers: ITS: MT215502, LSU: MT215552, HIS3: MT212195.

Notes: The new isolate (MFLUCC 19-0317) grouped with *Gliocladiopsis aquaticus* isolates collected from Thailand with high statistical support (Figure 6.46). Our collection also shares similar morphology with *G. aquaticus* in having similar sporodochial morphology, forming phialides in 2–5 terminal whorls per branch and, similar conidiophores and conidial sizes (Hyde et al. 2018). Our isolate (MFLUCC 19-0317) and two species of *G. aquaticus* (MFLUCC 17-1811, MFLUCC 17-2028) showed 6 nucleotide differences (1.2%, 1 gap) in the HIS3 region, and ITS region was identical. TUB2 gene region of *G. aquaticus* (MFLUCC 19-0317) was not available

for comparison. Based on the morphological similarities and phylogenetic analysis we identify our collection as *Gliocladiopsis aquaticus* and a new host record from *Cassia fistula*.



Note a Herbarium material. b, c Conidiomata on the host. c–g Conidiophores with conidia. h Conidia. i Germinating conidium. Scale bars: d, e = 50 µm, f–i = 20 µm.

Figure 6.47 *Gliocladiopsis aquaticus* (MFLU 18-2750)

Gliocladiopsis tenuis (Bugnic.) Crous and M.J. Wingf., Mycol. Res. 97(4): 446 (1993)

Figure 6.48

On decaying fruits of palms and *Swietenia mahagoni*. Sexual morph: Undetermined. **Asexual morph**: Appearing as white masses on the substrate. *Conidiophores* penicillate, 80–105 × 4.4–8.5 μm, septate, branched, hyaline, without stipe extensions and terminal vesicles. *Conidiogenous apparatus* with several series of hyaline branches and primary branches 15–26 × 3.8–6 μm, aseptate and secondary branches 8.7–24.5 × 1.9–5.2 μm, aseptate and tertiary branches 12.1–16.2 × 2.5–4.1 μm, aseptate and quaternary branches absent. *Conidiogenous cells* phialidic. *Phialides* 10–14.7 × 2.2–3.7 ($\bar{x}$ = 12.4 × 2.8 μm, n = 25), doliiform to cymbiform to cylindrical, arranged in terminal whorls of 2–4 per branch, sometimes with a minute collarette, central phialide frequently extending above the rest. *Conidia* 11.4–18 × 2.1–3.2 μm ($\bar{x}$ = 15.6 × 2.5 μm, n = 35), 1-septate, cylindrical, with rounded ends, straight, hyaline, smooth-walled, without appendages. *Chlamydospores* extensive, in clearly delimited chains. *Conidia* on MEA smaller, 9.4–14.2 × 1.5–2.7 ($\bar{x}$ = 12 × 2.3 μm, n = 35).

Culture characteristics: Colonies growing on MEA, reaching 30 mm within 2 weeks at 28°C, sporulation after 8 weeks, circular, surface effused, edge entire, initially yellowish white, orange brown to golden brown with age, reverse brown, mycelium superficial and partially immersed, branched, septate, hyaline to orange-brown, smooth-walled.

Material examined: THAILAND, Chiang Rai Province, personal garden, on decaying fruits of palm tree, 18 August 2017, R.H. Perera, CR-F 12 (MFLU 18-2741), living culture MFLUCC 19-0309 and *ibid*. Mae Fah Luang University Garden, on decaying fruits of *Swietenia mahagoni* (Meliaceae), 6 September 2017, R.H. Perera, Maho 05 (MFLU 18-2771), living culture MFLUCC 19-0316.

GenBank numbers: ITS: MT215499, HIS3: MT212193, TEF1: MT212206, TUB2: MT212212 (MFLUCC 19-0309) and ITS: MT215500, LSU: MT215551, TUB2: MT212213 (MFLUCC 19-0316)

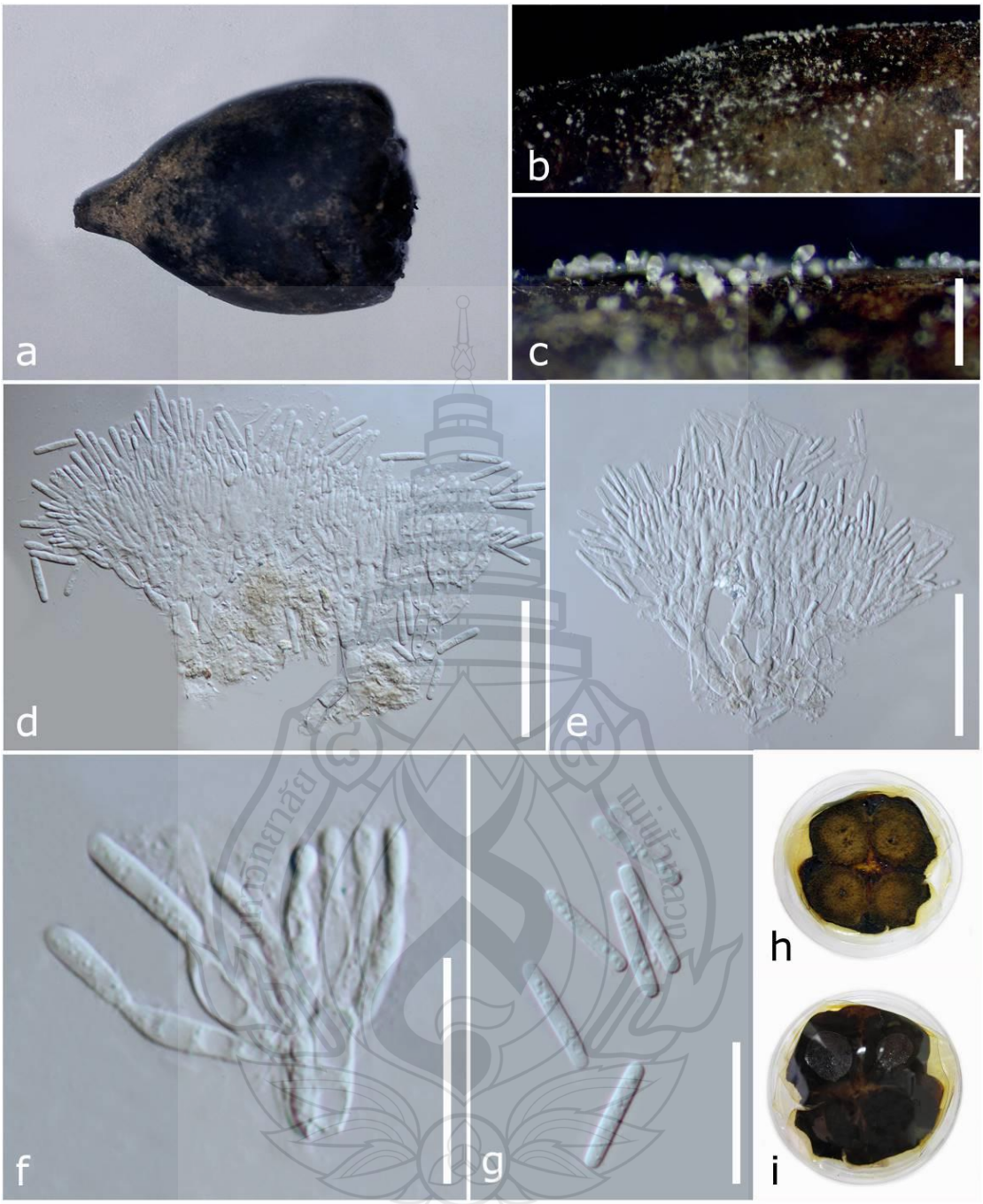
Notes: Isolates MFLUCC 19-0309 and MFLUCC 19-0316 group with ex-type of *Gliocladiopsis tenuis* (IMI 68205) and other *G. tenuis* isolates. They were identified as *Gliocladiopsis tenuis* based on morphology and phylogenetic analysis (Figure 32) (Crous and Wingfield, 1993 and Crous and Peerally, 1996). *Gliocladiopsis tenuis* MFLU 18-2771 is a new record on *Swietenia mahagoni*.

Gliocladiopsis swieteniae R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556860 and Facesoffungi number: FoF07762, Figure 6.49

Etymology: Named after the host genus *Swietenia*.

Saprobic on decaying *Swietenia mahagoni* fruits. Sexual morph: Undetermined. Asexual morph: appearing as yellowish masses on the substrate. *Conidiophores* 70–105 × 5.2–7.6 μm, penicillate without stipe extensions and terminal vesicles, very pale brown. *Conidiogenous apparatus* with several series of hyaline to very pale brown branches: primary branches 16.7–32 × 4.5–7 μm, aseptate or 1-septate and secondary branches 11.2–20 × 2.7–5 μm, aseptate, hyaline and tertiary branches 10–14 × 2.3–3.8 μm, aseptate, hyaline and quaternary branches 8.5–13 × 1.7–2 μm, rare to absent, aseptate, hyaline. *Phialides* 10.6–17 × 1.9–3.8 μm, doliiform to cymbiform, arranged in terminal whorls of 2–6 per branch, with periclinal thickening and minute collarettes. *Subverticillate conidiophores* absent. *Conidia* (12.7–)14.4–17.9(–18.3) × 1.4–2 μm ($\bar{x}$ = 16.5 × 1.8, n = 40 μm), cylindrical, hyaline, smooth, with rounded ends, straight, 1-septate, lacking a visible abscission scar.



Note (a) Herbarium material. (b, c) Conidiomata on the host. (d–f) Conidiophores with conidia. (g) Conidia. (h, i) Colony on MEA. Scale bars: b = 1 mm, c = 500 µm, d, e = 50 µm, f, g = 20 µm.

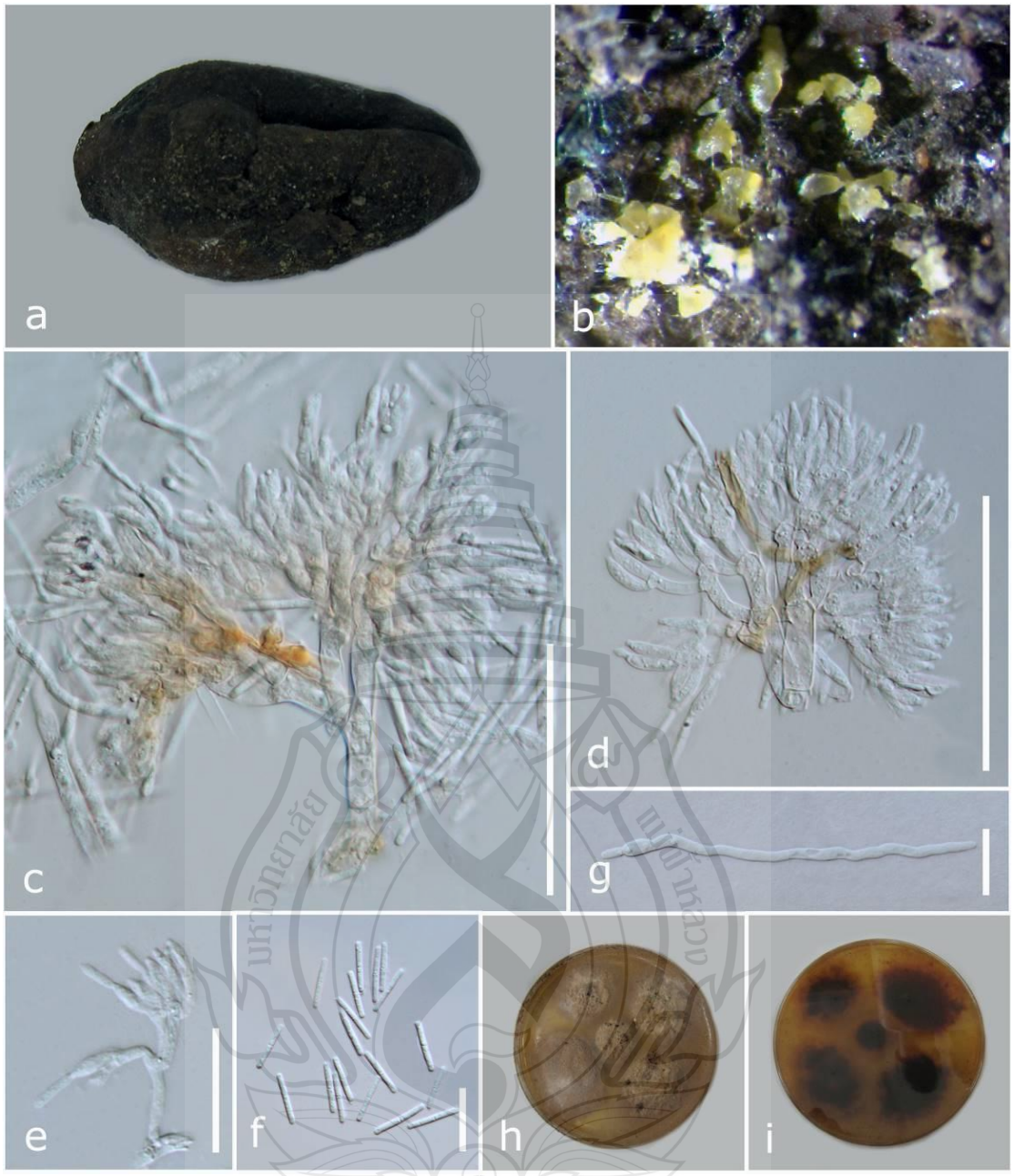
Figure 6.48 *Gliocladiopsis tenuis* (MFLU 18-2741)

Culture characteristics: Conidia germinating on PDA within 8 hours. Colonies growing on PDA reaching 30 mm within 2 weeks at 28°C, circular, with effuse surface, edge entire, aerial mycelium dense, initially white, becoming sayal brown to sepia (reverse).

Material examined: THAILAND, Chiang Rai Province, Mae Fah Luang University Garden, on decaying fruits of *Swietenia mahagoni* (Meliaceae), 20 September 17, R.H. Perera, Maho 08 (MFLU 18-2767, holotype), ex-type living culture MFLUCC 17-2616.

GenBank numbers: ITS: MT215501, HIS3: MT212194, TUB2: MT212214.

Notes: *Gliocladiopsis swieteniae* is sister to *Gliocladiopsis aquaticus* isolates (MFLUCC 17-1811, MFLUCC 17-2028 and MFLUCC 19-0317) with high support (90% MLBT, 1.0 BYPP and Figure 32). *Gliocladiopsis swieteniae* and *G. aquaticus* also share similar morphology in having yellowish sporodochia and similar conidiophore size (Hyde et al., 2018). However, *G. swieteniae* differs from *G. aquaticus* in having smaller conidia (14.4–17.9 × 1.4–2 vs. 16.5–21 × 2–3 μm) (Hyde et al., 2018). A comparison of the ITS, TUB2 and HIS3 gene regions of *G. swieteniae* and ex-type of *G. aquaticus* (MFLUCC 17-1811) reveals 1 (0.6%, 1 gap), 8 (1.3%, 0 gaps) and 13 (2.8%, 1 gap) nucleotide differences, respectively. *G. swieteniae* and *G. aquaticus* (MFLUCC 17-2028) showed 3 nucleotides differences (0.6%, 2 gaps) in the ITS region, 10 different nucleotides (1.6%, 0 gaps) in the TUB2 region and, 13 different nucleotides (2.8%, 1 gap) in the HIS3 region. *Gliocladiopsis swieteniae* and *G. aquaticus* (MFLUCC 19-0317) showed 2 nucleotides differences (0.4%, 0 gaps) in the ITS region, and 10 different nucleotides in the HIS3 (2.2%, 1 gap) region. TUB2 gene region of *G. aquaticus* (MFLUCC 19-0317) was not available for comparison. Even though morphological differences are not strongly supported, we introduce *G. swieteniae* as a novel species considering nucleotide differences in ITS, TUB2 and HIS3 gene regions.



Note (a) Herbarium material. (b) Conidiomata on the host. (c–e) Conidiophores with conidia. (f) Conidia. (g) Germinating conidium. (h, i) Colony on MEA. Scale bars: c, d = 50 µm, e–g = 20 µm.

Figure 6.49 *Gliocladiopsis swieteniae* (MFLU 18-2767, holotype)

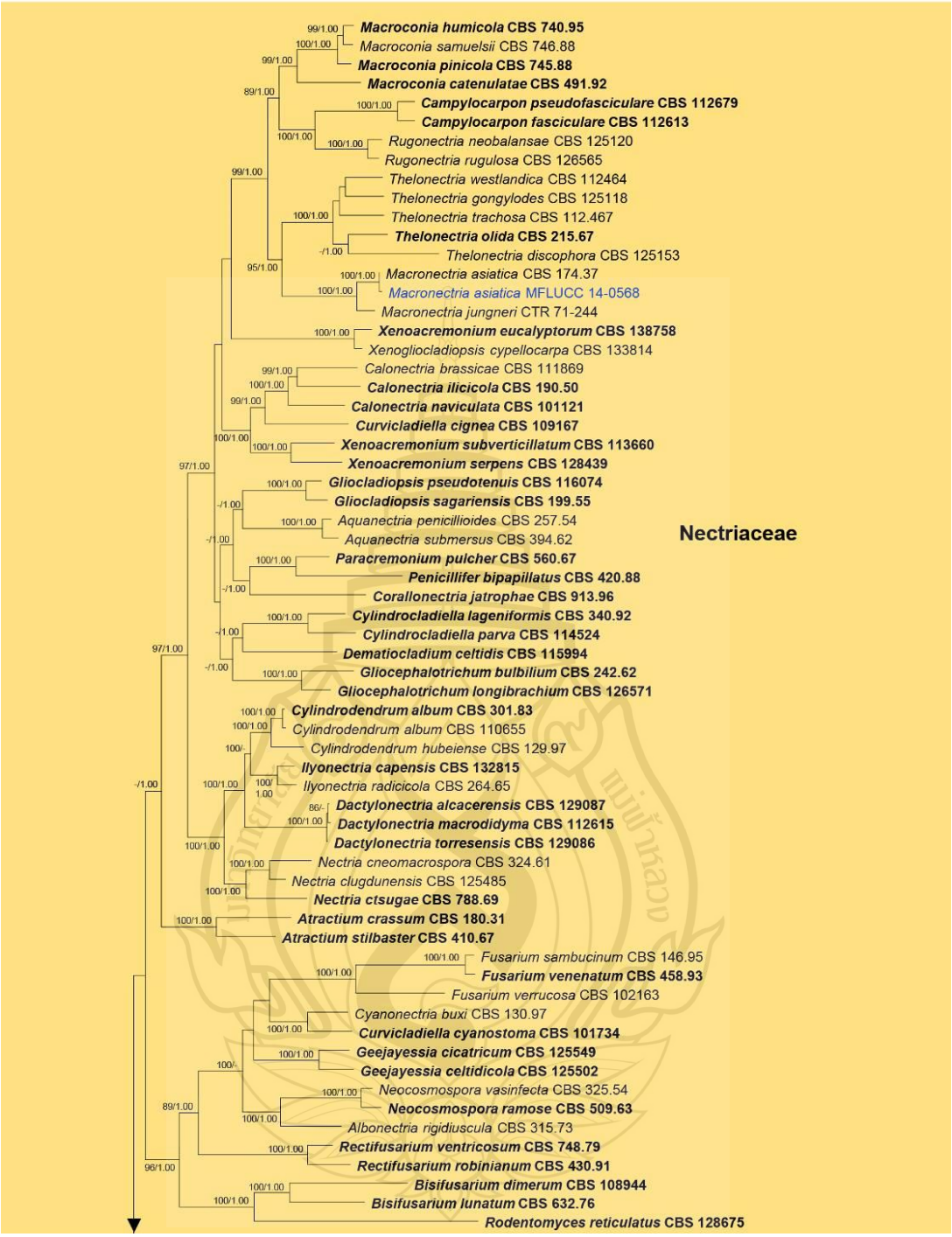
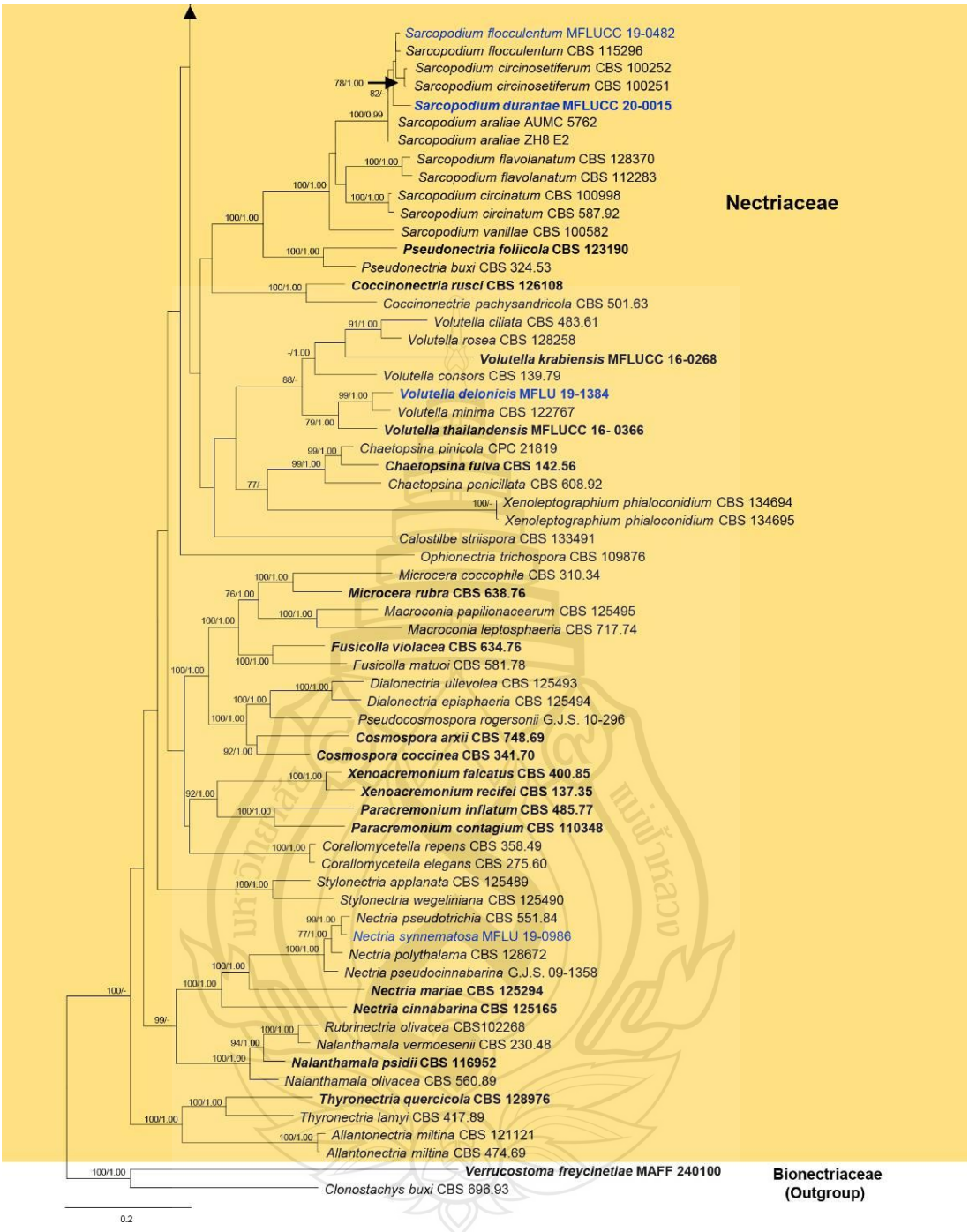


Figure 6.50 Phylogram generated from RAxML analysis based on combined LSU, ITS, RPB1, RPB2, TEF1 and TUB2 sequence data of selected Nectriaceae isolates



Note Sequences from one hundred and twenty-nine taxa, which comprise 4456 characters including gaps, are included in the analyses. The tree was rooted to *Clonostachys buxi* CBS 696.93 and *Verrucostoma freycinetiae* MAFF 240100. The scale bar indicates 0.2 nucleotide changes per site.

Figure 6.50 (continued)

Macronectria Salgado and P. Chaverri

Macronectria asiatica Salgado and Guu, in Salgado-Salazar, Rossman and Chaverri, Fungal Diversity 80: 448 (2016)

Figure 6.51

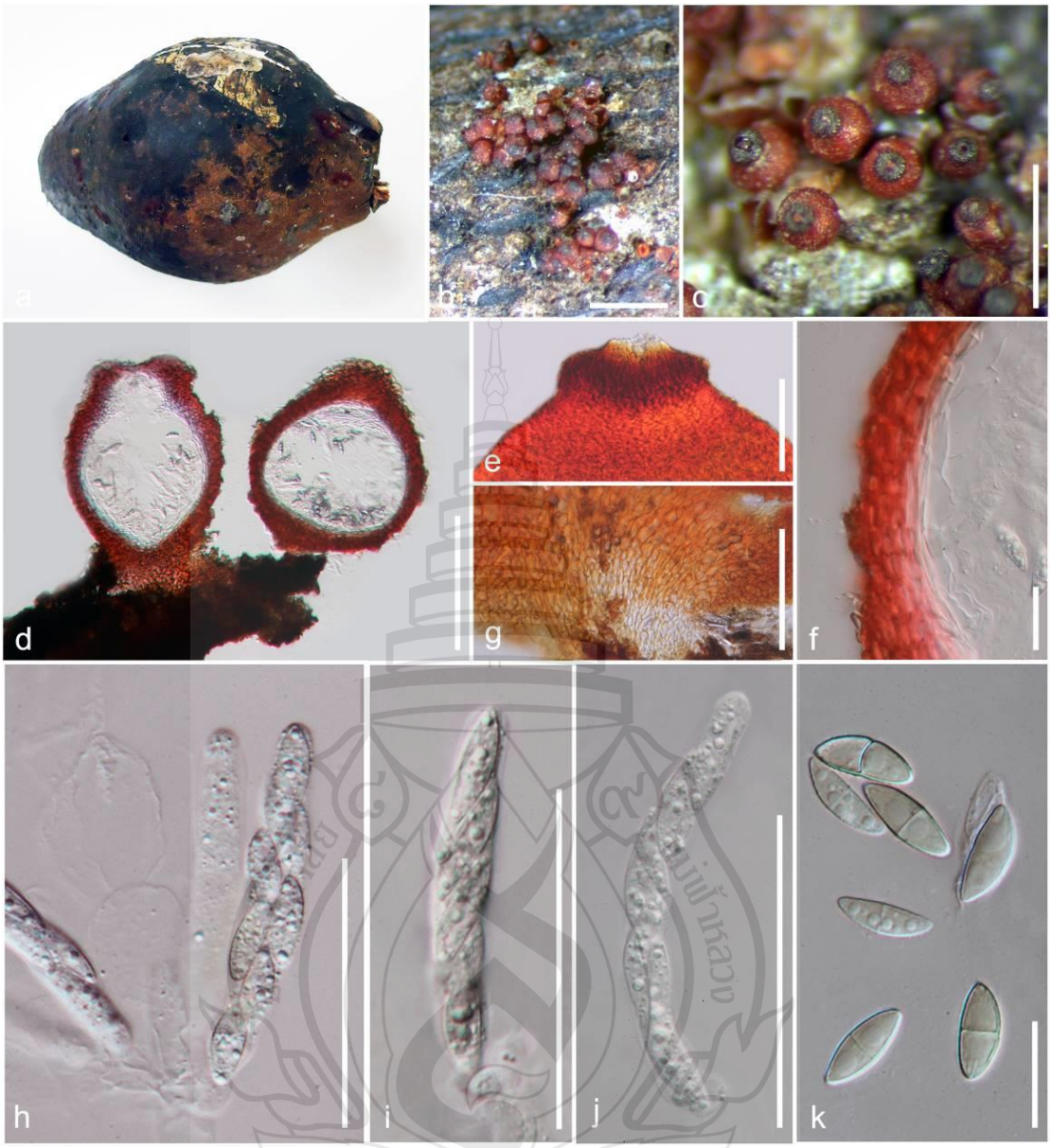
Saprobic on various plant substrates including fruits. Sexual morph: *Ascomata* 380–533 μm diam (n = 10), perithecial, gregarious in groups of many, superficial on an erumpent stroma, subglobose to pyriform, sometimes elongated and flask shaped, ostiole papillate, 128–280 μm wide, constricted below apex, not collapsing when dry, orange to sienna, with papilla same colour as perithecium, becoming dark black red when aged, red in 5% KOH, surface smooth. *Peridium* 20–40 μm, of two intergrading regions and outer region of intertwined hyphae with cells slightly elliptical, inner region of flattened fusoids cells. *Asci* 75–96 × 13–27 μm ($\overline{x}$ = 83 × 21.5 μm, n = 15), 8-spored, unitunicate, clavate, thin-walled, short pedicellate, apex simple. *Ascospores* 26–31 × 8.7–11 μm ($\overline{x}$ = 29.5 × 9.8 μm, n = 25), bi-seriate, fusiform, sometimes inequilateral, 1-septate, not constricted at septum, hyaline, striate. Asexual morph: See Salgado–Salazar et al. (2016).

Culture characteristics: Ascospores germinating on PDA within 12 hours. Colonies growing on PDA, reaching 2.6 cm in 7 days at 25°C, surface effused, smooth, margin entire to undulate, aerial mycelium rare, initially white, becoming yellowish orange, reverse yellowish, organge at centre.

Material examined: Thailand, Chiang Rai Province, Mae Fah Luang university garden, on decaying fruits of *Swietenia mahagoni* (Meliaceae), 4 August 2014, R.H. Perera, RHP 09 (MFLU 16-1050), living culture MFLUCC 14-0568.

GenBank numbers: ITS: MT215505, LSU: MT215554, SSU: MT199562, TUB2: MT212217.

Notes: We identify our new isolate as *Macronectria asiatica* and *Swietenia mahagoni* as a new host record for the fungus.



Note (a) Herbarium material. (b, c) Ascomata on host. (d) Ostiole in face view. (e) Ostiole in side view. (f) Section of ostiole. (g) Section of ascomata. (h) Section of peridium. (j) Catenophyses. (i, k, l) Asci. (m–p) Ascospores. (q) Germinating ascospore. (r, s) Colony on PDA. Scale bars: b = 1 mm, c = 500 µm, d, e = 200 µm, f = 100 µm, g, h = 200 µm, i = 20 µm, j–l = 50 µm, n–p = 10 µm, q = 20 µm.

Figure 6.51 *Macronectria asiatica* (MFLU 16-1050)

Nectria (Fr.) Fr.

Nectria synnematosa R.H. Perera, Maharachch., E.B.G. Jones and K.D. Hyde

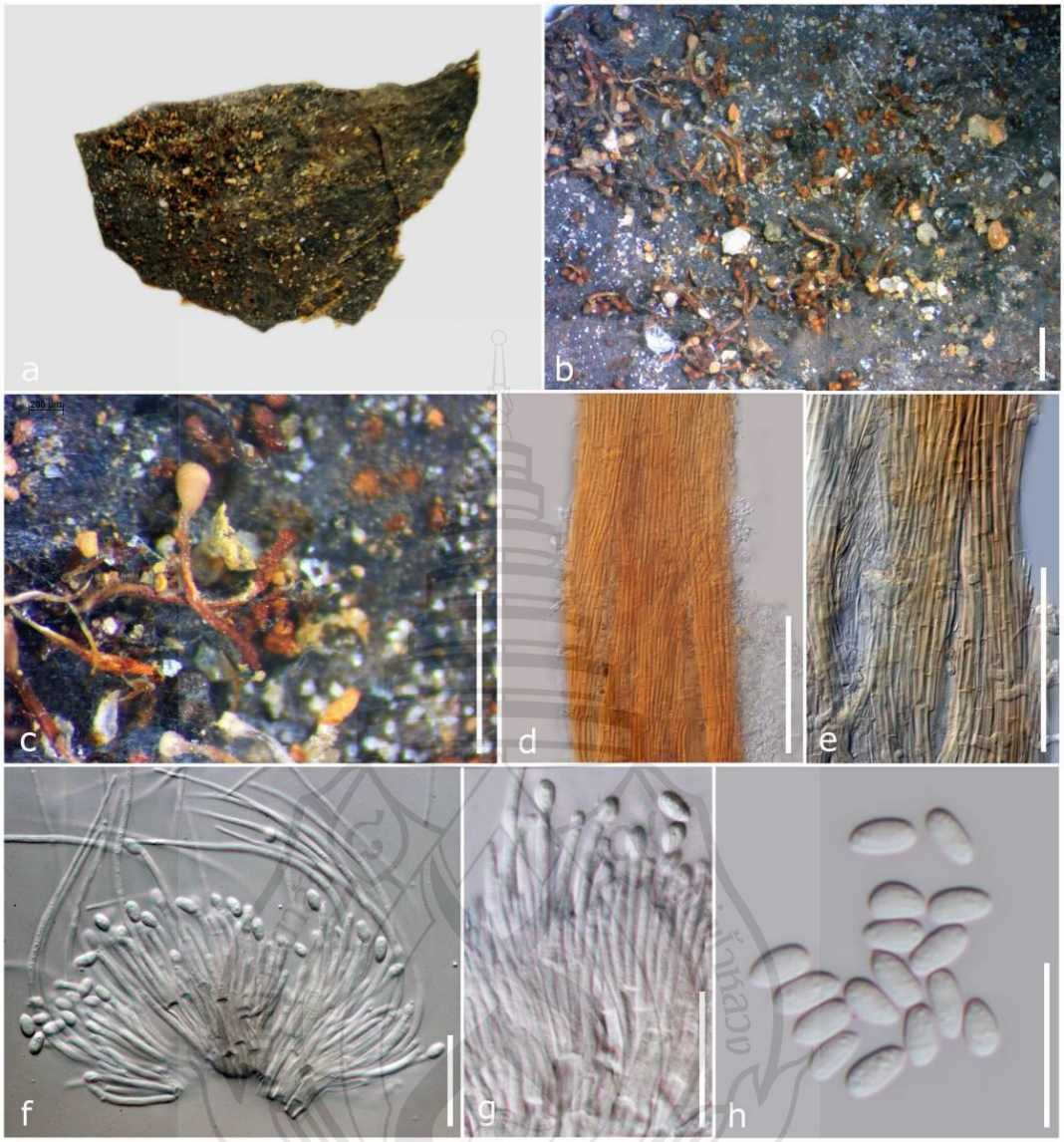
Figure 6.52

On decaying seed pods of *Delonix regia*. Sexual morph: See Hirooka et al. (2012). Asexual morph: Synnematous. *Synnemata* 1000–1800 μm high including stipe, 72–115 μm wide (n = 20), erumpent through epidermis, solitary or gregarious, caespitose, cylindrical-capitate, subulate-capitate, or claviform. *Stipe* erect or nodding, usually unbranched or rarely up to 3 branched at base, medium to slender, distinctly hispid at base to mid-level, red-brown at base, turning dark red in 5% KOH. *Hyphae on stipe* 3.4–4.5 μm wide, hyphae pigmented orange brown at base, becoming less pigmented towards apex, KOH+. *Ornamental hyphae on stipe* 6–17 μm long, 2.2–4.5 μm wide (n = 16), cylindrical, straight, curved, sinuous or twisted, arising laterally at more or less right angles, distributed evenly over surface of synnemata, usually unbranched but occasionally dichotomously branched, aseptate. *Conidiophores* with sterile hyphae monoverticillate or biverticillate. *Conidiogenous cells* 16–22 × 1.4–1.8 μm (n = 20), enteroblastic, monophialidic, cylindrical to subulate, straight or curved, with periclinal thickening, collarette not conspicuous. *Sterile hyphae* 68–88 × 1.5–1.9 μm (n = 16), mixed with phialides, acicular, usually curved or sometimes straight, unbranched or dichotomously branched, often in groups of 1–3. *Conidial masses* 140–285 μm wide, globose, hemispherical or more-or-less discoid, whitish yellow to sienna. *Conidia* 3.1–4.5 × 1.6–2.2 μm ($\bar{x}$ = 3.9 × 2 μm, n = 55), ellipsoidal, obovate or oblong, aseptate, multi-guttulate, hyaline, smooth-walled.

Material examined: THAILAND, Chiang Mai Province, on decaying seed pods of *Delonix regia* (Fabaceae), 1 September 2016, R.H. Perera, S-16 (MFLU 19-0986).

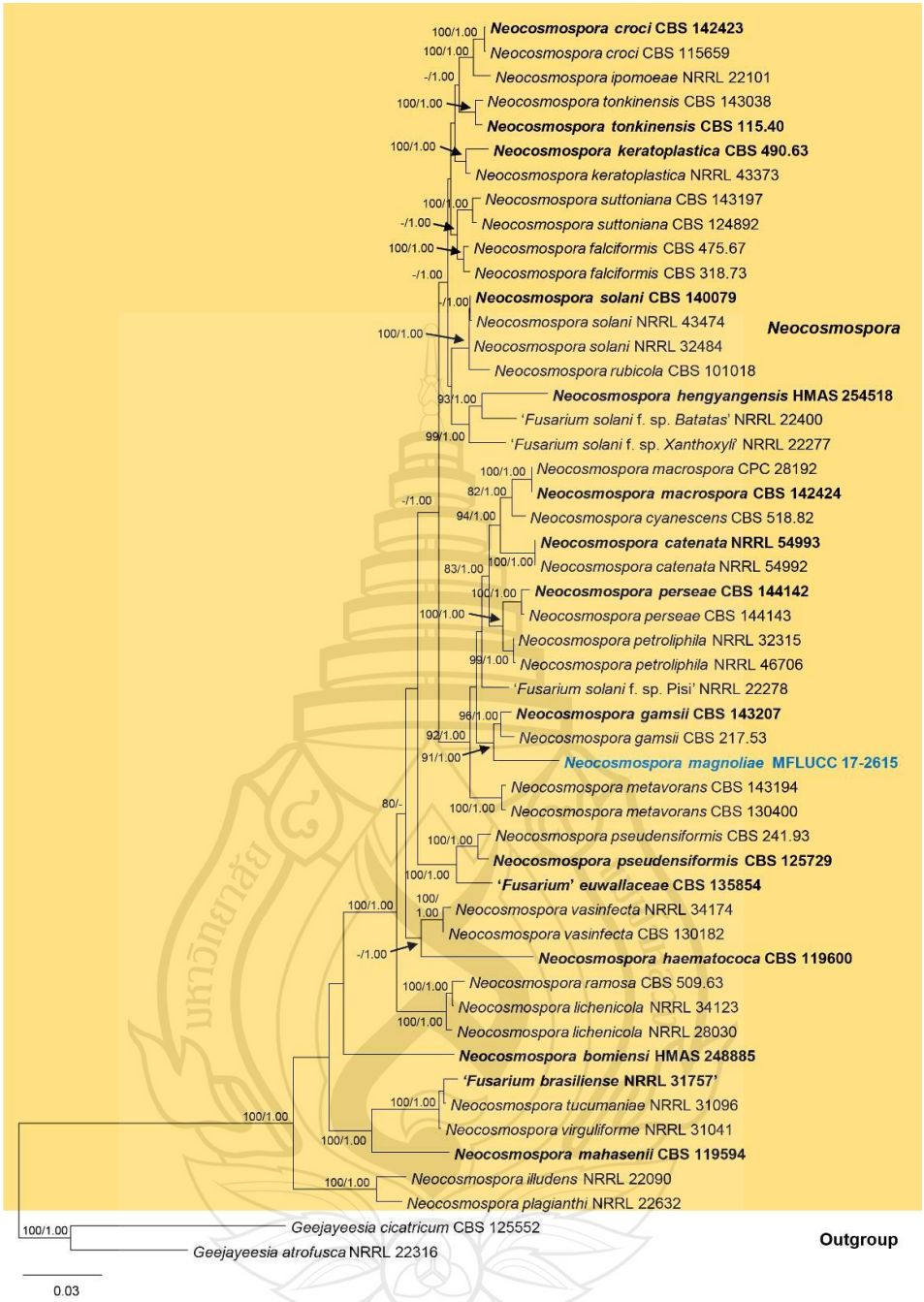
GenBank numbers: ITS: MT215506, LSU: MT215555, TUB2: MT212218.

Notes: DNA was directly extracted from fruiting bodies of this fungus. This collection represents *Delonix regia* as a new host record for *Nectria synnematosa*.



Note (a) Herbarium material. (b, c) Synnemata on host. (d) Stipe with ornamental hyphae on stipe. (e) Stipe hyphal strands. (f) Sterile hyphae and conidiophores. (g) Conidiophores with conidia. (h) Conidia. Scale bars: b, c = 1 mm, d, e = 100 µm, f, g = 20 µm, h = 10 µm.

Figure 6.52 *Nectria synnematosa* (MFLU 19-0986)



Note Sequences from fifty-one taxa, which comprise 3425 characters including gaps, are included in the analyses. The tree was rooted to *Geejayeesia atrofusca* NRRL 22316 and *Geejayeesia cicatricum* CBS 125552. The scale bar indicates 0.03 nucleotide changes per site.

Figure 6.53 Phylogram generated from RAxML analysis based on combined LSU, ITS, TEF1 and RPB2 sequence data of *Neocosmospora* isolates

Neocosmospora E.F. Sm.

Neocosmospora magnoliae R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556861 and Facesoffungi number: FoF07764, Figure 6.54

Etymology: Named after the host genus *Magnolia*.

Associated with dried fruits of *Magnolia champaca*. **Sexual morph:** *Ascomata* 200–250 × 180–220 µm and perithecial, astromatic, solitary or gregarious, superficial, globose to pyriform, orange to orange brown, glabrous, coarsely warted, warts 23–45 µm diam, 10–50 µm tall, ostiolate. *Ostiole* non-papillate, canal periphysate. *Peridium* 15–38 µm diam., inner region 1–2 layers of hyaline, flattened cells of *textura angularis* and outer region composed of 3–5 layers of orange brown, thick-walled cells of *textura angularis* and in face view a *textura angularis* of thick-walled, medium to dark brown cells. *Hamathecium* of hyaline, distinctly septate catenophyses, 14–20 µm wide. *Asci* 55–76 × 9.8–13 µm ($\bar{x}$ = 67 × 11 µm, n = 25), 8-spored, unitunicate, clavate, short-pedicellate, with a broad flattened apex, with a minute apical apparatus, J-. *Ascospores* (5–)8.3–11.7 × 4.5–5.8 µm ($\bar{x}$ = 10 × 5 µm, n = 30), obliquely uniseriate or irregularly biseriate, broadly ellipsoid to obovoid or subfusiform, 1-septate, not constricted at the septum, 2 or 4 guttulate, hyaline to pale yellow-brown, thick-walled, finely striate when mature. **Asexual morph:** Undetermined.

Culture characteristics: Ascospores germinating on PDA within 12 hours. Colonies growing on PDA, reaching up to 2.6 cm within 7 days at 28°C, surface effused, smooth, margin entire, aerial mycelium rare, initially white, turning rosy pink, reverse rosy pink.

Material examined: THAILAND, Chiang Rai Province, Mae Fah Luang University garden, dried fruits of *Magnolia champaca* (Magnoliaceae) on the ground, 07 September 2017, R.H. Perera, MAG 01 (MFLU 18-2748, holotype), ex-type living culture MFLUCC 17-2615.

GenBank numbers: ITS: MT215508, LSU: MT215557, RPB2: MT212200, TEF1: MT212207.

Notes: Our new isolate (MFLUCC 17-2615) grouped sister to two isolates of *Neocosmospora gamsii*, CBS 143207 and CBS 217.53 with moderate bootstrap support (91% and Figure 5.53). Our isolate and ex-type *N. gamsii* (CBS 143207) showed 4

nucleotide differences (0.7%, no gaps) in the ITS region, 12 nucleotide differences (1.8%, 2 gaps) in the TEF1 region, and 36 different nucleotides (7.3%, no gaps) in the RPB2 region, while their LSU sequences were identical. Our isolate and *N. gamsii* strain (CBS 217.53) showed 18 nucleotide differences (3.4%, 4 gaps) in the ITS region, 8 nucleotide differences (1.2%, no gaps) in the TEF1 region, and 36 different nucleotides (7.3%, no gaps) in the RPB2 region, while their LSU sequences were identical. *Neocosmospora magnoliae* can be distinguished from *N. gamsii* by its orange to orange brown ascomata and smaller asci (55–76 vs. 70–97.5 µm), while *N. gamsii* has orange to dark brown-red ascomata (Sandoval–Denis and Crous, 2018). Hence, based on the above-mentioned differences in morphology and molecular sequence data, a new species, *N. magnoliae* is introduced.

Sarcopodium Ehrenb. ex Schlecht.

Sarcopodium durantae R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF557322 and Facesoffungi number: FoF07765, Figure 6.55

Etymology: Named after the host genus *Duranta*.

Saprobic on dry fruits of *Duranta erecta*. **Sexual morph:** *Ascomata* 175–210 µm high, 170–210 µm wide, perithecial, solitary or in groups, superficial on a minute stroma surrounded by white mycelium, globose to broadly obpyriform, not collapsing when dry, red, turning dark red in 5% KOH, spinulose hyphal hairs arising from the surface of the ascomatal wall, ostiole slightly papillate. *Peridium* 17–26 µm, composed of 3–5 layers of dark orange colour cells of *textura angularis*. *Hamathecium* comprising hyaline, distinctly septate catenophyses, each cell 16–25 µm long × 9–15 µm wide. *Asci* 50–75 × 7.5–10 µm ($\bar{x}$ = 61 × 8.8 µm), unitunicate, 8-spored, clavate to fusiform, short pedicellate, with an apical ring, J-. *Ascospores* 12–15 × 4–6 µm ($\bar{x}$ = 13.4 × 5 µm), uni-seriate to multi-seriate, ellipsoid to fusiform, 1-septate, slightly constricted at the septum, guttulate, hyaline to pale yellow-brown, striate. **Asexual morph:** Undetermined.

Note (a) Herbarium material. (b) Ascomata on host. (c) Section of ascoma. (d) Peridium in section. (e) Peridium in face view. (f–h) Asci. (i–n) Ascospores. (o) Germinating ascospore. (p, q) Colony on PDA. Scale bars: b, c = 100 µm, d = 50 µm, e = 20 µm, f–h = 50 µm, i–n = 10 µm, o = 20 µm.

Figure 6.54 *Neocosmospora magnoliae* (MFLU 18-2748, holotype)

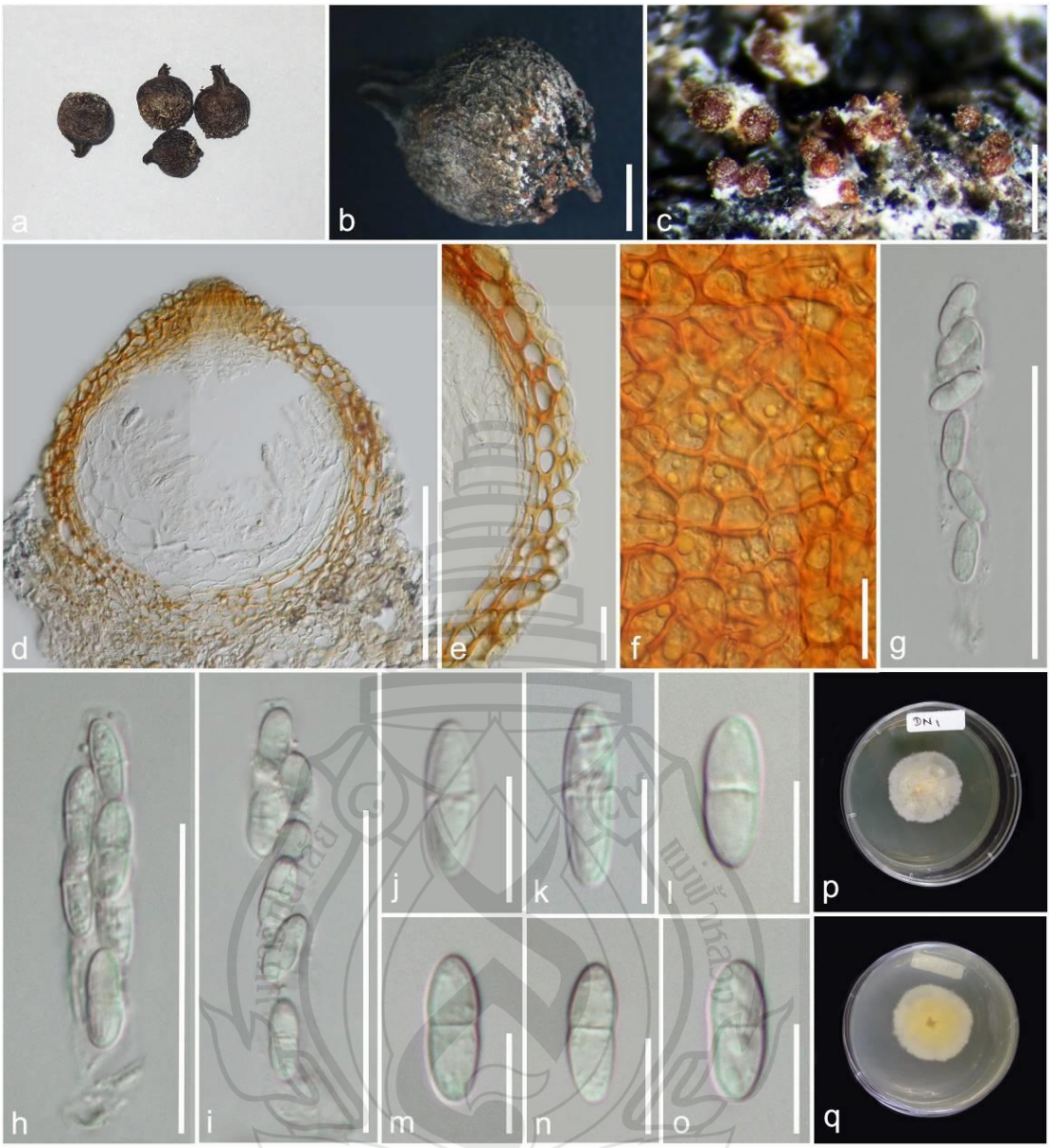
Culture characteristics: Ascospores germinating on PDA within 12 hours. Colonies growing on PDA reaching 4 cm in 7 days at 28°C, surface effused, smooth,

margin entire, aerial mycelium rare, initially white, becoming pale yellowish orange, reverse yellowish, organge at centre.

Material examined: Thailand, Chiang Rai Province, on dried fruits of *Duranta erecta* L. (Verbenaceae), 25 November 2018, D. Sandaruwan, DN1 (MFLU 18-2719, holotype), ex-type living culture MFLUCC 20-0015.

GenBank numbers: ITS: MT386004, LSU: MT386007, TEF1: MT383671, TUB2: MT383672.

Notes: *Sarcopodium durantae* (MFLUCC 20-0015) groups with *Sarcopodium* species, forming an unsupported clade (Figure 6.50). Our isolate and ex-type *S. flocculentum* (CBS 115296) showed 7 different nucleotides (3%, 2 gaps) in the TEF1 region, 8 different nucleotides (1%, 1 gap) in the TUB2 region. A comparison of the TUB2 and TEF1 gene regions of *S. durantae* (MFLUCC 20-0015) and *S. circinosetiferum* (CBS 100251) reveals 20 (3%, 6 gaps) and 16 (6%, 2 gaps) nucleotide differences, respectively. Our new isolate and *S. flocculentum* (CBS 115296) showed 7 different nucleotides (3%, 2 gaps) in the TEF1 region, 8 different nucleotides (1%, 1 gap) in the TUB2 region. A comparison of the TUB2 and TEF1 gene regions of *S. durantae* and *S. flocculenta* (MAFF 241413) reveals 9 (2%, 1 gap) and 14 (7%, 4 gaps) nucleotide differences, respectively. *Sarcopodium mammiforme* and *S. raripilum* do not have DNA sequence data in the GenBank for the comparison. *Sarcopodium durantae* can be distinguished from *S. flocculentum* by smaller ascomata (175–210 × 170–210 vs. 224–314 × 215–293 μm) and larger ascospores (12–15 × 4–6 vs. 10–13 × 3–4.5 μm) (Rossman et al., 1999). *Sarcopodium durantae* differs from *S. mammiforme* by having smaller ascomata (175–210 × 170–210 vs. 300–700 μm) and smaller ascospores (12–15 × 4–6 vs. 24–30 × 7–9 μm) (Rossman et al., 1999). *Sarcopodium durantae* has smaller ascospores when compared to *S. raripilum* (12–15 × 4–6 vs. 27.5–32 × 6.5–8 μm) (Rossman et al., 1999). *Sarcopodium durantae* differs from *S. oblongisporum* in having larger asci (50–75 × 7.5–10 vs. 43–59 × 6–7.6 μm) and ascospores (12–15 × 4–6 vs. 9.5–12.2 × 2.2–3.9 μm) (Nong and Zhuang, 2005). Based on these morphological differences, a new species, *S. durantae* is introduced in the genus *Sarcopodium*.



Note (a) Herbarium material. (b, c) Ascomata on host. (d) Section of ascoma. (e) Section of the peridium. (f) Peridium in face view. (g–i) Asci. (j–o) Ascospores, (p, q) Colony on PDA. Scale bars: b = 2 mm, c = 500 µm, d = 100 µm, e, f = 20 µm, g–i = 50 µm, j–o = 10 µm.

Figure 6.55 *Sarcopodium durantae* (MFLU 18-2719, holotype)

Sarcopodium flocculentum (Henn. and E. Nyman) Pennycook and P.M. Kirk, Index Fungorum 418: 1 (2019)

Facesoffungi number: FoF07766, Figure 6.56

Associated with Fabaceae hosts and *Eucalyptus grandis*. **Sexual morph**: *Ascomata* 150–180 µm high, 135–170 µm wide, perithecial, solitary or in groups, superficial on a minute stroma, subglobose to broadly obpyriform, sometimes collapsing apically to form cups when dry, red, turning dark red in 5% KOH, spinulose hyphal hairs arising from the surface of the ascomatal wall and forming around the ascomatal base, ostiole papillate. *Peridium* 16–34 µm, composed of 2–4 layers of dark orange colour cells of *textura angularis*, thinner around ostiole, 2–12 µm wide, composed of compactly arranged, flat cells. *Hamathecium* comprising hyaline, distinctly septate catenophyses, each cell 4.1–19.4 µm long × 6.3–12 µm wide. *Asci* 35–63 × 6.2–8.3 µm ($\bar{x}$ = 50 × 7.4 µm), unitunicate, 8-spored, clavate to fusiform, short pedicellate, with apical ring, J-. *Ascospores* 7.2–12 × 3.5–4.6 µm ($\bar{x}$ = 9.3 × 3.9 µm), uni-seriate to multi-seriate, ellipsoid to fusiform, 1-septate, slightly constricted at the septum, hyaline to pale yellow-brown, striate. **Asexual morph**: See Sutton (1981).

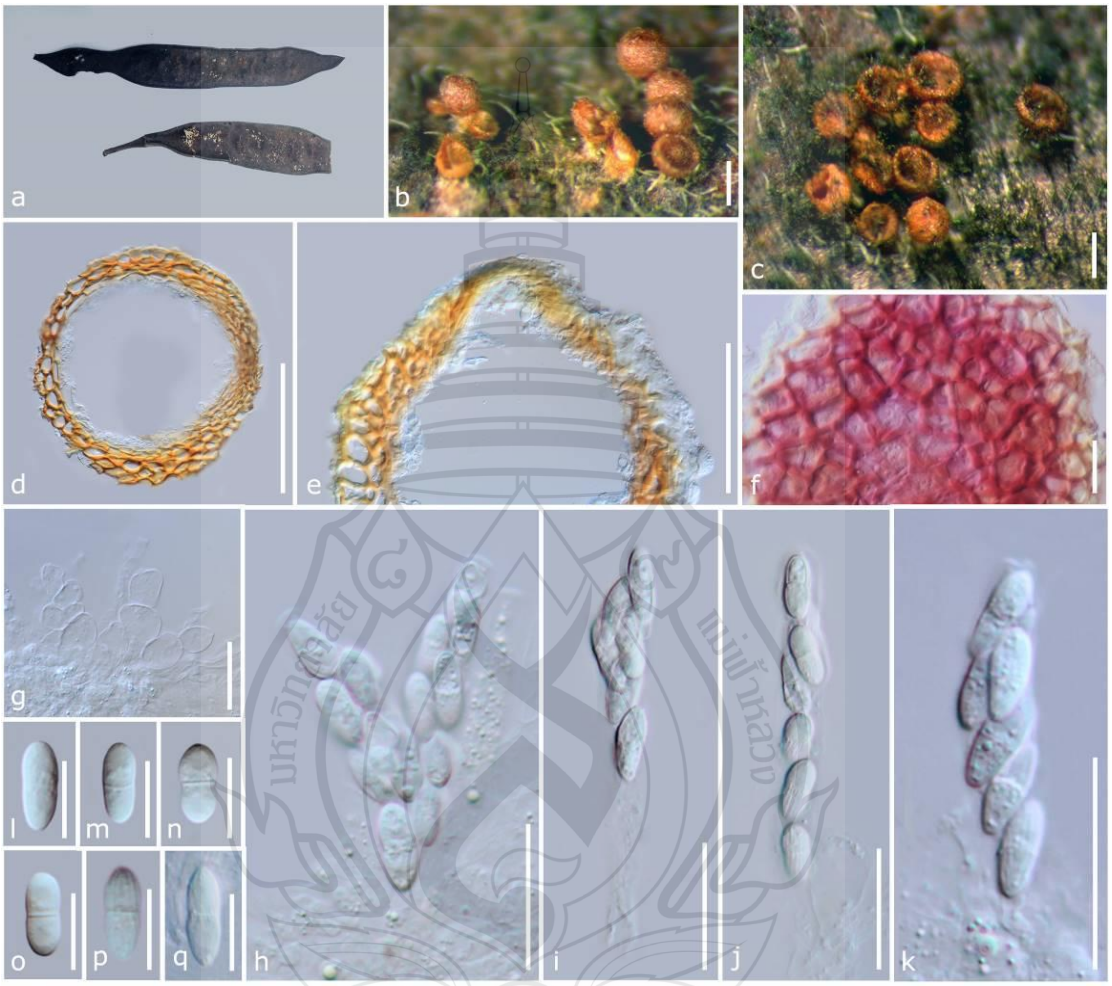
Culture characteristics: Ascospores germinating on PDA within 12 hours. Colonies growing on PDA reaching 3.8 cm in 7 days at 28°C, surface effused, smooth, margin entire, aerial mycelium rare, initially white, becoming yellowish orange, reverse brownish orange.

Material examined: Thailand, Chiang Rai Province, on dried seed pods of *Leucaena leucocephala* (Lam.) de Wit (Fabaceae), September 2017, I.D. Goonasekara, Ipil 01 (MFLU 19-0988), living culture, MFLUCC 19-0482.

GenBank numbers: ITS: MT215507, LSU: MT215556.

Notes: Our collection resembles the genus *Sarcopodium* by having red ascomata and spinulose hyphal hairs arising from the surface of the ascomatal wall and forming around the ascomatal base (Rossman et al., 1999 and Lombard et al., 2015). In our phylogenetic analysis, the new isolate (MFLUCC 19-0482) clusters with *S. flocculentum* (CBS 115296) (Figure 6.50). *Sarcopodium flocculentum* previously reported from two Fabaceae hosts (*Pongamia pinnata* and *Albizia richardiana*) and *Eucalyptus grandis* in India (Sutton 1981). Our isolate and *S. flocculentum* strain (CBS 115296) showed 1 nucleotide difference (no gaps) in the ITS region while, their LSU sequences were

identical, which indicates that they are same species (Jeewon and Hyde, 2016). However, only the asexual morph was reported for *S. flocculentum* (Sutton, 1981). We identified our collection as the sexual morph of *S. flocculentum* and *Leucaena leucocephala* as a new host record for the fungus.



Note (a) Herbarium material. (b, c) Ascomata on host. (d) Section of ascoma. (e) Section of ostiole. (f) Peridium in face view (in 5% KOH). (g) Catenophyses. (h–k) Asci. (l–q) Ascospores. Scale bars: b, c = 200 µm, d = 100 µm, e = 50 µm, f–k = 20 µm, l–q = 10 µm.

Figure 6.56 *Sarcopodium flocculentum* (MFLU 19-0988)

Volutella Tode

Volutella delonicis R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556863 and Facesoffungi number: FoF07767, Figures 6.57, 6.58

Etymology: Named after the host genus *Delonix*.

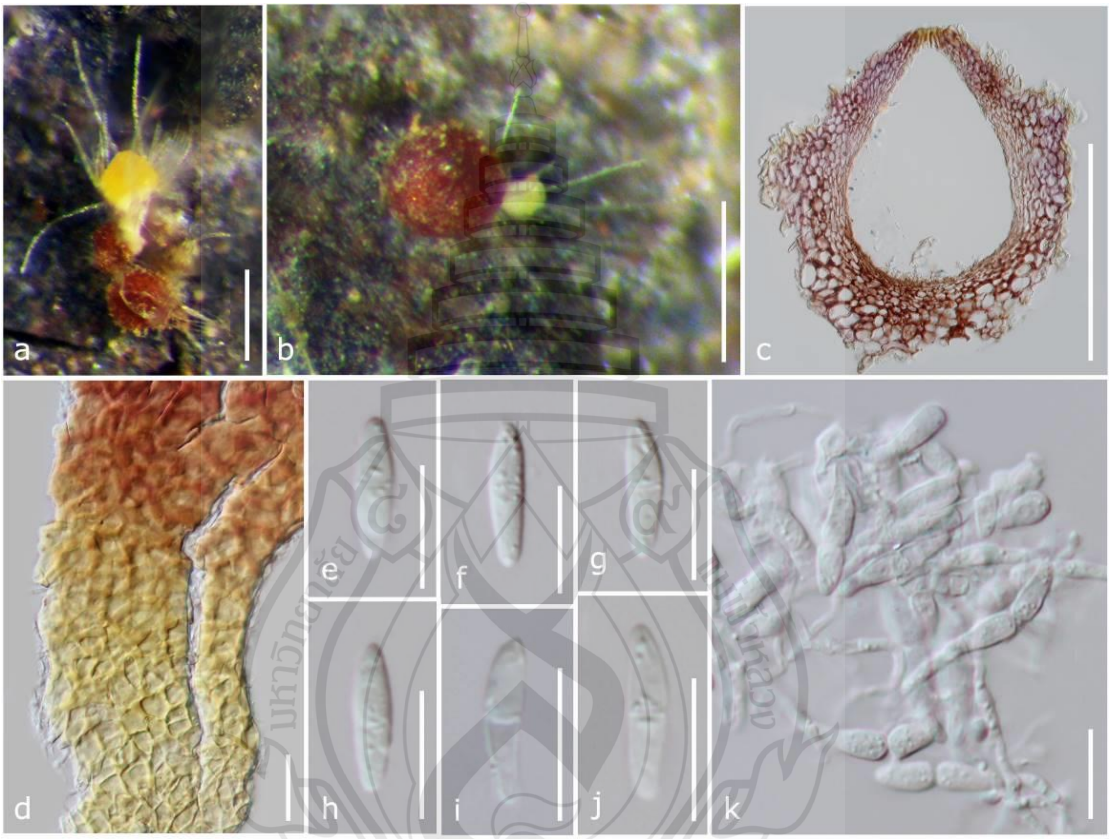
Saprobic on seed pods of *Delonix regia.* **Sexual morph**: *Ascomata* associated with conidiomata, 285–345 µm high, 260–280 µm wide (n = 6), perithecial, solitary, basal stroma inconspicuous, superficial, obpyriform to pyriform, with an acute apex, orange to red, turning dark red in 5% KOH, surface finely roughened. *Peridium* 45–82 wide, two strata, outer stratum composed of 5–9 layers of orange to red, thick-walled cells of *textura globosa* to *textura angularis* and inner stratum composed of 2–4 layers of orange to red, flat, thick-walled cells of *textura angularis* and thinner around ostiole, composed of elongated cells. *Asci* not observed. *Ascospores* 10.7–13.1 × 2.5–3.3 µm ($\bar{x}$ = 11.9 × 2.9 µm, n = 20), 1-septate, hyaline, fusiform to biconic, smooth-walled, without appendages, germinated inside the ascomata. **Asexual morph**: Hyphomycetous, sporodochial, stroma inconspicuous. *Sporodochia* sessile, yellow. *Setae* 197–318 × 4.7–8 µm ($\bar{x}$ = 258 × 6 µm, n = 10), forming around the margin of conidiomata, hyaline, aseptate, stiff, cylindrical, tapering towards the apex, apex rounded. *Conidiophores* terverticillate, branched, septate, hyaline. *Conidiogenous apparatus* with subulate, conidiogenous cells, 8–9 × 1.9–2.5 µm ($\bar{x}$ = 8.6 × 2.3 µm, n = 20), monophialidic, hyaline, with periclinal thickening, collarette prominent, up to 1.7 µm long, 1.9 µm wide. *Conidia* 5.2–7.4 × 1.1–1.5 µm ($\bar{x}$ = 6.1 × 1.3 µm, n = 30), slimy, aseptate, hyaline, oblong, smooth-walled, without mucilaginous sheath, forming yellow masses.

Material examined: Thailand, Chiang Mai Province, on decaying seed pods of *Delonix regia* (Fabaceae), 20 December 2016, R.H. Perera, Delo 02 (MFLU 19-1384, holotype).

GenBank numbers: ITS: MT215504, LSU: MT215553, RPB1: MT212196, TUB2: MT212216.

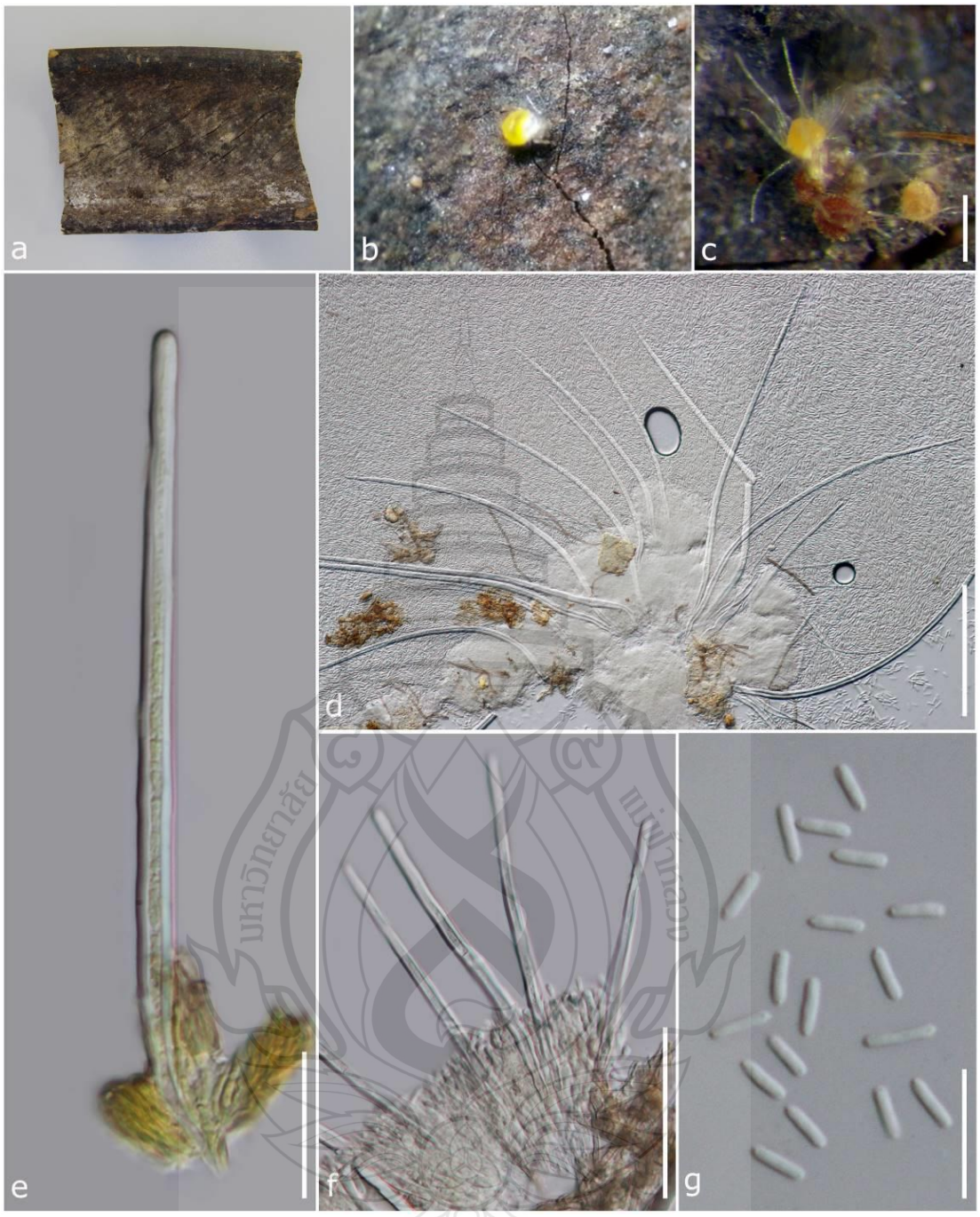
Notes: Holomorph of *Volutella delonicis* was associated with decaying seed pods of *Delonix regia*. *Volutella delonicis* has a close phylogenetic affinity to *V. minima* CBS 122767 in multi-locus phylogenetic analysis (Figure 6.50). *Volutella delonicis* has yellow sporodochia and aseptate setae, while *V. minima* produces white sporodochia and septate

setae (Höhnel 1909). Furthermore, *V. delonicis* forms larger conidia than *V. minima* (5.2–7.4 µm vs. 3–5 µm) (Höhnel, 1909). A comparison of the LSU, ITS, RPB2 and TUB2 nucleotides of these two strains reveals 8 (0.9%), 10 (1.8%), 15 (1.6%), 44 (6.2%) and 40 (7.1%) nucleotide differences respectively in each gene region, which indicates that they are distinct taxa (Jeewon and Hyde, 2016).



Note (a, b) Ascomata associated with conidiomata on host. (c) Section of ascoma. (d) Peridium in face view. (e–j) Ascospores. (k) Ascospores germinating inside the ascomata. Scale bars: a–c = 200 µm, d = 20 µm, e–k = 10 µm.

Figure 6.57 *Volutella delonicis* (MFLU 19-1384, holotype)



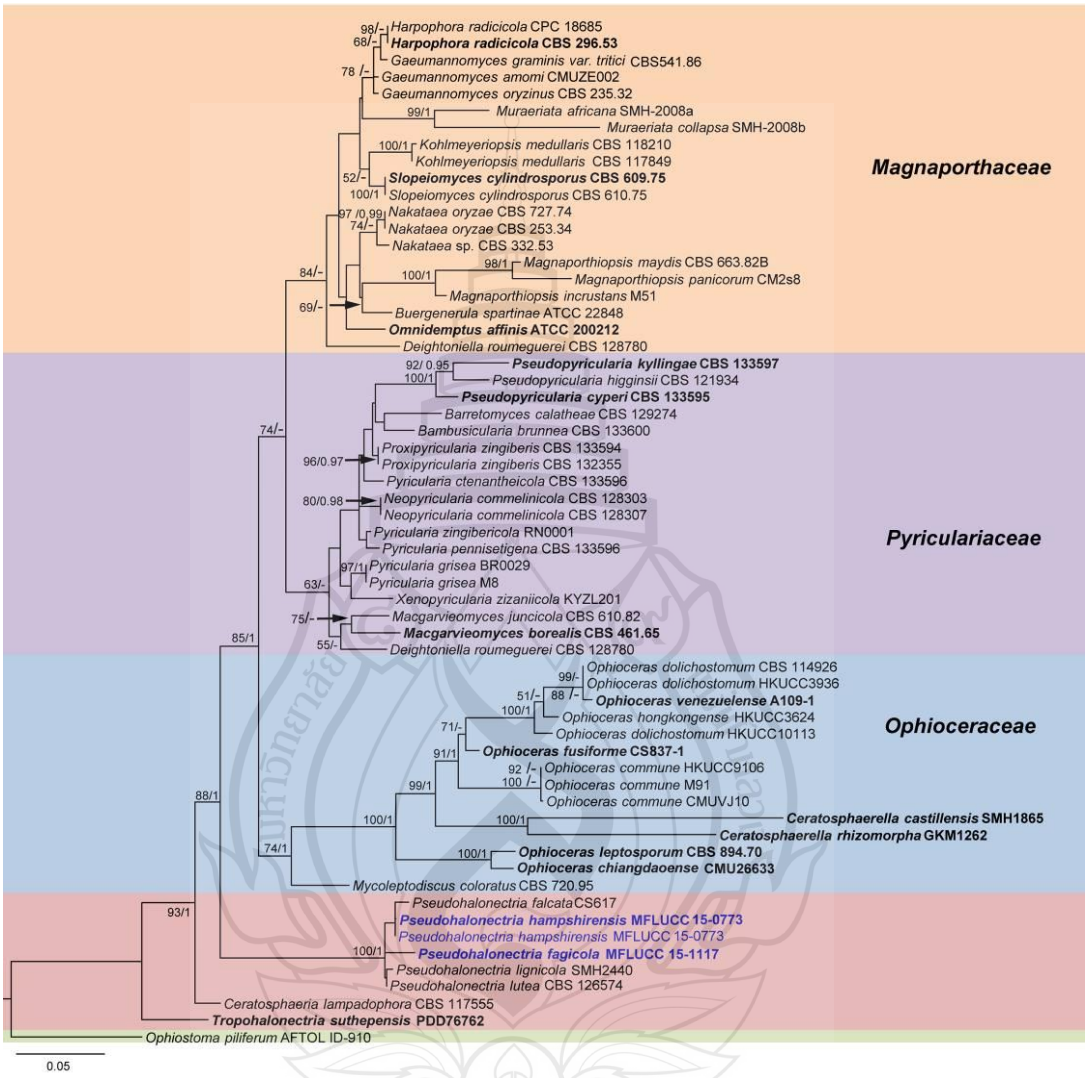
Note (a) Herbarium material. (b, c) Sporodochia (c associated with ascomata). (d) Sporodochium mounted in water. (e) Seta. (f, g) Conidiogenous apparatus. (h) Conidia. Scale bars: c = 200 µm, d = 100 µm, e = 50 µm, f, g = 20 µm, h = 10 µm.

Figure 6.58 *Volutella delonicis* (MFLU 19-1384, holotype)

Magnaporthales Thongk. et al

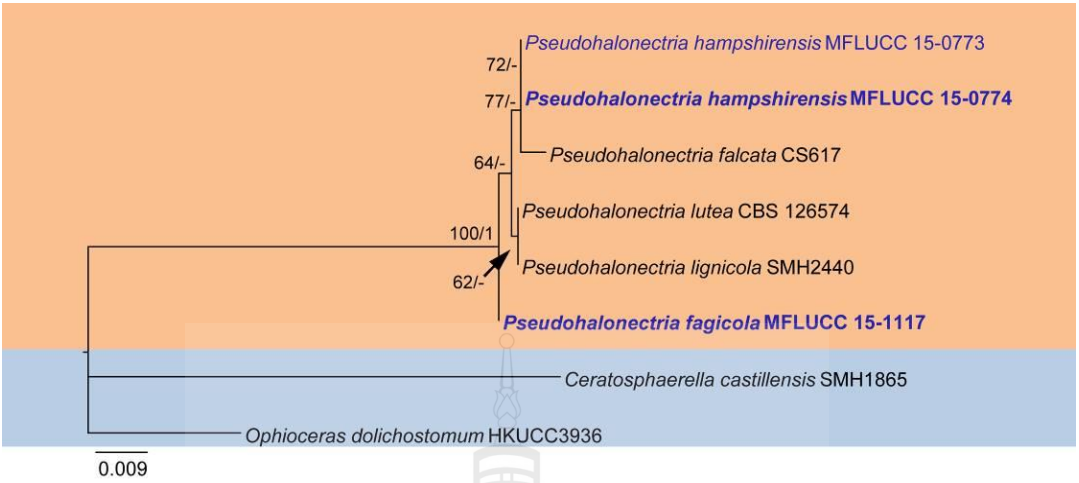
Pseudohalonectriaceae Hongsanan and K.D. Hyde

Pseudohalonectria Minoura and T. Muroi



Note Maximum likelihood bootstrap support values greater than 50% and Bayesian posterior probabilities (PP) above 95% are shown near the nodes. The new isolates are in blue and ex-type sequences in bold. The tree is rooted with Ophiostoma piliferum.

Figure 6.59 Phylogram generated from maximum likelihood analysis based on combined LSU, SSU and TEF1 sequence data



Note Maximum likelihood bootstrap support values greater than 50% and Bayesian posterior probabilities (PP) above 95% are shown near the nodes. The new isolates are in blue and ex-type sequences in bold. The tree is rooted with *Ophioceras dolichostomum* and *Ceratosphaerella castillenses.*

Figure 6.60 Phylogram generated from maximum likelihood analysis based on combined LSU and SSU sequence data of the genus *Pseudohalonectria*

Key to the species of *Pseudohalonectria*

1. Found in marine habitats, asci (4–) 8-spored..... *P. halophila*

1. Found in terrestrial or freshwater habitats, asci 8-spored.....2

2. Ascospores 0–1-septate, surrounded by a mucilaginous sheath ..... *P. miscanthicola*

2. Ascospores aseptate or multi-septate, not surrounded by a mucilaginous sheath ...3

3. Ascospores mostly longer than 85 µm.....4

3. Ascospores length less than 85 µm.....5

4. Ascospores 6–16-septate, hyaline, falcate, found in aquatic habitats..... *P. falcata*

4. Ascospores 4–8 septate, hyaline to pale yellow, filiform or sigmoid, found in terrestrial habitats.....*P. longirostrum*

5. Ascospores 0–3-septate, ascospores fusiform..... *P. hampshirensis*

5. Ascospores more than 3 septate, ellipsoidal, cylindrical, filiform or very rarely fusiform.....6

6. Neck longer than 700 µm, ascospores hyaline 7

6. Neck shorter than 700 µm, hyaline to pale orange, pale brown or pale pink 9

7. Ascomata 500–1000 µm in diameter, ascospores cylindrical.....*P. aomoriensis*

7. Ascomata within 340–560 µm in diameter, ascospores filiform 8

8. Asci longer than 120 µm, ascospores longer than 70 µm.....*P. palmicola*

8. Asci less than 80 µm, ascospores shorter than 65 µm .....*P. tayloriae*

9. Ascospores longer than 70 µm, filiform or cylindrical.....*P. eubenangeensis*

9. Ascospores mostly smaller than 70 µm, ellipsoidal, rarely cylindrical, sometimes allantoid.....10

10. Necks short (250 µm or less) .....*P. adversaria*

10 Necks long (250 µm or longer).....11

11. Ascospores 33 µm or less, asci 104 µm or less .....*P. fagicola*

11. Ascospores 34 µm or longer, asci 105 µm or longer 12

12. Asci and ascospores wide (asci 17.5 µm or longer, ascospores 7.5–12.5 µm).....*P. fuxianii*

12. Asci and ascospores thin (asci 18 µm or longer, ascospores 3.5–8.4 µm) 13

13. Ascospores consistently 5-septate, end cells lighter .....*P. lutea*

13. Ascospores 5- to 11-septate, hyaline or evenly pigmented throughout *P. lignicola*

Pseudohalonectria fagicola R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum: IF552161, Facesoffungi number: FoF02231, Figure 6.61

Etymology: In reference to the host genus Fagus, and cola meaning loving.

Saprobic on beech cupules (*Fagus sylvatica*). **Sexual morph**: *Ascomata* 275–690 × 225–500 μm, solitary to less commonly aggregated, immersed with a protruding neck, globose to depressed globose, greenish yellow at first, becoming darkened with age, rostrate. *Neck* 90–390 × 70–160 μm, conical, composed of parallel hyphae, outer hyphae outwardly directed, subglobose with enlarged ends, greenish yellow, periphysate. *Peridium* 9–32 μm wide, membranous, 5–12 cell layers, inner layer composed pale yellow cells of textura angularis, outer cells pseudoparenchymatic, composed of darkened yellow, laterally compressed cells of *textura angularis*. *Paraphyses* 62–116 × 3.1–5.6 μm, 1–4-septate, wide at base, tapering towards the apex, thin-walled, attached to ascogenous hyphae. *Asci* 83–104 × 8.8–11 μm diam. ($\bar{x}$ = 93 × 10 μm, n = 30), 8-spored, unitunicate, cylindrical, straight or sigmoidal, separating at the basal septum from ascogenous hyphae, thimble-shaped apical apparatus, J-. *Ascospores* 26–33 × 3.9–5.1 μm diam. ($\bar{x}$ = 29 × 4.4 μm, n = 30), 4–6 (–7)-septate, overlapping uniseriate to biseriate, pale brown, pink/orange in mass, ellipsoidal, straight to curved, constricted or not-constricted at the septa, after discharge accumulating in a mass at the neck opening. **Asexual morph**: Undetermined.

Culture characters: Slow growing, reaching 3 cm diam. within 21 days incubation on PDA, at 16°C, circular, effuse, with regular margin, yellowish-green in center and hyaline towards the margin from above and reverse yellow green to brown.

Material examined: UK, Hampshire, Bishops Waltham, slightly anoxic, stagnant water, on beech cupules (*Fagus sylvatica* L.), 3 June 2015, E. B. G. Jones, GJ 177b (MFLU 16-1085, holotype, *ibid*. (GZ, isotype), ex-type living culture, MFLUCC 15-1117.

GenBank numbers: LSU: KX426219, SSU: KX426223, TEF1: KX426226

Notes: *Pseudohalonectria fagicola* forms a separate clade (100% ML/PP) within the genus *Pseudohalonectria* as a sister taxon (Figure 6.59, 6.60) and shares some common characteristics, but differs in that it generally has smaller asci and ascospores. In *P. lignicola* asci (90–132 × 11–17.54 μm) and ascospores (38.4–74.8 × 3.5–6.5 μm) are larger. *Pseudohalonectria fagicola* is characterized by ellipsoidal 5–6(–7)-septate ascospores, while *P. lignicola* has 5–11 septa and cylindrical ascospores (Shearer, 1989). Although the shape of the ascospores of *P. fagicola* is similar to *P. lutea*, they are smaller than ascospores of *P. lutea* (48–68 × 4.8–8.4 μm) (Shearer, 1989). *Pseudohalonectria*

fagicola differs from *P. hampshirensis* in its smaller ascomata. *Pseudohalonectria hampshirensis* has 0–3–4-septate, fusiform ascospores, while *P. fagicola* has 5–6(–7), ellipsoidal ascospores. Morphologically *P. fagicola* differs from other *Pseudohalonectria* species in the size of its ascomata, asci, ascospores and ascospore septation.

Pseudohalonectria hampshirensis R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum: IF552162, Facesoffungi number: FoF02232, Figure 6.62

Etymology: Refers to the county, Hampshire where the holotype was collected.

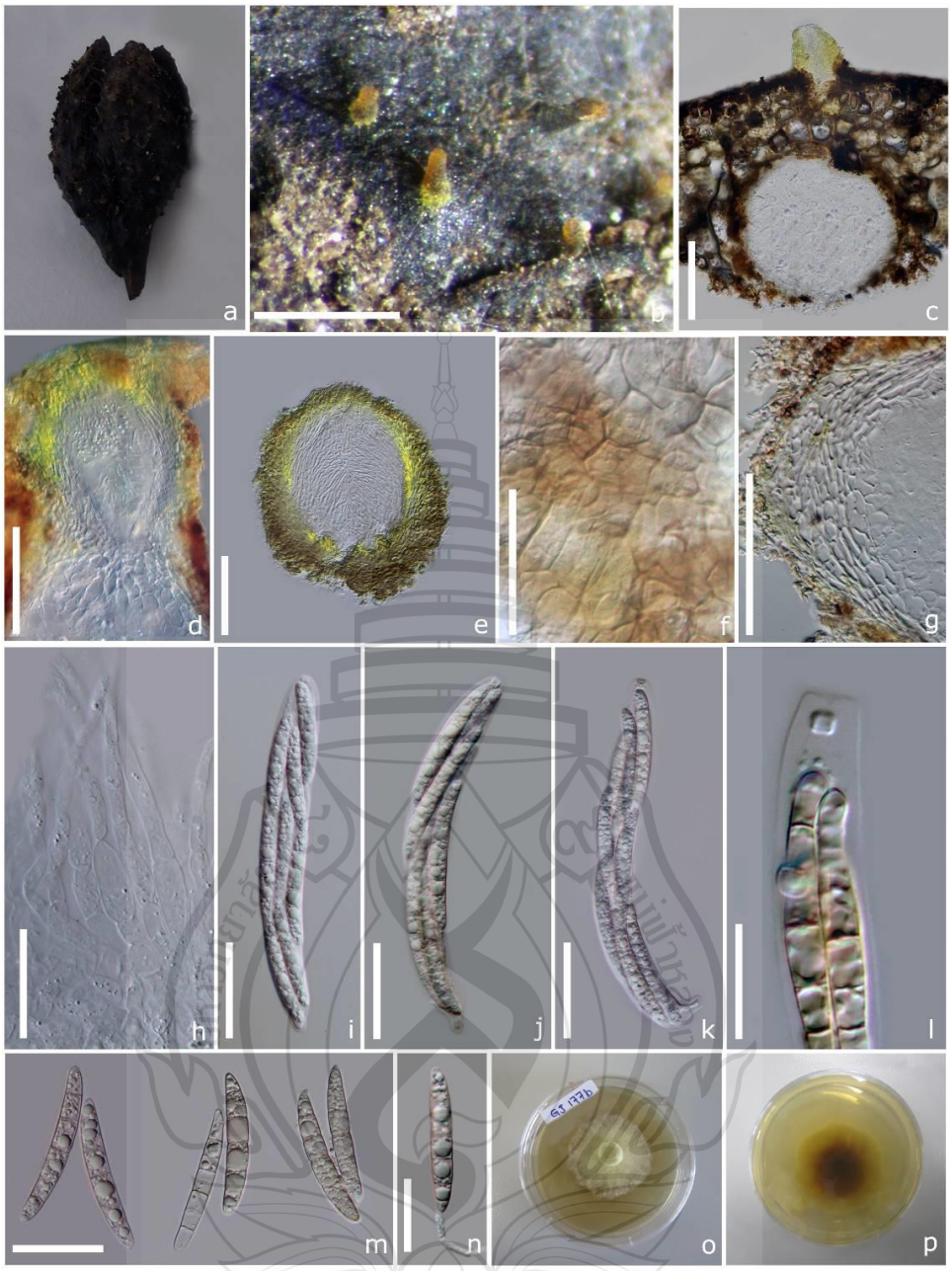
Saprobic on beech cupules (*Fagus sylvatica* L.). **Sexual morph**: *Ascomata* 360–800 × 350–720 μm, solitary to less commonly aggregated, immersed with a long neck, globose to depressed globose, greenish yellow at first, becoming darkened with age. Neck 311 –632 × 53–192 μm, long, cylindrical to conical, composed of parallel hyphae, outer hyphae outwardly directed, subglobose with enlarged ends, greenish yellow, periphysate. *Peridium* membranous, comprising 6–10 cell layers, inner layers composed of pale yellow cells of textura angularis, outer layer composed of darkened yellow compressed cells of textura angularis. *Paraphyses* 40–95 × 5.1–9.3 μm, 1–4(–5)-septate, wide at the base, tapering towards the apex, thin-walled, attached to ascogenous hyphae. *Asci* 143–196 × 16–24 μm diam. ($\bar{x}$ = 196 × 24 μm, n = 30), 8-spored, unitunicate, cylindrical, straight or curved, with J-, thimble-shaped, apical ring, separating at the basal septum from ascogenous hyphae. *Ascospores* 29–57 × 7–14 ($\bar{x}$ = 45 × 11, n = 30) μm, overlapping uniseriate to biseriate, pale brown, long ellipsoidal with bluntly rounded ends, straight, 0–3 (–4)-septate, constricted or not-constricted at the septa, after discharge accumulating in a mass at the neck opening. **Asexual morph**: Undetermined.

Culture characters: Slow growing, reaching 2.7 cm within 21 days on PDA, at 16 °C, circular, effuse, with regular margin, yellowish-green in center and hyaline towards the margin from above and reverse yellow green to brown.

Material examined: UK, Hampshire, Bishops Waltham, slightly anoxic, stagnant water, on beech cupules (*Fagus sylvatica* L.), 3 June 2015, E.B.G. Jones, GJ 177 (MFLU 16-1086, holotype) and *ibid*. (GZ, isotype) and ex-type living cultures MFLUCC 15-0774 and UK, Hampshire, Bishops Waltham, slightly anoxic, stagnant water, embedded in unidentified decaying wood, 3 June 2015, E.B.G. Jones, GJ 168 (MFLU 16-1077, paratype), ex-paratype living culture MFLUCC 15-0773.

GenBank numbers: LSU: KX426218, SSU: KX426221, TEF1: KX426224 (MFLUCC 15-0774), LSU: KX426220, SSU: KX426222, TEF1: KX426225 (MFLUCC 15-0773)

Notes: *Pseudohalonectria hampshirensis* is a distinct species in the genus as supported by molecular and morphological characters. In the phylogenetic analysis, *P. hampshirensis* grouped with *P. falcata* (Figures 6.59, 6.60). However, morphologically *P. hampshirensis* is different from *P. falcata*. Ascomata of *P. falcata* are smaller (277–535 μm) than *P. hampshirensis* (360–800 × 350–720 μm). Ascospores of *P. hampshirensis* are shorter (29–57 × 7–14 μm), fusiform and 0–3 (–4) septate, while *P. falcata* has longer (97–166 × 4.2–7.2 μm), falcate, 6–16-septate ascospores (Shearer, 1989). Morphologically *P. hampshirensis* differs from other *Pseudohalonectria* species in the size of the ascomata, asci, ascospores and ascospore septation (Table 6.2).



Note (a, b) Appearance of ascomata on host substrate. (c) Longitudinal section through ascoma. (d, e) Close up of the ostiole with periphyses. (f) Peridium in surface view. (g) Peridium. (h) Paraphyses. (i–k) Immature and mature asci. (l) Ascus in Melzer's reagent. (m) Ascospores. (n) Germinating ascospore. (o, p) Cultures on MEA. Bars: b = 500 μm, c = 200 μm, d, e = 50 μm, f = 20 μm, g = 50 μm, h–k = 20 μm and l = 10 μm, m, n = 20 μm.

Figure 6.61 *Pseudohalonectria fagicola* (MFLU 16-1085, holotype)

Microascales Luttr. ex Benny and R.K. Benj.

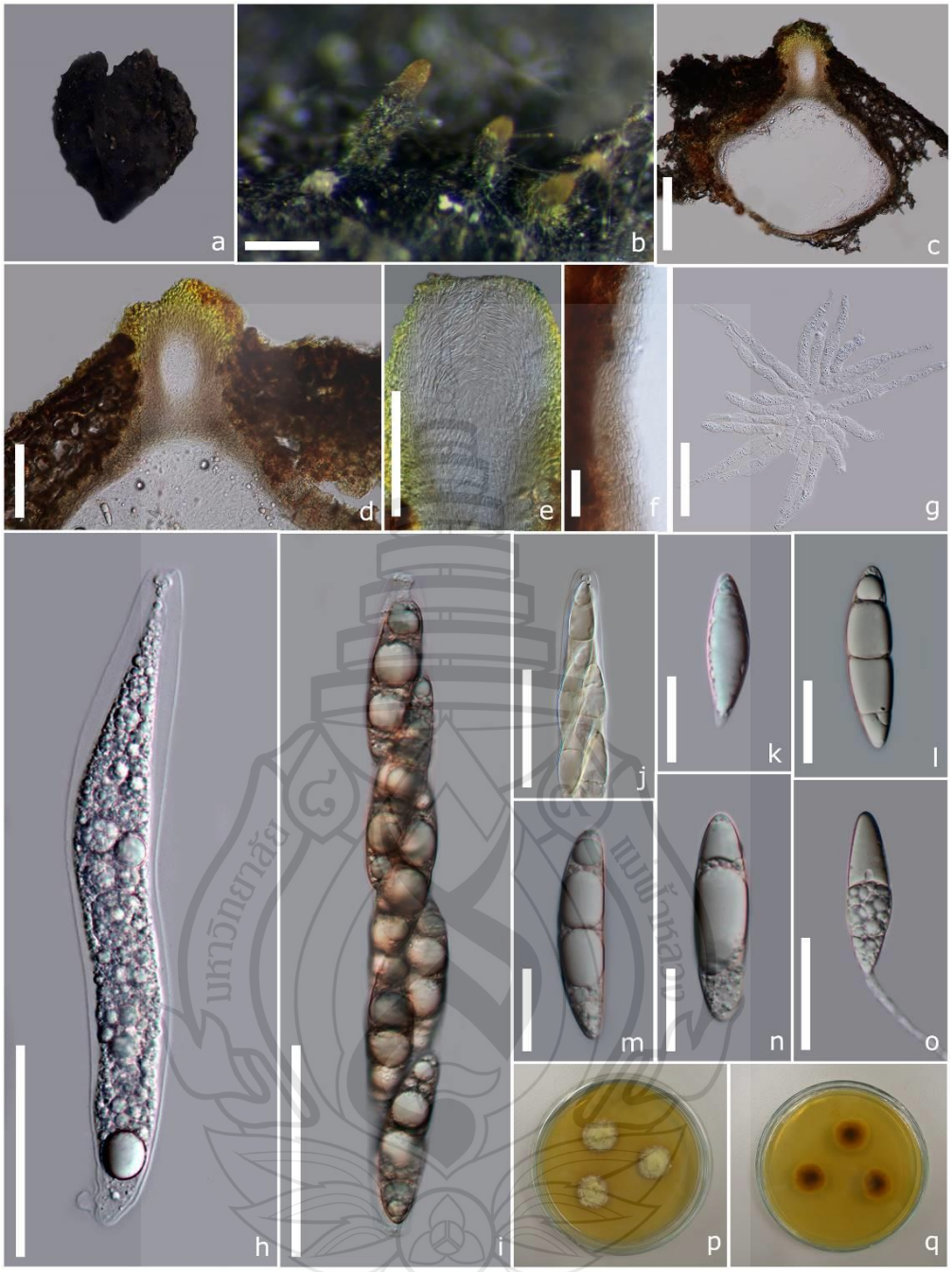
Microascaceae Luttr. ex Malloch

Parascedosporium Gilgado, Gené, Cano and Guarro

Parascedosporium putredinis (Corda) Lackner and de Hoog

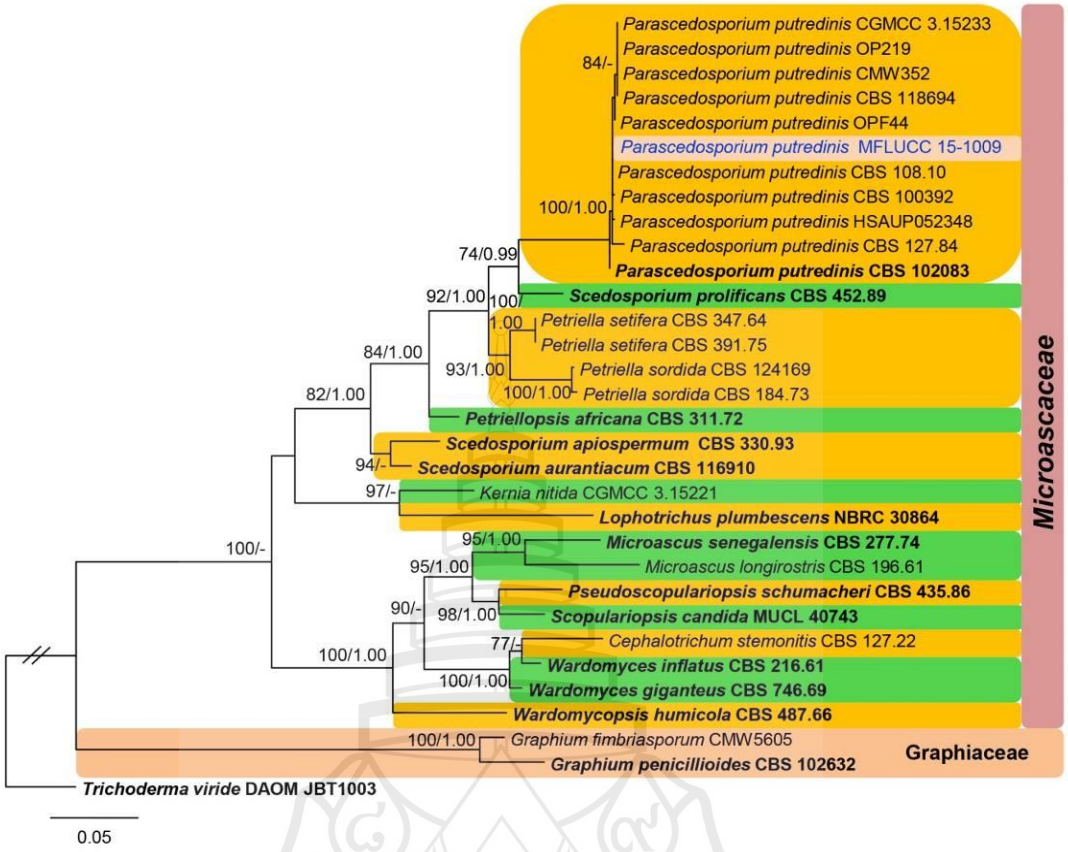
Facesoffungi number: FoF04482, Figures 6.64, 6.65, 6.66

Saprobic or *pathogenic* on plant material, or isolated from soil and dung. **Sexual morph:** Undetermined. **Asexual morph from the natural substrate:** *Conidiomata* graphium-like synnema. *Synnemata* 707–851 µm tall, erect, with a cylindrical stipe. *Stipe* 8–14 µm wide, olivaceous grey, smooth-walled, terminating in a slimy head of conidia, appearing as a slimy droplet, 31–64 µm. *Conidiogenous cells* 12.8–21×1.1–1.9 µm ($\bar{x}$ = 15.3×1.4 µm and n = 10), percurrent, cylindrical, smooth-walled. *Conidia* 4.2–6.1×2.4–3.4 µm ($\bar{x}$ = 5×2.4 µm and n = 25), oblong, hyaline, smooth-walled. **Synnematal stage from the culture:** *Conidiomata* graphium-like synnema. *Synnemata* 300–555 µm tall, erect, with a cylindrical stipe. *Stipe* 28–41 µm wide, dark grey, smooth-walled, terminating in a slimy head of conidia, appearing as a slimy droplet, 83–255 µm. *Conidiogenous cells* 17–22×0.8–1.8 µm ($\bar{x}$ = 20.3×1.3 µm and n = 10), percurrent, cylindrical, hyaline, smooth-walled. *Conidia* 6.8–9.2×3–4.5 µm ($\bar{x}$ = 8×3.8 µm and n = 25), ovate to subcylindrical, base obtuse to subtruncate, aseptate, straight, multi-guttulate, hyaline, smooth-walled. **Solitary conidiophores from culture:** *Conidiophores* 1.5–2.1 µm wide, solitary, emerging from aerial mycelium, undifferentiated, simple, often reduced to conidiogenous cells, or irregularly branched, with branches often bearing two to five conidiogenous cells, thin-walled. *Conidiogenous cells* 8.6–24.4×1.7–2.5 µm ($\bar{x}$ = 14.1×2.2 µm and n = 20), cylindrical to flask-shaped, hyaline, thin-walled, denticulate, usually terminating in a cluster of two to three cylindrical denticles. *Conidia* 4.7–7.3×2.7–4.2 µm ($\bar{x}$ = 6.2×3.5 µm and n = 25), obovate or subglobose, hyaline, smooth, more or less thick-walled.



Note (a, b) Appearance of ascomata on host substrate. (c, d) Longitudinal section through ascoma. (e) Close up of the base of neck (f) Close up of the peridium. (g) Paraphyses. (h, i) Immature and mature asci. (j) Ascus in Melzer's reagent. (k–n) Ascospores. (o) Germinating ascospore. (p, q) Cultures on MEA. Bars: b, c = 200 µm, d–f = 100 µm, g–j = 50 µm, k–n = 20 µm.

Figure 6.62 *Pseudohalonectria hampshirensis* (MFLU 16-1086, holotype)



Note Maximum likelihood bootstrap support values (ML≥75%) and Bayesian posterior probabilities (PP≥0.99) are shown near the nodes. The new isolate in blue and ex-type strains in bold. The scale bar represents the expected number of nucleotide substitutions per site. The tree is rooted to *Trichoderma viride*.

Figure 6.63 Maximum likelihood tree resulting from analysis of combined ITS and LSU sequence data of selected taxa of Microascaceae and Graphiaceae

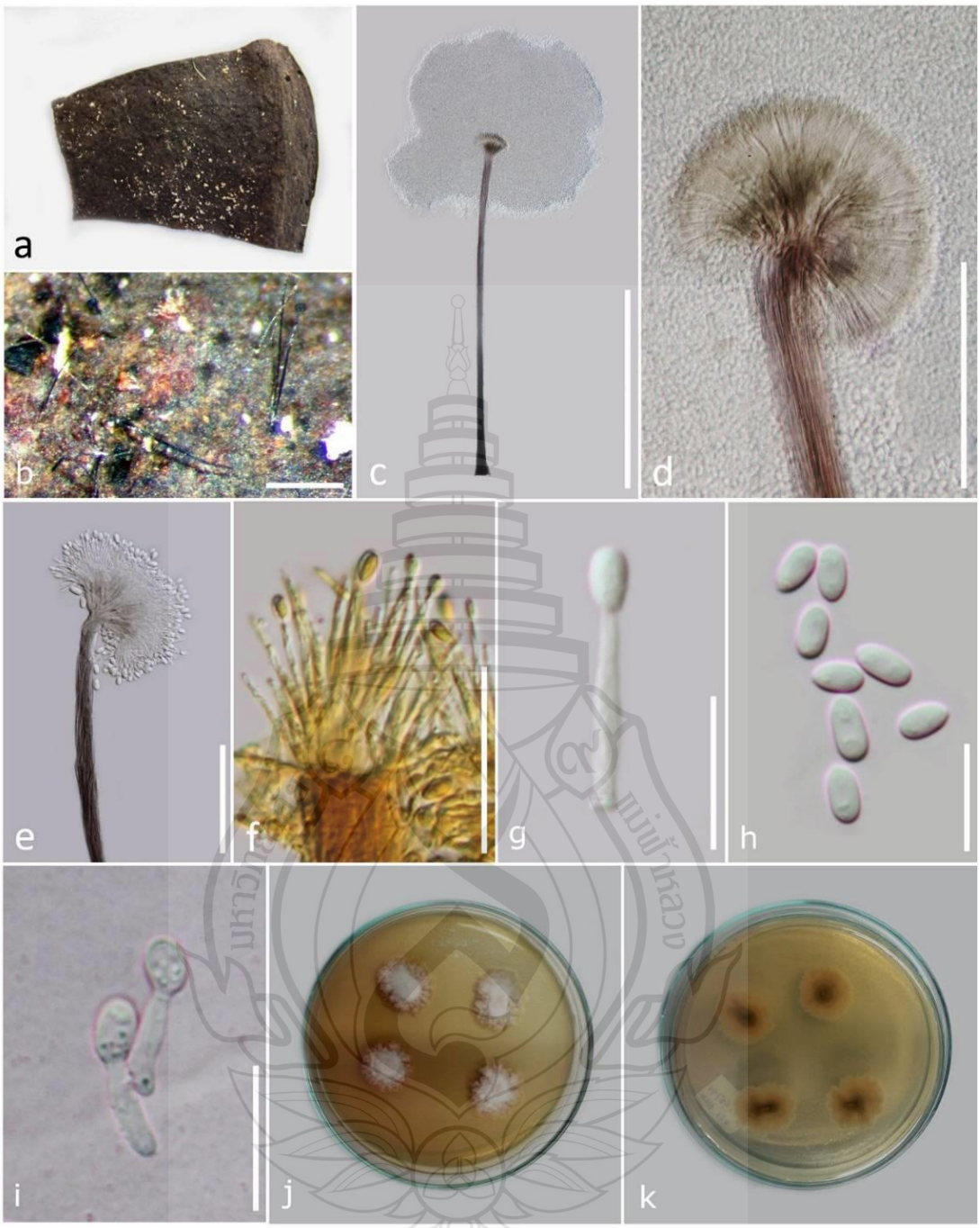
Culture characteristics: Reaching 20–27 mm within 7 days on MEA, at 25 °C, circular, with sparse aerial mycelium, and smooth, margins lobed, white from above, reverse gray in the center, becoming white towards the margin. Aerial mycelium produced simple conidiophores within 7 days at the margins. Synnemata produced on MEA within 30 days. Colonies becoming dark gray, and slightly granular at the centre due to the abundance of synnemata.

Material examined: THAILAND, Chiang Rai Province, Mae Fah Luang University campus, on a dried seed pod of *Delonix regia* (Boj. ex Hook.) Raf. (Fabaceae), 14 December 2015, R.H. Perera, RHP 130 (MFLU 17-0736), dry culture on MEA, MFLU 18-0516 and living culture, MFLUCC 15-1009.

GenBank numbers: ITS: MH048678, LSU: MH048679, SSU: MH048680, TEF1: MH048681.

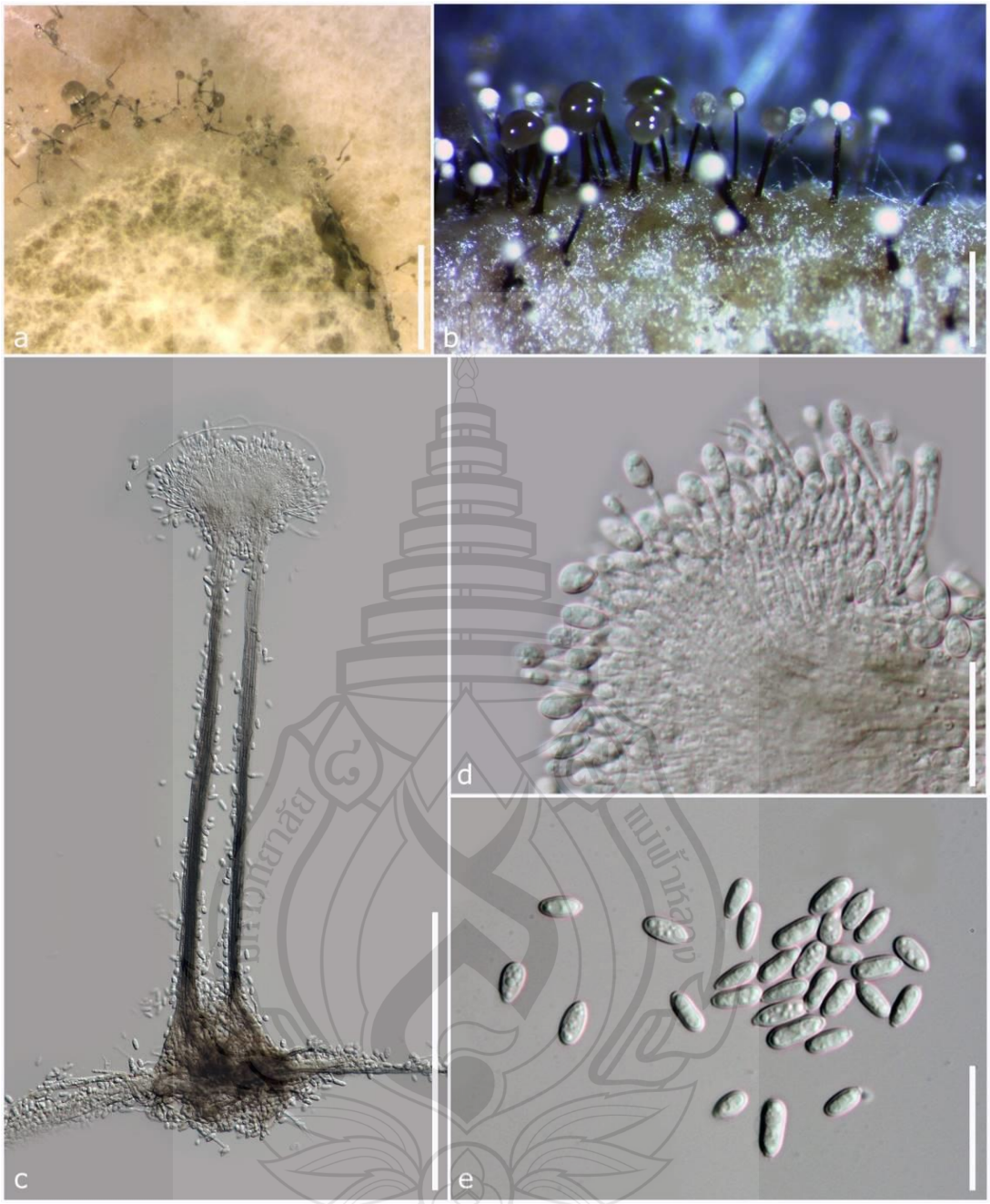
Notes: Our new isolate (MFLUCC 15-1009) clustered with other *Parascedosporium putredinis* strains in the phylogenetic tree (Figure 6.63). Differences of two bases were noted in the ITS region between our new isolate and the ex-type (CBS 102083). The new collection produced synnemata and lateral solitary conidiophores (in culture) similar to the holotype of *P. putredinis*. Our new *P. putredinis* isolate is slightly different from the holotype in possessing larger conidia (6.8–9.2×3–4.5 vs. 5.5–7.5×2.5–3.5 μm) (Gilgado et al., 2007). By considering the morphological and molecular data we designate our new collection as *P. putredinis*.

Parascedosporium putredinis has been isolated from different countries with different habitats. Strains have been isolated from living plant leaves, seeds of *Tectona grandis*, other plant debris and soil or dung. In the Center of Excellence in Fungal Research (Mae Fah Luang University), we are investigating diversity of microfungi on wild seeds and fruits in Thailand. However, this is the first record of *P. putredinis* on *Delonix regia* seed pods and first record from Thailand. It is possible that *P. putredinis* is a species complex but this requires further study with more genes. Currently There are only ITS and SSU sequence data available for *P. putredinis* in GenBank. Our study provides additional LSU and TEF1 sequences for future studies.



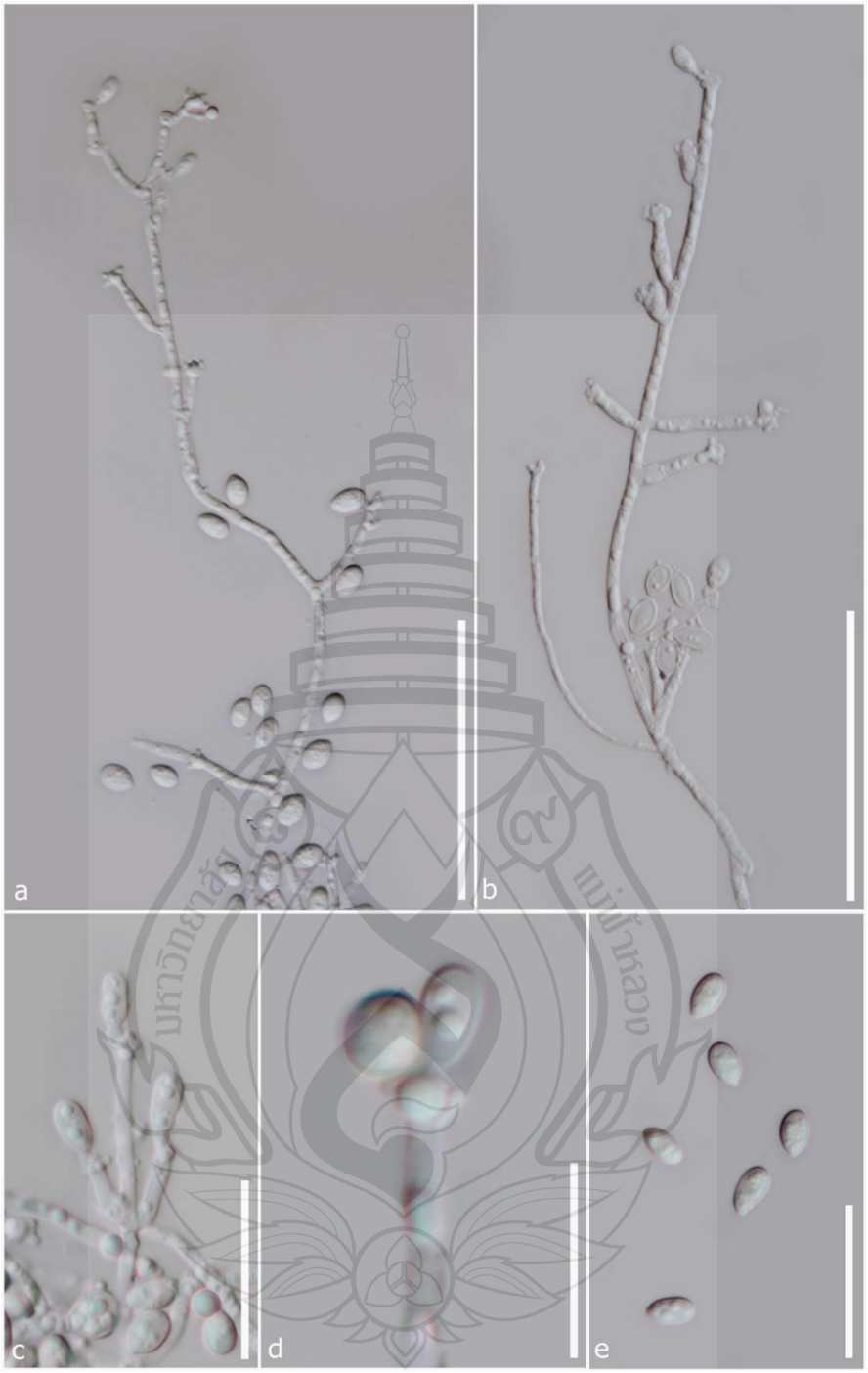
Note (a) Herbarium material. (b) Conidiomata on the host substrate. (c) Conidiophore with conidia. (d, e) Close up of the apex of the stipe. (f, g) Conidiogenous cells with conidia. (h) Conidia. (i) Germinating conidia. (j, k) Colonies on MEA. Scale bars: b, c = 500 μm, d = 100 μm, e = 50 μm, f = 20 μm, g = 10 μm, h, i = 10 μm.

Figure 6.64 *Parascedosporium putredinis* (MFLU 17-0736)



Note (a, b) Synnemata on MEA. (c) Synnemata. (d) Conidiophore with conidia. (e) Conidia. Scale bars: a = 1 mm, b = 500 μm, c = 200 μm, d, e = 20 μm.

Figure 6.65 *Parascedosporium putredinis* graphium stage on MEA (MFLU 18-0516)



Note (a, b) Aerial hyphae with simple or branched conidiophores producing sympodial conidia. (c, d) Lateral, cylindrical conidiogenous cells with conidia. (e) Conidia. Scale bars: a, b = 50 μm, c = 20 μm, d = 10 μm, e = 20 μm.

Figure 6.66 *Parascedosporium putredinis* solitary conidiophores on MEA (MFLU 18-0516)

Xylariales *Nannf.*

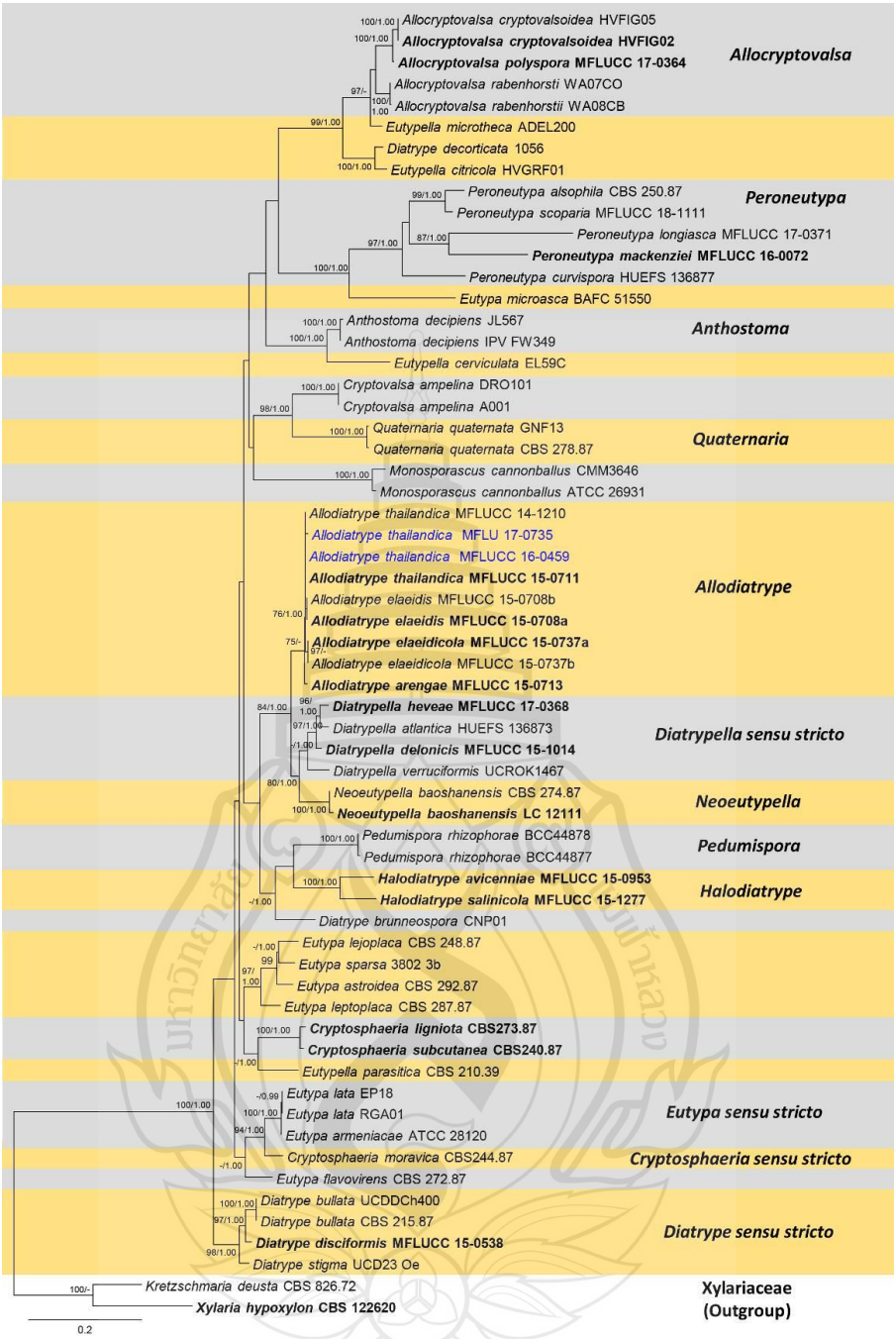
Diatrypaceae Nitschke

Allodiatrype Konta and K.D. Hyde

Allodiatrype thailandica (R.H. Perera, Jian K. Liu and K.D. Hyde) Konta and K.D. Hyde 2020

Figure 6.68

Saprobic on decaying wood or seed pods of *Delonix regia*. **Sexual morph:** *Stromata* 540–1050 μm wide, gregarious or scattered on host, erumpent, arising through the cracks in host tissue, with 1–5 ascomata immersed in white entostroma becoming greenish yellow near the periphery, stromata outer layer black. *Ascomata* 280–370 μm high, 150–300 μm wide ($\bar{x}$ = 320 × 210 μm, n = 20), perithecial, immersed in stromatic tissues, aggregated, globose to subglobose, narrowing towards the apex and very narrow at the base of papilla, pale brown, ostiolate, papillate. *Papilla* 85–150 μm high, 80–110 μm wide, immersed in outer layer of stromata, conical, apex wider than base, periphysate, periphyses 17–28 μm long. *Peridium* 20–27 μm wide, comprising an outer, brown, thick-walled, stratum of 4–5 layers of cells of *textura angularis* and inner, hyaline, thick-walled, stratum of 7–10 layers of cells of *textura angularis* and peridium in face view a *textura angularis* of thin-walled, medium to dark brown cells. *Hamathecium* comprising long, 7.4–10.3 μm wide ($\bar{x}$ = 8.9 μm, n=20), septate, paraphyses, slightly constricted at basal septa, and narrowing and tapering towards the apex. *Asci* 75–120 × 6.1–9.4 μm ($\bar{x}$ = 101 × 8.2 μm, n = 20), 4–8-spored, unitunicate, clavate, with narrow, long, thin-walled pedicel, with thick-walled, swollen upper portion, apex flat, with J- apical apparatus.



Note Sequences from sixty-one taxa, which comprise 993 2169 characters including gaps, were included in the analyses. The tree was rooted to *Kretzschmaria deusta* (CBS 826.72) and *Xylaria hypoxylon* (CBS 122620). The scale bar indicates 0.2 nucleotide changes per site.

Figure 6.67 Phylogram generated from RAxML analysis based on combined ITS and TUB2 sequence data of Diatrypaceae isolates

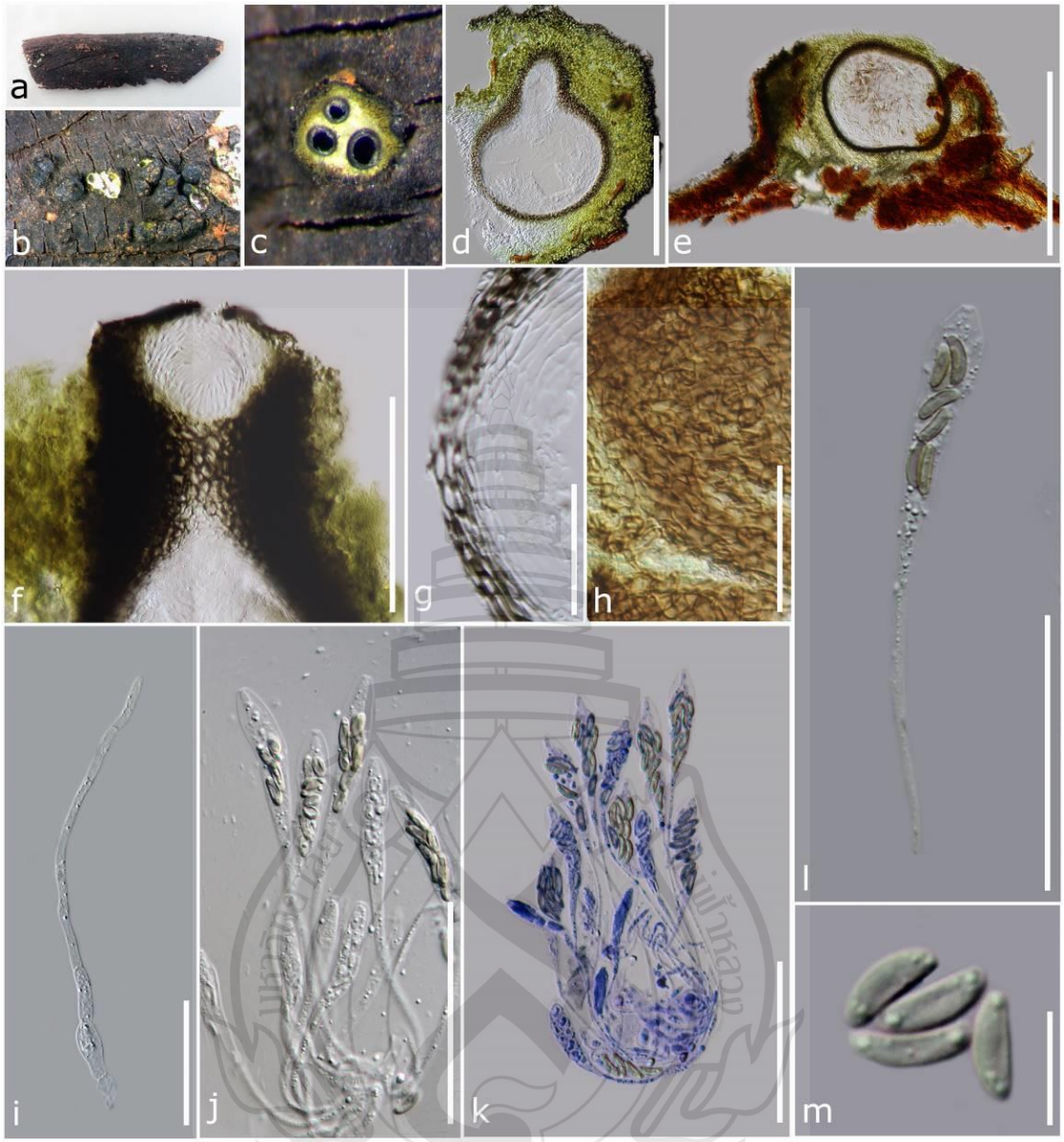
Ascospores 6.5–10.7 × 1.6–2.7 µm ($\bar{x}$ = 7.8 × 2.2 µm, n = 50), biseriate, allantoid to cylindrical, unicellular, pale brown at maturity, thick-walled, with small, fat globules at ends, smooth-walled. **Asexual morph:** See Li et al. (2016).

Culture characteristics: Ascospores germinated on PDA within 12 hours. Reaching 3.5 cm within 14 days on PDA at 25°C, colonies medium dense, circular, flat, with diffuse margin, white, greenish yellow with time, below similar in colour, not zonate.

Material examined: THAILAND, Chiang Rai Province, Mae Fah Luang University premises, on dried seed pods of *Delonix regia* (Fabaceae), 6 January 2015, R.H. Perera, RHP 150 (MFLU 17-0735), *ibid*. Doi Mae Salong, on unidentified plant stem, 15 March 2014, R.H. Perera, M-1 (MFLU 16-1073), living culture MFLUCC 16-0459.

GenBank numbers: ITS: MT386002, LSU: MT215541, TUB2: MT212210 (MFLU 17-0735) and ITS: MT386003, LSU: MT215542 (MFLUCC 16-0459).

Notes: In molecular phylogenetic analysis our new isolates clustered with putative strain of *Allodiatrype thailandica* (MFLUCC 15-3662) (Figure 6.67). Our collection is similar to *A. thailandica* by greenish yellow entostroma, ascospore colour and size (Li et al., 2016 and Konta et al., 2020). It is therefore reported here as a new host record of *A. thailandica* and in providing TUB2 gene region sequence for the first time.



Note (a) Herbarium material. (b) Appearance of ascomata on host substrate. (c) Cross section through stromata with ascomata. (d, e) Vertical section through stromata with ascomata. (f) Ostiole. (g) Peridium. (h) Peridium in face view. (i) Paraphyses. (j–l) Asci. (m) Ascospores. Scale bars: d, e = 200 µm, f–h = 100 µm, i = 20 µm, j–l = 50 µm, m = 10 µm.

Figure 6.68 *Allodiatrype thailandica* (MFLU 17-0735)

Diatrypella (Ces. and De Not.) De Not.

Key to the related species of *Diatrypella*

1. Ascospores 4–5 µm long on average ..... *Diatrypella major*
1. Ascospores 6–10 µm long on average 2
2. Entorostroma yellowish or olive-green.....3
2. Entorostroma white 4
3. Asci larger, 120–150 × 15.5–21.5 µm ..... *D. tectonae*
3. Asci smaller, 40 × 8–12 µm.....*D. frostii*
4. Stromata small, up to 2 mm diam. 5
4. Stromata larger than 2 mm .....*D. vulgaris*
5. 1–4 ascomata per stromata, on twigs of *Hevea brasiliensis*.....*D. heveae*
5. 3–4 ascomata per stromata, on seed pods of *Delonix regia* .....*D. delonicis*

Diatrypella delonicis R.H. Perera and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556450 and Facesoffungi number: FoF02658 and Figure 131, Figure 6.69

Etymology: Named after the host genus.

Saprobic on dried seed pods of *Delonix regia*. **Sexual morph:** *Stromata* 0.65–1.28 mm wide, solitary or gregarious on host, immersed, with 3–4 ascomata immersed in a single stroma, comprising of outer, dark brown to black, small, tightly packed, thin parenchymatous cell layer, inner white, loosely packed, parenchymatous cells. *Ascomata* 243–340 µm high, 217–380 µm diam., ($\overline{x}$ = 310 × 331 µm, n = 20), perithecial, immersed in stromatic tissues, aggregated, globose to subglobose, sometimes with flattened base, pale to dark brown, carbonaceous, ostioles not prominent. *Peridium* 16–24 µm wide ($\overline{x}$ = 18 µm, n= 20), 2 layered, inner 3–6 layers of hyaline, flattened, elongate, thin walled cells of *textura angularis*, outer 4–7 layers of pale to dark brown, flattened, thick-walled cells of *textura angularis*. *Hamathecium* comprising 8.2–13 µm wide ($\overline{x}$ = 9.8 µm, n = 20), septate, paraphyses, longer than the asci, tapering towards the apex, wider at the base. *Asci* 95–100 × 14–20 µm ($\overline{x}$ = 100 × 18 µm, n = 25), multi-spored, unitunicate, clavate, with narrow, long, thin-walled pedicel, with swollen upper portion, apex rounded,

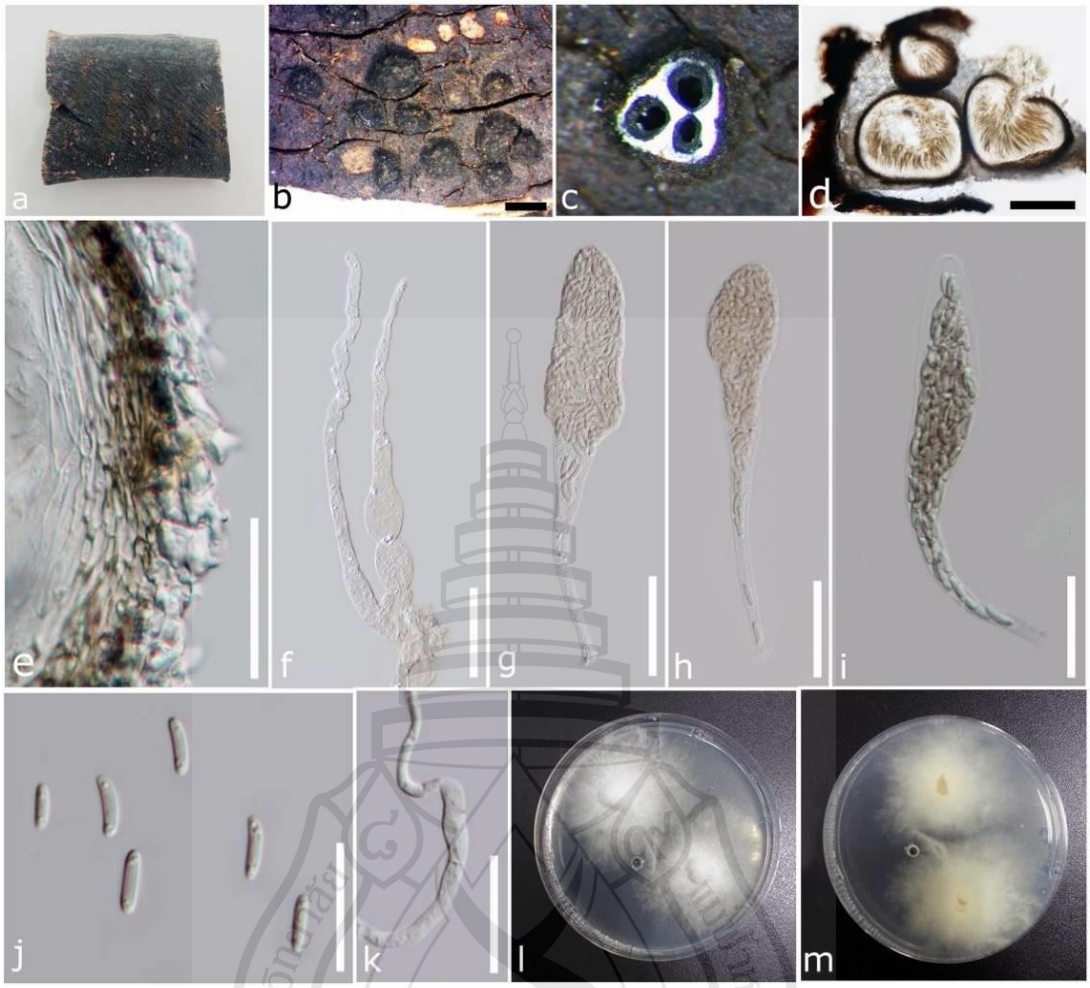
without a visible apical apparatus. *Ascospores* 6.2–7.4 × 1.4–1.8 µm ($\bar{x}$ = 6.7 × 1.6 µm, n= 20), overlapping, pale brown, allantoid to cylindrical, unicellular, with small, fat globules at the ends, smooth-walled, without sheath or appendages. **Asexual morph:** Undetermined

Culture characters: Ascospores germinated on PDA within 18 hours and germ tube produced from one or both ends of the ascospore. Reaching 6.5 cm within 14 days on PDA, at 25 °C, colonies medium dense, circular, flat, with diffuse margin, white, below similar in color, not zonate, not producing pigmentation on PDA media.

Material examined: THAILAND, Chiang Rai Province, premises of Mae Fah Luang University, in front of S7 building, on dried seed pods of *Delonix regia* (Boj. ex Hook.) Raf. (Fabaceae), 10 December 2014, R.H. Perera, RHP 75 (MFLU 16-1016, **holotype)**, *ibid*., RHP 77 (MFLU 16-1032), ex-type living culture (MFLUCC 15-1014).

GenBank numbers: MFLUCC 15-1014: LSU: MH812996, ITS MH812994 and TUB2: MH847790 and MFLU 16-1032: LSU: MH812997, ITS MH812995 and TUB2: MH847791.

Notes: *Diatrypella delonicis* clusters with *D. major*, *D. frostii* and *D. vulgaris* within *Diatrypella sensu stricto* (Figure 6.67). DNA sequences of *D. delonicis* and putative strain of *D. major* (1058) differed in 2 nucleotides in the ITS region. DNA sequences of *D. delonicis* and putative strain of *D. frostii* (UFMGCB 1917) differed in 10 nucleotides in the ITS region. Sequence data of the TUB2 region of *D. major* and *D. frostii* are not available in the GenBank for the comparison. *Diatrypella delonicis* and ex-type strain of *D. vulgaris* (HVGRF03) showed 1 nucleotide difference in the ITS region, and 14 different nucleotides in the TUB2 region. DNA sequences of *D. delonicis* and ex-type strain of *D. tectonae* (MFLUCC 12-0172a) differed in 7 nucleotide positions of the ITS region. DNA sequence data of *D. heveae* (ex-type MFLUCC 17-0368) differed in 11 nucleotides in the ITS region and 33 in the TUB2. A key to species is provided above including the phylogenetically closely related species and the taxa were described from Thailand, *D. heveae* and *D. tectonae*.



Note (a) Herbarium material. (b) Appearance of stromata on host substrate. (c) Longitudinal section through stroma with ascomata. (d) Vertical section through stromata. (e) Close up of the peridium. (f) Paraphyses. (g–i) Asci. (j) Ascospores. (k) Germinating ascospore. (l, m) Colonis on PDA. Scale bars: b = 1 mm, d = 500 µm, e–i, k = 20 µm, j = 10 µm, k = 20 µm.

Figure 6.69 *Diatrypella delonicis* (MFLU 16-1016, holotype)

Hypoxylaceae DC. emend. M. Stadler and L. Wendt.

Hypoxylon Bull.

Hypoxylon delonicis R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556864 and Facesoffungi number: FoF07769, Figure 6.73

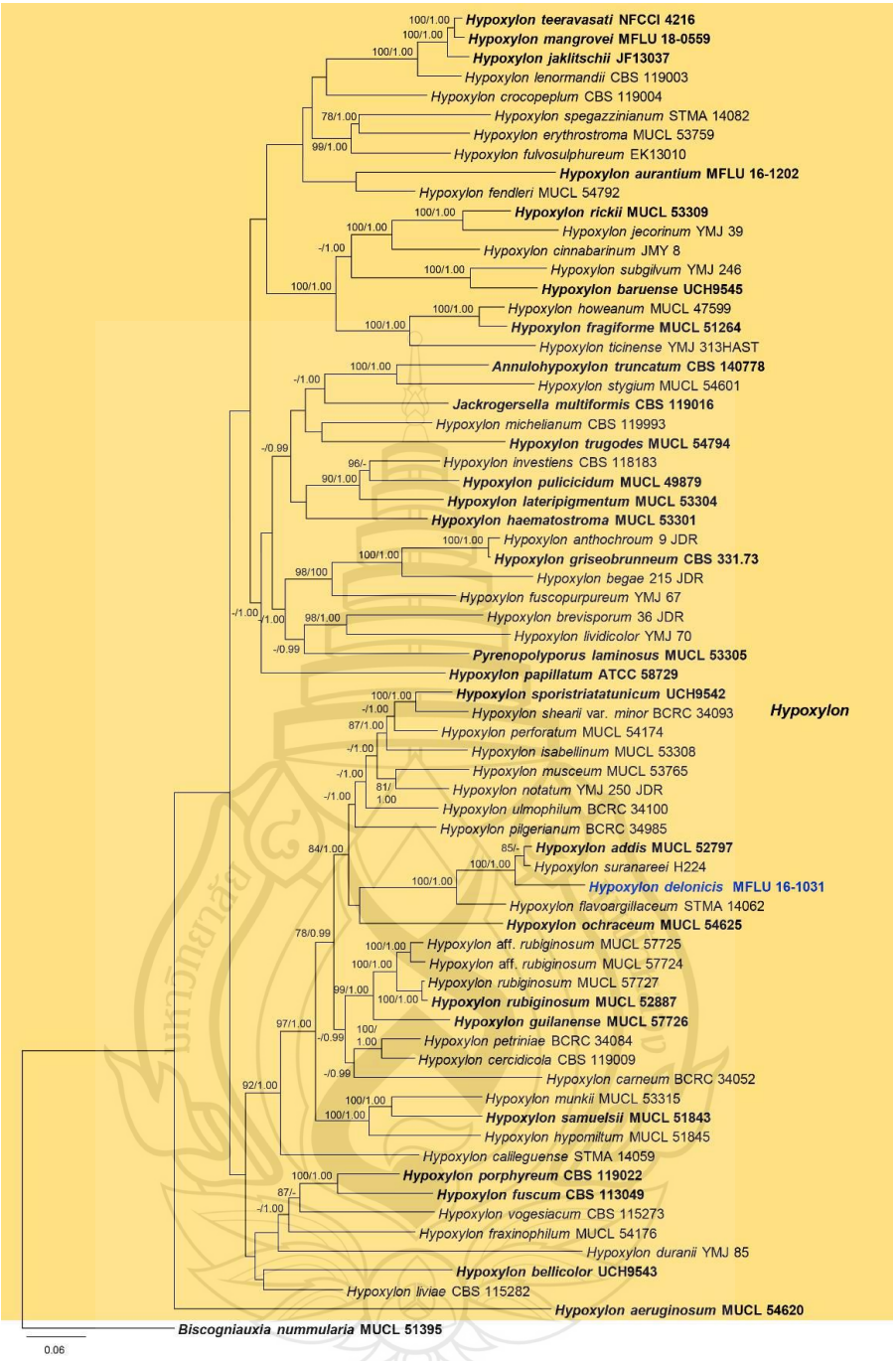
Etymology: Named after the host genus *Delonix.*

Notes: Colours were determined as in the previous literature of *Hypoxylon* species and the codes following Rayner (1970).

Saprobic on dried seed pods of *Delonix regia*. **Sexual morph:** *Ascostromata* 1.3–2.3 mm diam., glomerate, effuse-pulvinate, with conspicuous perithecial mounds, surface dark Brick (60), orange red granules immediately beneath surface and between perithecia, with KOH extractable pigments Citrine (13). *Ostioles* umbilicate, opening at the centre of a raised disc. *Ascomata* 300–635 × 200–485 μm ($\bar{x}$ = 423 × 328 μm), perithecial, obovoid. *Peridium* 20–75 μm, multilayered, inner layers composed of flattened, hyaline cells of *textura angularis*, outer layers composed of brown cells of *textura globosa*. *Paraphyses* absent. *Asci* 110–140 × 8–12 μm ($\bar{x}$ = 126 × 10 μm, n = 20), 8-spored, unitunicate, cylindrical, pedicellate, apex simple. *Ascospores* 12.4–15 × 6.3–7.4 μm ($\bar{x}$ = 13.4 × 6.8 μm, n = 40), uniseriate, one-celled, ellipsoid-inequilateral, with narrowly rounded ends, brown to dark brown, with sigmoid germ slit spore-length, guttulate, guttules aggregated in ends when mature, perispore dehiscent in 10% KOH, smooth-walled, epispore smooth. **Asexual morph:** Undetermined.

Material examined: THAILAND, Chiang Rai Province, Mae Fah Luang University premises, on dried seed pods of *Delonix regia* (Fabaceae), 6 January 2015, R.H. Perera, RHP 26 (MFLU 16-1031, holotype).

GenBank numbers: ITS: MT215503, LSU: MT386008, TUB2: MT212215.

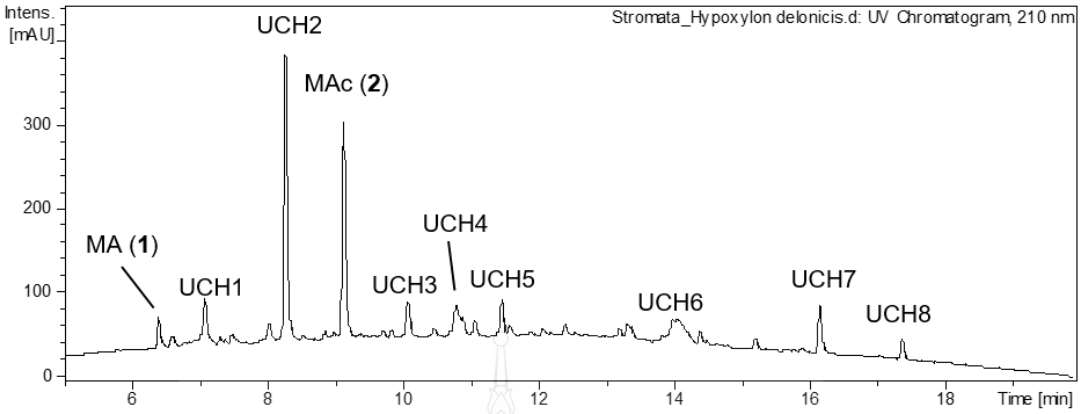


Note Sequences from sixty-nine taxa, which comprise 2290 characters including gaps, are included in the analyses. The tree was rooted to *Biscogniauxia nummularia* (MUCL 51395). The scale bar indicates 0.06 nucleotide changes per site.

Figure 6.70 Phylogram generated from RAxML analysis based on combined ITS and TUB2 sequence data of *Hypoxylon* isolates

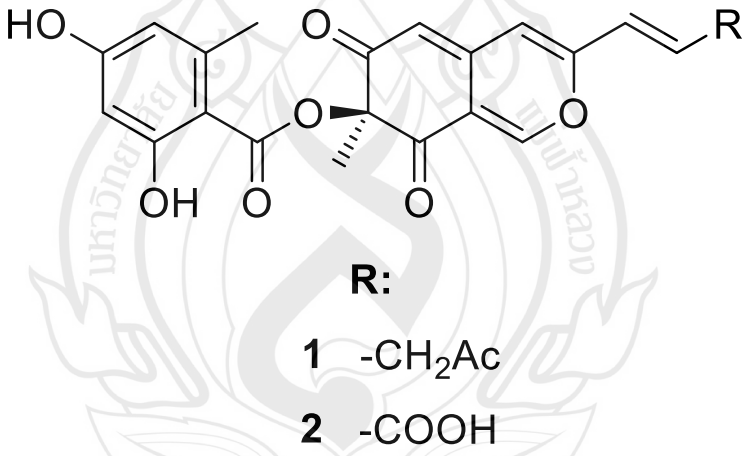
Notes: Phylogenetically *Hypoxylon delonicis* is related to *H. addis* and *H. suranareei* with high statistical support (100% MLBT, 1.00 BYPP and Figure 6.70). However, the holotype of *H. suranareei* was not available from the herbarium where it was reported to be deposited in the protologue, and the comparison with this species can only rely on the published data. *Hypoxylon delonicis* can be distinguished from *H. suranareei* by having larger ascomata 300–635 × 200–485 vs. 200–400 μm, and broader asci (8–12 vs. 3.8–5 μm) and ascospores (6.3–7.4 vs. 5–6.3 μm) (fide Suwannasai et al., 2006). *Hypoxylon delonicis* differs from *H. addis* in having shorter asci lacking an apical apparatus (110–140 vs.170–190 μm) and by its ascospores having a smooth (vs. faintly striate) perispore (Fournier et al., 2010b). *Hypoxylon addis* was collected from an Euphorbiaceae host in Ethiopia. *Hypoxylon delonicis* resembles *H. shearii* by glomerate stromata, but differs in having conspicuous raised discs around the ostioles, which are absent in *H. shearii* (Fournier et al., 2010b). *Hypoxylon shearii* has been collected from *Quercus* wood (Ju and Rogers, 1996 and Fournier et al., 2010b). *Hypoxylon delonicis* is also similar to *H. gibriacense* by its glomerate stromata and lack of an apical apparatus in asci (Fournier et al., 2010b). However, *H. delonicis* differs from *H. gibriacense* in having larger ascospores (12.4–15 × 6.3–7.4 vs. 11.5–13 × 6–6.8 μm) and by its ascospores having a smooth (vs. fairly conspicuous striate) perispore (Fournier et al., 2010b). Hence, we introduce *H. delonicis* as a new species based on both morphological and molecular evidence.

Secondary metabolites*:* The stromatal extract was prepared and measured by HR-ESI-MS as described before (Kuhnert et al., 2017). The extract of *Hypoxylon delonicis* was found to contain the known azaphilone pigments mitorubrinol acetate (1) and mitorubrinic acid (2), which are widespread in *Hypoxylon* and form the core structures of more complicated metabolites (Surup et al., 2018) (Figs 6.71, 6.72). Besides, several peaks indicating probably representing yet unknown azaphilones were observed and labelled UCH1−8, with UCH2 even being the main peak within the extract and may accound for the citrine color of the stromatal extract in KOH (notably, mitorubrins give an orange colour in KOH). It was of course not an option to attempt to isolate and identify these unknown components, to avoid destruction of valuable holotype specimen. However, it could be an option to watch out for the new fungus and collect more material for future mycochemical studies.



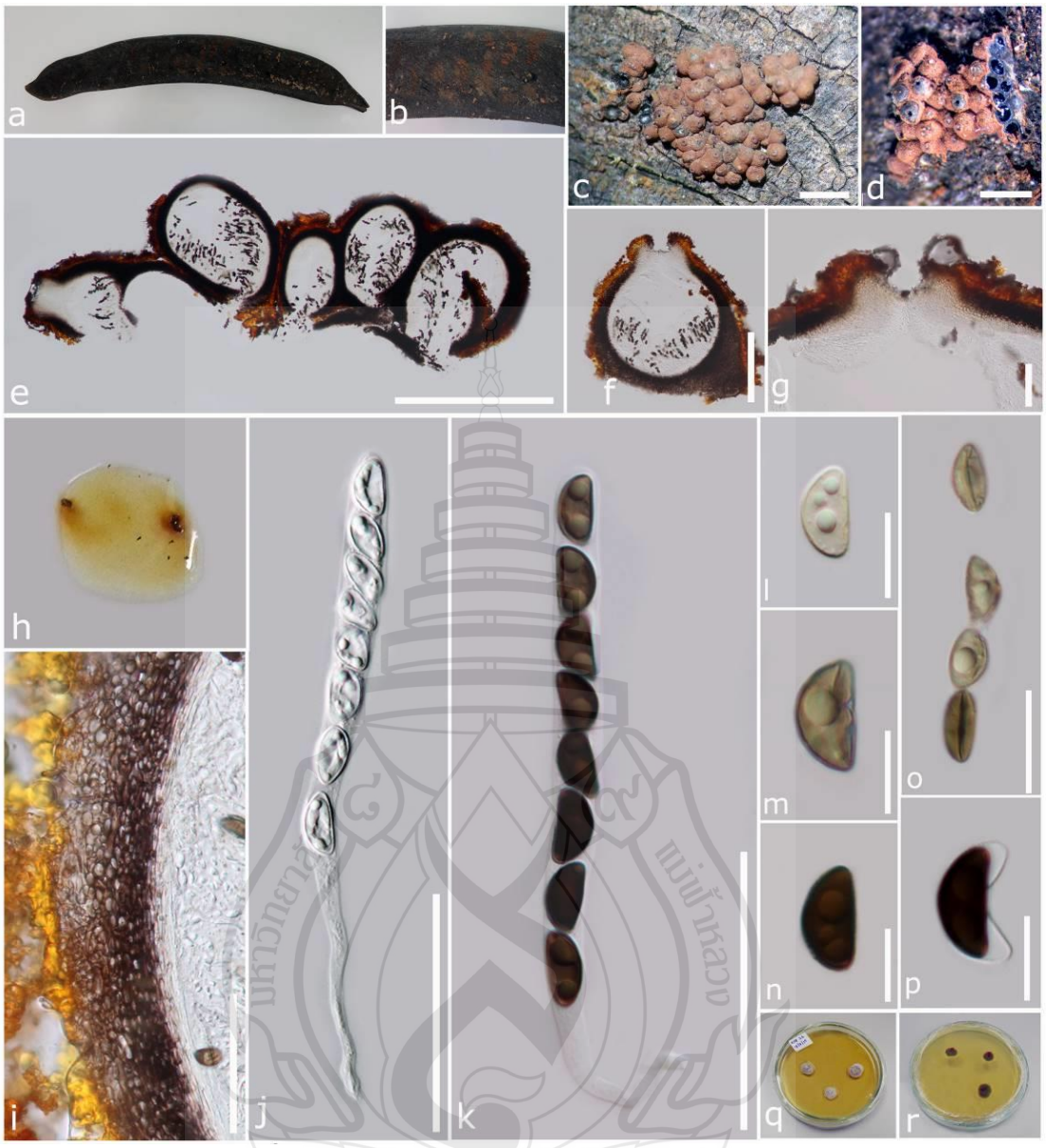
Note MA = Mitorubrinic acid (1), MAc = Mitorubrinol acetate (2), UCH1−8 = unknown compounds from *H. delonicis*.

Figure 6.71 HPLC-UV/VIS chromatogram of the stromatal extract of *Hypoxylon delonicis* at 210 nm



Note (1) mitorubrinol acetate. (2) mitorubrinic acid.

Figure 6.72 Known secondary metabolites found in stromatal extracts of *Hypoxylon delonicis*



Note (a) Herbarium material. (b–d) Appearance of ascomata on host substrate. (e, f) Vertical section through stromata with ascomata. (g) Ostiole. (h) Stromatal pigments in 10% KOH. (i) Close up of the peridium. (j–l) Immature and mature asci. (m–o) Immature and mature ascospores. (p) Ascospores with the germ slit. (q) Ascospore with released epispore in 5% KOH. Scale bars: d, e = 500 µm, f = 200 µm, g = 100 µm, i–l = 50 µm, m–o = 10 µm, p = 20 µm, q = 10 µm.

Figure 6.73 *Hypoxylon delonicis* (MFLU 16-1031, holotype)

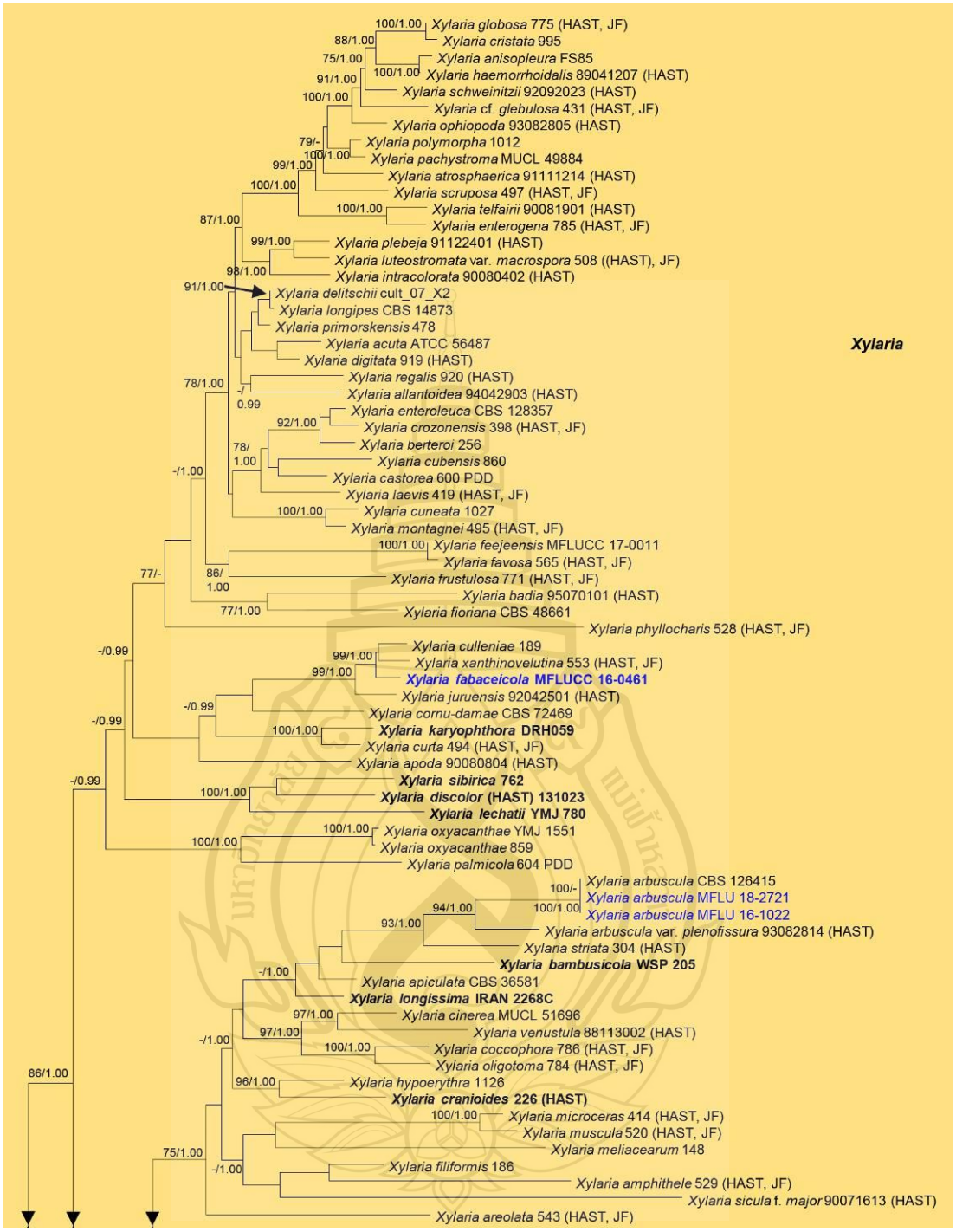
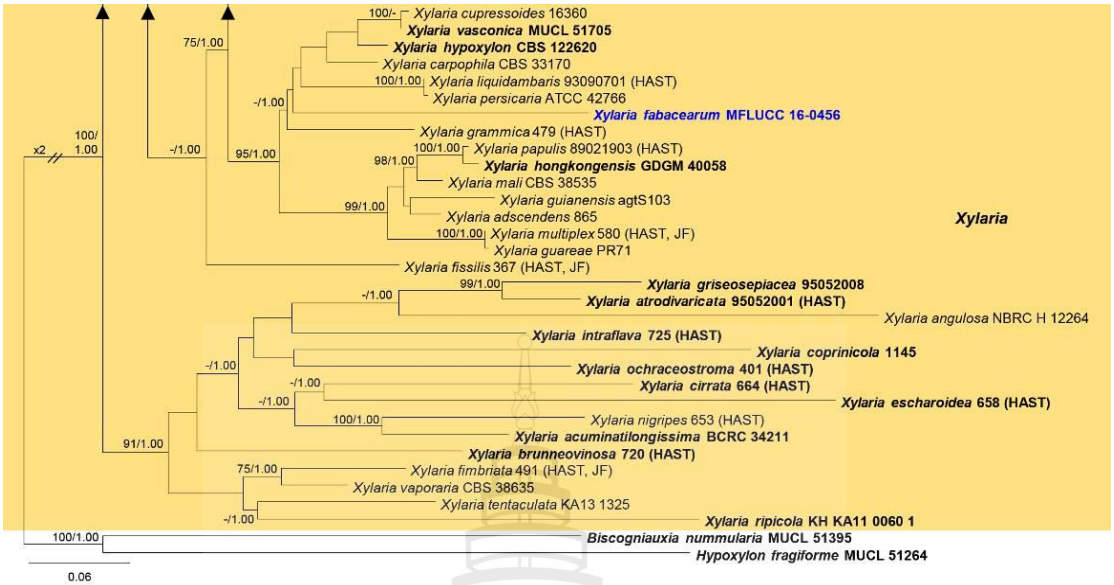


Figure 6.74 Phylogram generated from RAxML analysis based on combined ITS, RPB2 and TUB2 sequence data of *Xylaria* isolates



Note Sequences from one hundred five taxa, which comprise 3476 characters including gaps, are included in the analyses. Tree was rooted to *Biscogniauxia nummularia* (MUCL 51395) and *Hypoxylon fragiforme* (MUCL 51264). The scale bar indicates 0.06 nucleotide changes per site.

Figure 6.74 (continued)

Xylariaceae Tul. and C. Tul.

Xylaria Hill ex Grev.

Xylaria arbuscula Sacc., Michelia 1(no. 2): 249 (1878)

Facesoffungi number: FoF07770, Figures 6.75, 6.76

On decaying fruits of *Swietenia mahagoni*. Sexual morph: *Stromata* gregarious to solitary, usually unbranched or rarely branched near base, stipitate, two types: longer stromata 9.5–18 mm high × 2–2.3 mm diam., abundant, with fertile head 4–8.5 mm long, cylindrical, conical to acute at the apex and stunted stromata, 1–3 mm high × 0.6–1.4 mm diam., rare, very short-stipitate, broadly conical or flattened, fertile head conical 0.7–1.1 mm long, with a conical sterile apex or apically obtuse and without visible perithecial contours, surface black, glabrous, obscurely cracked and roughened and internal tissue white, brownish grey in the stipe, solid, KOH. *Ostioles* obtusely papillate, black, often inconspicuous. *Peridium* 15–25 µm thick, composed of pale to brown cells of *textura angularis*. *Ascomata* 360–500 µm diam. ($\bar{x}$ = 440 µm), completely immersed,

perithecial, subglobose. *Paraphyses* 1.9–2.8 µm wide, hypha-like, septate, hyaline, thin-walled, embedded in gelatinous matrix. *Asci* 120–170 × 6.5–7.8 µm ($\bar{x}$ = 142 × 7.2 µm), 8-spored, unitunicate, cylindrical, the spore-bearing parts 75–106 µm long ($\bar{x}$ = 90 µm), apical apparatus cylindrical, with a J+ apical ring, 3.2–3.6 × 2–2.6 µm ($\bar{x}$ = 3.4 × 2.3 µm). *Ascospores* 12.4–18 × 4.6–6.2 µm ($\bar{x}$ = 14.6 × 5.4 µm), obliquely to transversely uniseriate, fusiform, inequilateral with narrowly rounded to subacute or slightly pinched ends, 1–2(–3) guttulate, brown, with a conspicuous, straight, germ slit slightly less than spore-length and epispore smooth, not dehiscent in 5% KOH. Asexual morph: *Stromata* 7–16 mm high × 1.3–2 mm diam., smaller than ascostroma, gregarious, unbranched, stipitate and head 5–7 mm in length, cylindrical, with a conical to acute apex and dark brown. *Conidiophores* 30–100 × 2–4 µm, forming around the stromatal head, pale brown, dichotomously branched, septate. *Conidia* 2.5–4.7(–10) × 2–4.8 µm ($\bar{x}$ = 4 × 3 µm), globose, subglobose, elliptical or sometimes angular or oblong, aseptate, with a flat basal abscission scar, hyaline, thick- and smooth-walled.

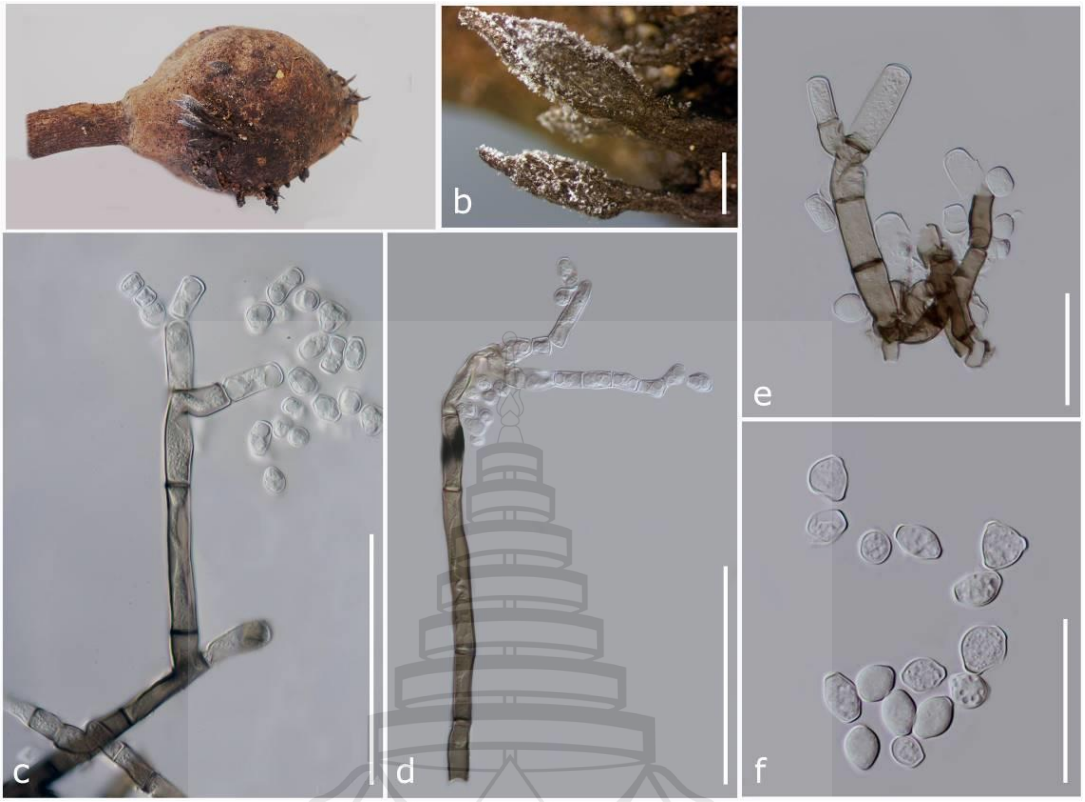
Material examined: THAILAND, Chiang Rai Province, Mae Fah Luang University garden, on decaying fruits of *Swietenia mahagoni* (Meliaceae), 16 August 2015, R.H. Perera, RHP 21 (MFLU 16-1022) and *ibid*., 16 December 2015, RHP 21b (MFLU 18-2721).

GenBank numbers: ITS: MT215513, LSU: MT215562 (MFLU 16-1022) and ITS: MT215514, LSU: MT215563 (MFLU 18-2721).

Notes: Wendt et al. (2017) and Daranagama et al. (2018) provided modern treatments of Xylariaceae which we follow here. Our new collections MFLU 16-1022 and MFLU 18-2721 grouped with *Xylaria arbuscula* (CBS 126415) with high statistical support in our phylogenetic analysis (Figure 6.74). Specimens MFLU 16-1022 and MFLU 18-2721 belong to asexual morph and sexual morph stages, which were collected from *Swietenia mahagoni* fruits at the same location. The ITS and LSU gene regions of MFLU 16-1022 and MFLU 18-2721 are identical. Sexual morph of our collection was similar to *X. arbuscula* in morphology, asci and ascospore dimensions (Saccardo, 1878b and Fournier et al., 2010a). The holotype of *X. arbuscula* was collected from a greenhouse in Germany (Saccardo, 1878b). There was no asexual morph of the fungus reported so far (Saccardo, 1878b and Fournier et al., 2010a).

Note (a) Herbarium material. (b, c) Appearance of ascostromata on host substrate. (d) Cross section through stromata with ascomata. (e) Vertical section through ascomata. (f) Close up of the peridium. (g) Paraphyses. (h–j) Asci. (k, l) Close up of apical ring (k in Melzer's iodine reagent). (m–s) Ascospores (q, r in 10% KOH, (s) arrows showing the germ slit). Scale bars: c, d = 2 mm, d = 500 µm, e = 200 µm, f–j = 50 µm, k, l = 20 µm, m–r = 10 µm, s = 20 µm.

Figure 6.75 *Xylaria arbuscula* (MFLU 18-2721)



Note (a) Herbarium material. (b) Conidiophores on stromata. (c–e) Conidiophores with conidia. (f) Conidia. Scale bars: b = 200 µm, c, d = 50 µm, e, f = 20 µm.

Figure 6.76 *Xylaria arbuscula* (MFLU 16-1022)

By considering the morphological similarities, similarities in the ITS loci and phylogenetic analysis we identify our collection as *X. arbuscula* (Jeewon and Hyde, 2016). This is the first record of *X. arbuscula* from *Swietenia mahagoni* and the first report of its asexual morph. Unfortunately, we were unable to amplify the RPB2 gene region of the fungus despite several attempts.

Xylaria fabacearum R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556865 and Facesoffungi number: FoF07771, Figure 6.77

Etymology: Named after the host family Fabaceae.

Saprobic on decaying seed pods of Fabaceae. **Sexual morph:** *Stromata* 4.5–16 mm long × 0.9–1.8 mm diam., fertile part up to 9 mm long × 1.8 mm diam., cylindrical, branched or unbranched, solitary or clustered, stipe, tomentose, black, with sterile apices.

External surface black, non-tomentose, roughened with ascomatal contours. *Internal tissue* white, not becoming hollow. *Ascomata* 290–480 µm high × 270–450 µm diam. ($\bar{x}$ = 390 × 376 µm), perithecial, globose to subglobose, mammiform, more less immersed, ostioles black, slightly papillate. *Peridium* 20–30 µm wide, composed of up to 12 layers of light brown-walled cells of *textura angularis* to *textura prismatica*, integrated with inner stroma cells. *Paraphyses* 1.4–2.4 µm wide, septate, hyaline. *Asci* 8-spored, 90–135 × 4–6 µm ($\bar{x}$ = 109 × 5 µm and n = 25), cylindrical, long stipitate, the spore-bearing part 56–65 µm long, with an inverted hat-shaped, J+ apical ring 2–2.5 × 1.5–2 µm ($\bar{x}$ = 2.3 × 1.7 µm, n = 10). *Ascospores* uniseriate to overlapping uniseriate, 9–11.2 × 3–4.3 µm ($\bar{x}$ = 10 × 3.6 µm, n = 35), ellipsoid-inequilateral, brown to dark brown, aseptate, guttulate and germ slit conspicuous, straight, running full-length of the ascospore, perispore indehiscent in 10% KOH and epispore smooth, lacking a hyaline sheath. **Asexual morph:** Undetermined.

Culture characteristics: Ascospores germinating on PDA within 14 hours. Colonies growing on MEA, reaching 30 mm in 14 days at 28°C, flat, initially white, aerial mycelium forming concentric rings with cottony texture, margin undulate, white to ash or black above, reverse dark brown.

Material examined: THAILAND, Chiang Mai Province, on decaying seed pods of Fabaceae, 20 December 2015, R.H. Perera, DeloL4, (MFLU 16-1061, holotype) and ex-type living culture MFLUCC 16-0456.

GenBank numbers: ITS: MT215512, LSU: MT215561, RPB2: MT212202, TUB2: MT212220.

Notes: *Xylaria fabacearum* (MFLUCC 16-0456) groups apart from other *Xylaria* species in an unsupported clade (Figure 6.74). *Xylaria fabacearum* resembles *X. culleniae*, *X. fabaceicola* and *X. xanthinovelutina* (which were mostly isolated from leguminous fruits), but differs mainly by having ascospores that lack a hyaline sheath (Ju et al., 2018). *Xylaria fabacearum* can be distinguished from *X. luzonensis* (which is also isolated from leguminous pods) by its larger, brown to dark brown ascospores (9–11.2 × 3–4.3 vs. 8.5–9.5 × 3–3.5 µm), while *X. luzonensis* has light brown ascospores (Ju et al., 2018). Hence, we identified our collection as a new species of *Xylaria*.

Xylaria fabaceicola R.H. Perera, E.B.G. Jones and K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF556866 and Facesoffungi number: FoF07772, Figure 6.78

Etymology: Named after the host family Fabaceae.

Saprobic on decaying seed pods of Fabaceae. **Sexual morph:** *Stromata* 13–25 mm long × 0.6–1.5 mm diam., fertile part up to 12 mm long × 1.2 mm diam., cylindrical, branched or unbranched, solitary or clustered, with sterile apices, stipe tomentose, black. *External surface* black, tomentose, roughened with ascomatal contours. *Internal tissue* white, not becoming hollow. *Ascomata* 360–550 µm high × 300–440 µm diam. ($\bar{x}$ = 480 × 375 µm), perithecial, mammiform, more or less immersed, ostioles black, slightly papillate. *Peridium* 30–45 µm wide, two regions, outer region of 8–10 layers of hyaline to light brown, thick-walled cells of *textura prismatica* and inner region of 4–6 layers of hyaline cells of *textura angularis. Paraphyses* 3–4 µm wide, septate, hyaline, tapering towards the apex. *Asci* 100–130 × 4.6–6.5 µm ($\bar{x}$ = 117 × 5.6 µm, n = 20) diam., unitunicate, 8-spored, cylindrical, long stipitate, the spore-bearing part 56–65 µm, with an inverted hat-shaped, J+ apical ring 1.7–2.3 µm × 1.3–1.8 µm ($\bar{x}$ = 2 × 1.5 µm, n = 10) diam. *Ascospores* 7.5–10 × 3.4–4.8 µm ($\bar{x}$ = 8.5 × 4.2 µm and n = 25) diam., uniseriate to overlapping uniseriate, ellipsoid-inequilateral, pale brown to brown, aseptate, guttulate and germ slit conspicuous, straight, slightly less than the spore length and surrounded with a hyaline sheath swelling at both ends to form non-cellular appendages, perispore indehiscent in 10% KOH, epispore smooth. **Asexual morph:** Undetermined.

Culture characteristics: Ascospores germinating on PDA within 12 hours. Colonies growing on MEA, reaching up to 55 mm in 14 days at 28°C, flat, initially white, aerial mycelium forming concentric rings with cottony texture, margin undulate, white to ash or black, reverse dark brown.

Note (a) Herbarium material. (b) Appearance of ascomata. (c, d) Vertical section through stroma with ascomata. (e) Face view of the peridium. (f) Section through peridium. (g) Paraphyses. (h–l) Asci. (l in Melzer's reagent). (m–o) Ascospores. (p) Germinating ascospore. Scale bars: b = 1 mm, c, d = 200 µm, e = 20 µm, f–j = 50 µm, k–l = 20 µm, m–o = 10 µm, p = 5 µm.

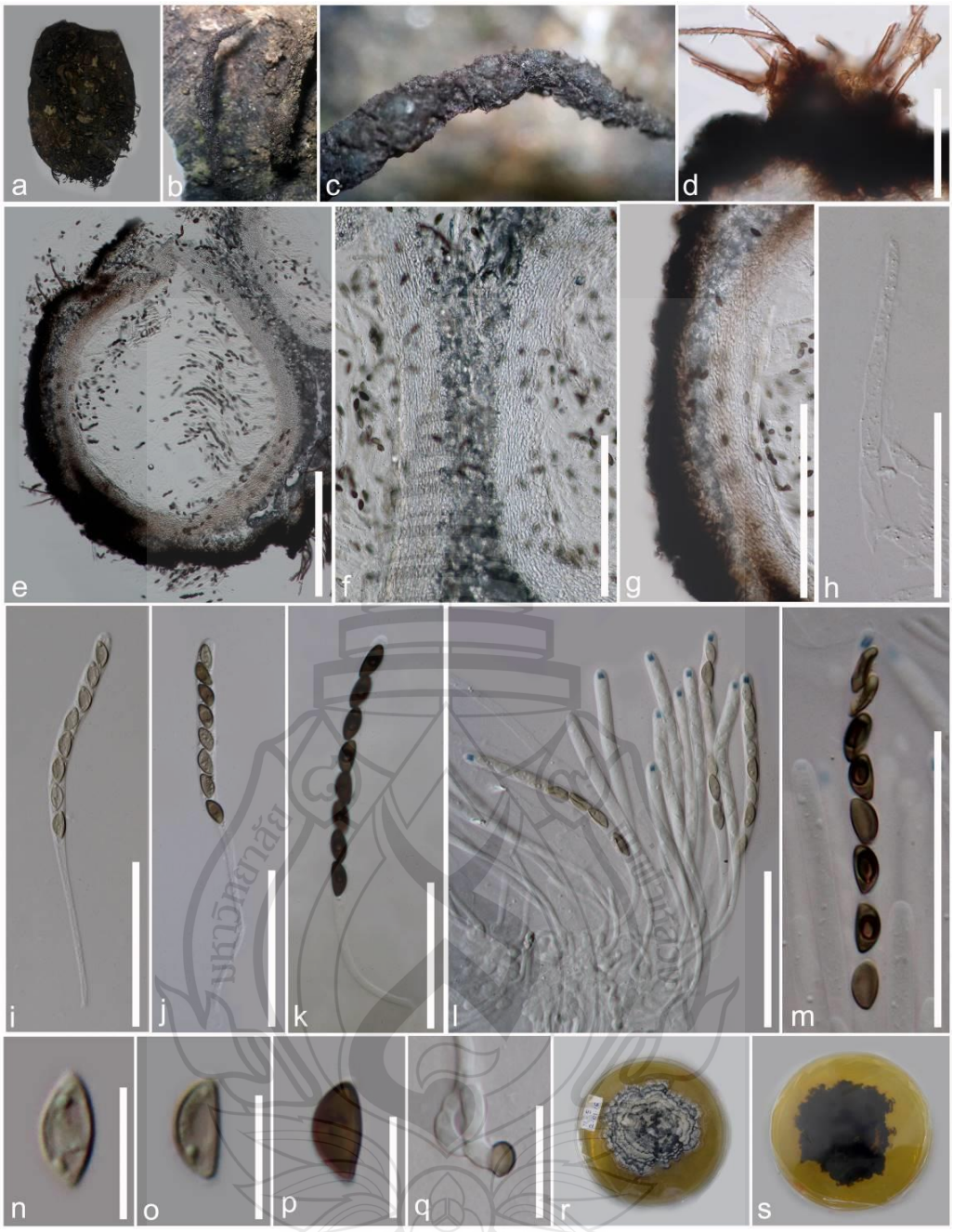
Figure 6.77 *Xylaria fabacearum* (MFLU 16-1061, holotype)

Material examined: THAILAND, Chiang Mai Province, Mushroom Research Center, on decaying seed pods of Fabaceae, 23 December 2015, R. H. Perera, M-8 (MFLU 16-1072, holotype) and ex-type living culture MFLUCC 16-0461.

GenBank numbers: ITS: MT215511, LSU: MT215560, RPB2: MT212201, TUB2: MT212219.

Notes: *Xylaria fabaceicola* (MFLUCC 16-0461) shows close phylogenetic relationship to *X. xanthinovelutina*, *X. culleniae* (which were mostly isolated from leguminous fruits), and *X. juruensis* (Figure 6.74). *Xylaria fabaceicola* can be distinguished by *X. xanthinovelutina* by smaller ascospores (7.5–10 × 3.4–4.8 vs. 9–12 × 3.5–5 µm), and shorter spore-bearing parts of its asci (56–65 vs. 65–85 µm) (Ju et al., 2018). A comparison of the ITS, RPB2 and TUB2 sequences of *X. fabaceicola* and *X. xanthinovelutina* (553 HAST, JF) revealed 13 (2.4%), 13 (1.4%) and 29 (4%) nucleotide differences, respectively, in each DNA locus. *Xylaria fabaceicola* resembles *X. culleniae*, from which it differs by having a smaller stroma (13–25 × 0.6–1.5 mm vs. 55–70 × 2–4 mm) (Ju et al., 2018). In considering morphological and, nucleotide differences in ITS, RPB2 and TUB2 regions, we identified our collection as a new *Xylaria* species.

There are several seed and fruit inhabiting *Xylaria* species, which lack DNA sequence data: *Xylaria duranii*, *X. euphorbiicola*, *X. guazumae*, *X. heloidea*, *X. himalayensis*, *X. jaliscoensis*, *X. patrisiae*, *X. psidii*, *X. rhizocola*, *X. rossmanae* and *X. warburgii* (Ju et al., 2018). We also compared our collections *X. fabacearum* and X. *fabaceicola* with these species based on morphological descriptions provided in Ju et al. (2018).



Note (a) Herbarium material. (b, c) Appearance of ascomata on host substrate. (d) Hairs. (e) Vertical section through stromata with ascoma. (f, g) Peridium. (h) Paraphyses. (i–l) Asci. (l in Melzer's reagent) (m Ascospores showing germ slit. (n–p) Ascospores. (q) Germinating ascospore. (r, s) Colonies on MEA. Scale bars: d = 50 µm, e = 200 µm, f = 100 µm, g–m = 50 µm, n–q = 10 µm.

Figure 6.78 *Xylaria fabaceicola* (MFLU 16-1072, holotype)

6.4 Fungal check list

Table 6.2 Fungi associated with wild seeds and fruits

Species	Taxonomy	Substrate	Host	Country	References
Absidia sp.	Cunninghamellaceae, Mucoromycetes, Mucoromycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Acremoniella atra (Corda) Sacc.	*Incertae sedis*, *Incertae sedis*, Ascomycota	cones, seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		seeds	*Abies lasiocarpa*	Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Festuca rubra*	Canada	Conners (1967)
		seeds	*Lolium perenne*	Canada	Conners (1967)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Acremoniella verrucosa Tognini	*Incertae sedis*, *Incertae sedis*, Ascomycota	seed	*Bromus inermis*	Canada	Conners (1967)
Acremonium alternatum Link	Bionectriaceae, Sordariomycetes, Ascomycota	seeds	*Abies lasiocarpa*	Canada	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Acremonium alternatum Link	Bionectriaceae, Sordariomycetes, Ascomycota	seeds	*Abies lasiocarpa*	Canada	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
Acremonium bacillisporum (Onions and G.L. Barron) W. Gams	Bionectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Acremonium charticola (Lindau) W. Gams	Bionectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Acremonium chilense Morgan-Jones, J.F. White and Piont.[#]	Bionectriaceae, Sordariomycetes, Ascomycota	**seeds**	***Dactylis glomerata***	**Chile**	**Morgan-Jones et al. (1990)**
Acremonium citrinum A. Giraldo, Guarro, Cano and Gené[#]	Bionectriaceae, Sordariomycetes, Ascomycota	**fruit**	**undetermined plant**	**Papua New Guinea**	**Giraldo-López et al. (2014)**
Acremonium spp.	Bionectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
			Ilex cinerea	Hong Kong	Tang, Hyde et al. (2003)
		pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Acrocalymma pterocarpi Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Acrocalymmaceae, Dothideomycetes, Ascomycota	**pod**	***Pterocarpus indicus***	**Thailand**	**Jayasiri et al. (2019)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Acrospeira mirabilis Berk. and Broome	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Acrospeira sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Acrostalagmus luteoalbus (Link) Zare, W. Gams and Schroers [as *Acrostalagmus cinnabarinus Corda*]	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Larix decidua*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1959)
Acrostaphylus lignicola Subram.	Hypoxylaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
Acrothecium tenebrosum (Preuss) Sacc.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Aecidium acanthocarpi J. Walker and van der Merwe[#]	*Incertae sedis*, Pucciniomycetes, Basidiomycota	**fruit**	***Acanthocarpus verticillatus***	**Australia**	**Walker and van der Merwe (2009)**
Agarwalomyces indicus R.K. Verma and Kamal[#**]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**fruits**	**Lythraceae**	**India**	**Verma and Rai (1987)**
Akanthomyces lecanii (Zimm.) Spatafora, Kepler and B. Shrestha	Cordycipitaceae, Sordariomycetes, Ascomycota	seed	*Pinus thunbergii*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
[as *Verticillium lecanii* (Zimm.) Viégas]					
Albifimbria verrucaria (Alb. and Schwein.) L. Lombard and Crous [as *Myrothecium verrucaria* (Alb. and Schwein.) Ditmar]	Stachybotryaceae, Sordariomycetes, Ascomycota	seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Albonectria rigidiuscula (Berk. and Broome) Rossman and Samuels [as *Fusarium rigidiusculum* W.C. Snyder and H.N. Hansen]	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus ponderosa*	USA	James (1983a)
Allomyces anomalus R. Emers.	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Lycium cestroides*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Allophoma siamensis Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Didymellaceae, Dothideomycetes, Ascomycota	**pod**	***Radermachera sinica***	**Thailand**	**Jayasiri et al. (2019)**
Alternaria alternata (Fr.) Keissl.	Pleosporaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		cones	*Picea glauca*	Canada	Mittal and Wang (1987)
		cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		cones, seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	*Magnolia grandiflora*	Thailand	Jayasiri et al. (2019)
		fruits	*Wikstroemia nutans*	Hong Kong	Tang, Hyde et al. (2003)
		pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Abies koreana*	Korea	Cho et al. (2007)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Betula pendula*	Finland, Poland	Lilja (1979), Mittal et al. (1990) and Krol et al. (2015)
		seeds	*Callistephus chinensis*	imported to Taiwan	Wu et al. (2006)
		seeds	*Casuarina equisetifolia*	India	Anju et al. (2012)
		seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
		seeds	*Dahlia* × *hybrida*	imported to Taiwan	Wu et al. (2006)
		seeds	*Dalbergia sissoo*	India	Kumar (2014) and Naz et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Delonix regia*	India	Sahu et al. (2003)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
		seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seeds	*Larix occidentalis*	USA	James et al. (1996)
		seed	*Larix* sp.	Japan	Watanabe (2010)
		seed	*Leucaena leucocephala*	Australia	Nik and Parbery (1977)
		seed	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seed	*Macroptilium lathyroides*	Australia	Nik and Parbery (1977)
		seed	*Macrotyloma axillare*	Australia	Nik and Parbery (1977)
		seed	*Medicago scutellata*	Australia	Nik and Parbery (1977)
		seeds	*Picea abies*	Poland	Krol et al. (2015)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1986, 1987) and Mittal et al. (1990)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seeds	*Pinus wallichiana*	Taiwan	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Primula* × *polyantha*	imported to Taiwan	Wu et al. (2006)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
		seeds	*Quercus robur*	Poland	Krol et al. (2015)
		seeds	*Quercus rubra*	Poland	Krol et al. (2015)
		seeds	*Robinia pseudoacacia*	Hungary	Hangyal-Balul (1983) and Mittal et al. (1990)
		seed	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
		seeds	*Tagetes patula*	imported to Taiwan	Wu et al. (2006)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)
		seed	*Trifolium semipilosum*	Australia	Nik and Parbery (1977)
		seeds	*Viola wittrockiana*	imported to Taiwan	Wu et al. (2006)
Alternaria arbusti E.G. Simmons	Pleosporaceae, Dothideomycetes, Ascomycota	pod	*Sesbania bispinosa*	India	Anita et al. (2009)
Alternaria atra (Preuss) Woudenb. and Crous [as *Stemphylium atrum* (Preuss) Sacc.]	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Alternaria atra (Preuss) Woudenb. and Crous [as *Ulocladium atrum* Preuss]		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Callistephus chinensis*	imported to Taiwan	Wu et al. (2006)
		seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)
		seeds	*Dahlia* × *hybrida*	imported to Taiwan	Wu et al. (2006)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Medicago sativa*	Australia	Nik and Parbery (1977)
		seeds	*Primula malacoides*	imported to Taiwan	Wu et al. (2006)
		seeds	*Tagetes patula*	imported to Taiwan	Wu et al. (2006)
Alternaria botrytis (Preuss) Woudenb. and Crous [as *Ulocladium botrytis* Preuss]	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
Alternaria brassicae (Berk.) Sacc.	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Alternaria chartarum Preuss [as *Ulocladium chartarum* (Preuss) E.G. Simmons]	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
Alternaria circinans (Berk. and M.A. Curtis) P.C. Bolle	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Alternaria citri (Penz.) Mussat	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
Alternaria consortialis (Thüm.) J.W. Groves and S. Hughes	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Agropyron cristatum*	Canada	Conners (1967)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Apium graveolens*	Canada	Conners (1967)
		seeds	*Medicago sativa*	Canada	Conners (1967)
		seed	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seed	*Quercus robur*	Poland	Krol et al. (2015)
		seed	*Quercus rubra*	Poland	Krol et al. (2015)
Alternaria consortialis (Thüm.) J.W. Groves and S. Hughes [as *Stemphylium consortiale* (Thüm.) J.W. Groves and Skolko]		seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
Alternaria cosmosa Y.S. Li and W.S. Wu[#]	Pleosporaceae, Dothideomycetes, Ascomycota	**seeds**	***Cosmos sulphureus***	imported to Taiwan, **Taiwan**	**Wu and Li (2005)** and Wu et al. (2006)
Alternaria danida E.G. Simmons[#]	Pleosporaceae, Dothideomycetes, Ascomycota	**seeds**	***Ageratum houstonianum***	**Italy**	**Simmons (1997)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Alternaria dianthi J.V. Almeida and Sousa da Câmara	Pleosporaceae, Dothideomycetes, Ascomycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
Alternaria dianthicola Neerg.	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
Alternaria ellipsoidea E.G. Simmons[#]	Pleosporaceae, Dothideomycetes, Ascomycota	**seeds**	***Dianthus barbatus***	**USA**	**Simmons (2002)**
Alternaria eryngii (Pers.) S. Hughes and E.G. Simmons	Pleosporaceae, Dothideomycetes, Ascomycota	pod	*Sesbania bispinosa*	India	Anita et al. (2009)
Alternaria graminicola E.G. Simmons[#]	Pleosporaceae, Dothideomycetes, Ascomycota	**grain**	**Poaceae plant [as Gramineae]**	**UK**	**Simmons (2007)**
Alternaria humicola Oudem.	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Alternaria infectoria E.G. Simmons	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Alternaria infectoria E.G. Simmons [as *Lewia infectoria* (Fuckel) M.E. Barr and E.G. Simmons]		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
Alternaria iridicola (Ellis and Everh.) J.A. Elliott	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Alternaria jesenskae Lzbuda, P. Elias and Sterfl.[#]	Pleosporaceae, Dothideomycetes, Ascomycota	**seeds**	***Fumana procumbens***	**Slovakia**	**Labuda et al. (2008)**
Alternaria linicola J.W. Groves and Skolko[#]	Pleosporaceae, Dothideomycetes, Ascomycota	**seeds**	***Linum usitatissimum***	**Canada**	**Groves and Skolko (1944)** and Conners (1967)
Alternaria longipes (Ellis and Everh.) E.W. Mason	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
Alternaria longissima Deighton and MacGarvie	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Alternaria maritima G.K. Sutherl.	Pleosporaceae, Dothideomycetes, Ascomycota	fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
Alternaria patula H.C. Wu and W.S. Wu[#]	Pleosporaceae, Dothideomycetes, Ascomycota	**seeds**	***Tagetes patula***	imported to Taiwan, **Taiwan**	**Wu and Wu (2005)** and Wu et al. (2006)
Alternaria peponis Yatel	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Alternaria oudemansii (E.G. Simmons) Woudenb. and Crous [as *Ulocladium oudemansii* E.G. Simmons]	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Alternaria radicina Meier, Drechsler and E.D. Eddy	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Alternaria ranunculi E.G. Simmons[#]	Pleosporaceae, Dothideomycetes, Ascomycota	**seeds**	***Ranunculus* sp.**	**Israel**	**Simmons (2007)**
Alternaria raphani J.W. Groves and Skolko	Pleosporaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Alternaria resedae Neerg.[#]	Pleosporaceae, Dothideomycetes, Ascomycota	**seeds**	***Reseda odorata***	**Denmark**	**Neergaard (1945)**
Alternaria spp.	Pleosporaceae, Dothideomycetes, Ascomycota	cones, seeds	*Pinus nigra*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus nigra* ssp. *nigra*	Canada	Vujanovic et al. (2000)
Alternaria spp. [as *Ulocladium* spp.]		cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		seeds	*Acer saccharum*	USA	Mittal et al. (1990) and Janerette (1979)
		seed	*Larix kaempferi*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
Alternaria sp. [as *Lewia* sp.]		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
		cones, seeds	*Pinus sylvestris* 'Fastigiata'	Canada	Vujanovic et al. (2000)
		pod	*Colophospermum mopane*	Southern Africa	Jordaan et al. (2006)
		seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Acer saccharum*	USA	Janerette (1979) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Natarajan et al. (2003)
		seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria heterophylla*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Betula alleghaniensis*	USA	Shigo and Yelenosky (1963) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Betula papyrifera*	USA	Smoot and Segall (1963)
		seeds	*Cupressus arizonica*	Uruguay	Anderson (1986a)
		seeds	*Cupressus macrocarpa*	Uruguay	Anderson (1986a)
		seeds	*Cupressus torulosa*	Uruguay	Anderson (1986a)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seeds	*Enterolobium contortisiliquum*	Uruguay	Anderson (1986a)
		seeds	*Eucalyptus grandis*	South Africa, Uruguay	Anderson (1986a) and Jimu et al. (2016)
		seeds	*Eucalyptus maidenii*	Uruguay	Anderson (1986a)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
		seeds	*Picea engelmannii*	USA	Fuller and Hildebrand (1985)
		seeds	*Picea sitchensis*	UK	Salt (1964), Mittal et al. (1990)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay, USA	Anderson (1986a) and Fraedrich and Miller (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus nigra*	Hungary	Hangyal (1973) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Hungary	Hangyal (1973) and Mittal et al. (1990)
		seeds	*Pinus taeda*	Georgia, USA	Anderson (1986a, b) and Huang and Kuhlman (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)
		seeds	*Quercus robur*	Turkey	Oskay et al. (2018)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Alternaria tenuis Nees	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Agrostis gigantea*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Albizia falcataria*	Philippines	Agmata (1979) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Natarajan et al. (2003)
		seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria heterophylla*	Egypt	El-Kady et al. (1986) and Mittal et al. (1990)
		seed	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971), Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	Bangladesh	Mittal et al. (1990)
		seed	*Bromus inermis*	Canada	Conners (1967)
		seeds	*Callistephus chinensis*	China	Gloyer (1931) and Crosier and Heit (1948)
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia fistula*	India	Mittal and Sharma (1981a) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cedrus deodara*	India, Uruguay	Munjal and Sharma (1975)
		seed	*Dactylis glomerata*	Canada	Conners (1967)
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b) and Mittal et al. (1990)
		seed	*Elymus virginicus*	Canada	Conners (1967)
		seeds	*Eucalyptus camaldulensis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Hungary	Mittal et al. (1990)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seed	*Festuca rubra*	Canada	Conners (1967)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Gmelina arborea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Larix decidua*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Lobelia erinus*	UK	Hall and Taylor (1983) and Mittal et al. (1990)
		seed	*Lolium perenne*	Canada	Conners (1967)
		seed	*Medicago sativa*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Phleum pratense*	Canada	Conners (1967)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus insularis*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seed	*Poa compressa*	Canada	Conners (1967)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
		seed	*Salvia officinalis*	Canada	Conners (1967)
		seed	*Setaria viridis*	Canada	Conners (1967)
Alternaria tenuissima (Kunze) Wiltshire	Pleosporaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seeds	*Betula pendula*	Finland	Lilja (1979) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
		seed	undetermined plant	India	Goswami and Ojha (2004)
Amorocoelophoma cassiae Jayasiri, E.B.G. Jones and K.D. Hyde[#**]	Amorosiaceae, Dothideomycetes, Ascomycota	**pod**	***Cassia* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Anisogenispora insignissima S.M. Leão, Gusmão and R.F. Castañeda[#**]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**fruit**	**dicotyledonous plant**	**Brazil**	**Leão-Ferreira et al. (2018)**
Anteaglonium gordoniae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Anteagloniaceae, Dothideomycetes, Ascomycota	**capsule**	***Gordonia* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Antennospora quadricornuta (Cribb and J.W. Cribb) T.W. Johnso	Halosphaeriaceae, Sordariomycetes, Ascomycota	fruit	undetermined plant	Panama	Schmitt and Shearer (2003)
Anthostomella clypeata (De Not.) Sacc.	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
Anthracoidea multicaulis Vánky and Salo[#]	Anthracoideaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Carex multicaulis***	**USA**	**Vánky and Salo (2011)**
Apiocarpella sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
Aplosporella dryobalonopis S.N.S. Srivast.[#]	Aplosporellaceae, Dothideomycetes, Ascomycota	**fruit**, seeds	***Dryobalanops aromatica***	**Malaysia**	**Srivastava (1956a)** and Mittal et al. (1990)
Aposphaeria sp.	Melanommataceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Arachnophora fagicola Hennebert[#]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**cupules**	***Fagus sylvatica***	**Belgium**	**Hennebert (1963)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Arachnophora hughesii R.F. Castañeda and Guarro[#]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**pod**	***Samanea saman***	**Cuba**	**Castañeda-Ruíz and Guarro (1998)**
Arcopilus aureus (Chivers) X.Wei *aureum* Chivers]	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Gossypium* sp.	Pakistan	Lodhi and Naeem (1955)
Archephoma cycadeoidellae K. Watan., H. Nishida and Tak. Kobay[#**]	Fossil fungus	**cone**	***Cycadeoidella japonica***	**Japan**	**Watanabe et al. (1999)**
Arthrinium spp.	Apiosporaceae, Sordariomycetes, Ascomycota	fruits	*Rhodomyrtus tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seed	*Gentiana* sp.	Japan	Watanabe (2010)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
		seeds	*Chamaecyparis obtusa*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Abies koreana*	Korea	Cho et al. (2007)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
Arthrobotrys arthrobotryoides (Berl.) Lindau	Orbiliaceae, Orbiliomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Arthrobotrys oligosporus Fresen.	Orbiliaceae, Orbiliomycetes, Ascomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
Arthrobotrys superbus Corda	Orbiliaceae, Orbiliomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Arthrobotrys superbus* var. *oligosporus (Fresen.) Coem.	Orbiliaceae, Orbiliomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Arxotrichum succineum (L.M. Ames) A. Nováková and M. Kolařík [as *Chaetomium succineum* L.M. *succineum* L.M. Ames]	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
Ascochyta agropyrina (Fairm.) Trotter	Didymellaceae, Dothideomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
Ascochyta conorum Henn.	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Ascochyta fagi Woron.	Didymellaceae, Dothideomycetes, Ascomycota	fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012) and Tateno et al. (2015)
Ascochyta spp.	Didymellaceae, Dothideomycetes, Ascomycota	fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		seeds	*Acer palmatum*	South Korea	Mathur (1974), Anderson (1986a)
Ascomycetes	Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
Ascotricha sp.	Xylariaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Aspergillus aculeatus Iizuka	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Delonix regia*	India	Sahu et al. (2003)
Aspergillus aculeatus [as '*occuleatus*']	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
Aspergillus amstelodami Thom and Church	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Aspergillus caespitosus Raper and Thom	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b)
Aspergillus candidus Link	Aspergillaceae, Eurotiomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Leucaena leucocephala*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
Aspergillus candidus Link [as *Aspergillus candidum*]		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Aspergillus carneus Blochwitz	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
Aspergillus chevalieri Thom and Church	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
Aspergillus clavatus Desm.	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Albizia lebbeck*	India	Mittal and Sharma (1982a) and Natarajan et al. (2003)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Aspergillus delicatus H.Z. Kong[#]	Aspergillaceae, Eurotiomycetes, Ascomycota	**fruit**	**undetermined plant**	**China**	**Kong 1997**
Aspergillus flavipes (Bainier and R. Sartory) Thom and Church	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
Aspergillus flavus Link	Aspergillaceae, Eurotiomycetes, Ascomycota	fruit	*Artocarpus communis*	Nigeria	Amusa et al. (2002)
		fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
		pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Acacia auriculiformis*	Philippines, Thailand	Quiniones (1985, 1987), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Agathis philippinensis*	Philippines	Quiniones (1987)
		seeds	*Agathis robusta*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Albizia falcataria*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Albizia julibrissin*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India, Philippines	Quiniones (1985, 1987), Mittal et al. (1990) and Natarajan et al. (2003)
		seeds	*Albizia procera*	Philippines	Dayan (1986), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Alstonia macrophylla*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Anthocephalus chinensis*	Philippines	Quiniones (1987)
		seeds	*Antidesma ghaesembilla*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Bauhinia acuminata*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bombax anceps*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	Bangladesh	Mittal et al. (1990)
		seeds	*Calamus ornatus*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cassia fistula*	India, Thailand	Mittal and Sharma (1981a) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines, Thailand	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975)
		seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Dalbergia cochinchinensis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b), Mittal et al. (1990) and Kumar (2014)
		seeds	*Delonix regia*	India	Sahu et al. (2003)
		seeds	*Eucalyptus alba*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus deglupta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Gliricidia sepium*	Philippines	Dayan (1986, 1987) and Mittal et al. (1990)
		seeds	*Gmelina arborea*	Philippines, Thailand	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Lagerstroemia speciosa*	Philippines	Dayan (1986, 1987) and Anderson (1986a)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seed	*Leucaena leucocephala*	Australia, Bangladesh, Philippines	Nik and Parbery (1977), Quiniones (1985, 1987), Mittal et al. (1990) and Islam et al. (2008)
		seed	*Medicago truncatula*	Australia	Nik and Parbery (1977)
		seeds	*Melia azedarach*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Parkia roxburghii*	Philippines	Dayan (1986) and Anderson (1986a)
		seeds	*Parkia roxburghii*	Philippines	Quiniones (1987)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Piliostigma malabaricum*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Piliostigma malabaricum*	Philippines	Quiniones (1987)
		seeds	*Pinus caribaea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus merkusii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Poland, USSR	Garbowski (1936) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India, Pakistan	Munjal and Sharma (1975), Mittal et al. (1990) and Farooq (2000)
		seeds	*Pittosporum resiniferum*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Pterocarpus indicus*	Philippines	Quiniones (1987)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Samanea saman*	Philippines, Thailand	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Serialbizzia acle*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seed	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Sesbania grandiflora*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Shorea robusta*	India, Thailand	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
		seeds	*Swietenia macrophylla*	Philippines	Dayan (1986), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
		seeds	*Toona calantas*	Philippines	Quiniones (1987)
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Wallaceodendron celibcum*	Philippines	Dayan (1986), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Xylia xylocarpa* var. *kerrii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Aspergillus flavus* var. *oryzae (Ahlb.) Kurtzman, M.J. Smiley, Robnett and Wicklow	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus kesiya*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Aspergillus fumigatus Fresen.	Aspergillaceae, Eurotiomycetes, Ascomycota	fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
		pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Albizia lebbeck*	India	Natarajan et al. (2003)
		seeds	*Atropa belladonna* var. *lutea*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cassia fistula*	India	Mittal and Sharma (1981a) and Mittal et al. (1990)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Delonix regia*	India	Sahu et al. (2003)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus deglupta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Leucaena leucocephala*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seed	*Peltophorum pterocarpum* [= *Peltophorum ferrugineum*]	India	Goswami and Ojha (2004)
		seeds	*Pinus merkusii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Rhamnus purshiana*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
		seed	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Shorea robusta*	Thailand	Mittal and Sharma (1982b) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Aspergillus funiculosus G. Sm.	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Aspergillus glaucus (L.) Link	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	Bangladesh	Mittal et al. (1990)
		seed	*Leucaena leucocephala*	Australia	Nik and Parbery (1977)
		seed	*Lotononis angolensis*	Australia	Nik and Parbery (1977)
		seed	*Medicago truncatula*	Australia	Nik and Parbery (1977)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)
		seed	*Stylosanthes gracilis*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Aspergillus glaucus (L.) Link [as *Aspergillus glauca*]		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
Aspergillus humicola Chaudhuri and Sachar	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Aspergillus janus Raper and Thom	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus wallichiana*	Pakistan	Farooq (2000)
Aspergillus koningii Oudem.	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Mittal (1983)
Aspergillus koningii Oudem. [as'*koninge*']		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Aspergillus luchuensis Inui	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Aspergillus nidulans (Eidam) G. Winter	Aspergillaceae, Eurotiomycetes, Ascomycota	fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Linum usitatissimum*	Canada	Conners (1967)
Aspergillus niger Tiegh.	Aspergillaceae, Eurotiomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008) and Krol et al. (2015)
		fruit	*Artocarpus communis*	Nigeria	Amusa et al. (2002)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Rhodomyrtus tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
		pod, seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pod, seed	*Sesbania bispinosa*	India	Anita et al. (2009)
		pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Acacia auriculiformis*	Philippines, Thailand	Quiniones (1985, 1987), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Albizia falcataria*	Philippines	Dayan (1986) and Quiniones (1987) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Albizia julibrissin*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India, Philippines	Dayan (1986), Quiniones (1987), Mittal et al. (1990), Natarajan et al. (2003) and Mohanan et al. (2005)
		seeds	*Albizia procera*	Philippines	Dayan (1986), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Atropa belladonna* var. *caucasica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Bauhinia acuminata*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Bombax anceps*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	Bangladesh	Mittal et al. (1990)
		seeds	*Calamus ornatus*	Philippines	Quiniones (1987)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia fistula*	India, Thailand	Mittal and Sharma (1981a)
		seeds	*Cassia siamea*	Philippines, Thailand	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	India, Philippines, Thailand	Anderson (1986a), Quiniones (1985, 1987), Mittal et al. (1990) and Anju et al. (2012)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Dalbergia cochinchinensis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Kumar (2014), Mittal and Sharma (1981b), Mittal et al. (1990) and Mohanan et al. (2005)
		seeds	*Eucalyptus alba*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus deglupta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Gliricidia sepium*	Philippines	Dayan (1986), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Gmelina arborea*	Philippines, Thailand	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Holarrhena antidysenterica*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Lagerstroemia calyculata*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Larix decidua*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Leucaena leucocephala*	Bangladesh, Philippines, Thailand	Quiniones (1985, 1987), Mittal et al. (1990) and Islam et al. (2008)
		seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seeds	*Melia azedarach*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Parkia roxburghii*	Philippines	Quiniones (1987)
		seeds	*Picea abies*	Poland, USSR	Prisyazhnyuk (1960), Mittal et al. (1990) and Krol et al. (2015)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Piliostigma malabaricum*	Philippines	Quiniones (1985) and Anderson (1986a, 1987)
		seeds	*Pinus caribaea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia	Huang and Kuhlman (1990)
		seeds	*Pinus kesiya*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Pinus oocarpa*	Honduras	Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus sylvestris*	Poland, USSR	Urosevic (1961), Anderson (1986a) and Krol et al. (2015)
		seeds	*Pinus taeda*	Georgia	Huang and Kuhlman (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pittosporum resiniferum*	Philippines	Dayan (1986), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)
		seeds	*Pterocarpus indicus*	Philippines	Quiniones (1987)
		seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
		seeds	*Ribes aureus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rosa mollis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Samanea saman*	Philippines, Thailand	Quiniones (1985), Anderson (1986a) and Mittal et al. (1990, 1987)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
		seeds	*Sesbania grandiflora*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Shorea robusta*	India, Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Shorea* spp.	India	Singh et al. (1979) and Mittal et al. (1990)
		seeds	*Swietenia macrophylla*	Philippines	Dayan (1986), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)
		seeds	*Toona calantas*	Philippines	Quiniones (1987)
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985) and Anderson (1986a, 1987)
		seeds	*Xylia xylocarpa* var. *kerrii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Aspergillus niger* var. *niger Tiegh.	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Delonix regia*	India	Sahu et al. (2003)
Aspergillus ochraceus G. Wilh.	Aspergillaceae, Eurotiomycetes, Ascomycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seed	*Abies balsamea*	Canada	Conners (1967)
		seeds	*Albizia lebbeck*	India	Mittal and Sharma (1982a) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	Bangladesh	Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seeds	*Cassia fistula*	India	Mittal and Sharma (1981a) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b) and Mittal et al. (1990)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus kesiya*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Aspergillus ochraceus G. Wilh. [as '*ochraceum*']		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
Aspergillus oryzae (Ahlb.) Cohn	Aspergillaceae, Eurotiomycetes, Ascomycota	pod, seed	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Picea excelsa*	USSR	Urosevic (1961), Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
Aspergillus parasiticus Speare	Aspergillaceae, Eurotiomycetes, Ascomycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seed	*Sesbania bispinosa*	India	Anita et al. (2009)
Aspergillus phoenicis (Corda) Thom and Currie	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Albizia lebbeck*	India	Mittal and Sharma (1982a) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
Aspergillus repens (Corda) Sacc.	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seed	*Setaria viridis*	Canada	Conners (1967)
Aspergillus restrictus G. Sm.	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Holarrhena antidysenterica*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Lagerstroemia calyculata*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Aspergillus ruber (Jos. König, Spieck. and W. Bremer) Thom and Church	Aspergillaceae, Eurotiomycetes, Ascomycota	seed	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Aspergillus spinulosporus Hubka, S.W. Peterson and M. Kolařík [as *Aspergillus nidulans* var. *echinulatus* Fennell and Raper]	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Casuarina* spp., *Pyrus* spp.	India	Sahai and Otra (1982)
Aspergillus spp.	Aspergillaceae, Eurotiomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Acacia confusa*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Albizia falcataria*	Philippines	Agmata (1979) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Mohanan et al. (2005)
		seeds	*Albizia procera*	Philippines	Agmata (1979), Anderson (1986a) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Anthocephalus chinensis*	Philippines	Agmata (1979) and Mittal et al. (1990)
		seeds	*Araucaria heterophylla*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Azadirachta indica*	Malaysia	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Betula alleghaniensis*	USA	Smoot and Segall (1963) and Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Friedrich (1969) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	India	Mittal et al. (1990)
		seeds	*Canavalia cathartica*	India	Anita and Sridhar (2009) and Seena and Sridhar (2004)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seeds	*Delonix regia*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
		seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
		seeds	*Eucalyptus globulus*	India	Anderson (1986a)
		seeds	*Eucalyptus grandis*	India	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus tereticornis*	India	Anderson (1986a)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Gmelina arborea*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Larix occidentalis*	USA	James et al. (1996)
		seeds	*Leucaena leucocephala*	Philippines	Agmata (1979), Anderson (1986a)
		seeds	*Manilkara bidentata*	USA	Bayman et al. (1998)
		seeds	*Picea engelmannii*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus elliottii*	Taiwan, USA	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus luchuensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus merkusii*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus nigra*	Hungary	Hangyal (1973) and Mittal et al. (1990)
		seeds	*Pinus patula*	East Africa	Gibson (1957) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus sylvestris*	Hungary, UK	Hangyal (1973), Whittle (1977) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Mason and van Arsdel (1978) and Anderson (1986a)
		seeds	*Pinus taiwanensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seeds	*Pinus thunbergii* [= *Pinus thunbergiana*]	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada, USA	Bloomberg (1966), Gordon (1967) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pseudotsuga menziesii*	Canada	Bloomberg (1966)
		seeds	*Sesbania grandiflora*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Tectona grandis*	India	Anderson (1986a) and Mohanan et al. (2005)
		seeds	*Vitex parviflora*	Philippines	Agmata (1979) and Anderson (1986a)
Aspergillus sulphureus Desm.	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
Aspergillus sulphureus Desm. [as '*sulphureous*']		seeds	*Albizia lebbeck*	India	Mittal and Sharma (1982a) and Mittal et al. (1990)
		seeds	*Cassia fistula*	India	Mittal and Sharma (1981a) and Mittal et al. (1990)
Aspergillus sydowii (Bainier and Sartory) Thom and Church	Aspergillaceae, Eurotiomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Aspergillus sydowii (Bainier and Sartory) Thom and Church [as '*sydowi*']		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Albizia lebbeck*	India	Mittal and Sharma (1982a) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seed	*Stylosanthes gracilis*	Australia	Nik and Parbery (1977)
Aspergillus tamarii Kita	Aspergillaceae, Eurotiomycetes, Ascomycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Leucaena leucocephala*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus patula*	Kenya	Gibson (1957) and Mittal et al. (1990)
		seed	*Sesbania bispinosa*	India	Anita et al. (2009)
Aspergillus terreus Thom	Aspergillaceae, Eurotiomycetes, Ascomycota	pod	*Sesbania bispinosa*	India	Anita et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Acacia auriculiformis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bombax anceps*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Thailand	Quiniones (1985) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	India	Anju et al. (2012)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia	Huang and Kuhlman (1990)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
Aspergillus terricola Marchal and É.J. Marchal	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Aspergillus unguis (Émile-Weill and L. Gaudin) Thom and Raper	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
Aspergillus ustus (Bainier) Thom and Church	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Delonix regia*	India	Sahu et al. (2003)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
Aspergillus variecolor (Berk. and Broome) Thom and Raper	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Albizia lebbeck*	India	Mittal and Sharma (1982a) and Mittal et al. (1990)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seed	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
		seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus kesiya*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
		seeds	*Xylia xylocarpa* var. *kerrii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Aspergillus wentii Wehmer	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Albizia lebbeck*	India	Mittal and Sharma (1982a) and Mittal et al. (1990)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Asteroma sp.	Gnomoniaceae, Sordariomycetes, Ascomycota	fruits	*Ardisia qinquegona*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
Asteromella sp.	*Incertae sedis*, Dothideomycetes, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Atrocalyx krabiensis Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Lophiotremataceae, Dothideomycetes, Ascomycota	**pods**	***Acacia* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Aureobasidium melanogenum (Herm.-Nijh.) Zalar, Gostinčar and Gunde-Cim. [as *Aureobasidium pullulans* var. *melanogenum* Herm.-Nijh.]	Saccotheciaceae, Dothideomycetes, Ascomycota	pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
Aureobasidium pullulans (de Bary and Löwenthal) G. Arnaud	Saccotheciaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		cones	*Picea glauca*	Canada	Mittal and Wang (1987)
		cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		cones	*Pinus strobus*	Canada	Mittal and Wang (1987)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Agrostis gigantea*	Canada	Conners (1967)
		seed	*Anethum graveolens*	USA	Conners (1967)
		seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seed	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)
		seeds	*Betula pendula*	Finland	Lilja (1979) and Mittal et al. (1990)
		seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seed	*Dactylis glomerata*	Canada	Conners (1967)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seed	*Festuca rubra*	Canada	Conners (1967)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
		seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Lolium perenne*	Canada	Conners (1967)
		seed	*Medicago sativa*	Canada	Conners (1967)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus ponderosa*	USA	Fuller and Hildebrand (1985)
		seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
Aureobasidium pullulans* var. *aubasidani Yurlova	Saccotheciaceae, Dothideomycetes, Ascomycota	pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
Aureobasidium spp.	Saccotheciaceae, Dothideomycetes, Ascomycota	seeds	*Acer saccharum*	USA	Janerette (1979) and Mittal et al. (1990)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013) and Hayatgheibi (2013)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
		seeds	*Picea engelmannii*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus ponderosa*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)
Austropleospora keteleeriae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	**cone**	***Keteleeria fortunei***	**China**	**Jayasiri et al. (2019)**
Basidiomycete	Basidiomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Corallorhiza striata*	Canada	Zelmer et al. (1996)
		seeds	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Platanthera hyperborea*	Canada	Zelmer et al. (1996)
		seeds	*Quercus robur*	Turkey	Oskay et al. (2018)
Basipetospora rubra G.T. Cole and W.B. Kendr.	Monascaceae, Eurotiomycetes, Ascomycota	**seed**	***Pinus thunbergii***	**Japan**	**Watanabe (2010)**
Beauveria sp.	Cordycipitaceae, Sordariomycetes, Ascomycota	seed	*Pinus monticola*	USA	Ganley and Newcombe (2006)
Beltrania rhombica Penz.	Beltraniaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Beltrania santapaui Piroz. and S.D. Patil	Beltraniaceae, Sordariomycetes, Ascomycota	seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
Beltrania spp.	Beltraniaceae, Sordariomycetes, Ascomycota	fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
Beltraniella vateriae K. Swapna, Nagaveni, Kunwar and Manohar.[#]	Beltraniaceae, Sordariomycetes, Ascomycota	**seeds**	***Vateria indica***	**India**	**Priya et al. (2011)**
Bhadradriella hyalina Nagaraju, Kunwar and Manohar.[#]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**pods**	***Roystonea regia***	**India**	**Nagaraju et al. (2011a)**
Biflagellosporella amazonensis Matsush.[#]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**fruit**	***Inga* sp.**	**Peru**	**Matsushima (1993)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Bipolaris setariae Shoemaker	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Setaria viridis*	Canada	Conners (1967)
Bipolaris sorokiniana Shoemaker	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Elymus virginicus*	Canada	Conners (1967)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Lolium perenne*	Canada	Conners (1967)
		seed	*Setaria viridis*	Canada	Conners (1967)
Bipolaris sp.	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Bispora antennata (Pers.) E.W. Mason	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus kesiya*	Thailand	Chalermpongse et al. (1984)
Bispora betulina (Corda) S. Hughes	*Incertae sedis*, *Incertae sedis*, Ascomycota	seed	*Gentiana* sp.	Japan	Watanabe (2010)
Bispora sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Black sterile mycelium	Fungi	seeds	*Albizia lebbeck*	India	Mohanan et al. (2005)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)
Blakeslea trispora Thaxt.	Choanephoraceae, Mucoromycetes, Mucoromycota	seeds	*Crataegus azarolus*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Blastocladia angusta A. Lund	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Celtis tenuifolia*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cephalotaxus drupacea*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cornus sanguinea*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lonicera caprifolium*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Blastocladia arborata S.N. Dasgupta and R. John[#]	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	**fruits**	**myrtaceous plant**	**India**	**Das-Gupta and John (1988)**
Blastocladia globosa Kanouse	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Arum korolkowii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Bryonia cretica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Juniperus communis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Juniperus oxycedrus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Opuntia ficus-indica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sorbus torminalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Trifolium pratense*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Vicia sativa*	Poland	Kiziewicz (2005)
Blastocladia gracilis Kanouse	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Cornus capitata*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Lonicera etrusca*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lonicera periclymenum*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rhamnus purshiana*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rhus copallina*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rosa mollis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Blastocladia pringsheimii Reinsch	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Celtis tenuifolia*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Juniperus communis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lycium chinense*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Blastocladia ramosa Thaxt.	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Ginkgo biloba*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Humulus lupulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Humulus scandens*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ilex verticillata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lonicera etrusca*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rhododendron nipponicum*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Blastocladia sessilis S.N. Dasgupta and R. John[#]	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	**various submerged fruits**	**undetermined plants**	**India**	**Das-Gupta and John (1988)**
Blastocladiella emersonii Cantino and Hyatt	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Zantedeschia albo-maculata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Blastocladiella microcystogena Whiffen	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Bryonia dioica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Blastocladiella stuebenii Couch and Whiffen	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Daphne gnidium*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Opuntia ficus-indica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Blastocladiopsis parva Whiffen ex Sparrow	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Atropa komarovii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Bryonia dioica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Conium maculatum*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Humulus*	Poland or/ imported to	Czeczuga et al. (2009)
		seeds	*Humulus scandens*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sambucus ebulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Vicia sativa*	Poland	Kiziewicz (2005)
Blyttiomyces laevis Sparrow	*Incertae sedis*, Chytridiomycetes, Chytridiomycota	seeds	*Atropa belladonna*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Boeremia linicola (Naumov and Vassiljevsky) Jayawardena, Jayasiri and K.D. Hyde [as *Ascochyta linicola* Naumov and Vassiljevsky]	Didymellaceae, Dothideomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)
Boothiomyces macroporosus (Karling) Letcher [as *Rhizophydium macroporosum* Karling]	Terramycetaceae, Rhizophydiomycetes, Chytridiomycota	seeds	*Asparagus officinalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Paris quadrifolia*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Botryocrea sclerotioides (Höhn.) Petr.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
Botryodiplodia acicola (Sacc.) Petr.	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Pinus sylvestris*	UK	Whittle (1977)
Botryodiplodia palmarum (Cooke) Petr. and Syd.	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
Botryodiplodia ribis (Schulzer and Sacc.) Namysł.	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Pinus oocarpa*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
Botryodiplodia spp.	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Adenanthera microsperma*	India	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria bidwillii*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	India	Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines	Mathur (1974) and Mittal et al. (1990)
		seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seeds	*Eucalyptus grandis*	Uruguay	Mathur (1974) and Anderson (1986a)
		seeds	*Ficus benjamina*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Leucaena* spp.	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus caribaea*	Madagascar	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus elliottii*	USA	Mathur (1974) and Mittal et al. (1990)
		seeds	*Pinus khasya*	Madagascar	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Shorea assamica*	Malaysia	Hong (1981) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Botryodiplodia theobromae Pat. = *Lasiodiplodia theobromae* (Pat.) Griffon and Maubl.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	fruit	*Artocarpus communis*	Nigeria	Amusa et al. (2002)
		fruits	*Alocasia odora*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ardisia punctata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Bridelia tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
		seeds	*Acacia auriculiformis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Acacia confusa*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Acrocarpus fraxinifolius*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Albizia falcataria*	Philippines	Dayan (1986) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Cordia alliodora*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Dalbergia cochinchinensis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Grevillea robusta*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Hevea* sp.	Malaysia	Edwards and Sutherland (1979) and Mittal et al. (1990)
		seeds	*Hevea brasiliensis*	India	Srivastava (1964) and Mittal et al. (1990)
		seeds	*Holarrhena antidysenterica*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Leucaena leucocephala*	Thailand	Quiniones (1985) and Mittal et al. (1990)
		seeds	*Melia azedarach*	Thailand	Chalermpongse et al. (1984)
		seeds	*Pinus* spp.	Nicaragua	Richardson (1983) and Anderson (1986a)
		seeds	*Pinus caribaea*	Guatemala, Nicaragua, Honduras	Mathur (1974)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus merkusii*	Philippines, Thailand	Agmata (1979), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus oocarpa*	Central America, UK	Rees (1982), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Swietenia macrophylla*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Tectona grandis*	-	Mathur (1974) and Anderson (1986a)
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Acacia auriculiformis*	Philippines	Quiniones (1987)
		seeds	*Albizia falcataria*	Philippines	Quiniones (1987)
		seeds	*Albizia julibrissin*	Philippines	Quiniones (1987)
		seeds	*Leucaena leucocephala*	Bangladesh, Philippines	Quiniones (1987) and Islam et al. (2008)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1987)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)
Botryosphaeria dothidea (Moug.) Ces. and De Not.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	cones	*Pinus patula*	South Africa	Smith et al. (1996)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		cones	*Pinus radiate*	South Africa	Smith et al. (1996)
Botryosphaeria spp.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	fruits	*Ardisia punctata*	Hong Kong	Tang and Hyde et al. (2003)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Botryosphaeria stevensii Shoemaker	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
Botryotinia fuckeliana (de Bary) Whetzel	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Botryotrichum sp.	Chaetomiaceae, Sordariomycetes, Ascomycota,	seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
Botrytis allii Munn	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Botrytis cinerea Pers.	Sclerotiniaceae, Leotiomycetes, Ascomycota	cones	*Pinus ponderosa*	USA	James (1983a) and James (1995)
		cones	*Pinus sylvestris*	UK	Whittle (1977)
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Abies amabilis*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Abies nordmanniana*	Austria, Georgia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seed	*Agropyron cristatum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Acer ginolamax*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer* sp.	South Korea	Mathur (1974) and Mittal et al. (1990)
		seeds	*Acrocarpus fraxinifolius*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Friedrich et al. (1971)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Callistephus chinensis*	China	Gloyer (1931) and Crosier and Heit (1948)
		seeds	*Carpinus eximia*	South Korea	Mathur (1974) and Mittal et al. (1990)
		seeds	*Cassia fistula*	India	Mathur (1974) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cedrela toona*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Centaurea cyanus*	China	Gloyer (1931) and Crosier and Heit (1948)
		seeds	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Gmelina arborea*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Jacaranda mimosifolia*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Larix decidua*	Poland, USSR	Kozlowska (1968), Mittal et al. (1990) and Krol et al. (2015)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Lolium perenne*	Canada	Conners (1967)
		seed	*Nierembergia frutescens*	Canada	Conners (1967)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus caribaea*	Cuba	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus nigra*	Hungary	Turchetti (1982) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982), Anderson (1986a) and James (1995)
		seeds	*Pinus sylvestris*	Poland, UK, USSR	Urosevic (1961), Whittle (1977), Anderson, (1986a) and Krol et al. (2015)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
		seed	*Salvia officinalis*	Canada	Conners (1967)
Botrytis sp.	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)
Botrytis viciae-hirsutae X.Y. Wang, L.X. Zhang and Z.Y. Zhang[#]	Sclerotiniaceae, Leotiomycetes, Ascomycota	**fruit**	***Vicia hirsuta***	**China**	**Wang et al. (1995)**
Brachydesmiella brasiliensis R.F. Castañeda, Gusmão and Heredia[#]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**pods**	**Fabaceae plant**	**Brazil**	**Castañeda-Ruiz et al. (2006)**
Brown, sterile mycelia	Fungi	seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Brunneiperidium involucratum Daranag., Camporesi and K.D. Hyde[#]	Xylariaceae, Sordariomycetes, Ascomycota	**cone**	***Pinus sylvestris***	**Italy**	**Daranagama et al. (2015)**
Buerenia myrrhidendri Döbbeler[#]	Protomycetaceae, Taphrinomycetes, Ascomycota	**fruits**	***Myrridendron donnell-smithii***	**Costa Rica**	**Döbbeler (1995)**
Cadophora fastigiata Lagerb. and Melin [as *Phialophora fastigiata* (Lagerb. and Melin) Conant]	Ploettnerulaceae, Leotiomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
Cadophora malorum (Kidd and Beaumont) W. Gams [as *Phialophora malorum* (Kidd and Beaumont) McColloch]	Ploettnerulaceae, Leotiomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
Calcarisporium sp.	Calcarisporiaceae, Sordariomycetes, Ascomycota	seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Caldariomyces fumago Woron.	Capnodiaceae, Dothideomycetes, Ascomycota,	fruit	*Gustavia superba*	Panama	Goos and Pirozynski (1975)
Calonectria brasiliensis (Bat. and Cif.) L. Lombard, M.J. Wingf. and Crous [as *Cylindrocladium brasiliense* (Bat. and Cif.) Peerally]	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus* sp.	Brazil	Cruz and Figueiredo (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Calonectria gracilis Crous, M.J. Wingf. and Alfenas [as *Cylindrocarpon gracile* Bugnic.]	Nectriaceae, Sordariomycetes, Ascomycota	cones	*Pinus ponderosa*	USA	James (1995)
		cones	*Pseudotsuga menziesii* var. *glauca*	USA	James (1995)
Calonectria kyotensis Terash.	Nectriaceae, Sordariomycetes, Ascomycota	fruit	undetermined plant	Panama	Samuels and Dumon (1982) and Piepenbring (2006)
Calonectria morganii Crous, Alfenas and M.J. Wingf. [as *Cylindrocladium scoparium* Morgan]	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Horsfieldia* sp.	Malaysia	Lee and Ahmad (1982) and Mittal et al. (1990)
		seeds	*Maesopsis eminii*	Malaysia	Lee and Ahmad (1982) and Mittal et al. (1990)
		seeds	*Shorea roxburghii*	Malaysia	Lee and Ahmad (1982) and Mittal et al. (1990)
		seeds	*Tsuga mertensiana*	Canada	Sutherland (1979) and Mittal et al. (1990)
Calycellina ochracea (Grelet and Croz.) Dennis	Pezizellaceae, Leotiomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
Calycina cupulincola [#] [as *Cystopezizella cupulincola* Svrček]	Pezizellaceae, Leotiomycetes, Ascomycota	**cupule**	***Quercus robur***	**former Czechoslovakia**	**Svrcek (1987)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Camarosporium sp.	Camarosporiaceae, Dothideomycetes, Ascomycota	seeds	*Chamaecyparis lawsoniana*	France, Italy	Motta and Saponaro (1983) and Mittal et al. (1990)
		seeds	*Cupressus abramsiana*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus arizonica*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus glabra*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus goveniana*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus lusitanica*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus lusitanica* var. *benthamii*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus sempervirens*	France, Italy	Motta and Saponaro (1983) and Mittal et al. (1990)
		seeds	*Cupressus torulosa*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Thuja orientalis*	Italy, France	Motta and Saponaro (1983) and Mittal et al. (1990)
Candida albicans (C.P. Robin) Berkhout	*Incertae sedis*, Saccharomycetes, Ascomycota	seeds	*Ficus pumila*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Candida asparagi F.Y. Bai and H.Z. Lu[#]	*Incertae sedis*, Saccharomycetes, Ascomycota	**fruit**	***Asparagus filicinus***	**China**	**Lu et al. (2004)**
Candida berthetii Boidin, Pignal, Mermiér and Arpin	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida blankii**-like**	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida caryicola Kurtzman[#]	*Incertae sedis*, Saccharomycetes, Ascomycota	**nut**	***Carya glabra***	**USA**	**Kurtzman (2001)**
Candida citrea Nakase	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida fructus (Nakase) S.A. Mey. and Yarrow	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida insectamans D.B. Scott, Van der Walt and Klift	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida krusei (Castell.) Berkhout	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida leandrae Ruivo, Pagnocca, Lachane and C.A. Rosa[#]	*Incertae sedis*, Saccharomycetes, Ascomycota	**fruit**	***Leandra reversa***	**Brazil**	**Ruivo et al. (2004)**
Candida linzhiensis F.Y. Bai and Z.W. Wu[#]	*Incertae sedis*, Saccharomycetes, Ascomycota	**fruit**	**undetermined plant**	**China**	**Wu and Bai (2006)**
Candida lipolytica**-like**	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Candida norvegensis Dietrichson ex Uden and H.R. Buckley	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida parapsilosis (Ashford) Langeron and Talice	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida quercitrusa**-like**	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida rugopelliculosa**-like**	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida sorbosa**-like complex**	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida sorboxylosa**-like complex**	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Candida spp.	*Incertae sedis*, Saccharomycetes, Ascomycota	seeds	*Acer saccharum*	USA	Janerette (1979) and Mittal et al. (1990)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Anderson (1986a)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
Candida uthaithanina Limtong, Jindam., Am-[#]	*Incertae sedis*, Saccharomycetes, Ascomycota	**fruit in dipterocarp forest**	**undetermined plant**	**Thailand**	**Limtong et al. (2011)**
Capnodiales spp.	Dothideomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Caryospora quercus Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Caryosporaceae, Dothideomycetes, Ascomycota	**fruit**	***Quercus* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Catenaria anguillulae Sorokīn	Catenariaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Atropa belladonna* var. *caucasica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Prunella grandiflora* ssp. *pyrenaia*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sambucus racemosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Vicia sativa*	Poland	Kiziewicz (2005)
Catenaria verrucosa Karling	Catenariaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Vicia sativa*	Poland	Kiziewicz (2005)
Catenochytridium carolinianum Berdan	Catenochytridiaceae, Cladochytriomycetes, Chytridiomycota	seeds	*Crataegus azarolus*, *Sambucus ebulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Catenophlyctis variabilis (Karling) Karling	Catenariaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Sambucus ebulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Catenularia sp.	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Centrolepidosporium sclerodermum R.G. Shivas and Vánky[#**]	*Incertae sedis*, Ustilaginomycetes, Basidiomycota	**nutlets**	***Centrolepis exserta***	**Australia**	**Shivas and Vánky (2007)**
Cephaliophora tropica Thaxt.	Ascodesmidaceae, Pezizomycetes, Ascomycota	seed	*Macroptilium lathyroides*	Australia	Nik and Parbery (1977)
Cephalosporium curtipes Sacc.	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Melia* spp.	India	Sahai and Otra (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Cephalosporium roseum Oudem.	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
Cephalosporium spp.	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Acrocarpus fraxinifolius*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Albizia falcataria*	Philippines	Mathur (1974) and Mittal et al. (1990)
		seeds	*Alnus maximowiczii*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Delonix regia*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Endospermum peltatum*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
		seeds	*Eucalyptus deglupta*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus globulus*	India	Anderson (1986a)
		seeds	*Ficus krishnae*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Gmelina arborea*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Gmelina moluccana*	Solomon Islands	Mathur (1974) and Anderson (1986a)
		seeds	*Lagerstroemia speciosa*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Leucaena leucocephala*	Philippines	Quiniones (1987), Mathur (1974) and Anderson (1986a)
		seeds	*Mimosa caesalpiniafolia*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Panax ginseng*	South Korea	Anderson (1986a)
		seeds	*Pinus elliottii*	Taiwan, USA	Rowan and Debarr (1974) and Anderson (1986a)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)
		seeds	*Pinus merkusii*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus taeda*	Georgia, USA	Anderson (1986a, b) and Huang and Kuhlman (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pseudotsuga menziesii*	Canada	Bloomberg (1969) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mathur (1974) and Anderson (1986a)
Cephalosporium subverticillatum Schulzer and Sacc.	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Cephalothecium roseum Corda	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Larix decidua*	USSR	Kozlowska (1968) and Mittal et al. (1990)
Ceratobasidium spp.	Ceratobasidiaceae, Agaricomycetes, Basidiomycota	seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
Ceratocystis ethacetica (Went) Mbenoun and Z.W. de Beer[#] [as *Thielaviopsis ethacetica* Went]	Ceratocystidaceae, Sordariomycetes, Ascomycota	**fruits**	***Saccharum* sp.**	**Indonesia**	**Mbenoun et al. (2014)**
Ceratocystis fagacearum (Bretz) J. Hunt	Ceratocystidaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USA	Mittal et al. (1990)
Ceratocystis spp.	Ceratocystidaceae, Sordariomycetes, Ascomycota	seeds	*Pinus taeda*	Georgia	Huang and Kuhlman (1990)
Ceratorhiza sp.	Ceratobasidiaceae, Agaricomycetes, Basidiomycota	seeds	*Corallorhiza maculata*	Canada	Zelmer et al. (1996)
		seeds	*Platanthera dilatata*	Canada	Zelmer et al. (1996)
		seeds	*Platanthera hyperborea*	Canada	Zelmer et al. (1996)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Spiranthes lacera*	Canada	Zelmer et al. (1996)
Cercospora spp.	Mycosphaerellaceae, Dothideomycetes, Ascomycota	seeds, seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Ceuthospora sp.	Phacidiaceae, Leotiomycetes, Ascomycota	cones, seeds	*Pinus albicaulis*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus tabulaeformis*	Canada	Vujanovic et al. (2000)
Chaetocladium brefeldii Tiegh. and G. Le Monn.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Sorbus torminalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Chaetomella sp.	Chaetomellaceae, Leotiomycetes, Ascomycota	seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
Chaetomium affine Corda [as '*offine*']	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Chaetomium cochliodes Palliser	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Platanus occidentalis*	USA	Mittal et al. (1990)
		seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Medicago sativa*	Canada	Conners (1967)
Chaetomium elatum Kunze	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seed	*Pinus patula*	Kenya	Gibson (1957) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Chaetomium gangligerum L.M. Ames	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Erysimum cheiri*	Pakistan	Lodhi and Naeem (1955)
		seeds	*Pseudotsuga menziesii*	Canada	Gordon (1967) and Mittal et al. (1990)
		seeds	*Verbena* sp.	Pakistan	Lodhi and Naeem (1955)
Chaetomium globosum Kunze	Chaetomiaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seed	*Abies balsamea*	Canada	Conners (1967)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seed	*Agrostis gigantea*	Canada	Conners (1967)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975)
		seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seed	*Desmodium intortum*	Australia	Nik and Parbery (1977)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seed	*Festuca rubra*	Canada	Conners (1967)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Lolium perenne*	Canada	Conners (1967)
		seed	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seed	*Phleum pratense*	Canada	Conners (1967)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)
		seeds	*Pinus pinaster*	Uruguay	Anderson (1986a)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Poland, USSR	Urosevic (1961) and Anderson (1986a) and Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seed	*Poa compressa*	Canada	Conners (1967)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seed	*Stylosanthes gracilis*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
		seed	*Teramnus uncinatus*	Australia	Nik and Parbery (1977)
		seed	*Trifolium repens*	Australia	Nik and Parbery (1977)
Chaetomium murorum Corda	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Chaetomium oblatum Dreyfuss and Arx[#]	Chaetomiaceae, Sordariomycetes, Ascomycota	**seed**	**undetermined plant**	**Israel**	**von Arx et al. (1986)**
Chaetomium spinulosum Sörgel	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
Chaetomium spirale Zopf	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus sylvestris*	Poland	Garbowski (1936) and Mittal et al. (1990)
Chaetomium spp.	Chaetomiaceae, Sordariomycetes, Ascomycota	fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
		seeds	*Acacia auriculiformis*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Albizia falcataria*	Philippines	Agmata (1979) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Natarajan et al. (2003) and Mohanan et al. (2005)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	India	Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines, Thailand	Quiniones (1985) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Dalbergia cochinchinensis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seeds	*Delonix regia*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Delonix regia*	Philippines	Quiniones (1987)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
		seeds	*Eucalyptus globulus*	India	Anderson (1986a)
		seeds	*Holarrhena antidysenterica*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Parkia roxburghii*	Philippines	Dayan (1986) and Anderson (1986a)
		seeds	*Parkia roxburghii*	Philippines	Quiniones (1987)
		seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Piliostigma malabaricum*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Piliostigma malabaricum*	Philippines	Quiniones (1987)
		seeds	*Pinus caribaea*	Central America	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus contorta*	USA	Sutherland (1979) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	Taiwan, USA	Rowan and Debarr (1974) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus kesiya*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus oocarpa*	Central America	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus sylvestris*	Poland	Garbowski (1936) and Mittal et al. (1990)
		seeds	*Pinus taeda*	Georgia, USA	Anderson (1986a, b) and Huang and Kuhlman (1990)
		seeds	*Polyscias nodosa*	Philippines	Agmata (1979) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955), Mittal et al. (1990)
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Samanea saman*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Serialbizia acle*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Swietenia macrophylla*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Tectona grandis*	India	Anderson (1986a) and Mohanan et al. (2005)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Chaetomium trilaterale Chivers	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
Chaetophoma sp.	*Incertae sedis*, Dothideomycetes, Ascomycota	seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Covington et al. (1982)
Chaetopsina fulva Rambelli	Nectriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Chaetopsina indica Nagaraju, Kunwar, Sureshk. and Manohar.#	Nectriaceae, Sordariomycetes, Ascomycota	**fruit**	***Albizia lebbeck***	**India**	**Nagaraju et al. (2011b)**
Chaetosphaeria garethjonesii R.H. Perera, Maharachch. and K.D. Hyde#	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	**pod**	**Fabaceae plant**	**Thailand**	**Perera, Maharachchikumbura, Bhat et al. (2016)**
Chaetostylum fresenii Tiegh. and G. Le Monn.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Chalastospora gossypii (Jacz.) U. Braun and Crous [as *Cladosporium malorum* Heald]	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Bromus inermis*	Canada	Conners (1967)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Medicago sativa*	Canada	Conners (1967)
Cheilaria sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
Chlamydomyces sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Chloridium chloroconium (W. Gams and Hol.-Jech.) Réblová and Seifert [as *Gonytrichum chlamydosporium* G.L. Barron and G.C. Bhatt]	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	fruits	*Alocasia odora*	Hong Kong	Tang, Hyde et al. (2003)
Chloridium sp.	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
Chrysomyxa ledi (Alb. and Schwein.) de Bary	Coleosporiaceae, Pucciniomycetes, Basidiomycota	cones	*Picea abies*	Finland	Kaitera et al. (2014)
		cones	*Picea glauca*	Finland	Kaitera et al. (2014)
		cones	*Picea omorika*	Finland	Kaitera et al. (2014)
Chrysomyxa monesis Ziller	Coleosporiaceae, Pucciniomycetes, Basidiomycota	cones	*Picea sitchensis*	Canada	Wood (1986)
Chrysomyxa pyrolata (Körn.) G. Winter	Coleosporiaceae, Pucciniomycetes, Basidiomycota	cones	*Picea abies*	Finland	Kaitera (2013) and Kaitera et al. (2009, 2014)
		cones	*Picea glauca*	Canada	Sutherland et al. (1984)
		cones	*Picea pungens*	USA	Nelson and Krebill (1970, 1982)
		cones	*Picea* spp.	Canada	Wood (1986)
		seeds	*Picea abies*	Finland, USSR	Prisyazhnyuk (1960), Mittal et al. (1990) and Tillman-Sutela et al. (2004)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Chrysomyxa woroninii Tranzschel	Coleosporiaceae, Pucciniomycetes, Basidiomycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Chrysosporium sp.	Onygenaceae, Eurotiomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Chytridium xylophilum Cornu	Chytridiaceae, Chytridiomycetes, Chytridiomycota	seeds	*Armeria transmontana*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa komarovii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Bryonia cretica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cornus capitata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Datura stramonium*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus aureus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Polygonum amphibium*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Chytriomyces aureus Karling	Chytriomycetaceae, Chytridiomycetes, Chytridiomycota	seeds	*Atropa komarovii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus gyoerffyi*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Ciboria alni (Maul) Whetzel	Sclerotiniaceae, Leotiomycetes, Ascomycota	seed	*Alnus rugosa*	Canada	Conners (1967)
		seeds	*Alnus* sp.	former Czechoslovakia	Anderson (1986a)
Ciboria batschiana (Zopf) N.F. Buchw.	Sclerotiniaceae, Leotiomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Quercus petraea*	France	Delatour and Morelet (1979) and Mittal et al. (1990)
		seeds	*Quercus robur*	France , Germany	Delatour and Morelet (1979), Mittal et al. (1990) and Schroder et al. (2004)
		seeds	*Quercus rubra*	France	Anderson (1986a)
		seeds	*Quercus* spp.	France	Anderson (1986a)
Ciboria betulae (Woronin) W.L. White	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Betula* spp.	Asia, Europe, North America, former Czechoslovakia	Buchwald (1947) and Mittal et al. (1990)
Ciboria rufofusca (O. Weberb.) Sacc.	Sclerotiniaceae, Leotiomycetes, Ascomycota	cone	*Picea* sp.	Canada	Conners (1967)
Cirrenalia nigrospora Somrith. Chatmala and E.B.G. Jones[#]	Halosphaeriaceae, Sordariomycetes, Ascomycota	pod	*Delonix regia*	Thailand	Somrithipol, Chatmala et al. (2002)
		pods	*Hevea brasiliensis*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Borassus machadonis*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	***Choerospondias axillaris***	**Thailand**	**Somrithipol, Jones et al. (2002)**
Cirrenalia sp.	Halosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Cistella sp.	Calloriaceae, Leotiomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Cladochytrium crassum Hillegas	Cladochytriaceae, Chytridiomycetes, Chytridiomycota	seeds	*Polygonum amphibium*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Cladochytrium hyalinum Berdan	Cladochytriaceae, Chytridiomycetes, Chytridiomycota	seeds	*Armeria maritima* ssp. *maritima*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sambucus ebulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Cladochytrium taianum S.C. Shen and Siang	Cladochytriaceae, Chytridiomycetes, Chytridiomycota	seeds	*Ginkgo biloba*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Cladochytrium tenue Nowak.	Cladochytriaceae, Chytridiomycetes, Chytridiomycota	seeds	*Cicuta virosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ficus pumila*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Juniperus oxycedrus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lonicera caprifolium*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Cladonia lacryma S. Hammer.[#]	Cladoniaceae, Lecanoromycetes, Ascomycota	**cones**	**evergreen plant**	**USA**	**Hammer (2001)**
Cladophialophora chaetospira (Grove) Crous and Arzanlou [as *Septonema chaetospira* (Grove) S. Hughes]	Herpotrichiellaceae, Eurotiomycetes, Ascomycota	seed	*Cercis chinensis*	Japan	Watanabe (2010)
Cladosporium aphidis Thüm.	Cladosporiaceae, Dothideomycetes, Ascomycota	pod	*Laburnum anagyroides*	UK	Jayasiri et al. (2019)
Cladosporium aterrimum Ellis and Everh.	Cladosporiaceae, Dothideomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Cladosporium austrohemisphaericum Bensch, Crous and U. Braun[#]	Cladosporiaceae, Dothideomycetes, Ascomycota	**fruit**	***Lagunaria patersonia***	**New Zealand**	**Bensch et al. (2015)**
Cladosporium bauhiniana Arv.Kumar, Anju Kumar and KHarwar[#]	Cladosporiaceae, Dothideomycetes, Ascomycota	**pods**	***Bauhinia varirgata***	**India**	**Kumar et al. (2006)**
Cladosporium chlorocephalum (Fresen.) E.W. Mason and M.B. Ellis	Cladosporiaceae, Dothideomycetes, Ascomycota	seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Cladosporium cladosporioides (Fresen.) G.A. de Vries	Cladosporiaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		cones	*Picea glauca*	Canada	Mittal and Wang (1987)
		cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		cones, seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		fruits	*Ardisia punctata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Bridelia tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
		pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seeds	*Acacia confusa*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seed	*Agropyron cristatum*	Canada	Conners (1967)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seed	*Anethum graveolens*	Canada	Conners (1967)
		seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seed	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Cassia siamea*	Philippines	Quiniones (1985)
		seeds	*Cassia siamea*	Philippines	Quiniones (1987)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
		seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Delonix regia*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seed	*Elymus virginicus*	Canada	Conners (1967)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seeds	*Leucaena leucocephala*	Philippines	Quiniones (1985, 1987)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Medicago sativa*	Canada	Conners (1967)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Musanga cecropioides*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus insularis*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seeds	*Pittosporum resiniferum*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus robur*	Poland	Krol et al. (2015)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seed	*Salvia officinalis*	Canada	Conners (1967)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985) and Anderson (1986a)
Cladosporium cucumerinum Ellis and Arthur	Cladosporiaceae, Dothideomycetes, Ascomycota	seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
Cladosporium dominicanum Zalar, de Hoog and Gunde-Cim.	Cladosporiaceae, Dothideomycetes, Ascomycota	pod	*Delonix regia*	Thailand	Jayasiri et al. (2019)
Cladosporium elegans Penz.	Cladosporiaceae, Dothideomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)
Cladosporium elegantulum Pidopl. and Deniak	Cladosporiaceae, Dothideomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Cladosporium entadae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Cladosporiaceae, Dothideomycetes, Ascomycota	**pod**	***Entada phaseoloides***	**Thailand**	**Jayasiri et al. (2019)**
Cladosporium epiphyllum (Pers.) Nees	Cladosporiaceae, Dothideomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Anderson (1986a)
Cladosporium herbarum (Pers.) Link	Cladosporiaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		cones	*Picea glauca*	Canada	Mittal and Wang (1987)
		cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seed	*Apium graveolens* var. *dulce*	USA	Conners (1967)
		seeds	*Betula pendula*	Finland	Lilja (1979) and Mittal et al. (1990)
		seed	*Bromus inermis*	Canada	Conners (1967)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seeds	*Pinus nigra*	Hungary	Hangyal (1973) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus sylvestris*	Hungary, UK, USSR	Urosevic (1961), Whittle (1977) and Anderson (1986a)
		seeds	*Quercus robur*	Poland	Krol et al. (2015)
Cladosporium hordei Pass.	Cladosporiaceae, Dothideomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Cladosporium magnoliigena Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Cladosporiaceae, Dothideomycetes, Ascomycota	**cone**	***Magnolia grandiflora***	**China**	**Jayasiri et al. (2019)**
Cladosporium oxysporum Berk. and M.A. Curtis	Cladosporiaceae, Dothideomycetes, Ascomycota	seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
		seed	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Sesbania bispinosa*	India	Anita et al. (2009)
Cladosporium spp.	Cladosporiaceae, Dothideomycetes, Ascomycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Acacia auriculiformis*	Philippines	Dayan (1986) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Acer saccharum*	USA	Janerette (1979) and Mittal et al. (1990)
		seeds	*Araucaria heterophylla*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Callistephus chinensis*	China	Gloyer (1931) and Crosier and Heit (1948)
		seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines	Quiniones (1987)
		seeds	*Casuarina equisetifolia*	Philippines, Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Delonix regia*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Endospermum peltatum*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013) and

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
					Hayatgheibi (2013)
		seeds	*Lagerstroemia speciosa*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Leucaena leucocephala*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
		seeds	*Picea engelmannii*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus kesiya*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seed	*Pinus monticola*	USA	Ganley and Newcombe (2006)
		seeds	*Pinus patula*	Kenya	Gibson (1957) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
		Seeds	*Pinus taeda*	USA	Anderson (1986a, b)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Polyscias nodosa*	Philippines	Agmata (1979) and Anderson (1986a)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Quercus robur*	Germany	Schroder et al. (2004)
		seeds	*Swietenia macrophylla*	Philippines	Agmata (1979) and Anderson (1986a)
Cladosporium sphaerospermum Penz.	Cladosporiaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Callistephus chinensis*	imported to Taiwan	Wu et al. (2006)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)
		seeds	*Picea excelsa*	USSR	Urosevic (1961)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
Cladosporium tenuissimum Cooke	Cladosporiaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
Claviceps bothriochloae Tanda and Y. Muray[#]	Clavicipitaceae, Sordariomycetes, Ascomycota	**seeds**	***Bothriochloa parviflora***	**Japan**	**Tanda (1991)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Claviceps microspora Tanda[#]	Clavicipitaceae, Sordariomycetes, Ascomycota	**seeds**	***Arundinella hirta***	**Japan**	**Tanda (1985)**
Claviceps panicoidearum Tanda and Y. Harada[#]	Clavicipitaceae, Sordariomycetes, Ascomycota	**seeds**	***Isachne globose***	**Japan**	**Tanda and Harada (1989)**
Clavochytridium simplex Doweld [as *Blastocladiella simplex* V.D. Matthews]	Blastocladiaceae, Blastocladiomycetes, Blastocladiomycota	seeds	*Hyoscyamus aureus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus gyoerffyi*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus niger* var. *vernalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lonicera etrusca*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lycium chinense*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Clavochytridium variabile Doweld [as *Blastocladiella variabilis* Harder and Sörgel]	Blastocladiaceae, BlastocladiomycetesBlastocladiomycota	seeds	*Cornus capitata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Clohiesia sp.	*Incertae sedis*, Sordariomycetes, Ascomycota	fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
Clonostachys candelabrum (Bonord.) Schroers [as *Verticillium candelabrum* Bonord.]	Bionectriaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Clonostachys compactiuscula (Sacc.) D. Hawksw. and W. Gams [as *Bionectria compactiuscula*]	Bionectriaceae, Sordariomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
[as *Verticillium compactiusculum* Sacc.]		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Clonostachys rosea (Link) Schroers, Samuels, Seifert and W. Gams	Bionectriaceae, Sordariomycetes, Ascomycota	seeds	*Quercus robur*	Turkey	Oskay et al. (2018)
Clonostachys sp. [as *Sesquicillium*]	Bionectriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Coccomyces strobilicola Spooner[#]	Rhytismataceae, Leotiomycetes, Ascomycota	**cone**	***Picea* sp.**	**Austria**	**Spooner (1987)**
Cochliobolus spp.	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Collariella bostrychodes (Zopf) X.Wei Wang and Samson [as *Chaetomium bostrychodes* Zopf]	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Colletotrichum aotearoa B.S. Weir and P.R. Johnst.[#]	Glomerellaceae, Sordariomycetes, Ascomycota	**berries**	***Coprosma* sp.**	**New Zealand**	**Weir et al. (2012)**
		fruits	*Dysoxylum spectabile*	New Zealand	Weir et al. (2012)
		fruits	*Vitex lucens*	New Zealand	Weir et al. (2012)
Colletotrichum capsici (Syd. and P. Syd.) E.J. Butler and Bisby	Glomerellaceae, Sordariomycetes, Ascomycota	seeds	*Sesbania grandiflora*	India	Anderson (1986a) and Srinivasan (1952)
Colletotrichum cosmi Damm, P.F. Cannon and Crous[#]	Glomerellaceae, Sordariomycetes, Ascomycota	**seed**	***Cosmos* sp.**	**The Netherlands**	**Damm et al. (2012)**
Colletotrichum dematium (Pers.) Grove	Glomerellaceae, Sordariomycetes, Ascomycota	seeds	*Viola wittrockiana*	imported to Taiwan	Wu et al. (2006)
Colletotrichum gloeosporioides (Penz.) Penz. and Sacc.	Glomerellaceae, Sordariomycetes, Ascomycota	fruits	*Alocasia odora*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ardisia punctata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ardisia qinquegona*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Dichroa febrifuga*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Rhodomyrtus tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
		seeds	*Agathis macrophylla*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Agathis philippinensis*	Philippines	Quiniones (1987)
		seeds	*Albizia lebbeck*	India	Mohanan et al. (2005)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Dalbergia cochinchinensis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Leucaena leucocephala*	Malaysia, Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
		seeds	*Pterocarpus indicus*	Philippines	Mathur (1974), Anderson (1986a) and Quiniones (1987)
		seeds	*Pongamia pinnata*	India	Jamaluddin et al. (1983) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Shorea acuminata*	Malaysia	Mittal et al. (1990)
		seeds	*Shorea materialis*	Malaysia	Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)
Colletotrichum gloeosporioides (Penz.) Penz. and Sacc. [as *Glomerella cingulata* (Stoneman) Spauld. and H. Schrenk]		fruits	*Alocasia odora*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ardisia crenata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
Colletotrichum godetiae Neerg.	Glomerellaceae, Sordariomycetes, Ascomycota	seed	*Clarkia hybrida*, cv. kelvon glory	Denmark	Damm et al. (2012)
		fruits	*Sambucus nigra*	The Netherlands	Damm et al. (2012)
Colletotrichum graminicola (Ces.) G.W. Wilson	Glomerellaceae, Sordariomycetes, Ascomycota	seeds	*Leucaena leucocephala*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
Colletotrichum lindemuthianum (Sacc. and Magnus) Briosi and Cavara	Glomerellaceae, Sordariomycetes, Ascomycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
Colletotrichum lini (Westerd.) Tochinai	Glomerellaceae, Sordariomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Colletotrichum musae (Berk. and M.A. Curtis) Arx	Glomerellaceae, Sordariomycetes, Ascomycota	fruits	*Ardisia qinquegona*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Wikstroemia nutans*	Hong Kong	Tang, Hyde et al. (2003)
Colletotrichum orbiculare Damm, P.F. Cannon and Crous	Glomerellaceae, Sordariomycetes, Ascomycota	fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
Colletotrichum spp.	Glomerellaceae, Sordariomycetes, Ascomycota	seed	*Sesbania bispinosa*	India	Anita et al. (2009)
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
		seeds	*Acer palmatum*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Acrocarpus fraxinifolius*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Cedrela odorata*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
		seeds	*Pinus caribaea*	UK	Hocking (1968) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus oocarpa*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
Colletotrichum spp. [as *Glomerella*]		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Colletotrichum truncatum (Schwein.) Andrus and W.D. Moore	Glomerellaceae, Sordariomycetes, Ascomycota	seeds	*Leucaena leucocephala*	Philippines	Quiniones (1987)
Comminutispora spp.	*Incertae sedis*, Dothideomycetes, Ascomycota	seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Conidioxyphium sp.	Trichomeriaceae, Eurotiomycetes, Ascomycota	fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
Conioscypha varia Shearer	Conioscyphaceae, Sordariomycetes, Ascomycota	fruit	*Scheelea zonensis*	Panama	Goos and Pirozynski (1975)
Coniosporium aterrimum (Corda) Sacc.	*Incertae sedis*, Eurotiomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Coniothecium atrum Corda	*Incertae sedis*, Leotiomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Coniothecium sp.	*Incertae sedis*, Leotiomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Coniothyrium conicola Vestergr.	Coniothyriaceae, Dothideomycetes, Ascomycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Coniothyrium leprosum Fairm.[#]	Coniothyriaceae, Dothideomycetes, Ascomycota	**fruits**	***Eucalyptus* sp.**	**USA**	**Millspaugh and Nuttall (1923)**
Coniothyrium olivaceum Bonord.	Coniothyriaceae, Dothideomycetes, Ascomycota	seed	*Betula alleghaniensis*	USA	Smoot and Segall (1963) and Mittal et al. (1990)
		seeds	*Melilotus* sp.	Canada	Conners (1967)
Coniothyrium quercinum (Bonord.) Sacc.	Coniothyriaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1964) and Mittal et al. (1990)
Coniothyrium spp.	Coniothyriaceae, Dothideomycetes, Ascomycota	seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Smoot and Segall (1963) and Mittal et al. (1990)
		seeds	*Chamaecyparis lawsoniana*	France, Italy	Motta and Saponaro (1983) and Mittal et al. (1990)
		seeds	*Cupressus abramsiana*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus arizonica*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus glabra*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus goveniana*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus lusitanica*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus lusitanica* var. *benthamii*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus sempervirens*	France, Italy	Motta and Saponaro (1983) and Mittal et al. (1990)
		seeds	*Cupressus torulosa*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Sequoia sempervirens*	USA	Davidson (1970) and Mittal et al. (1990)
		seeds	*Thuja orientalis*	Italy, France	Motta and Saponaro (1983) and Mittal et al. (1990)
Coniozyma leucospermi (Crous and Denman) Crous	*Incertae sedis*, Dothideomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Cophinforma atrovirens (Mehl and Slippers) A. Alves and A.J.L. Phillips	Botryosphaeriaceae, Dothideomycetes, Ascomycota	pod	*Ailanthus* sp.	Thailand	Jayasiri et al. (2019)
Coprinopsis spp.	Psathyrellaceae, Agaricomycetes, Basidiomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
Coprinus sp.	Agaricaceae, Agaricomycetes, Basidiomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975)
Cordana terrestris (Timonin) Hern.-Restr., Gené and Guarro [as *Pseudobotrytis terrestris* (Timonin) Subram.]	Cordanaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Cordyceps farinosa (Holmsk.) Kepler, B. Shrestha and Spatafora	Cordycipitaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
[as *Paecilomyces farinosus* (Holmsk.) A.H.S. Br. and G. Sm.]					
Corollospora novofusca Kohlm. and Volkm.-Kohlm.[#]	Halosphaeriaceae, Sordariomycetes, Ascomycota	**fruit**	***Casuarina* sp.**	**USA**	**Kohlmeyer and Volkmann-Kohlmeyer (1991)**
Corynelia fructigena A.R. Wood, van der Linde, Cheew. and Crous[#]	Coryneliaceae, Eurotiomycetes, Ascomycota	**fruit**	***Podocarpus latifolius***	**South Africa**	**Wood et al. (2015)**
Corynespora sp. [as '*Corynospora*']	Corynesporascaceae, Dothideomycetes, Ascomycota	seeds	*Cassia siamea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Cronartium conigenum Hedgc. and N.R. Hunt	Cronartiaceae, Pucciniomycetes, Basidiomycota	cones	*Pinus maximinoi*	Guatemala	Rayachhltry et al. (1995b)
		cones	*Pinus oocarpa*	Guatemala	Rayachhltry et al. (1995a)
		cones	*Pinus pseudostrobus*	Guatemala	Rayachhltry et al. (1995a)
Cronartium harknessii E. Meinecke [as *Peridermium harknessii* J.P. Moore]	Cronartiaceae, Pucciniomycetes, Basidiomycota	cones	*Pinus contorta*	USA	Byler and Platt (1972)
		cones	*Pinus muricata*	USA	Byler and Platt (1972)
Cryptococcus foliicola Q.M. Wang and F.Y. Bai	Cryptococcaceae, Tremellomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Cryptococcus sp.	Cryptococcaceae, Tremellomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Cryptophiale udagawae Piroz. and Ichinoe	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
Cryptospora longispora Servazzi	Gnomoniaceae, Sordariomycetes, Ascomycota	seeds	*Araucaria excelsa*	USA	Kahn et al. (1965) and Mittal et al. (1990)
Cunninghamella echinulata (Thaxt.) Thaxt. ex Blakeslee	Cunninghamellaceae, Mucoromycetes, Mucoromycota	seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
Cunninghamella elegans Lendn.	Cunninghamellaceae, Mucoromycetes, Mucoromycota	seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
Curreya conorum (Fuckel) Sacc.	Didymosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Curreya spp.	Didymosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Curvularia australiensis (Bugnic. ex M.B. Ellis) Manamgoda, L. Cai and K.D. Hyde [as *Drechslera australiensis* Bugnic. ex M.B. Ellis]	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Viola wittrockiana*	imported to Taiwan	Wu et al. (2006)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Curvularia hawaiiensis (Bugnic. ex M.B. Ellis) Manamgoda, L. Cai and K.D. Hyde [as *Drechslera hawaiiensis* Bugnic. ex M.B. Ellis]	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Leucaena leucocephala*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Curvularia pallescens Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Curvularia affinis Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Cassia siamea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Holarrhena antidysenterica*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
Curvularia brachyspora Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Acacia auriculiformis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1985) and Anderson (1986a, 1987)
Curvularia clavata B.L. Jain	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Delonix regia*	India	Sahu et al. (2003)
Curvularia eragrostidis (Henn.) J.A. Mey.	Pleosporaceae, Dothideomycetes, Ascomycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)
		seed	*Desmodium uncinatum*	Australia	Nik and Parbery (1977)
		seed	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seed	*Macroptilium lathyroides*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
		seed	*Teramnus uncinatus*	Australia	Nik and Parbery (1977)
Curvularia geniculata (Tracy and Earle) Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seeds	*Holarrhena antidysenterica*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
		seeds	*Samanea saman*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Curvularia inaequalis (Shear) Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seed	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Dactylis glomerata*	Canada	Conners (1967)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Festuca elatior*	Canada	Conners (1967)
		seeds	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Curvularia intermedia Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Curvularia lunata (Wakker) Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Acacia confusa*	Philippines	Agmata (1979) and Anderson (1986a)
		seed	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bombax anceps*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	Bangladesh	Mittal et al. (1990)
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cassia siamea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Dalbergia sissoo*	India	Naz et al. (2015)
		seeds	*Delonix regia*	India, Philippines	Dayan (1986), Mittal et al. (1990) and Sahu et al. (2003)
		seeds	*Eucalyptus grandis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Eucalyptus tereticornis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Lagerstroemia calyculata*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Leucaena leucocephala*	Bangladesh, Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990) and Islam et al. (2008)
		seeds	*Melia azedarach*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Musanga cecropioides*	Philippines	Agmata (1979) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus kesiya*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus merkusii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Shorea robusta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
		seeds	*Swietenia macrophylla*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985) and Anderson (1986a)
Curvularia maculans (C.K. Bancr.) Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Mittal (1983)
Curvularia ovoidea (Hiroë) Munt.-Cvetk.	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)
Curvularia pallescens Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Acacia auriculiformis*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Anthocephalus chinensis*	Philippines	Quiniones (1987)
		seeds	*Bombax anceps*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cassia floribunda*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	India, Philippines	Quiniones (1985, 1987), Anderson (1986a) and Anju et al. (2012)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975)
		seeds	*Eucalyptus alba*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Triplaris cumingiana*	Philippines	Dayan (1986) and Mittal et al. (1990)
Curvularia prasadii R.L. Mathur and B.L. Mathur	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
Curvularia senegalensis (Speg.) Subram.	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Curvularia spicifera (Bainier) Boedijn	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Delonix regia*	India	Sahu et al. (2003)
		seeds	*Setaria glauca*	Pakistan	Lodhi and Naeem (1955)
Curvularia spp.	Pleosporaceae, Dothideomycetes, Ascomycota	pod	*Sesbania bispinosa*	India	Anita et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Albizia lebbeck*	India	Natarajan et al. (2003)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seeds	*Eucalyptus alba*	Thailand	Chalermpo ngse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus grandis*	South Africa, Uruguay	Anderson (1986a) and Jimu et al. (2016)
		seeds	*Eucalyptus maidenii*	Uruguay	Anderson (1986a)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay, USA	Anderson (1986a) and Fraedrich and Miller (1995)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Anderson (1986a)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Curvularia verruculosa Tandon and Bilgrami ex M.B. Ellis	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
Cutaneotrichosporon cutaneum (Beurm., Gougerot and Vaucher bis) Xin Zhan Liu, F.Y. Bai, M. Groenew. and Boekhout [as *Trichosporon cutaneum* (Beurm., Gougerot and Vaucher bis) M. Ota]	Trichosporonaceae, Tremellomycetes, Basidiomycota	seeds	*Rhododendron smirnowii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Valeriana officinalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Cyathus ibericus J.C. Zamora and Poveda-Molero[#]	Nidulariaceae, Agaricomycetes, Basidiomycota	**cones**	***Pinus halepensis***	**Spain**	**Crous, Wingfield, Burgess et al. (2016)**
Cyberlindnera maclurae (Kurtzman) Minter[#] [as *Pichia maclurae* Kurtzman]	Phaffomycetaceae, Saccharomycetes, Ascomycota	**pomes**	***Maclura pomifera***	**USA**	**Kurtzman (2000)**
Cyberlindnera saturnus (Klöcker) Minter [as *Hansenula saturnus* (Klöcker) Syd. and P. Syd.]	Phaffomycetaceae, Saccharomycetes, Ascomycota	seeds	*Bryonia cretica*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Humulus lupulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Juniperus communis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Pistacia terebinthus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Podophyllum peltatum*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rhus copallina*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rhus gueinzii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sambucus racemosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Cycasicola leucaenae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Thyridariaceae, Dothideomycetes, Ascomycota	**pod**	***Leucaena* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Cyclaneusma minus (Butin) DiCosmo, Peredo and Minter	Marthamycetaceae, Leotiomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Cylindroaseptospora leucaenae Jayasiri, E.B.G. Jones and K.D. Hyde[#**]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	**pod**	***Leucaena* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Cylindroaseptospora siamensis Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	**pod**	***Leucaena* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Cylindrocephalum spp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Cylindrocephalum stellatum (Harz) Sacc.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Cylindrochytridium endobioticum Willoughby	*Incertae sedis*, Cladochytriomycetes, Chytridiomycota	seeds	*Cornus sanguinea*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Cylindrochytridium johnstonii Karling	*Incertae sedis*, Cladochytriomycetes, Chytridiomycota	seeds	*Cornus capitata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Cylindrocladium spp.	Nectriaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Pinus lambertiana*	USA	Anderson (1986a) and Schubert (1961)
		seeds	*Shorea assamica*	Malaysia	Hong (1981) and Mittal et al. (1990)
Cylindrodendrum hubeiense (W.Y. Zhuang, Y. Nong and J. Luo) L. Lombard and Crous[#] [as *Neonectria hubeiensis* W.Y. Zhuang, Y. Nong and J. Luo]	Nectriaceae, Sordariomycetes, Ascomycota	**fruits**	***Rhododendron* sp.**	**China**	**Zhuang et al. (2007)**
Cylindrodendrum sp.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Quercus robur*	Turkey	Oskay et al. (2018)
Cylindromyces striatus Manohar., D.K. Agarwal and N.K. Rao[#**]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**pods**	**undetermined plant**	**India**	**Manoharachary et al. (2004)**
Cylindrosporella alnea (Pers. ex Lév.) Höhn.	Gnomoniaceae, Sordariomycetes, Ascomycota	seeds	*Alnus* sp.	Denmark	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Cylindrosporium platanoidis (Allesch.) Died.	Ploettnerulaceae, Leotiomycetes, Ascomycota	seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
Cytosphaera sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
Cytospora chrysosperma (Pers.) Fr.	Cytosporaceae, Sordariomycetes, Ascomycota	seeds, pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
Cytospora curreyi Sacc.	Cytosporaceae, Sordariomycetes, Ascomycota	seeds	*Larix* spp.	UK	Noble et al. (1958) and Anderson (1986a)
Cytospora intermedia Sacc.	Cytosporaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Cytospora intermedia Sacc. [as *Valsa intermedia* Nitschke]		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Cytospora pinastri Fr.	Cytosporaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus albicaulis*	Canada	Vujanovic et al. (2000)
Cytospora spp.	Cytosporaceae, Sordariomycetes, Ascomycota	seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Quercus robur*	Turkey	Oskay et al. (2018)
Dactylaria spp.	Calloriaceae, Leotiomycetes, Ascomycota	fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Dactylium dendroides (Bull.) Fr.	Orbiliaceae, Orbiliomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Dasyscyphella longistipitata Hosoya	Lachnaceae, Leotiomycetes, Ascomycota	fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012)
Dasyscyphella longistipitata Hosoya[#]	Lachnaceae, Leotiomycetes, Ascomycota	**fruit cupule**	***Fagus sylvatica***	**Japan**	**Ono and Hosoya 2001**
Dasyscyphus fuscescens (Pers.) Gray	Hyaloscyphaceae, Leotiomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
Dasyscyphus sp.	Hyaloscyphaceae, Leotiomycetes, Ascomycota	cone	*Picea sitchensis*	USA	Conners (1967)
Dasyscyphus virgineus (Batsch) Gray	Hyaloscyphaceae, Leotiomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
Davidhawksworthia ilicicola Crous[#**]	Dermateaceae, Leotiomycetes, Ascomycota	**fruit**	***Ilex aquifolium***	**The Netherlands**	**Crous and Groenewald (2016)**
Davidiella spp.	Davidiellaceae, Dothideomycetes, Ascomycota	seed capsules, seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Delitschia nypae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Delitschiaceae, Dothideomycetes, Ascomycota	**fruit**	***Nypa fruticans***	**Thailand**	**Jayasiri et al. (2019)**
Delonicicola siamense R.H. Perera, Maharachch. and K.D. Hyde[#**]	Delonicicolaceae, Sordariomycetes, Ascomycota	**pods**	***Delonix regia***	**Thailand**	**Perera et al. (2017)**
Dendrophoma sp.	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	seeds	*Cupressus torulosa*	Uruguay	Anderson (1986a)
		seeds	*Pinus elliottii*	USA	Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Dendrostoma leiphaemia (Fr.) Senan. and K.D. Hyde [as *Amphiporthe leiphaemia* (Fr.) Butin]	Erythrogloeaceae, Sordariomycetes, Ascomycota	seeds	*Quercus robur*	Germany	Schroder et al. (2004)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Dermatosorus schoenoplecti Vánky and R.G. Shiva[#]	Anthracoideaceae, Ustilaginomycetes, Basidiomycota	**seeds**	***Schoenoplectus mucronatus***	**Australia**	**Vánky and Shivas (2003)**
Diaporthales sp.	Sordariomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Diaporthe angelicae (Berk.) Wehm.	Diaporthaceae, Sordariomycetes, Ascomycota	seeds	*Heracleum sphondylium*	France	Gomes et al. (2013)
Diaporthe archeri [as *Phomopsis archeri* B. Sutton]	Diaporthaceae, Sordariomycetes, Ascomycota	fruits	*Alocasia odora*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ardisia crenata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Bridelia tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Dichroa febrifuga*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Wikstroemia nutans*	Hong Kong	Tang, Hyde et al. (2003)
Diaporthe arecae (H.C. Srivast., Zakia and Govindar.) R.R. Gomes, Glienke and Crous[#]	Diaporthaceae, Sordariomycetes, Ascomycota	**fruits**	***Areca catechu***	**India**	**Gomes et al. (2013)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
Diaporthe casuarinae [as *Phomopsis casuarinae* (Tassi) Died.]	Diaporthaceae, Sordariomycetes, Ascomycota	seeds	*Casuarina equisetifolia*	Australia, USA	Bose (1944), Anderson (1986a) and Bayman et al. (1998)
Diaporthe collariana R.H. Perera and K.D. Hyde[#]	Diaporthaceae, Sordariomycetes, Ascomycota	**fruits**	***Magnolia champaca***	**Thailand**	**Perera, Hyde, Dissanayake et al. (2018)**
Diaporthe conorum (Desm.) Niessl [as *Phomopsis conorum* (Sacc.) Died.]	Diaporthaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus mugo* 'Galica'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus nigra*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris*	Canada	Vujanovic et al. (2000)
Diaporthe eres Nitschke	Diaporthaceae, Sordariomycetes, Ascomycota	fruits	*Fraxinus* sp.	The Netherlands	Gomes et al. (2013)
		seeds	*Abies nordmanniana*	Austria	Talgø et al. (2010)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
Diaporthe heveae [as *Phomopsis heveae* (Petch) Boedijn]	Diaporthaceae, Sordariomycetes, Ascomycota	seeds	*Hevea brasiliensis*	Malaysia	Mittal et al. (1990) and Srivastava (1956b)
		seeds	*Hevea* sp.	Malaysia	Edwards and Sutherland (1979) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Diaporthe hongkongensis R.R. Gomes, Glienke and Crous[#]	Diaporthaceae, Sordariomycetes, Ascomycota	**fruit**	***Dichroa febrifuga***	**Hong Kong**	**Gomes et al. (2013)**
Diaporthe insularis Nitschke	Diaporthaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Diaporthe occulta (Fuckel) Nitschke [as *Phomopsis occulta* Traverso]	Diaporthaceae, Sordariomycetes, Ascomycota	seeds	*Juniperus virginiana*	Denmark	Neergaard (1958) and Anderson (1986a)
		seeds	*Larix* spp.	Denmark	Anderson (1986a)
Diaporthe pseudotsugae Dissan., Camporesi and K.D. Hyde[#]	Diaporthaceae, Sordariomycetes, Ascomycota	**cones**	***Pseudotsuga menziesii***	**Italy**	**Dissanayake, Camporesi, Hyde, Zhang et al. (2017)**
Diaporthe quercella [as *Phomopsis quercella* (Sacc. and Roum.) Died.]	Diaporthaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seeds	*Quercus* spp.	USSR	Urosevic (1983) and Mittal et al. (1990)
Diaporthe rosae Samarakoon and K.D. Hyde	Diaporthaceae, Sordariomycetes, Ascomycota	fruits	*Magnolia champaca*	Thailand	Perera, Hyde, Persoh et al. (2018)
		fruits	*Senna siamea*	Thailand	Perera, Hyde, Persoh et al. (2018)
Diaporthe spp.	Diaporthaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus contorta*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus mugo* 'Galica'	Canada	Vujanovic et al. (2000)
		fruits	*Maesa perlarius*	Hong Kong	Gomes et al. (2013)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Quercus* spp.	USSR	Urosevic (1983) and Mittal et al. (1990)
Diaporthe spp. [as *Phomopsis*]		cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012) and Tateno et al. (2015)
		fruits	*Dichroa febrifuga*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
		pod	*Colophospermum mopane*	Southern Africa	Jordaan et. al (2006)
		seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Acacia auriculiformis*	Philippines	Quiniones (1987)
		seeds	*Acer palmatum*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Janerette (1979) and Mittal et al. (1990)
		seeds	*Acrocarpus fraxinifolius*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines, Thailand	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Cordia alliodora*	Colombia	Mathur (1974) and Anderson (1986a)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seeds	*Leucdena diversifolia*	Guatemala	Mathur (1974) and Anderson (1986a)
		seeds	*Melia azedarach*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus elliottii*	USA	Mittal et al. (1990)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Poland, UK	Whittle (1977) and Krol et al. (2015)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Anderson (1986a)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Quercus rubra*	Poland	Krol et al. (2015)
Diaporthe stipata [as *Phomopsis stipata* (Lib.) B. Sutton]	Diaporthaceae, Sordariomycetes, Ascomycota	fruits	*Ardisia crenata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Dichroa febrifuga*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
Diaporthe subordinaria (Desm.) R.R. Gomes, Glienke and Crous	Diaporthaceae, Sordariomycetes, Ascomycota	seeds	*Plantago lanceolate*	New Zealand	Gomes et al. (2013)
Diaporthe viticola Nitschke	Diaporthaceae, Sordariomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
Dicoccum asperum (Corda) Sacc.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Dichotomopilus dolichotrichus (L.M. Ames) X.Wei Wang and Samson [as *Chaetomium dolichotrichum* L.M. Ames]	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
Dichotomopilus erectus (Skolko and J.W. Groves) X.Wei Wang and Samson [as *Chaetomium erectum* Skolko and J.W. Groves]	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Dichotomopilus funicola (Cooke) X.Wei Wang and Samson [as *Chaetomium funicola* Cooke]	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Abies nordmanniana*	Austria	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seed	*Anethum graveolens*	Canada	Conners (1967)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seed	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seed	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Dichotomopilus indicus (Corda) X.Wei Wang and Samson [as *Chaetomium indicum* Corda]	Chaetomiaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Lolium perenne*	Scotland	Conners (1967)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Dichotomopilus reflexus (Skolko and J.W. Groves) X.Wei Wang and Samson [as *Chaetomium reflexum* Skolko and J.W. Groves]	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
Dictyochaeta fructicola (M.S. Patil, U.S. Yadav and S.D. Patil) Whitton, McKenzie and K.D. Hyde[#] [as *Codinaea fruticola* M.S. Patil, U.S. Yadav and S.D. Patil]	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	**carpus**	***Butea monosperma***	**India**	**Patil et al. (1991)**
Dictyochaeta sp.	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Dictyochaetopsis brasiliensis M. Cladduch, Gené, Stchigel and Guarro[#]	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	**fruit**	**Papillonaceae plant**	**Brazil**	**Calduch et al. (2002)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Dictyocheirospora lithocarpi Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Dictyosporiaceae, Dothideomycetes, Ascomycota	**fruit**	***Lithocarpus* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Dictyocheirospora nabanheensis Tibpromma and K.D. Hyde	Dictyosporiaceae, Dothideomycetes, Ascomycota	pod	*Leucaena* sp.	Thailand	Jayasiri et al. (2019)
Dictyopolyschema pirozynskii M.B. Ellis	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
Dictyosporium tetraseriale Goh, Yanna and K.D. Hyde	Dictyosporiaceae, Dothideomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Didymella coffeae-arabicae (Aveskamp, Verkley and Gruyter) Qian Chen and L. Cai	Didymellaceae, Dothideomycetes, Ascomycota	pod	*Leucaena* sp.	China	Jayasiri et al. (2019)
Didymella fabae G.J. Jellis and Punith.	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Didymella glomerata (Corda) Qian Chen and L. Cai	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Quercus robur*	Turkey	Oskay et al. (2018)
Didymella glomerata (Corda) Qian Chen and L. Cai [as *Phoma glomerata* (Corda) Wollenw. and Hochapfel]		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Larix occidentalis*	USA	James et al. (1996)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Didymella pomorum (Thüm.) Qian Chen and L. Cai [as *Phoma pomorum* Thüm.]	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Larix occidentalis*	USA	James et al. (1996)
Didymocrea leucaenae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	**pod**	***Leucaena* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Didymosphaeria sp.	Didymosphaeriaceae, Dothideomycetes, Ascomycota	pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
Dinemasporium strigosum (Pers.) Sacc.	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	fruits	*Ardisia crenata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Dichroa febrifuga*	Hong Kong	Tang, Hyde et al. (2003)
Dioszegia sp.	Bulleribasidiaceae, Tremellomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Diplodia conigena Desm.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Diplodia frumenti Ellis and Everh.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Diplodia gossypina Cooke	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Pinus elliottii* var. *elliottii*	USA	Miller and Bramlett (1979) and Anderson (1986a)
Diplodia magnoliigena Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	**cone**	***Magnolia grandiflora***	**China**	**Jayasiri et al. (2019)**
Diplodia rosulata Gure, Slippers and Stenlid[#]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	**seeds**	***Prunus africana***	**Ethiopia**	**Gure, Slippers et al. (2005)**
Diplodia spp.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	fruits	*Dichroa febrifuga*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
		seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus elliottii*	Taiwan, USA	Rowan and Debarr (1974) and Mittal et al. (1990)
		Seeds	*Pinus elliottii* var. *elliottii*	Georgia	Huang and Kuhlman (1990)
		seeds	*Pinus luchuensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Pinus taiwanensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus thunbergii* [= *Pinus thunbergiana*]	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Podocarpus falcatus*	Ethiopia	Gure, Slippers et al. (2005)
		seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
		seed	*Sesbania bispinosa*	India	Anita et al. (2009)
Diplodina sp.	Gnomoniaceae, Sordariomycetes, Ascomycota	seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Diplodites sweetii Kalgutkar, Nambudiri and Tidwell[#]	Fossil fungus	**perminera lized fruit**	***Viracarpon* sp.**	**India**	**Kalgutkar et al. (1993)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Discosia querci Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Sporocadaceae, Sordariomycetes, Ascomycota	**seeds**	***Quercus* sp.**	**UK**	**Jayasiri, Hyde, Jones et al. (2018)**
Discosia sp.	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Grevillea robusta*	Rwanda	Mathur (1974) and Anderson (1986a)
Discotubeufia browneae Jayasiri, E.B.G. Jones and K.D. Hyde[#**]	Tubeufiaceae, Dothideomycetes, Ascomycota	**pod**	***Brownea* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Discula quercina (Cooke) Sacc.	Gnomoniaceae, Sordariomycetes, Ascomycota	seeds	*Quercus robur*	Germany	Schroder et al. (2004)
Discula spp.	Gnomoniaceae, Sordariomycetes, Ascomycota	seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Quercus robur*	Poland	Krol et al. (2015)
		seeds	*Quercus rubra*	Poland	Krol et al. (2015)
Discula umbrinella (Berk. and Broome) M. Morelet	Gnomoniaceae, Sordariomycetes, Ascomycota	seeds	*Quercus rubra*	France	Anderson (1986a)
Dothidea sp.	Dothideaceae, Dothideomycetes, Ascomycota	cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
Dothiorella lampangensis Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	**fruit**	**Rutaceae plant**	**Thailand**	**Jayasiri et al. (2019)**
Dothiorella sempervirentis Abdollahz., Zare and A.J.L. Phillips[#]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	**cones**	***Cupressus sempervirens***	**Iran**	**Abdollahzadeh et al. (2014)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Dothiorella spp.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Araucaria excelsa*	USA	Kahn et al. (1965) and Mittal et al. (1990)
		seeds	*Howea forsteriana*	North America	Anderson (1986a)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia	Huang and Kuhlman (1990)
		seeds	*Podocarpus falcatus*	Ethiopia	Gure, Slippers et al. (2005)
		seeds	*Pongamia pinnata*	India	Jamaluddin et al. (1983) and Mittal et al. (1990)
Drechslera bicolor (Mitra) Subram. and B.L. Jain	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seeds	*Pinus caribaea*	Cuba	Mathur (1974) and Anderson (1986a)
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
Drechslera dictyoides (Drechsler) Shoemaker	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Festuca elatior*	Canada	Conners (1967)
Drechslera halodes (Drechsler) Subram. and B.L. Jain	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
Drechslera maydis (Y. Nisik. and C. Miyake) Subram. and B.L. Jain	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus insularis*	Philippines	Agmata (1979) and Anderson (1986a)
Drechslera rostrata (Drechsler) M.J. Richardson and E.M. Fraser	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Chamaecyparis obtusa*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Melia azedarach*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Drechslera siccans (Drechsler) Shoemaker	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Lolium perenne*	Canada	Conners (1967)
Drechslera sorokiniana (Shoemaker) Subram. and B.L. Jain	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
Drechslera spp.	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus grandis*	Uruguay	Anderson (1986a)
		seeds	*Jacaranda mimosifolia*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Drechslera tetramera (McKinney) Subram. and B.L. Jain	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Holarrhena antidysenterica*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Leucaena leucocephala*	Philippines	Agmata (1979) and Anderson (1986a)
Drepanopeziza brunnea (Ellis and Everh.) Rossman and W.C. Allen [*Marssonina brunnea* (Ellis and Everh.) Magnus]	Drepanopezizaceae, Leotiomycetes, Ascomycota	seeds	*Populus* sp.	New Zealand	Spiers and Wenilam (1983) and Mittal et al. (1990)
Echinobotryum atrum Corda	Microascaceae, Sordariomycetes, Ascomycota	seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
Endochytrium digitatum Karling	Endochytriaceae, Chytridiomycetes, Chytridiomycota	seeds	*Atropa belladonna*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Endochytrium ramosum Sparrow	Endochytriaceae, Chytridiomycetes, Chytridiomycota	seeds	*Cornus capitata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ilex verticillata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Endoconidioma rosae-hissaricae Wanas., Gafforov, E.B.G. Jones and K.D. Hyde[#]	Dothideaceae, Dothideomycetes, Ascomycota	**fruits**	***Rosa canina***	**Uzbekistan**	**Wanasinghe et al. (2018)**
Endophragmia sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Endophragmiella bukkensis Révay[#]	Helminthosphaeriaceae, Sordariomycetes, Ascomycota	**cone**	***Picea abies***	**Hungary**	**Révay (1987)**
Endophragmiella lignicola S. Hughes	Helminthosphaeriaceae, Sordariomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Kirk (1986)
Endoraecium kauaianum Berndt[#]	Raveneliaceae, Pucciniomycetes, Basidiomycota	**fruits**	***Acacia koa***	**USA**	**Berndt (2011)**
Entoloma alboproximum (Largent, Aime and T.W. Henkel) Mešić and Tkalčec[#] [as *Nolanea alboproxima* Largent, Aime and T.W. Henkel]	Entolomataceae, Agaricomycetes, Basidiomycota	**seed husks**	***Dicymbe* sp.**	**Guyana**	**Henkel et al. (2014)**
Epichlöe canadensis Charlton and C.A. Young[#]	Clavicipitaceae, Sordariomycetes, Ascomycota	**seeds**	***Elymus canadensis***	**USA**	**Charlton et al. (2012)**
Epichlöe typhina (Pers.) Brockm.	Clavicipitaceae, Sordariomycetes, Ascomycota	seed	*Festuca arundinacea*	USA	Rycyk Jr and Sharpe (1984)
		seed	*Festuca rubra*	New Zealand	Latch et al. (1984)
Epicoccum neglectum Desm.	Didymellaceae, Dothideomycetes, Ascomycota	seed	*Bromus inermis*	Canada	Conners (1967)
		seed	*Festuca rubra*	Canada	Conners (1967)
		seed	*Lolium perenne*	Canada	Conners (1967)
		seed	*Phleum pratense*	Canada	Conners (1967)
		seed	*Poa compressa*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Epicoccum nigrum Link	Didymellaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		cones, seeds	*Pinus nigra*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris*	Canada	Vujanovic et al. (2000)
		fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seed	*Agropyron cristatum*	Canada	Conners (1967)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seed	*Apium graveolens* var. *dulce*	USA	Conners (1967)
		seed	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seed	*Dactylis glomerata*	Canada	Conners (1967)
		seed	*Elymus virginicus*	Canada	Conners (1967)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
		seeds	*Pinus taeda*	USA	Mason and van Arsdel (1978) and Anderson (1986a)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Poa annua*	Pakistan	Lodhi and Naeem 1955
		seeds	*Quercus robur*	Germany, Poland	Krol et al. (2015) and Schroder et al. (2004)
		seed	*Setaria viridis*	Canada	Conners (1967)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
		seed	*Trifolium semipilosum*	Australia	Nik and Parbery (1977)
Epicoccum poae Qian Chen, Crous and L. Cai[#]	Didymellaceae, Dothideomycetes, Ascomycota	**seeds**	***Poa annua***	**USA**	**Chen et al. (2017)**
Epicoccum purpurascens Ehrenb. ex Schltdl.	Didymellaceae, Dothideomycetes, Ascomycota	cones	*Pinus sylvestris*	UK	Whittle (1977)
		seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Russia	Talgø et al. (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds, pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		seeds	*Pinus sylvestris*	UK	Whittle (1977)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Quercus alba*	USA	Vozzo (1984) and Anderson (1986a)
		seeds	*Quercus falcata*	USA	Vozzo (1984) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Quercus nigra*	USA	Vozzo (1984) and Anderson (1986a)
		seeds	*Quercus phellos*	USA	Vozzo (1984) and Anderson (1986a)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
Epicoccum spp.	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Acer saccharum*	USA	Janerette (1979) and Mittal et al. (1990)
		seeds	*Araucaria heterophylla*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seed	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
Epochnium monilioides Link	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Epulorhiza sp.	Tulasnellaceae, Agaricomycetes, Basidiomycota	seeds	*Cypripedium acaule*	Canada	Zelmer et al. (1996)
		seeds	*Cypripedium calceolus*	Canada	Zelmer et al. 1996
		seeds	*Platanthera hyperborea*	Canada	Zelmer et al. (1996)
		seeds	*Platanthera praeclara*	Canada	Zelmer et al. (1996)
		seeds	*Spiranthes magnicampo rum*	Canada	Zelmer et al. (1996)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Eriospora leucostoma Berk. and Broome	Stictidaceae, Lecanoromycetes, Ascomycota	fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
Ernakulamia krabiensis Jayasiri, E.B.G. Jones and K.D. Hyde#	Tetraplosphaeriaceae, Dothideomycetes, Ascomycota	**pods**	***Acacia* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Erysiphe diervillae* var. *chasanensis V.P. Gelyuta#	Erysiphaceae, Leotiomycetes, Ascomycota	**fruit**	***Weigela praecox***	**Japan**	**Gelyuta (1990)**
Erysiphe sp.	Erysiphaceae, Leotiomycetes, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a)
Eudarluca biconica Katum.	Phaeosphaeriaceae, Dothideomycetes, Ascomycota	seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
Eurotium chevalieri L. Mangin	Aspergillaceae, Eurotiomycetes, Ascomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
Eurotium rubrum Jos. König, Spieck. and W. Bremer	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
Eurotium spp.	Aspergillaceae, Eurotiomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
Exobasidium symploci-japonicae* var. *carpogenum Nagao and S. Ogawa#	Exobasidiaceae, Exobasidiomycetes, Basidiomycota	**fruit**	***Symplocos lucida***	**Japan**	**Nagao et al. (2003)**
Exophiala spp.	Herpotrichiellaceae, Eurotiomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Exserohilum rostratum (Drechsler) K.J. Leonard and Suggs	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
Fairmaniella leprosa (Fairm.) Petr. and Syd.	*Incertae sedis*, *Incertae sedis*, Ascomycota	pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
Filobasidium wieringae (Á. Fonseca, Scorzetti and Fell) Xin Zhan Liu, F.Y. Bai, M. Groenew. and Boekhout [as *Cryptococcus wieringae* Á. Fonseca, Scorzetti and Fell]	Filobasidiaceae, Tremellomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seeds	*Shorea talura*	Malaysia	Mittal et al. (1990)
Fitzpatrickella operculata Benny, Samuelson and Kimbr.[#]	Coryneliaceae, Eurotiomycetes, Ascomycota	**fruits**	***Drimys confertifolia***	**Chile**	**Benny et al. (1985)**
Flabellascoma minimum A. Hashim., K. Hiray. and Kaz. Tanaka	Lophiostomataceae, Dothideomycetes, Ascomycota	pod	*Leucaena leucocephala*	Thailand	Jayasiri et al. (2019)
Fumago vagans Pers.	*Incertae sedis*, *Incertae sedis*, Ascomycota	cone	*Humulus lupulus*	Canada	Conners (1967)
Fusariella indica R.Y. Roy and B. Rai	Bionectriaceae, Sordariomycetes, Ascomycota	seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b) and Mittal et al. (1990)
Fusarium acuminatum Ellis and Everh.	Nectriaceae, Sordariomycetes, Ascomycota	cones	*Pinus ponderosa*	USA	James (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		cones	*Pseudotsuga menziesii* var. *glauca*	USA	James (1995)
		seed	*Acer negundo*	Canada	Conners (1967)
		seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Apium graveolens* var. *dulce*	USA	Conners (1967)
		seed	*Festuca rubra*	Canada	Conners (1967)
		seeds	*Larix occidentalis*	USA	James et al. (1996)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Pinus elliottii*	Argentina	Lori and Salerno (2003)
		seeds	*Pinus ponderosa*	USA	James 1985a and (1995)
		seeds	*Pinus taeda*	Argentina	Lori and Salerno (2003)
		seeds	*Pseudotsuga menziesii*	Canada, USA	James (1986a) and Axelrood et al. (1995)
		seeds	*Pseudotsuga menziesii* var. *glauca*	USA	James (1995)
Fusarium anthophilum (A. Braun) Wollenw.	Nectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Fusarium arthrosporioides Sherb.	Nectriaceae, Sordariomycetes, Ascomycota	seed	*Lolium perenne*	Canada	Conners (1967)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Fusarium avenaceum (Fr.) Sacc. [as *Gibberella avenace*a R.J. Cook]	Nectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seed	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Lolium perenne*	Scotland	Conners (1967)
		seeds	*Picea abies*	Italy, USSR	Prisyazhnyuk (1960), Mittal et al. (1990) and Motta et al. 1996
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada	Axelrood et al. (1995)
		seeds	*Quercus robur*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Fusarium bulbigenum Cooke and Massee	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Fusarium bulbigenum* var. *blasticola (Rostr.) Wollenw.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Fusarium chlamydosporum Wollenw. and Reinking	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
Fusarium circinatum Nirenberg and O'Donnell	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus radiata*	USA	Dwinell 1999
Fusarium caeruleum Lib. ex Sacc.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Fusarium compactum (Wollenw.) Raillo	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
Fusarium culmorum (Wm.G. Sm.) Sacc.	Nectriaceae, Sordariomycetes, Ascomycota	seed	*Abies* spp.	UK	Anderson (1986a) and Batko (1956)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Lolium perenne*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Medicago sativa*	Canada	Conners (1967)
		seeds	*Medicago truncatula*	Australia	Nik and Parbery (1977)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Tectona grandis*	-	Mathur (1974) and Anderson (1986a)
Fusarium dlaminii Marasas, P.E. Nelson and Toussoun	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Picea abies*	Italy	Motta et al. 1996
Fusarium equiseti (Corda) Sacc.	Nectriaceae, Sordariomycetes, Ascomycota	seed	*Acrocarpus fraxinifolius*	India, Rwanda	Mathur (1974) and Anderson (1986a)
		seed	*Albizia gummifera*	Rwanda	Mathur (1974) and Mittal et al. (1990)
		seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seed	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)
		seed	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seed	*Bombax ceiba*	India	Mathur (1974) and Mittal et al. (1990)
		seed	*Cupressus* spp.	Syria	Mathur (1974) and Anderson (1986a)
		seed	*Delonix regia*	Brazil	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus deglupta*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Festuca elatior*	Canada	Conners (1967)
		seeds	*Festuca rubra*	Canada	Conners (1967)
		seeds	*Gmelina arborea*	India	Mathur (1974) and Anderson (1986a)
		seed	*Grevillea robusta*	Rwanda	Mathur (1974) and Anderson (1986a)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Lolium perenne*	Canada	Conners (1967)
		seeds	*Panicum mileaceum*	Canada	Conners (1967)
		seeds	*Phleum pratense*	Canada	Conners (1967)
		seeds	*Picea abies*	Italy, USSR	Prisyazhnyuk (1960), Mittal et al. (1990) and Motta et al. 1996
		seeds	*Pinus caribaea*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	Argentina	Lori and Salerno (2003)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus merkusii*	Zambia	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus oocarpa*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus taeda*	Argentina, Georgia	Huang and Kuhlman (1990) and Lori and Salerno (2003)
		seeds	*Portulaca grandiflora*	Canada	Conners (1967)
		seeds	*Prosopis juliflora*	Chile	Mathur (1974) and Mittal et al. (1990)
		seeds	*Prosopis tamarugo*	Chile	Mathur (1974) and Mittal et al. (1990)
		seeds	*Robinia pseudoacacia*	Hungary	Hangyal-Balul (1983) and Mittal et al. (1990)
		seeds	*Setaria viridis*	Canada	Conners (1967)
		seeds	*Tectona grandis*	-	Mathur (1974) and Anderson (1986a)
Fusarium graminearum Schwabe	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Quercus robur*	Poland	Krol et al. (2015)
Fusarium heterosporum Nees and T. Nees	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Fusarium incarnatum (Desm.) Sacc.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus elliottii*	Argentina	Lori and Salerno (2003)
		seeds	*Pinus taeda*	Argentina	Lori and Salerno (2003)
Fusarium lateritium Nees	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Araucaria heterophylla*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pseudotsuga menziesii*	Canada	Axelrood et al. (1995)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Fusarium moniliforme J. Sheld.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Abies grandis*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Abies nordmanniana*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Acacia auriculiformis*	Philippines	Quiniones (1987)
		seeds	*Acacia raddiana*	Israel	Mathur (1974) and Anderson (1986a)
		seeds	*Acer* sp.	South Korea	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Acrocarpus fraxinifolius*	India, Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Adenanthera microsperma*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Adina cordifolia*	India	Mathur (1974) and Anderson (1986a)
		seed	*Albizia falcataria*	Philippines	Mathur (1974) , Quiniones (1987) and Anderson (1986a)
		seed	*Albizia julibrissin*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Albizia procera*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Albizia stipulata*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Alstonia macrophylla*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Anthocephalus chinensis*	Philippines	Quiniones (1987)
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Calamus ornatus*	Philippines	Quiniones (1987)
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Cedrela odorata*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Cedrela toona*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Chukrasia tabularis*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Cordia alliodora*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seeds	*Dalbergia sissoo*	India, Madagascar	Mathur (1974), Anderson (1986a) and Kumar (2014)
		seeds	*Endospermum peltatum*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Eucalyptus camaldulensis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus grandis*	Uruguay	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Ficus benjamina*	India	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Gmelina arborea*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Grevillea robusta*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Jacaranda mimosifolia*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Juniperus coreana*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Kydia calycina*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Leucaena cunningham*	Malawi	Mathur (1974) and Anderson (1986a)
		seeds	*Leucaena diversifolia*	Guatemala	Mathur (1974) and Anderson (1986a)
		seeds	*Leucaena latisiliqua*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Leucaena leucocephala*	Malaysia, Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Leucaena* spp.	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Mimosa caesalpiniafolia*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Mimosa scabrella*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Picea abies*	Italy	Motta et al. (1996)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Piliostigma malabaricum*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize [as British Honduras], Central America, Honduras, Madagascar	Hocking (1968), Rees (1982) and Anderson (1986a)
		seeds	*Pinus caribaea* var. *bahamensis*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus caribaea* var. *caribae*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus caribaea* var. *hondurensis*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus elliottii*	Canada, USA	Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	Brazil, USA	Matur (1974), Anderson (1986a) and Fraedrich and Miller (1995)
		seeds	*Pinus insularis*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus khasya*	Brazil, Madagascar	Mathur (1974), Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus merkusii*	Philippines, Zambia	Agmata (1979), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus occidentalis*	Cuba	Anderson (1986a) and Richardson (1979)
		seeds	*Pinus oocarpa*	Central America, India, UK	Rees (1982), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus palustris*	USA	Pawuk (1978) and Anderson (1986a)
		seeds	*Pinus pinaster*	Italy, Uruguay	Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus pungens*	USA	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Anderson (1986a)
		seeds	*Pinus taeda*	Brazil, Canada, USA	Mason and van Arsdel (1978) and Anderson (1986a)
		seeds	*Pinus wallichiana*	Pakistan	Farooq (2000)
		seeds	*Pittosporum resiniferum*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Polyscias nodosa*	Philippines	Agmata (1979) and Mittal et al. (1990)
		seeds	*Prosopis juliflora*	Brazil, Chile	Mathur (1974) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada	Axelrood et al. (1995)
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pterospermum acerifolium*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Tectona grandis*	India, Philippines, Thailand	Mathur (1974), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Toona calantas*	Philippines	Quiniones (1987)
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Ulmus davidiana*	South Korea	Mathur (1974) and Anderson (1986a)
Fusarium moniliforme* var. *minus Wollenw. and Reinking	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Fusarium moniliforme* var. *subglutinans Wollenw. and Reinking	Nectriaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus taeda*	USA	Barrows-Broaddus and Dwinell (1985)
		seeds	*Pinus echinata*	USA	Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus elliottii* var. *elliottii*	USA, Philippines	Miller and Bramlett (1979) and Anderson (1986a)
		seeds	*Pinus oocarpa*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus pinaster*	Italy	Mittal et al. (1990) and Motta 1986
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
Fusarium nivale Ces. ex Berl. and Voglino	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Fusarium oxysporum Schltdl.	Nectriaceae, Sordariomycetes, Ascomycota	cones	*Pinus ponderosa*	USA	James (1995)
		cones, seeds	*Pseudotsuga menziesii* var. *glauca*	USA	James (1995)
		pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pod, seed	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria bidwillii*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Araucaria heterophylla*	Egypt	El-Kady et al. (1986) and Mittal et al. (1990)
		seed	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Caltha leptosepala*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seeds	*Crataegus azarolus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)
		seeds	*Eucalyptus deglupta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seed	*Hyoscyamus niger*	Canada	Conners (1967)
		seeds	*Larix decidua*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Larix occidentalis*	USA	James (1986b) and James et al. (1996)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Mimosa scabrella*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Picea abies*	Italy, Poland	Krol et al. (2015)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Picea glauca*	Canada, USA	James (1985b), Mittal and Wang (1986) and Mittal et al. (1990)
		seeds	*Picea pungens*	USA	James (1985b)
		seeds	*Pinus caribaea*	Belize [or as British Honduras], Cuba, UK	Hocking (1968), Rees (1982), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	Argentina, South Africa	Cilliers et al. (1995) and Lori and Salerno (2003)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus lambertiana*	USA	Anderson (1986a)
		seeds	*Pinus oocarpa*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus palustris*	USA	Pawuk (1978) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982), Anderson (1986a) and James (1986c, 1995)
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus taeda*	Argentina, USA, Uruguay	Mason and van Arsdel (1978) and Lori and Salerno (2003)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Pseudotsuga menziesii*	Canada, USA	James (1983b), (1984, 1986a) and Axelrood et al. (1995)
		seeds	*Pterospermum acerifolium*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1964) and Mittal et al. (1990)
		seeds	*Robinia pseudoacacia*	Hungary	Hangyal-Balul (1983) and Mittal et al. (1990)
		seeds	*Shorea materialis*	Malaysia	Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mathur (1974) and Anderson (1986a)
Fusarium oxysporum* f. *lini (Bolley) W.C. Snyder and H.N. Hansen	Nectriaceae, Sordariomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Fusarium oxysporum* f. *perniciosum (Hepting) Toole	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Albizia julibrissin*	USA	Quiniones (1985) and Anderson (1986a)
Fusarium oxysporum* f.sp. *elaeidis Toovey	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Elaeis guineensis*	Africa, Colombia, Surinam	Locke and Colhoun (1973) and Mittal et al. (1990)
Fusarium oxysporum* f.sp. *koae D.E. Gardner	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Acacia* spp.	Hawaii	Anderson (1986a) and Gardner (1980)
Fusarium oxysporum* var. *aurantiacum (Corda) Rabenh.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Fusarium poae (Peck) Wollenw.	Nectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Panicum mileaceum*	Canada	Conners (1967)
		seeds	*Picea abies*	Italy	Motta et al. (1996)
		seeds	*Pinus sylvestris*	UK	Whittle (1977)
		seeds	*Pseudotsuga menziesii*	Canada, USA	Gordon (1967), Mittal et al. (1990) and Axelrood et al. (1995)
		seed	*Setaria viridis*	Canada	Conners (1967)
Fusarium proliferatum (Matsush.) Nirenberg ex Gerlach and Nirenberg	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Picea abies*	Italy	Motta et al. (1996)
		seeds	*Pinus elliottii*	Argentina	Lori and Salerno (2003)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus taeda*	Argentina	Lori and Salerno (2003)
Fusarium redolens Wollenw.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Fusarium roseum Link [as *Gibberella pulicaris* (Kunze) Sacc.]	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
		seeds	*Pinus lambertiana*	USA	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Pinus palustris*	USA	Pawuk (1978) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	James (1983a)
		seeds	*Pinus taeda*	USA	Mason and van Arsdel (1978) and Anderson (1986a)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Prunus serrulata*	Japan	Watanabe (2010)
Fusarium sambucinum Fuckel	Nectriaceae, Sordariomycetes, Ascomycota	seed	*Hyoscyamus niger*	Canada	Conners (1967)
		seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seeds	*Larix occidentalis*	USA	James (1986b) and James et al. (1996)
		seeds	*Picea abies*	Italy	Motta et al. (1996)
		seeds	*Pinus ponderosa*	USA	James 1985a
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
		seeds	*Pseudotsuga menziesii*	Canada	Axelrood et al. (1995)
Fusarium sambucinum **var. *coeruleum*** Wollenw.	Nectriaceae, Sordariomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
Fusarium sarcochroum (Desm.) Sacc.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Abies amabilis*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Acacia auriculiformis*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Acacia modesta*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Acer palmatum*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Acrocarpus fraxinifolius*	India, Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Adenanthera microsperma*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Albizia falcataria*	Philippines	Mathur (1974) and Mittal et al. (1990)
		seeds	*Albizia gummifera*	Rwanda	Mathur (1974) and Mittal et al. (1990)
		seeds	*Albizia julibrissin*	Philippines	Quiniones (1987)
		seeds	*Albizia procera*	Philippines	Agmata (1979), Quiniones (1987) and Anderson (1986a)
		seeds	*Alstonia macrophylla*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Anogeissus pendula*	Costa Rica	Mathur (1974) and Mittal et al. (1990)
		seeds	*Anthocephalus chinensis*	Philippines	Quiniones (1987)
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Bombax malabaricum*	Pakistan	Lodhi and Naeem 1955
		seeds	*Calamus ornatus*	Philippines	Quiniones (1987)
		seeds	*Carpinus eximia*	South Korea	Mathur (1974) and Mittal et al. (1990)
		seeds	*Cassia acutifolia*	Egypt	Mathur (1974) and Mittal et al. (1990)
		seeds	*Cassia fistula*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Cedrela odorata*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Cordia alliodora*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Delonix regia*	Brazil, Philippines	Dayan (1986), Anderson (1986a) and Quiniones (1987)
		seeds	*Eucalyptus camaldulensis*	Egypt	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus maidenii*	Uruguay	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Ficus benjamina*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Gmelina arborea*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Gmelina moluccana*	Solomon Islands	Mathur (1974) and Anderson (1986a)
		seeds	*Grevillea robusta*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Kydia calycina*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Leucaena leucocephala*	India, Philippines	Singh et al. (1983), Anderson (1986a), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Leucaena* spp.	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Melaleuca* spp.	India	Anderson (1986a)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Mimosa caesalpiniafolia*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Mimosa scabrella*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Piliostigma malabaricum*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Pinus caribaea*	Cuba, UK	Rees (1982), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus caribaea* var. *hondurensis*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus elliottii*	Argentina, USA	Mathur (1974), Anderson (1986a) and Lori and Salerno (2003)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia, Uruguay, USA	Anderson (1986a), Huang and Kuhlman (1990) and Fraedrich and Miller (1995)
		seeds	*Pinus kesiya*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Pinus khasya*	Madagascar	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus merkusii*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus oocarpa*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus patula*	Madagascar	Anderson (1986a) and Gibson (1957)
		seeds	*Pinus pinaster*	Uruguay	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus taeda*	Argentina, Canada, Georgia	Mathur (1974), Anderson (1986a), Huang and Kuhlman (1990) and Lori and Salerno (2003)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Polyscias nodosa*	Philippines	Agmata (1979) and Mittal et al. (1990)
		seeds	*Prosopis juliflora*	Chile	Mathur (1974) and Mittal et al. (1990)
		seeds	*Prosopis tamarugo*	Chile	Mathur (1974) and Mittal et al. (1990)
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Sesbania sesban*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Taxodium mucronatum*	India	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Tectona grandis*	India, Philippines, Thailand	Mathur (1974), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Toona calantas*	Philippines	Quiniones (1987)
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Wallaceodendron celibcum*	Philippines	Dayan (1986), Anderson (1986a) and Quiniones (1987)
Fusarium sporotrichioides Sherb.	Nectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		cones	*Picea glauca*	Canada	Mittal and Wang (1987)
		cones, seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Larix occidentalis*	USA	James et al. (1996)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seeds	*Pinus ponderosa*	USA	James (1985a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Anderson (1986a)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975)
		seeds	*Quercus robur*	Poland	Krol et al. (2015)
		seeds	*Robinia pseudoacacia*	Hungary	Hangyal-Balul (1983)
Fusarium spp.	Nectriaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus nigra*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus nigra* ssp. *nigra*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris* 'Argentea-Compacta'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus uncinata*	Canada	Vujanovic et al. (2000)
		fruits	*Alocasia odora*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ardisia punctata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
		fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Rhodomyrtus tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Abies nordmanniana*	Austria, Georgia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Natarajan et al. (2003) and Mohanan et al. (2005)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria heterophylla*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Bombax ceiba*	India	Mittal et al. (1990)
		seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b) and Mittal et al. (1990)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus globulus*	Portugal	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Hungary, Poland	Mittal et al. (1990) and Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013) and Hayatgheibi (2013)
		seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seeds	*Leucaena leucocephala*	Bangladesh	Islam et al. (2008)
		seeds	*Maesopsis eminii*	Malaysia	Mittal et al. (1990)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
		seeds	*Picea abies*	Poland	Krol et al. (2015)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	Taiwan, USA	Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus luchuensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus nigra*	Hungary	Hangyal (1973) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus sylvestris*	Hungary, Poland	Hangyal (1973) and Mittal et al. (1990) and Krol et al. (2015)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Mittal et al. (1990)
		seeds	*Pinus taiwanensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus thunbergii* [= *Pinus thunbergiana*]	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seed	*Portulaca grandiflora*	Canada	Conners (1967)
		seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)
		seeds	*Quercus robur*	Germany, Poland, Turkey	Schroder et al. (2004), Krol et al. (2015) and Oskay et al. (2018)
		seeds	*Quercus rubra*	Poland	Krol et al. (2015)
		seeds	*Quercus* spp.	USSR	Urosevic (1983) and Mittal et al. (1990)
		seeds	*Shorea assamica*	Malaysia	Hong (1981) and Mittal et al. (1990)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Shorea talura*	Malaysia	Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Fusarium stilboides Wollenw.	Nectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Fusarium subglutinans (Wollenw. and Reinking) P.E. Nelson, Toussoun and Marasas	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
Fusarium subglutinans* f.sp. *pini J.C. Correll, T.R. Gordon, McCain, J.W. Fox, Koehler, D.L. Wood and M.E. Schultz	Nectriaceae, Sordariomycetes, Ascomycota	cones	*Pinus radiata*	USA	Dwinell (1998)
		seeds	*Pinus radiata*	USA	Dwinell (1998) and Storer et al. (1998)
Fusarium torulosum (Berk. and M.A. Curtis) Nirenberg	Nectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Fusarium tricinctum (Corda) Sacc.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Picea abies*	Italy	Motta et al. (1996)
		seeds	*Picea glauca*	USA	James (1985b)
		seeds	*Picea pungens*	USA	James (1985b)
		seeds	*Pinus palustris*	USA	Pawuk (1978) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Mason and van Arsdel (1978) and Anderson (1986a)
Fusarium verticillioides (Sacc.) Nirenberg	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seeds	*Pinus elliottii*	Argentina	Lori and Salerno (2003)
		seeds	*Pinus taeda*	Argentina	Lori and Salerno (2003)
Fusella olivacea (Corda) Sacc.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Fusicoccum spp.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	cones, seeds	*Pinus flexilis*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus mugo* 'Galica'	Canada	Vujanovic et al. (2000)
		seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
		seeds	*Pinus elliottii*	USA	Rowan and Debarr (1974) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Fusicolla acetilerea (Tubaki, C. Booth and T. Harada) Gräfenhan and Seifert [as *Fusarium merismoides* var. *acetilereum* Tubaki, C. Booth and T. Harada]	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus oocarpa*	UK	Rees (1982) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
Fusicolla merismoides (Corda) Gräfenhan [as	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Pinus caribaea*	UK	Rees (1982) and Mittal et al. (1990)
Fusarium merismoides Corda]		seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Fusidium spp.	Nectriaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
Gaeumannomyces sp.	Magnaporthaceae, Sordariomycetes, Ascomycota	fruits	*Dichroa febrifuga*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
Genicularia spp.	Orbiliaceae, Orbiliomycetes, Ascomycota	seeds	*Abies procera*	Norway	Talgø et al. (2010)
Geniculodendron pyriforme G.A. Salt	Caloscyphaceae, Pezizomycetes, Ascomycota	seeds	*Abies concolor* 'glauca'	USA	Schröder et al. (2002)
		seeds	*Abies concolor*	Germany (imported seeds from USA and Canada)	Schröder et al. (2002)
		seeds	*Abies grandis*	Germany (imported seeds from USA and Canada), USA	Schröder et al. (2002)
		seeds	*Larix occidentalis*	USA	James et al. (1996)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Picea engelmannii*	Germany (imported seeds from USA and Canada)	Schröder et al. (2002)
		seeds	*Picea sitchensis*	Canada, Germany (imported seeds from USA and Canada)	Sutherland and Woods (1978) and Schröder et al. (2002)
		seeds	*Picea* spp.	Canada	Woods et al. (1982) and Anderson (1986a)
		seeds	*Pinus resinosa*	Canada	Epners (1964) and Mittal et al. (1990)
		seeds	*Pinus* spp.	UK	Salt (1974) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Canada	Epners (1964) and Mittal et al. (1990)
Geniculosporium spp.	Xylariaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012) and Tateno et al. (2015)
Geomyces sp.	Thelebolaceae, Leotiomycetes, Ascomycota	seed	*Pinus monticola*	USA	Ganley and Newcombe (2006)
Geopyxis sp.	Tarzettaceae, Pezizomycetes, Ascomycota	seed	*Pinus monticola*	USA	Ganley and Newcombe (2006)
Geotrichum spp.	Dipodascaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
		seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Natarajan et al. (2003)
		seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seeds	*Dalbergia sissoo*	India	Naz et al. (2015)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	USA	Mittal et al. (1990)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
Gibbera sphyrospermi G.J. Samuel, M.E. Barr and C.T. Rogers[#]	*Incertae sedis*, Dothideomycetes, Ascomycota	**fruit**	***Sphyrospermum cordifolium***	**Panama**	**Samuels et al. (1988)**
Gilmaniella spp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Glaxoa pellucida P.F. Cannon[#**]	*Incertae sedis*, Dothideomycetes, Ascomycota	**cones**	***Cupressus sempervirens***	**UK**	**Cannon (1997)**
Gliocephalotrichum bulbilium J.J. Ellis and Hesselt.	Nectriaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
***Gliocephalotrichum* sp.**	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
Gliocladium roseum Bainier	Bionectriaceae, Sordariomycetes, Ascomycota	seed	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b)
Gliocladium solani (Harting) Petch	Bionectriaceae, Sordariomycetes, Ascomycota	fruits	*Alocasia odora*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
Gliocladium spp.	Hypocreaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		seed	*Gentiana* sp.	Japan	Watanabe (2010)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pseudotsuga menziesii*	Canada	Bloomberg (1969) and Mittal et al. (1990)
Gliocladium verticillioides (G.A. Newton) Pidoplitschka	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Gliomastix roseogrisea (S.B. Saksena) Summerb. [as *Cephalosporium roseogriseum* S.B. Saksena]	Bionectriaceae, Sordariomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Mittal (1983)
Gliocladiopsis tenuis (Bugnic.) Crous and M.J. Wingf. [as *Cylindrocarpon tenue* Bugnic.]	Nectriaceae, Sordariomycetes, Ascomycota	cones	*Pseudotsuga menziesii* var. *glauca*	USA	James (1995)
Gloeosporium acericola Allesch.	Dermateaceae, Leotiomycetes, Ascomycota	seeds	*Acer* sp.	USSR	Anderson (1986a)
Gloeosporium bolleyi R. Sprague	Dermateaceae, Leotiomycetes, Ascomycota	seed	*Setaria viridis*	Canada	Conners (1967)
Gloeosporium spp.	Dermateaceae, Leotiomycetes, Ascomycota	seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Liriodendron tulipifera*	USA	Anderson (1986a)
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Gloeosporium ulmicola Miles	Dermateaceae, Leotiomycetes, Ascomycota	seeds	*Ulmus pumila*	Romania	Georgescu and Petrescu (1954) and Mittal et al. (1990)
		seeds	*Ulmus* spp.	Romania	Richardson (1979) and Anderson (1986a)
Gloeotinia temulenta (Prill. and Delacr.) M. Wilson, Noble and E.G. Gray	Helotiaceae, Leotiomycetes, Ascomycota	seed	*Lolium perenne*	Scotland	Conners (1967)
Gloniopsis fluctiformis Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Hysteriaceae, Dothideomycetes, Ascomycota	**fruit**	**Combretaceae plant**	**Thailand**	**Jayasiri et al. (2019)**
Gloniopsis leucaenae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Hysteriaceae, Dothideomycetes, Ascomycota	**pod**	***Leucaena* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Gnomonia quercina Kleb.	Gnomoniaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Gnomoniopsis fructicola (G. Arnaud) Sogonov [as *Gnomonia fructicola* (G. Arnaud) Fall]	Gnomoniaceae, Sordariomycetes, Ascomycota	fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
Gonapodya bohemica Cejp	Gonapodyaceae, Monoblepharidomycetes, Chytridiomycota	seeds	*Sambucus racemosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Gonapodya polymorpha Thaxt.	Gonapodyaceae, Monoblepharidomycetes, Chytridiomycota	seeds	*Calluna vulgaris*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cornus capitata*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Crataegus azarolus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lonicera periclymenum*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lotus uliginosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lycium chinense*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Prunella grandiflora* ssp. *pyrenaia*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rosa mollis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Gonapodya prolifera (Cornu) A. Fisch.	Gonapodyaceae, Monoblepharidomycetes, Chytridiomycota	seeds	*Borago officinalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ginkgo biloba*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Humulus lupulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Humulus scandens*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rhus gueinzii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Gonapodya siliquiformis (Reinsch) Thaxt. [as '*siliquaeformis*']	Gonapodyaceae, Monoblepharidomycetes, Chytridiomycota	seeds	*Bryonia alba*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Daphne gnidium*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Daphne mezereum*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus niger*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sambucus ebulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sorbus torminalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Gonatobotrys flavus Bonord	Ceratostomataceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Gonatobotryum spp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Gonytrichum macrocladum (Sacc.) S. Hughes	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Graminopassalora graminis (Fuckel) U. Braun, C. Nakash., Videira and Crous [as *Passalora graminis* (Fuckel) Höhn.]	Mycosphaerellaceae, Dothideomycetes, Ascomycota	seed	*Phleum pratense*	Canada	Conners (1967)
Graphium rigidum (Pers.) Sacc.	Graphiaceae, Sordariomycetes, Ascomycota	fruit	*Apeiba* sp.	Panama	Morris and Finley (1956)
Graphium sp.	Graphiaceae, Sordariomycetes, Ascomycota	seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
Guignardia cocogena (Cooke) Punith.	Phyllostictaceae, Dothideomycetes, Ascomycota	fruits	*Ardisia punctata*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
Guignardia dioscoreae Sawada ex Katum.	Phyllostictaceae, Dothideomycetes, Ascomycota	fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
Guignardia musae Racib.	Phyllostictaceae, Dothideomycetes, Ascomycota	fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
Guignardia robiniae S. Ito and Kobayasi	Phyllostictaceae, Dothideomycetes, Ascomycota	seeds	*Robinia pseudoacacia*	Japan	Sato and Shoji 1960 and Anderson (1986a)
Gymnoascus bourquelotii Boud.	Gymnoascaceae, Eurotiomycetes, Ascomycota	seeds	*Gossypium* sp.	Pakistan	Lodhi and Naeem (1955)
Gymnopus asetosus Antonín, Ryoo and Ka[#]	Omphalotaceae, Agaricomycetes, Basidiomycota	**cone**	**undetermined plant**	**South Korea**	**Antonín et al. (2014)**
Gymnosporangium clavariiforme (Wulfen) DC.	Pucciniaceae, Pucciniomycetes, Basidiomycota	fruit	*Amelanchier* sp.	Canada	Conners (1967)
Gymnosporangium clavipes Cooke and Peck	Pucciniaceae, Pucciniomycetes, Basidiomycota	fruit	*Amelanchier* sp.	Canada	Conners (1967)
Gymnosporangium inconspicuum F. Kern	Pucciniaceae, Pucciniomycetes, Basidiomycota	fruit	*Amelanchier florida*	Canada	Conners (1967)
Hanseniaspora guilliermondii Pijper	Saccharomycodaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Hanseniaspora meyeri Cadez, Poot, Raspor and M.T. Sm.[#]	Saccharomycodaceae, Saccharomycetes, Ascomycota	**fruit**	***Sapindus* sp.**	**USA**	**Cadez et al. (2003)**
Hanseniaspora occidentalis M.T. Sm.	Saccharomycodaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Hansfordia spp.	Hansfordiaceae, Sordariomycetes, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Hapalophragmiopsis ponderosa (Syd., P. Syd. and E.J. Butler) Thirum. [as '*ponderosum'*]	Raveneliaceae, Pucciniomycetes, Basidiomycota	seeds	*Acacia* spp.	India	Malia and Tattar (1978) and Anderson (1986a)
Helicoma guttulatum Y.Z. Lu, Boonmee and K.D. Hyde	Tubeufiaceae, Dothideomycetes, Ascomycota	fruits	*Lithocarpus* sp.	Thailand	Jayasiri et al. (2019)
		fruits	undetermined plant	Thailand	Jayasiri et al. (2019)
Helicomyces candidus (Preuss) Sacc.	Tubeufiaceae, Dothideomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Helicomyces elegans Morgan	Tubeufiaceae, Dothideomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Helicomyces roseus Link	Tubeufiaceae, Dothideomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Helicosporium melghatianum Dharkar, Subhedar, Hande and Shahezad[#]	Tubeufiaceae, Dothideomycetes, Ascomycota	**pods**	***Pongamia pinnata***	**India**	**Dharkar et al. (2010)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Helicosporium pulvinatum (Nees and T. Nees) Pers.	Tubeufiaceae, Dothideomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Helicosporium sp.	Tubeufiaceae, Dothideomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Helminthosporium linicola Kletsh.	Massarinaceae, Dothideomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)
Helminthosporium rostratum Drechsler	Massarinaceae, Dothideomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Helminthosporium sativum Pammel, C.M. King and Bakke	Massarinaceae, Dothideomycetes, Ascomycota	seeds	*Bombax ceiba*	Pakistan	Lodhi and Naeem (1955)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Helminthosporium spp.	Massarinaceae, Dothideomycetes, Ascomycota	seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Araucaria bidwillii*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b), Mittal et al. (1990) and Naz et al. (2015)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	USA	Rowan and Debarr (1974) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Anderson (1986a)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Helminthosporium spiciferum (Bainier) Nicot	Massarinaceae, Dothideomycetes, Ascomycota	seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Helminthosporium tetramerum McKinney [as '*tetramer*']	Massarinaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Helotiales sp.	Leotiomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Helotium fagineum (Pers.) Fr.	Helotiaceae, Leotiomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
Helotium strobilinum (Fr.) Fuckel	Helotiaceae, Leotiomycetes, Ascomycota	seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Helotium virgultorum Fr.	Helotiaceae, Leotiomycetes, Ascomycota	seeds	*Picea abies*	USSR	Barrows-Broaddus and Dwinell (1985) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Hendersonia strobilina Curr.	Phaeosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Hermatomyces sphaericus (Sacc.) S. Hughes	Hermatomycetaceae, Dothideomycetes, Ascomycota	pod	*Entada phaseoloides*	Thailand	Jayasiri et al. (2019)
Herpotrichia juniperi (Sacc.) Petr.	Melanommataceae, Dothideomycetes, Ascomycota	cones, seeds	*Pinus contorta*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus densiflora*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus mugo* 'Galica'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus ponderosa*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus rigida*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris* 'Argentea-Compacta'	Canada	Vujanovic et al. (2000)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		cones, seeds	*Pinus sylvestris* 'Beuvronensis'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus tabulaeformis*	Canada	Vujanovic et al. (2000)
Heterobasidion annosum (Fr.) Bref.	Bondarzewiaceae, Agaricomycetes, Basidiomycota	seeds	*Abies* spp.	North America	Batko (1959) and Anderson (1986a)
Heteroconium decorosum R.F. Castañeda, Saikawa and Guaro[#]	Antennulariellaceae, Dothideomycetes, Ascomycota	**pod**	***Samanea saman***	**Cuba**	**Castañeda-Ruíz et al. (1999)**
Hirsutella uncinata Seifert and H. Boulay[#]	Ophiocordycipitaceae, Sordariomycetes, Ascomycota	**follicles**	***Hakea* sp.**	**Australia**	**Seifert and Boulay (2004)**
Hormiscium antiquum (Corda) Sacc.	Torulaceae, Dothideomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Hormiscium stilbosporum (Corda) Sacc.	Torulaceae, Dothideomycetes, Ascomycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
***Hormodendrum* sp.** [as '*Hormodendron*']	Cladosporiaceae, Dothideomycetes, Ascomycota	seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada, USA	Salisbury (1955) and Mittal et al. (1990)
Hormonema spp.	*Incertae sedis*, Dothideomycetes, Ascomycota	pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seed	*Pinus monticola*	USA	Ganley and Newcombe (2006)
Humicola fuscoatra Traaen	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
Humicola homopilata (Omvik) X. Wei Wang and Houbraken [as *Chaetomium homopilatum* Omvik]	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Humicola sp.	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Hyalocephalotrichum indicum Nagaraju, Kunwar, Sureshk. and Manohar.[#]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**fruit litter**	***Acacia auriculiformis***	**India**	**Nagaraju et al. (2011)c**
Hyalodendron sp.	Trichosporonaceae, Tremellomycetes, Basidiomycota	seeds	*Pinus taeda*	USA	Mason and van Arsdel (1978) and Anderson (1986a)
Hyaloscypha cupularum Svrček[#]	Hyaloscyphaceae, Leotiomycetes, Ascomycota	**cupule**	***Quercus* sp.**	**former Czechoslovakia**	**Svrcek (1987)**
Hyaloscypha leuconica (Cooke ex Stev.) Nannf.	Hyaloscyphaceae, Leotiomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
Hyaloscypha strobilicola* var. *parvispora Huhtinen[#]	Hyaloscyphaceae, Leotiomycetes, Ascomycota	**cone scales**	***Pinus sabiniana***	**USA**	**Huhtinen (1990)**
Hyaloscypha sulphureopilosa Svrček[#]	Hyaloscyphaceae, Leotiomycetes, Ascomycota	**cones**	***Picea abies***	**former Czechoslovakia**	**Svrcek (1986)**
Hydnum auriscalpium L.	Hydnaceae, Agaricomycetes, Basidiomycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Hymenoscyphus cassiae M.P. Sharma[#]	Helotiaceae, Leotiomycetes, Ascomycota	**pods**	***Cassia* sp.**	**India**	**Sharma (1991)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Hymenoscyphus fraxineus (T. Kowalski) Baral, Queloz and Hosoya [as *Chalara fraxinea* T. Kowalski]	Helotiaceae, Leotiomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013), Hayatgheibi (2013) and Marčiulynienė et al. (2017)
Hymenoscyphus seminis-alni Baral, B. Grauw. and M. Eckel[#]	Helotiaceae, Leotiomycetes, Ascomycota	**seeds**	***Alnus glutinosa***	**Germany**	**Baral (1996)**
Hymenoscyphus splendens Abdullah, Descals and J. Webster[#]	Helotiaceae, Leotiomycetes, Ascomycota	**fruit cupules**	***Fagus sylvatica***	**UK**	**Abdullah et al. (1981)**
Hyphopichia buzzinii L.R. Ribeiro, A.R.O. Santos, N. Jacques, Grondin, Casareg., C.A. Lara, Lachance and C.A. Rosa[#]	*Incertae sedis*, Saccharomycetes, Ascomycota	**fruit**	***Clidemia* sp.**	**Guiana**	**Ribeiro et al. (2017)**
Hypocreales sp.	Sordariomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
Hypoderma conigenum (Pers.) DC.	Rhytismataceae, Leotiomycetes, Ascomycota	seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960)
Hypoxylon hinnuleum (G. Sm.) Kuhnert and Sir [as *Nodulisporium hinnuleum* G. Sm.]	Hypoxylaceae, Sordariomycetes, Ascomycota	seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Hypoxylon spp. [as *Nodulisporium*]	Hypoxylaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Hysterobrevium hakeae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Hysteriaceae, Dothideomycetes, Ascomycota	**fruit**	***Hakea actites***	**Australia**	**Jayasiri, Hyde, Jones et al. (2018)**
Ilyonectria destructans (Zinssm.) Rossman, L. Lombard and Crous [as *Cylindrocarpon destructans* (Zinssm.) Scholten]	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
Ilyonectria radicicola (Gerlach and L. Nilsson) P. Chaverri and Salgado [as *Cylindrocarpon radicicola* Wollenw.]	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Picea excelsa*, *Pinus sylvestris*, *Quercus* spp.	USSR	Urosevic (1961, 1983) and Anderson (1986a)
Iodophanus carneus (Pers.) Korf	Pezizaceae, Pezizomycetes, Ascomycota	seeds	coniferae plant	Scotland	Vaartaja et al. (1964) and Anderson (1986a)
Isaria spp.	Cordycipitaceae, Sordariomycetes, Ascomycota	seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Issatchenkia occidentalis Kurtzman, M.J. Smiley and C.J. Johnson	Saccharomycetaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Ityorhoptrum verruculosum M.B. Ellis ex P.M. Kirk	*Incertae sedis*, *Incertae sedis*, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Kirk 1986
Juxtiphoma eupyrena (Sacc.) Valenz.-Lopez, Crous, Stchigel, Guarro and Cano [as *Phoma eupyrena* Sacc.]	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Larix occidentalis*	USA	James et al. 1996
Kallichroma tethys (Kohlm. and E. Kohlm.) Kohlm. and Volkm.-Kohlm.	Bionectriaceae, Sordariomycetes, Ascomycota	seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
Rhizophlyctis hyalina (Karling) Sparrow Karlingia hyalina Karling	Rhizophlyctidaceae, Chytridiomycetes, Chytridiomycota	seeds	*Trifolium pratense*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Karlingia polonica Hassan	Rhizophlyctidaceae, Chytridiomycetes, Chytridiomycota	seeds	*Armeria maritima* ssp. *maritima*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Karlingia rosea (de Bary and Woronin) A.E. Johanson	Rhizophlyctidaceae, Chytridiomycetes, Chytridiomycota	seeds	*Vicia sativa*	Poland	Kiziewicz (2005)
Karlingia spinosa Karling	Rhizophlyctidaceae, Chytridiomycetes, Chytridiomycota	seeds	*Ficus pumila*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Karlingiella elongata (Karling) G.H. Jerônimo, A.L. Jesus and Pires-Zottar. [as *Nowakowskiella elongata* Karling]	*Incertae sedis*, Chytridiomycetes, Chytridiomycota	seeds	*Cicuta virosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cuscuta europaea*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Karlingiomyces lobatus (Karling) Sparrow	Polychytriaceae, Polychytriomycetes, Chytridiomycota	seeds	*Ginkgo biloba*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Khuskia oryzae H.J. Huds.	*Incertae sedis*, Sordariomycetes, Ascomycota	seeds	*Delonix regia*	India	Sahu et al. (2003)
Kionocephala catenulata M.B. Ellis ex P.M. Kirk[#**]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**fruit cupule**	***Fagus sylvatica***	**UK**	**Kirk 1986**
Kloeckera africana (Klöcker) Janke	Saccharomycetaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Kloeckera apiculata (Reess) Janke	Saccharomycetaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Kuraishia borneana Kurtzman, Kurtzman and Robnett[#]	Pichiaceae, Saccharomycetes, Ascomycota	**fruit waste**	**undetermined plant**	**Brunei**	**Kurtzman and Robnett (2014)**
Lacellina graminicola (Berk. and Broome) Petch	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
Lachnum tengii W.Y Zhuang[#]	Lachnaceae, Leotiomycetes, Ascomycota	**nuts**	**undetermined plant**	**China**	**Zhuang (2002)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Laetinaevia colobanthi I.J. Gamundi and H.A. Soubedi[#]	Calloriaceae, Leotiomycetes, Ascomycota	**fruit**	***Colobanthus quitensis***	**Antarctica**	**Gamundí and Spinedi 1988**
Lanceispora sp.	*Incertae sedis*, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Lasiodiplodia sp.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Lasiodiplodia avicenniarum Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	**fruit**	***Avicennia marina***	**Thailand**	**Jayasiri et al. (2019)**
Lasiodiplodia pseudotheobromae A.J.L. Phillips, A. Alves and Crous	Botryosphaeriaceae, Dothideomycetes, Ascomycota	pod	*Afzelia xylocarpa*	Thailand	Jayasiri et al. (2019)
		pod	*Quercus* sp.	Thailand	Jayasiri et al. (2019)
Lasiodiplodia swieteniae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	**fruit**	***Swietenia* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Lasiodiplodia theobromae (Pat.) Griffon and Maubl.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	fruit	undetermined plant	Guinea	Phillips et al. (2013)
		fruit, pod	undetermined plant	Thailand	Jayasiri et al. (2019)
		pod	*Acacia* sp.	Thailand	Jayasiri et al. (2019)
		pod	*Calophyllum inophyllum*	Thailand	Jayasiri et al. (2019)
		seeds	*Pinus caribaea*	Central America	Rees 1988

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus elliottii*	Brazil, South Africa	Cilliers et al. (1995) and Maciel et al. (2015)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus taeda*	Brazil	Maciel et al. (2015)
Lauriomyces ellipticus Somrith. and E.B.G. Jones[#]	Lauriomycetaceae, Leotiomycetes, Ascomycota	**fruit**	**undetermined plant**	**Thailand**	**Somrithipol and Jones (2007)**
Lauriomyces sakaeratensis Somrith., Kosol and E.B.G. Jones[#]	Lauriomycetaceae, Leotiomycetes, Ascomycota	**fruits**	***Dipterocarpus costatus***	**Thailand**	**Somrithipol et al. (2006)**
Lecanora shangrilaensis Z.T. Zhao and L. Lü[#]	Lecanoraceae, Lecanoromycetes, Ascomycota	**cones**	***Pinus* sp.**	**China**	**Lü and Zhao (2017)**
Lecanora substrobilina Printzen[#]	Lecanoraceae, Lecanoromycetes, Ascomycota	**cones**	***Pinus* sp.**	**USA**	**Printzen 2001**
Lecythophora spp.	Coniochaetaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Leptosphaeria sp.	Leptosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Leptosphaerulina sp.	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
Leptoxyphium kurandae Crous and R.G. Shivas	Capnodiaceae, Dothideomycetes, Ascomycota	fruits	*Lagerstroemia loudonii*	Thailand	Jayasiri et al. (2019)
Leucaenicola aseptata Jayasiri, E.B.G. Jones and K.D. Hyde[#**]	Bambusicolaceae, Dothideomycetes, Ascomycota	**pod**	***Leucaena* sp.**	**Thailand**	**Jayasiri et al. (2019)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Leptostroma sp.	Rhytismataceae, Leotiomycetes, Ascomycota	cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
Leucaenicola phraeana Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Bambusicolaceae, Dothideomycetes, Ascomycota	**pod**	***Leucaena* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Lirula macrospora (R. Hartig) Darker	Rhytismataceae, Leotiomycetes, Ascomycota	seeds	*Abies* spp	USSR	Anderson (1986a)
Lophiotrema praemorsum (Lasch) Sacc.	Lophiotremataceae, Dothideomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
Lophiotrema psychotriae A.M.C. Tang, K.D. Hyde, C.K.M. Tsui and R.T. Corlett[#] [as '*psychotrii*']	Lophiotremataceae, Dothideomycetes, Ascomycota	**fruits**	***Psychotria asiatica***	**Hong Kong**	Tang, Hyde et al. (2003) and **Tang, Hyde, Tsui et al. (2003)**
		fruits	*Rhodomyrtus tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
Lophium zalerioides J.F. Li, Phookamsak, Camporesi and K.D. Hyde[#]	Mytilinidiaceae, Dothideomycetes, Ascomycota	**cone**	***Cupressus glabra***	**Italy**	**Hyde, Norphanphoun et al. (2017)**
Lophodermium pinastri (Schrad.) Chevall.	Rhytismataceae, Leotiomycetes, Ascomycota	seeds	*Pinus* spp.	North America, UK	Noble et al. (1958) and Anderson (1986a)
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Lophodermium seditiosum Minter, Staley and Millar	Rhytismataceae, Leotiomycetes, Ascomycota	seeds	*Pinus sylvestris*	Germany	Bentele et al. (2014)
Macrochytrium botrydioides Minden	*Incertae sedis*, Chytridiomycetes, Chytridiomycota	seeds	*Armeria transmontana*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Asparagus officinalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Atropa belladonna*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa caucasica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa komarovii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Bryonia dioica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Celtis australis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cornus capitata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Crataegus azarolus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Podophyllum peltatum*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sorbus torminalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Macrophoma fraxini Delacr.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Fraxinus* sp.	former Czechoslovakia	Anderson (1986a)
Macrophoma nitens Berl. and Voglino	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Macrophoma spp.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	fruits	*Ardisia qinquegona*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Rhodomyrtus tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		seeds	*Eucalyptus camaldulensis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
Macrophomina phaseolina (Tassi) Goid.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Albizia stipulata*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Cedrela odorata*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Leucdena diversifolia*	Guatemala	Mathur (1974) and Anderson (1986a)
		seeds	*Musanga cecropioides*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus caribaea*	Central America, Madagascar, UK	Rees (1982) and Anderson (1986a) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus insularis*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus merkusii*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Swietenia macrophylla*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Tabebuia heptaphylla*	Brazil	Mathur (1974) and Anderson (1986a)
Macrophomina phaseolina (Tassi) Goid. [as *Macrophomina phaseoli* (Maubl.) S.F. Ashby]		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985) and Anderson (1986a)
Macrophomina phaseolina (Tassi) Goid. [as *Macrophoma phaseoli* Maubl.]		seeds	*Acacia auriculiformis*	Philippines	Quiniones (1987)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1987)
		seeds	*Gmelina arborea*	Philippines	Quiniones (1987)
		seeds	*Toona calantas*	Philippines	Quiniones (1987)
Macrophomina spp.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Chukrasia tabularis*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Cupressus arizonica*	Uruguay	Anderson (1986a)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Leucaena* spp.	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Shorea acuminata*	Malaysia	Mittal et al. (1990)
		seeds	*Shorea talura*	Malaysia	Mittal et al. (1990)
		seeds	*Tectona grandis*	-	Mathur (1974) and Anderson (1986a)
Malassezia globosa Midgley, E. Guého and J. Guillot	Malasseziaceae, Malasseziomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Malassezia sp.	Malasseziaceae, Malasseziomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Marasmius cryptocystidiatus Corner[#]	Marasmiaceae, Agaricomycetes, Basidiomycota	**fruit husks**	***Willughbeia* sp.**	**Singapore**	**Corner (1996)**
Marasmius fagi (Kalamees) Kalamees[#] [as *Collybia fagi* Kalamees]	Marasmiaceae, Agaricomycetes, Basidiomycota	**fruit**	***Fagus* sp.**	**Russia**	**Vaasma et al. (1986)**
Marasmius micromerus Corner[#]	Marasmiaceae, Agaricomycetes, Basidiomycota	**fruits**	***Polyalthia* sp.**	**Malaysia**	**Corner (1996)**
Massarina spp.	Massarinaceae, Dothideomycetes, Ascomycota	cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Melampsora abietis-canadensis (Farl.) C.A. Ludw.	Melampsoraceae, Pucciniomycetes, Basidiomycota	cone	*Tsuga canadensis*	Canada	Conners (1967)
Melanconium apiocarpum Link	Melanconidaceae, Sordariomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Mittal et al. (1990) and Urosevic (1961)
Melanconium apiocarpum Link [as '*apiocarpon*']		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
Melanconium bicolor Nees	Melanconidaceae, Sordariomycetes, Ascomycota	seeds	*Picea excelsa*, *Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Melanospora papillata Hotson	Ceratostomataceae, Sordariomycetes, Ascomycota	seed	*Linum usitatissimum*, *Lolium perenne*	Canada	Conners (1967)
Melanospora spp.	Ceratostomataceae, Sordariomycetes, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Melanospora spp. [as *Gonatobotrys*]		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Melanospora simplex (Corda) D. Hawksw. [as *Gonatobotrys simplex* Corda]	Ceratostomataceae, Sordariomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
Melanospora zamiae Corda	Ceratostomataceae, Sordariomycetes, Ascomycota	seeds	*Abies* spp.	UK	Batko (1959) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Gossypium* sp.	Pakistan	Lodhi and Naeem 1955
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Lolium perenne*	Canada	Conners (1967)
Memnoniella echinata (Rivolta) Galloway	Stachybotryaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Cassia fistula*	India	Mittal and Sharma (1981a) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seeds	*Pinus merkusii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Memnoniella spp.	Stachybotryaceae, Sordariomycetes, Ascomycota	seeds	*Tectona grandis*	India	Anderson (1986a)
Menisporopsis sp.	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	fruits	*Rhodomyrtus tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
Metarhizium sp.	Clavicipitaceae, Sordariomycetes, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Metschnikowia laotica Sipiczki[#]	Metschnikowiaceae, Saccharomycetes, Ascomycota	**fruit**	**undetermined plant**	**Laos**	**Sipiczki (2014)**
Meyerozyma guilliermondii (Wick.) Kurtzman and M. Suzuki [as *Candida guilliermondii* (Castell.) Langeron and Guerra]	Debaryomycetaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Micraspis strobilina Dennis	Micraspidaceae, Leotiomycetes, Ascomycota	cones	*Pinus sylvestris*	UK	Dennis (1971)
Microascus longirostris Zukal	Microascaceae, Sordariomycetes, Ascomycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
Microbotryum perfoliatae Vánky[#]	Microbotryaceae, Microbotryomycetes, Basidiomycota	**seeds**	***Claytonia perfoliata***	**USA**	**Vánky 1998**
Microbotryum silybum Vánky and Berner[#]	Microbotryaceae, Microbotryomycetes, Basidiomycota	**seed**	***Silybum marianum***	**Greece**	**Vánky and Berner (2003)**
Microdochium sp. [as *Monographella*]	Microdochiaceae, Sordariomycetes, Ascomycota	seeds	*Phyllostachys edulis*	China	Shen et al. (2014)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Microsphaeropsis globulosa (Sousa da Câmara) B. Sutton	Didymosphaeriaceae, Dothideomycetes, Ascomycota	fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)
Microthecium sepedonioides (Preuss) Y. Marín, Stchigel, Guarro and Cano [as *Papulaspora sepedonioides* Preuss]	Ceratostomataceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Millerozyma acaciae (Van der Walt) Kurtzman and M. Suzuki [as *Pichia acaciae* Van der Walt]	Debaryomycetaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Mollisia ligni (Desm.) P. Karst.	Mollisiaceae, Leotiomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
Mollisia sp.	Mollisiaceae, Leotiomycetes, Ascomycota	cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
Monacrosporium sp.	Orbiliaceae, Orbiliomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
Monilia sitophila (Mont.) Sacc.	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Monilia sitophila (Mont.) Sacc. [as *sitophyla*]		seeds	*Abies sibirica*	USSR	Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Monilia sp.	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Alnus sibirica*	South Korea	Mathur (1974) and Mittal et al. (1990)
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Chamaecypa ris obtusa*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia	Huang and Kuhlman (1990)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Samanea saman*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Monilinia amelanchieris (J.M. Reade) Honey	Sclerotiniaceae, Leotiomycetes, Ascomycota	fruit	*Amelanchier* sp.	Canada	Conners (1967)
Monilinia azaleae Honey[#] [as *Monilia azalea* L.R. Batra]	Sclerotiniaceae, Leotiomycetes, Ascomycota	**fruits**	***Rhododendr on roseum***	**USA**	**Batra (1991)**
Monilinia gaylussaciae L.R. Batra[#] [as *Monilia gaylussaciae* L.R. Batra]	Sclerotiniaceae, Leotiomycetes, Ascomycota	**fruits**	***Gaylussacia baccata***	**USA**	**Batra (1988)**
Monilinia jezoensis Yuk. Takah., T. Sano and Y. Harada[#] [as *Monilia jezoensis* Yuk. Takah., Ichihashi and Y. Harada]	Sclerotiniaceae, Leotiomycetes, Ascomycota	**fruits**	***Rhododendr on kaempferi***	**Japan**	**Takahashi et al. (2005)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Monilinia fructicola (G. Winter) Honey	Sclerotiniaceae, Leotiomycetes, Ascomycota	fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
Monilinia ssiori Y. Harada, Ma. Saaki and T. Sano#	Sclerotiniaceae, Leotiomycetes, Ascomycota	**fruits**	***Prunus ssiori***	**Japan**	**Harada et al. (2005)**
Monochaetia ilicina (Sacc.) Nag Raj	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Ardisia crenata*	Hong Kong	Tang, Hyde et al. (2003)
Monochaetia karstenii (Sacc. and P. Syd.) B. Sutton	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
Monochaetia sp.	Sporocadaceae, Sordariomycetes, Ascomycota	cones	*Picea glauca*	Canada	Mittal and Wang (1987)
Monocillium spp.	Niessliaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
		seeds	*Eucalyptus globulus*	India	Anderson (1986a)
		seeds	*Eucalyptus grandis*	India	Anderson (1986a)
		seeds	*Eucalyptus tereticornis*	India	Anderson (1986a)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Monotospora sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Monotosporella sp.	Pleurotheciaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Mortierella candelabrum Tiegh. and G. Le Monn.	Mortierellaceae, Mortierellomycetes, Mucoromycota	seeds	*Crataegus azarolus*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Mortierella hyalina (Harz) W. Gams	Mortierellaceae, Mortierellomycetes, Mucoromycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
Mucor adventitius Oudem.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Mucor circinelloides Tiegh.	Mucoraceae, Mucoromycetes, Mucoromycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
Mucor erectus Bainier	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Crataegus azarolus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sorbus torminalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Mucor globosus Schreb.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Mucor globosus Schreb. [as '*globosum*']		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Mucor hiemalis Wehmer	Mucoraceae, Mucoromycetes, Mucoromycota	cones	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Abies alba*	Poland	Krol et al. (2015)
		seed	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seeds	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968) and Mittal et al. (1990)
		seeds	*Pinus patula*	Kenya	Gibson (1957) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Mucor microsporus Bonord.	Mucoraceae, Mucoromycetes, Mucoromycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seed	*Sesbania bispinosa*	India	Anita et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Mucor mucedo L.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USSR	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964), Prisyazhnyuk (1960) and Mittal et al. (1990)
Mucor piriformis A. Fisch.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Rosa mollis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Mucor piriformis A. Fisch. [as *Mucor alboater* Naumov]		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Mucor plumbeus Bonord.	Mucoraceae, Mucoromycetes, Mucoromycota	pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Anderson (1986a)
Mucor racemosus Bull.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	UK, USSR	Prisyazhnyuk (1960), Urosevic (1961), Whittle (1977) and Anderson (1986a)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Sorbus torminalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Mucor silvaticus Hagem	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Rosa mollis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Mucor spp.	Mucoraceae, Mucoromycetes, Mucoromycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		cones	*Pinus sylvestris*	UK	Whittle (1977)
		seeds	*Abies nordmanniana*	Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Acer saccharum*	USA	Janerette (1979) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Natarajan et al. (2003)
		seeds	*Abies nordmanniana*	Georgia, Russia	Talgø et al. (2010)
		seeds	*Bombax anceps*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	India	Mittal et al. (1990)
		seeds	*Cassia fistula*	India	Mittal and Sharma (1981a) and Mittal et al. (1990)
		seeds	*Cedrus deodara*	India	Mittal (1983) and Mittal et al. (1990)
		seeds	*Dalbergia cochinchinensis*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus globulus*	India	Anderson (1986a)
		seeds	*Eucalyptus grandis*	India	Anderson (1986a)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Eucalyptus tereticornis*	India	Anderson (1986a)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seeds	*Picea engelmannii*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968) and Mittal et al. (1990)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia, USA	Huang and Kuhlman (1990) and Fraedrich and Miller (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus lambertiana*	USA	Schubert (1961) and Anderson (1986a)
		seeds	*Pinus nigra*	Hungary	Hangyal (1973) and Mittal et al. (1990)
		seeds	*Pinus patula*	East Africa	Gibson (1957) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Hungary, Poland, UK	Hangyal (1973) and Whittle (1977) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada, USA	Anderson (1986a) and James (1984)
		seeds	*Quercus robur*	Germany	Schroder et al. (2004)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
		seeds	*Swietenia macrophylla*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Anderson (1986a) and Mohanan et al. (2005)
Mucor spinosus Schrank	Mucoraceae, Mucoromycetes, Mucoromycota	seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Mucor strictus Hagem	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Sorbus torminalis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Mundkurella japonica Denchev and Kakish.[#]	Urocystidaceae, Ustilaginomycetes, Basidiomycota	**fruits**	***Kalopanax pictus***	**Japan**	**Denchev and Kakishima (2007)**
Muyocopron dipterocarpi Mapook, Boonmee and K.D. Hyde	Muyocopronaceae, Dothideomycetes, Ascomycota	pod	*Delonix regia*	Thailand	Jayasiri et al. (2019)
Muyocopron lithocarpi Mapook, Boonmee and K.D. Hyde	Muyocopronaceae, Dothideomycetes, Ascomycota	pod	*Cercis chinensis*	China, Thailand	Jayasiri et al. (2019)
		pod	*Peltophorum* sp.	China, Thailand	Jayasiri et al. (2019)
Mycena albidorosea Robiich.[#]	Mycenaceae, Agaricomycetes, Basidiomycota	**cones**	***Picea abies***	**Italy**	**Robich (2003)**
Mycena cupressincola Robich[#]	Mycenaceae, Agaricomycetes, Basidiomycota	**cones**	***Cupressus* sp.**	**Italy**	**Robich (2016)**
Mycena deeptha Aravind. and Manim.[#]	Mycenaceae, Agaricomycetes, Basidiomycota	**fruits**	***Vateria indica***	**India**	**Aravindakshan et al. (2012)**
Mycena depilata R. Singer[#]	Mycenaceae, Agaricomycetes, Basidiomycota	**fruit**	**dicotyledon-ous plant**	**Brazil**	**Singer (1989)**
Mycena detrusa Mass Geest and E Horak[#]	Mycenaceae, Agaricomycetes, Basidiomycota	**cupule**	***Lithocarpus* sp.**	**Papua New Guinea**	**Geesteranus and Horak (1995)**
Mycena extenuata Mass Geest. and de Meijer[#]	Mycenaceae, Agaricomycetes, Basidiomycota	**fruit**	**Bignoniacea e plant**	**Brazil**	**Geesteranus and de Meijer (1998)**
Mycena mirata (Peck) Sacc	Mycenaceae, Agaricomycetes, Basidiomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Mycena plumipes (Kalchbr.) P.A. Moreau[#] [as *Agaricus plumipes* Kalchbr.]	Mycenaceae, Agaricomycetes, Basidiomycota	**cones**	***Pinus* sp.**	**Hungary**	**Moreau (2003)**
Mycocalicium hyaloparvicellulum Daranagama and K.D. Hyde[#]	Mycocaliciaceae, Eurotiomycetes, Ascomycota	**cone**	***Pinus halepensis***	**Italy**	**Ariyawansa, Hyde et al. (2015)**
Mycocalicium llimonae Hladun and D. Muňiz[#]	Mycocaliciaceae, Eurotiomycetes, Ascomycota	**cones**	***Pinus halepensis***	**Spain**	**Muñiz and Hladun (2007)**
Mycogone sp.	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Nothofagus* sp.	UK	Anderson (1986a)
Mycosphaerella sp.	Mycosphaerellaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Mycosphaerellaceae sp.	Mycosphaerellaceae, Dothideomycetes, Ascomycota	seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Mycovellosiella fulva (Cooke) Arx	Mycosphaerellaceae, Dothideomycetes, Ascomycota	fruit	*Artocarpus communis*	Nigeria	Amusa et al. (2002)
Myrothecium mucunae R.F. Castaneda and W.B. Kendr[#]	Stachybotriaceae, Sordariomycetes, Ascomycota	**seed**	***Mucuna urens***	**Cuba**	**Castañeda-Ruíz and Kendrick (1991)**
Myrothecium spp.	Stachybotriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Tectona grandis*	-	Mathur (1974) and Anderson (1986a)
		seeds	*Tilia americana*	USA	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Mytilinidion didymospora Jayasiri, Camporesi and K.D. Hyde[#]	Mytilinidiaceae, Dothideomycetes, Ascomycota	**cones**	***Cupressus glabra***	**Italy**	**Jayasiri, Hyde, Jones et al. (2018)**
Mytilinidion scolecosporum M.L. Lohman	Mytilinidiaceae, Dothideomycetes, Ascomycota	cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
Naemacyclus fimbriatus (Schwein.) DiCosmo, Peredo and Minter	Marthamycetaceae, Leotiomycetes, Ascomycota	cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
Naemacyclus minor Butin	Marthamycetaceae, Leotiomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Nakazawaea ernobii (Lodder and Kreger-van Rij) Kurtzman and Robnett [as *Candida karawaiewii* Yarrow and S.A. Mey.]	*Incertae sedis*, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Naranus cryptomeriae Ts. Watan.[#**]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**seeds**	***Cryptomeria japonica***	**Japan**	**Watanabe (1995)**
Nawawia filiformis (Nawawi) Marvanová	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Nectria gigantospora Zimm.	Nectriaceae, Sordariomycetes, Ascomycota	fruits	*Didymopanax morototoni*	Panama	Samuels and Dumon (1982) and Piepenbring (2006)
Nectria haematococca Berk. and Broome	Nectriaceae, Sordariomycetes, Ascomycota	fruit	palm tree	Panama	Samuels and Dumon (1982)
Nectria radicicola Gerlach and L. Nilsson	Nectriaceae, Sordariomycetes, Ascomycota	fruit	Balanophoraceae plant	Peru	Samuels and Dumon (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruit	undetermined plant	Panama	Samuels and Dumon (1982)
Nectria spp.	Nectriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
Nectriaceae sp.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Quercus robur*	Turkey	Oskay et al. (2018)
Neocosmospora solani (Mart.) L. Lombard and Crous [as *Fusarium solani* (Mart.) Sacc.]	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Acacia auriculiformis*	Philippines	Quiniones (1987)
		seeds	*Agathis dammara*	Philippines	Quiniones (1985) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Albizia procera*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Albizia stipulata*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Alstonia macrophylla*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Araucaria bidwillii*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria heterophylla*	Egypt	El-Kady et al. (1986) and Mittal et al. (1990)
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	India	Mathur (1974) and Mittal et al. (1990)
		seed	*Bromus inermis*	Canada	Conners (1967)
		seeds	*Calamus ornatus*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines	Quiniones (1987)
		seeds	*Cedrela odorata*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Chamaecyparis obtusa*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Dalbergia sissoo*	India, Madagascar	Mathur (1974), Anderson (1986a) and Kumar (2014)
		seeds	*Endospermum peltatum*	Philippines	Agmata (1979) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Gmelina arborea*	India, Philippines	Mathur (1974), Anderson (1986a) and Quiniones (1987)
		seeds	*Grevillea robusta*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seeds	*Leucaena leucocephala*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Leucaena* spp.	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Picea glauca*	USA	James 1985b
		seeds	*Picea pungens*	USA	James 1985b
		seeds	*Piliostigma malabaricum*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Cuba, UK	Rees (1982), Anderson (1986a) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus caribaea* var. *caribae*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus elliottii*	Argentina, USA	Rowan and Debarr (1974), Anderson (1986a) and Lori and Salerno (2003)
		seeds	*Pinus elliottii* var. *elliottii*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus merkusii*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus oocarpa*	Central America	Rees (1982) and Anderson (1986a)
		seeds	*Pinus palustris*	USA	Pawuk (1978) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982)
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Anderson (1986a)
		seeds	*Pinus taeda*	Argentina, USA	Mathur (1974), Anderson (1986a) and Lori and Salerno (2003)
		seeds	*Pittosporum resiniferum*	Philippines	Quiniones (1985) and Anderson (1986a, 1987)
		seeds	*Prosopis juliflora*	Chile	Mathur (1974) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Pseudotsuga menziesii*	USA	James (1983b), (1984)
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979), Anderson (1986a) and Quiniones (1987)
		seeds	*Pterospermum acerifolium*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Quercus alba*	USA	Vozzo (1984) and Anderson (1986a)
		seeds	*Quercus falcata*	USA	Vozzo (1984) and Anderson (1986a)
		seeds	*Quercus nigra*	USA	Vozzo (1984) and Anderson (1986a)
		seeds	*Quercus phellos*	USA	Vozzo (1984) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
		seeds	*Swietenia macrophylla*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Taxodium mucronatum*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Tectona grandis*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Toona calantas*	Philippines	Quiniones (1987)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985) and Anderson (1986a, 1987)
		seeds	*Ulmus davidiana*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Wallaceodendron celibcum*	Philippines	Quiniones (1985, 1987) and Anderson (1986a)
Neodeightonia planchoniae Jayasiri and K.D. Hyde[#]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	**fruit**	***Planchonia* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Neofusicoccum eucalyptorum (Crous, H. Sm. ter and M.J. Wingf.) Crous, Slippers and A.J.L. Phillips	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds, seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Neofusicoccum mangiferae (Syd. and P. Syd.) Crous, Slippers and A.J.L. Phillips [as *Fusicoccum eucalypti* Sousa da Câmara]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
Neofusicoccum parvum (Pennycook and Samuels) Crous, Slippers and A.J.L. Phillips [as *Botryosphaeria parva* Pennycook and Samuels]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	fruit	*Magnolia grandiflora*	China	Jayasiri et al. (2019)
		pod	*Cercis chinensis*	China	Jayasiri et al. (2019)
		seeds	*Podocarpus falcatus*	Ethiopia	Gure, Slippers et al. (2005)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Neofusicoccum ribis (Slippers, Crous and M.J. Wingf.) Crous, Slippers and A.J.L. Phillips [as *Botryosphaeria ribis* Grossenb. and Duggar]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Pinus caribaea*	UK	Mittal et al. (1990)
Neohelicosporium fusisporum Jayasiri and K.D. Hyde[#]	Tubeufiaceae, Dothideomycetes, Ascomycota	**fruit**	**Malvaceae plant**	**Thailand**	**Jayasiri, Hyde, Jones et al. (2017)**
Neohelicosporium hyalosporum Y.Z. Lu, J.C. Kang and K.D. Hyde	Tubeufiaceae, Dothideomycetes, Ascomycota	pod	*Delonix regia*	Thailand	Jayasiri et al. (2019)
Neolindgomyces pandani Jayasiri, E.B.G. Jones and K.D. Hyde[#**] [as *Neolindgomyces pandanae* Jayasiri, E.B.G. Jones and K.D. Hyde]	Lindgomycetaceae, Dothideomycetes, Ascomycota	**fruit**	***Pandanus* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Neonectria didymum [as *Cylindrocarpon didymum* (Harting) Wollenw.]	Nectriaceae, Sordariomycetes, Ascomycota	cones	*Pinus ponderosa*	USA	James (1995)
		cones	*Pseudotsuga menziesii* var. *glauca*	USA	James (1995)
		seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
		seeds	*Pseudotsuga menziesii* var. *glauca*	USA	James (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Neonectria ramulariae Wollenw.	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Abies koreana*	Korea	Cho et al. (2007)
Neonectria spp. [as *Cylindrocarpon*]	Nectriaceae, Sordariomycetes, Ascomycota	seeds	*Abies nordmanniana*	Georgia	Talgø et al. (2010)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
Neopestalotiopsis clavispora (G.F. Atk.) Maharachch., K.D. Hyde and Crous [as *Pestalotia clavispora* G.F. Atk.]	Sporocadaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Neopestalotiopsis foedans (Sacc. and Ellis) Maharachch., K.D. Hyde and Crous [as *Pestalotiopsis foedans* (Sacc. and Ellis) Steyaert]	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Pinus oocarpa*	Central America	Mathur (1974) and Anderson (1986a)
Neopyrenochaetacercidis Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Neopyrenochaetaceae, Dothideomycetes, Ascomycota	**pod**	***Cercis chinensis***	**China**	**Jayasiri et al. (2019)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Neoroussoella entadae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Roussoellaceae, Dothideomycetes, Ascomycota	**pod**	***Leucaena* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Neoroussoella leucaenae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Roussoellaceae, Dothideomycetes, Ascomycota	**pod**	***Leucaena* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Neosartorya delicata H.Z. Kong[#]	Aspergillaceae, Eurotiomycetes, Ascomycota	**fruit**	**undetermined plant**	**China**	**Kong (1997)**
Neoscytalidium dimidiatum (Penz.) Crous and Slippers [as *Hendersonula toruloidea* Nattrass]	Botryosphaeriaceae, Dothideomycetes, Ascomycota	fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
Neosetophoma lunariae Crous and R.K. Schumach.[#]	Phaeosphaeriaceae, Dothideomycetes, Ascomycota	**seeds**	***Lunaria annua***	**Germany**	**Hernandez-Restrepo et al. (2016)**
Neotyphodium huerfanum (J.F. White, G.T. Cole and Morgan-Jones) Glenn, C.W. Bacon and Hanlin[#] [as *Acremonium huerfanum* J.F. White, G.T. Cole and Morgan-Jones]	Clavicipitaceae, Sordariomycetes, Ascomycota	**seeds**	***Festuca arizonica***	**USA**	**White et al. (1987)**
Neurospora cerealis (Dowding) Dania García, Stchigel and Guarro [as *Gelasinospora cerealis* Dowding]	Sordariaceae, Sordariomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
Neurospora sp.	Sordariaceae, Sordariomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Neurospora tetraspora Dania García, Stchigel and Guarro [as *Gelasinospora tetrasperma* Dowding]	Sordariaceae, Sordariomycetes, Ascomycota	seed	*Festuca rubra*	Canada	Conners (1967)
Niesslia pusilla (Speg. and Roum.) G. Winter	Niessliaceae, Sordariomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
Nigrospora gossypii Jacz.	Apiosporaceae, Sordariomycetes, Ascomycota	seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
Nigrospora oryzae (Berk. and Broome) Petch	Apiosporaceae, Sordariomycetes, Ascomycota	seed	*Bromus inermis*	Canada	Conners (1967)
		seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seeds	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Nigrospora sacchari (Speg.) E.W. Mason	Apiosporaceae, Sordariomycetes, Ascomycota	pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Nigrospora sphaerica (Sacc.) E.W. Mason	Apiosporaceae, Sordariomycetes, Ascomycota	pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Elymus virginicus*	Canada	Conners (1967)
		seeds	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seeds	*Helichrysum* sp.	Pakistan	Lodhi and Naeem 1955
		seed	*Poa compressa*	Canada	Conners (1967)
		seed	*Setaria viridis*	Canada	Conners (1967)
Nigrospora spp.	Apiosporaceae, Sordariomycetes, Ascomycota	fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012)
		pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seeds, seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Cupressus* spp.	Syria	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia, USA	Huang and Kuhlman (1990) and Fraedrich and Miller (1995)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Anderson (1986a)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979) and Anderson (1986a)
		seed	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Swietenia macrophylla*	Philippines	Agmata (1979) and Anderson (1986a)
Nothophoma quercina (Syd. and P. Syd.) Qian Chen and L. Cai	Didymellaceae, Dothideomycetes, Ascomycota	cone	*Keteleeria fortune*	China	Jayasiri et al. (2019)
Nowakowskiella elegans (Nowak.) J. Schröt.	Nowakowskiellaceae, Chytridiomycetes, Chytridiomycota	seeds	*Armeria maritima* ssp. *maritima*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Armeria transmontana*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa belladonna*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cicuta virosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cornus capitata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cuscuta europaea*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ficus pumila*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lotus uliginosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Prunella grandiflora* ssp. *pyrenaia*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Sambucus ebulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ulex europaeus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Vicia sativa*	Poland	Kiziewicz (2005)
Nowakowskiella hemisphaerospora Shanor	Nowakowskiellaceae, Chytridiomycetes, Chytridiomycota	seeds	*Armeria maritima* ssp. *maritima*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Nowakowskiella macrospora Karling	Nowakowskiellaceae, Chytridiomycetes, Chytridiomycota	seeds	*Ficus pumila*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Nowakowskiella profusa Karling	Nowakowskiellaceae, Chytridiomycetes, Chytridiomycota	seeds	*Ficus pumila*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Nowakowskiella ramosa E.J. Butler	Nowakowskiellaceae, Chytridiomycetes, Chytridiomycota	seeds	*Crataegus azarolus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ulex europaeus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Ochroconis ailanthi Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Sympoventuriaceae, Dothideomycetes, Ascomycota	**pod**	***Ailanthus* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Oedocephalum glomerulosum (Bull.) Sacc.	*Incertae sedis*, Pezizomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Poland	Garbowski (1936) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Oedocephalum lineatum B.K. Bakshi	*Incertae sedis*, Pezizomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
Oedocephalum spp.	*Incertae sedis*, Pezizomycetes, Ascomycota	seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Oidiodendron spp.	Myxotrichaceae, Leotiomycetes, Ascomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
Oidiodendron cereale (Thüm.) G.L. Barron	Myxotrichaceae, Leotiomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Oidiodendron flavum Svilv.	Myxotrichaceae, Leotiomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
Oidiodendron griseum Robak	Myxotrichaceae, Leotiomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Oidium sp.	Erysiphaceae, Leotiomycetes, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Olpidium gregarium (Nowak.) J. Schröt.	Olpidiaceae, Chytridiomycetes, Chytridiomycota	seeds	*Calla palustris*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Olpitrichum sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Ombrophila strobilina (Fr.) P. Karst.	Gelatinodiscaceae, Leotiomycetes, Ascomycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Oospora glauca (Preuss) Sacc.	Erysiphaceae, Leotiomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Oospora lactis (Fresen.) Sacc.	Erysiphaceae, Leotiomycetes, Ascomycota	seed	*Apium graveolens* var. *dulce*	USA	Conners (1967)
		seed	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Phleum pratense*	Canada	Conners (1967)
Oospora verticillioides Sacc.	Erysiphaceae, Leotiomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Ophiostoma conicola Marm. and Butin[#]	Ophiostomataceae, Sordariomycetes, Ascomycota	**cones**	***Pinus cembroides***	**Mexico**	**Marmolejo and Butin (1990)**
Ophiostoma spp.	Ophiostomataceae, Sordariomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962, 1983) and Mittal et al. (1990)
Ophiostoma valachicum Georgescu, Teodoru and Badea	Ophiostomataceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1964) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Ovatospora brasiliensis (Bat. and Pontual) X.Wei Wang and Samson [as *Chaetomium brasiliense* Bat. and Pontual]	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Desmodium intortum*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
Paecilomyces divaricatus (Thom) Samson, Houbraken and Frisvad[as *Spicaria divaricata* (Thom) J.C. Gilman and E.V. Abbott]	Thermoascaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Paecilomyces puntonii (Vuill.) Nann.	Thermoascaceae, Eurotiomycetes, Ascomycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
Paecilomyces roseolus G. Sm.	Thermoascaceae, Eurotiomycetes, Ascomycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
Paecilomyces spp.	Thermoascaceae, Eurotiomycetes, Ascomycota	seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Mohanan et al. (2005)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seeds	*Delonix regia*	India	Sahu et al. (2003)
		seeds	*Eucalyptus alba*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus citriodora*	India	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus deglupta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus globulus*	India	Anderson (1986a)
		seeds	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
Paecilomyces variotii Bainier	Thermoascaceae, Eurotiomycetes, Ascomycota	seed	*Pinus merkusii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Palaeodiplodites yezoensis K. Watan., H. Nishida and Tak. Kobay[#**]	Fossil fungus	**cone**	***Cycadeoidella japonica***	**Japan**	**Watanabe et al. (1999)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Palaeopericonia fritzschei C.G. Ibáñez and Zamuner[#**]	Fossil fungus	**fossilised cones**	***Araucaria mirabilis***	**USA**	**Ibáñez and Zamuner (1996)**
Papiliotrema laurentii (Kuff.) Xin Zhan Liu, F.Y. Bai, M. Groenew. and Boekhout [as *Cryptococcus laurentii* (Kuff.) C.E. Skinner]	Rhynchogastremaceae, Tremellomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Papularia arundinis (Corda) Fr.	Apiosporaceae, Sordariomycetes, Ascomycota	seed	*Acer* sp.	China	Conners (1967)
		seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Elymus virginicus*	Canada	Conners (1967)
		seed	*Festuca rubra*	Canada	Conners (1967)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Phleum pratense*	Canada	Conners (1967)
		seed	*Poa compressa*	Canada	Conners (1967)
		seed	*Setaria viridis*	Canada	Conners (1967)
Papularia sphaerosperma (Pers.) Höhn.	Apiosporaceae, Sordariomycetes, Ascomycota	seed	*Lolium perenne*	Canada	Conners (1967)
Papulaspora spp.	*Incertae sedis*, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seeds	*Araucaria bidwillii*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Manilkara bidentata*	USA	Bayman et al. (1998)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Paraconiothyrium archidendri Verkley, Göker and Stielow [as *Austropleospora archidendri* (Verkley, Göker and Stielow) Ariyaw. and K.D. Hyde]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	pod	*Leucaena* sp.	Thailand	Jayasiri et al. (2019)
Paraconiothyrium fuckelii (Sacc.) Verkley and Gruyter [as *Coniothyrium fuckelii* Sacc.]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Cercis chinensis*	Japan	Watanabe (2010)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seeds	*Picea abies*	Poland	Krol et al. (2015)
		seed	*Pinus sylvestris*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Parascedosporium putredinis (Corda) Lackner and de Hoog	Microascaceae, Sordariomycetes, Ascomycota	pod	*Delonix regia*	Thailand	Perera, Hyde, Jones et al. (2018)
Paramyrotheciu m roridum (Tode) L. Lombard and Crous [as *Myrothecium roridum* Tode]	Stachybotryaceae, Sordariomycetes, Ascomycota	seeds	*Acrocarpus fraxinifoliu s*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Eucalyptus grandis*	Uruguay	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Mathur (1974) and Anderson (1986a)
Passalora sp.	Mycosphaerellaceae, Dothideomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Penicilliopsis africana Samson and Seifert[#]	Aspergillaceae, Eurotiomycetes, Ascomycota	**seed**	**undetermin ed plant**	**Africa**	**Samson and Seifert (1986)**
Penicilliopsis indica K. Swapna and Nagaveni[#]	Aspergillaceae, Eurotiomycetes, Ascomycota	**seeds**	***Dysoxylum malabaricu m***	**India**	**Priya and Nagveni (2012)**
Penicillium albicans Bainier	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Penicillium arenarium Shaposhn. and Manteifel	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Penicillium aurantiogriseum Dierckx	Aspergillaceae, Eurotiomycetes, Ascomycota	cones, seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		seeds	*Casuarina equisetifolia*	India	Anju et al. (2012)
		seeds	*Delonix regia*	India	Sahu et al. (2003)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
Penicillium brefeldianum B.O. Dodge	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
Penicillium brevicompactum Dierckx	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Penicillium arenicola Chalab. [as *Penicillium canadense* G. Sm.]	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Cassia fistula*	India	Mittal and Sharma (1981a) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India, Pakistan	Mittal and Sharma (1982b), Mittal et al. (1990) and Farooq (2000)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Penicillium arenicola Chalab. = *Penicillium canadense* G. Sm. [as '*canadicum*']		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Penicillium candidum Link	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Penicillium capsulatum Raper and Fennell	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Casuarina equisetifolia*	India	Anju et al. (2012)
Penicillium cataractarum Visagie, Malloch and Seifert[#]	Aspergillaceae, Eurotiomycetes, Ascomycota	**nuts**	***Carya cordiformis***	**Canada**	**Visagie et al. (2016)**
Penicillium citrinum Thom	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Dalbergia sissoo*	India	Naz et al. (2015)
Penicillium chrysogenum Thom	Aspergillaceae, Eurotiomycetes, Ascomycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pod, seed	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seeds	*Casuarina equisetifolia*	India	Anju et al. (2012)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Anderson (1986a) and Urosevic (1961)
		seeds	*Pseudotsuga menziesii*	USA	James (1984) and Anderson (1986a)
		seeds	*Quercus robur*	Poland	Krol et al. (2015)
		seeds	*Quercus rubra*	Poland	Krol et al. (2015)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
Penicillium chrysogenum Thom [as *P. notatum* Westling]		seeds	*Pinus caribaea*	Belize [as British Honduras], Thailand	Hocking (1968) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Penicillium chrysogenum* var. *chrysogenum Thom	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Delonix regia*	India	Sahu et al. (2003)
Penicillium citrinum Thom	Aspergillaceae, Eurotiomycetes, Ascomycota	pod, seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seeds	*Canavalia maritima*	India	Seena and Sridhar (2004)
		seeds	*Casuarina equisetifolia*	India	Anju et al. (2012)
		seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
Penicillium coccotrypicola Holdom, Y.P. Tan and R.G. Shivas[#]	Aspergillaceae, Eurotiomycetes, Ascomycota	**seeds**	***Archontophoenix cunninghamiana***	**Australia**	**Crous, Wingfield et al. (2014)**
Penicillium crustaceum (L.) Fr.	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Garbowski (1936) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Penicillium cyclopium Westling	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
		seed	*Desmodium uncinatum*	Australia	Nik and Parbery (1977)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Lotononis angolensis*	Australia	Nik and Parbery (1977)
		seed	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seeds	*Pinus sylvestris*	UK	Whittle (1977)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seed	*Stylosanthes gracilis*	Australia	Nik and Parbery (1977)
		seed	*Trifolium burchellianum*	Australia	Nik and Parbery (1977)
		seed	*Trifolium repens*	Australia	Nik and Parbery (1977)
		seed	*Trifolium semipilosum*	Australia	Nik and Parbery (1977)
Penicillium decumbens Thom	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seed	*Macroptilium lathyroides*	Australia	Nik and Parbery (1977)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seed	*Stylosanthes gracilis*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
Penicillium digitatum (Pers.) Sacc.	Aspergillaceae, Eurotiomycetes, Ascomycota	fruits	*Ardisia crenata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Rhodomyrtus tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
Penicillium divergens Bainier and Sartory	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR, Poland	Urosevic (1961), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Penicillium ellipsoideosporum L. Wang and H.Z. Kong#	Aspergillaceae, Eurotiales, Eurotiomycetes	**seeds**	***Ficus microcarpa***	**China**	**Wang and Kong (2000)**
Penicillium expansum Link	Aspergillaceae, Eurotiales, Eurotiomycetes	seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus sylvestris*	Poland, USSR	Prisyazhnyuk (1960), Mittal et al. (1990) and Krol et al. (2015)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus robur*	Poland	Krol et al. (2015)
		seeds	*Quercus rubra*	Poland	Krol et al. (2015)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Penicillium frequentans Westling	Aspergillaceae, Eurotiales, Eurotiomycetes	seed	*Casuarina* spp.	UK	Whittle (1977)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Cupressus* spp	UK	Whittle (1977)
		seed	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Lotononis angolensis*	Australia	Nik and Parbery (1977)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Pinus sylvestris*	UK	Whittle (1977)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
		seeds	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
		seeds	*Teramnus uncinatus*	Australia	Nik and Parbery (1977)
Penicillium fuscum (Sopp) Raper and Thom	Aspergillaceae, Eurotiales, Eurotiomycetes	seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
Penicillium glabrum (Wehmer) Westling	Aspergillaceae, Eurotiales, Eurotiomycetes	pod, seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Penicillium glabrum (Wehmer) Westling [as '*glabra*']		fruits	*Ardisia crenata*	Hong Kong	Tang, Hyde et al. (2003)
Penicillium glaucoalbidum (Desm.) Houbraken and Samson [as *Thysanophora penicillioides* (Roum.) W.B. Kendr.]	Aspergillaceae, Eurotiomycetes, Ascomycota	cones, seed	*Pinus densiflora*	Japan	Kasai et al. (1995) and Watanabe (2010)
		seeds	*Picea abies*	Finland	Tillman-Sutela et al. (2004)
Penicillium glaucum Link	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Penicillium granulatum Bainier	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Larix decidua*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
Penicillium implicatum Biourge	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
Penicillium italicum Wehmer	Aspergillaceae, Eurotiomycetes, Ascomycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	USA	James (1984) and Anderson (1986a)
Penicillium janthinellum Biourge	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus sylvestris*	UK	Whittle (1977)
Penicillium lanosum Westling	Aspergillaceae, Eurotiomycetes, Ascomycota	seed	*Lotononis angolensis*	Australia	Nik and Parbery (1977)
		seed	*Macroptilium atropurpureum*	Australia	Nik and Parbery (1977)
		seed	*Medicago sativa*	Australia	Nik and Parbery (1977)
		seed	*Medicago tribuloides*	Australia	Nik and Parbery (1977)
		seed	*Medicago truncatula*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
		seed	*Teramnus uncinatus*	Australia	Nik and Parbery (1977)
		seed	*Trifolium burchellianum*	Australia	Nik and Parbery (1977)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Trifolium repens*	Australia	Nik and Parbery (1977)
		seed	*Trifolium semipilosum*	Australia	Nik and Parbery (1977)
Penicillium lapidosum Raper and Fennell	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
Penicillium luteoviride Biourge	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Penicillium martensii Biourge	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
Penicillium multicolor Grig.-Man. and Porad.	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
Penicillium nigricans K.W. Zaleski	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Pinus taeda*	Georgia	Huang and Kuhlman (1990)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Sapium* spp	India	Sahai and Otra (1982)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Penicillium nucicola Visagie, Malloch and Seifert[#]	Aspergillaceae, Eurotiales, Eurotiomycetes	**nuts**	***Carya ovata***	**Canada**	**Visagie et al. (2016)**
Penicillium oxalicum Currie and Thom	Aspergillaceae, Eurotiales, Eurotiomycetes	seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
Penicillium patulum Bainier	Aspergillaceae, Eurotiales, Eurotiomycetes	seeds	*Larix occidentalis*	USA	James et al. 1996
Penicillium restrictum J.C. Gilman and E.V. Abbott	Aspergillaceae, Eurotiales, Eurotiomycetes	seeds	*Cedrus deodara*	India	Mittal (1983)
Penicillium roqueforti Thom	Aspergillaceae, Eurotiales, Eurotiomycetes	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Penicillium spp.	Aspergillaceae, Eurotiomycetes, Ascomycota	acorns, seeds	*Quercus robur*	Poland	Jankowiak (2008) and Krol et al. (2015)
		cones, seed	*Pinus densiflora*	Japan	Kasai et al. (1995) and Watanabe (2010)
		cones, seeds	*Pinus ponderosa*	USA	Fuller and Hildebrand (1985) and James (1995) and Mittal et al. (1990)
		cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris*	UK	Whittle (1977)
		cones, seeds	*Pseudotsuga menziesii* var. *glauca*	USA	James (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012)
		fruit	*Artocarpus communis*	Nigeria	Amusa et al. (2002)
		fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
		fruits	*Bridelia tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Sarcandra glabra*	Hong Kong	Tang, Hyde et al. (2003)
		pod, seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		pods	*Delonix regia*	Thailand, Philippines	Dayan (1986), Mittal et al. (1990) and Somrithipol, Jones et al. (2002)
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Acacia auriculiformis*	Philippines, Thailand	Chalermpongse et al. (1984), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Acacia confusa*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Albizia falcataria*	Philippines	Dayan (1986), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Albizia julibrissin*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India, Philippines	Agmata (1979), Anderson (1986a), Quiniones (1987) and Natarajan et al. (2003)
					Mohanan et al. (2005)
		seeds	*Albizia procera*	Philippines	Agmata (1979), Anderson (1986a) and Quiniones (1987)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Alstonia macrophylla*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Anthocephalus chinensis*	Philippines	Agmata (1979), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Antidesma ghaesembilla*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria heterophylla*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Bauhinia acuminata*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Betula alleghaniensis*	USA	Smoot and Segall 1963 and Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula pendula*	Finland, Poland	Lilja (1979), Mittal et al. (1990) and Krol et al. (2015)
		seeds	*Bombax anceps*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	Bangladesh, India	Mittal et al. (1990)
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia fistula*	India, Thailand	Mittal and Sharma (1981a) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines, Thailand	Quiniones (1985, 1987) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Casuarina equisetifolia*	Philippines, USA	Quiniones (1985, 1987), Anderson (1986a) and Bayman et al. 1998
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seed	*Desmodium uncinatum*	Australia	Nik and Parbery (1977)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
		seeds	*Eucalyptus citriodora*	India	Anderson (1986a)
		seeds	*Eucalyptus deglupta*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Eucalyptus globulus*	India	Anderson (1986a)
		seeds	*Eucalyptus grandis*	India, South Africa	Anderson (1986a) and Jimu et al. (2016)
		seeds	*Eucalyptus maidenii*	Uruguay	Anderson (1986a)
		seeds	*Eucalyptus tereticornis*	India	Anderson (1986a)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seeds	*Gliricidia sepium*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Gmelina arborea*	Philippines, Thailand	Quiniones (1985), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Lagerstroemia calyculata*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Lagerstroemia speciosa*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Leucaena leucocephala*	Bangladesh, Philippines, Thailand	Chalermpongse et al. (1984), Anderson (1986a), Quiniones (1987), Mittal et al. (1990) and Islam et al. (2008)
		seeds	*Manilkara bidentata*	USA	Bayman et al. 1998
		seed	*Medicago truncatula*	Australia	Nik and Parbery (1977)
		seeds	*Melia azedarach*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Musanga cecropioides*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Parkia roxburghii*	Philippines	Dayan (1986), Anderson (1986a) and Quiniones (1987)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Picea abies*	Poland	Krol et al. (2015)
		seeds	*Picea engelmannii*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Piliostigma malabaricum*	Philippines	Quiniones (1985) and Anderson (1986a, 1987)
		seeds	*Pinus caribaea*	Belize [or as British Honduras]	Hocking (1968), Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	Taiwan, USA	Rowan and Debarr (1974) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay, USA	Anderson (1986a) and Fraedrich and Miller (1995)
		seeds	*Pinus kesiya*	Philippines, Thailand	Quiniones (1985), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus lambertiana*	USA	Anderson (1986a) and Schubert (1961)
		seeds	*Pinus merkusii*	Philippines	Agmata (1979) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus nigra*	Hungary	Hangyal (1973) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Hungary, Poland	Hangyal (1973), Mittal et al. (1990) and Krol et al. (2015)
		seeds	*Pinus taeda*	USA	Mason and van Arsdel (1978) and Anderson (1986a)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pittosporum resiniferum*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada, USA	Salisbury (1955) and Mittal et al. (1990)
		seeds	*Quercus robur*	Germany	Schroder et al. (2004)
		seeds	*Quercus rubra*	Poland	Krol et al. (2015)
		seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
		seeds	*Samanea saman*	Philippines, Thailand	Quiniones (1985, 1987), Anderson (1986a) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Sequoia sempervirens*	USA	Davidson (1970) and Mittal et al. (1990)
		seeds	*Serialbizzia acle*	Philippines	Quiniones (1985) and Anderson (1986a, 1987)
		seeds	*Shorea assamica*	Malaysia	Hong (1981) and Mittal et al. (1990)
		seeds	*Shorea robusta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)
		seeds	*Swietenia macrophylla*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Anderson (1986a) and Mohanan et al. (2005)
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Vitex parviflora*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Wallaceodendron celibcum*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Xylia xylocarpa* var. *kerrii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Penicillium steckii K.W. Zaleski	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Penicillium thomii Maire	Aspergillaceae, Eurotiomycetes, Ascomycota	cones	*Picea glauca*	Canada	Mittal and Wang (1987)
		cones, seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
Penicillium urticae Bainier	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Cupressus* spp.	India	Sahai and Otra (1982)
		seeds	*Pyrus* spp.	India	Sahai and Otra (1982)
Penicillium viridicatum Westling	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
Penicillium vulpinum (Cooke and Massee) Seifert and Samson [as *Penicillium claviforme* Bainier]	Aspergillaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
Peniophora sp.	Peniophoraceae, Agaricomycetes, Basidiomycota	seeds	*Quercus robur*	Turkey	Oskay et al. (2018)
Periconia byssoides Pers.	Periconiaceae, Dothideomycetes, Ascomycota	fruits	*Magnolia grandiflora*	Thailand	Jayasiri et al. (2019)
		pod	*Peltophorum* sp.	Thailand	Jayasiri et al. (2019)
		seed	*Acer* sp.	Canada	Conners (1967)
Periconia byssoides Pers. [as *Periconia pycnospora* Fresen.]		seed	*Agropyron cristatum*	China	Conners (1967)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Periconia circinata (L. Mangin) Sacc. and D. Sacc.	Periconiaceae, Dothideomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)
Periconia delonicis Jayasiri, E.B.G. Jones and K.D. Hyd[#]	Periconiaceae, Dothideomycetes, Ascomycota	**pod**	***Delonix regia***	**Thailand**	**Jayasiri et al. (2019)**
Periconia spp.	Periconiaceae, Dothideomycetes, Ascomycota	pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seeds	*Eucalyptus sp.*	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Peridermium conorum-piceae (Reess) Arthur and F. Kern	Cronartiaceae, Pucciniomycetes, Basidiomycota	cones	*Picea canadensis*	USA	Arthur and Kern (1906)
		cones	*Picea engelmannii*	USA	Arthur and Kern (1906)
		cones	*Picea excelsa*	USA	Arthur and Kern (1906)
		cones	*Picea Mariana*	USA	Arthur and Kern (1906)
		cones	*Picea rubra*	USA	Arthur and Kern (1906)
Perisporium vulgare Corda	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Pestalotiopsis adusta (Ellis and Everh.) Steyaert	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Diploclisia glaucescens*	Hong Kong	Maharachchikumbura et al. (2014)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
Pestalotiopsis diploclisiae Maharachch., K.D. Hyde and Crous[#]	Sporocadaceae, Sordariomycetes, Ascomycota	**fruit**	***Litsea rotundifolia***	**Hong Kong**	**Tang, Hyde et al. (2003)**
Pestalotiopsis espaillatii (Cif. and Gonz. Frag.) Satya	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
Pestalotiopsis flavidula (Tassi) Y.X. Chen [as *Pestalotia flavidula* Tassi]	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Pinus elliottii* var. *elliottii*	Georgia	Huang and Kuhlman (1990)
Pestalotiopsis funerea (Desm.) Steyaert	Sporocadaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus koraiensis*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus mugo* 'Hesse'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus mugo* var. *pumilio*	Canada	Vujanovic et al. (2000)
		seeds	*Chamaecyparis lawsoniana*	France, Italy	Motta and Saponaro (1983) and Mittal et al. (1990)
		seeds	*Cupressus abramsiana*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus arizonica*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cupressus funebris*	Uruguay	Anderson (1986a)
		seeds	*Cupressus glabra*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus goveniana*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus lusitanica*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus lusitanica* var. *benthamii*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus sempervirens*	France, Italy	Motta and Saponaro (1983) and Mittal et al. (1990)
		seeds	*Cupressus torulosa*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus alba*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus grandis*	Uruguay	Anderson (1986a)
		seeds	*Libocedrus decurrens*	UK	Anderson (1986a)
		seeds	*Pinus* spp.	UK	Anderson (1986a)
		seeds	*Pseudotsuga menziesii*	UK	Anderson (1986a)
		seeds	*Thuja orientalis*	Italy, France	Motta and Saponaro (1983) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Pestalotiopsis glandicola (Castagne) Steyaert [as *Pestalotia castagnei* Desm.]	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Pestalotiopsis glandicola (Castagne) Steyaert [as *Pestalotia glandicola* (Castagne) Guba]		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Pestalotiopsis gracilis (Kleb.) Steyaert	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
Pestalotiopsis guepinii (Desm.) Steyaert [as '*guepini*']	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Cupressus macrocarpa*	Uruguay	Anderson (1986a)
		seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)
Pestalotiopsis mangiferae (Henn.) Steyaert	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
Pestalotiopsis neglecta (Thüm.) Steyaert	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
Pestalotiopsis phoenicis (Vize) Y.X. Chen	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
Pestalotiopsis shoreae Yu Song, Tangthir., K.D. Hyde and Y. Wang[#]	Sporocadaceae, Sordariomycetes, Ascomycota	**seeds**	***Shorea obtuse***	**Thailand**	**Song et al. (2014)**
Pestalotiopsis spp.	Sporocadaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		seeds	*Bauhinia purpurea*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bauhinia variegata*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Cassia bakeriana*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Mauritius	Bose (1944) and Anderson (1986a)
		seeds	*Chamaecyparis* sp.	Japan	Anderson (1986a)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Eucalyptus maidenii*	Uruguay	Anderson (1986a)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966)
		seeds	*Quercus* spp.	Scotland	Anderson (1986a)
Pestalotiopsis spp.[as *Pestalosphaeria*]		seed	*Sesbania bispinosa*	India	Anita et al. (2009)
Pestalotiopsis versicolor (Speg.) Steyaert	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
Peyronellaea sp.	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Pezicula cinnamomea (DC.) Sacc.	Dermateaceae, Leotiomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Pezicula eucalypti Korf and Iturr[#]	Dermateaceae, Leotiomycetes, Ascomycota	**capsule**	***Eucalyptus* sp.**	**Spain**	**Iturriaga and Korf 1997**
Peziza sciophila Medardi[#]	Pezizaceae, Pezizomycetes, Ascomycota	**cones**	***Picea* sp.**	**Italy**	**Medardi (2007)**
Phaeoisaria clematidis (Fuckel) S. Hughes	Pleurotheciaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
Phaeomarasmius laccarioides Har. Takah.[#]	Tubariaceae, Agaricomycetes, Basidiomycota	**fruit**	***Liquidambar styraciflua***	**Japan**	**Takahashi 2001**
Phaeosphaeria lunariae Crous and R.K. Schumach.[#]	Phaeosphaeriaceae, Dothideomycetes, Ascomycota	**pods**	***Lunaria annua***	**Germany**	**Hernandez-Restrepo et al. (2016)**
Phaeosphaeria sinensis Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Phaeosphaeriaceae, Dothideomycetes, Ascomycota	**pod**	***Wisteria* sp.**	**China**	**Jayasiri et al. (2019)**
Phialophora atrovirens (J.F.H. Beyma) Schol-Schwarz	Herpotrichiellaceae, Eurotiomycetes, Ascomycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Phialophora spp.	Herpotrichiellaceae, Eurotiomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
Phlyctochytrium aureliae Ajello	Phlyctochytriaceae, Chytridiomycetes, Chytridiomycota	seeds	*Arum korolkowii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Zantedeschia albo-maculata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Phoma anceps Sacc.	Didymellaceae, Dothideomycetes, Ascomycota	seed	*Medicago sativa*	Canada	Conners (1967)
Phoma araucariae Traverso	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Araucaria excelsa*	USA	Mittal et al. (1990)
Phoma herbarum Westend.	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Larix occidentalis*	USA	James et al. 1996
Phoma hibernica Grimes, M. O'Connor and Cummins	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Phoma lineolata Desm.	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Larix* spp.	Denmark, UK, USA	Noble et al. (1958) and Anderson (1986a)
Phoma spp.	Didymellaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		cones, seeds	*Pinus sylvestris*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris* 'Watereri'	Canada	Vujanovic et al. (2000)
		fruits	*Alocasia odora*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ardisia crenata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Bridelia tomentosa*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Dichroa febrifuga*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex asprella*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
		pod	*Colophospermum mopane*	Southern Africa	Jordaan et al. (2006)
		pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seed	*Larix* sp.	Japan	Watanabe (2010)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Acacia auriculiformis*	Philippines	Mathur (1974), Anderson (1986a) and Quiniones (1987)
		seeds	*Acacia confusa*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Acacia modesta*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Acacia raddiana*	Israel	Mathur (1974) and Anderson (1986a)
		seeds	*Acacia* spp.	Egypt	Mathur (1974) and Anderson (1986a)
		seeds	*Acer palmatum*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Acrocarpus fraxinifolius*	India, Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Adina cordifolia*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Adenanthera microsperma*	India	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Agathis robusta*	Philippines, UK	Quiniones (1985, 1987) and Anderson (1986a)
		seeds	*Albizia falcataria*	Philippines	Mathur (1974) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	Philippines	Quiniones (1987)
		seeds	*Albizia stipulata*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Alnus sibirica*	South Korea	Mathur (1974) and Mittal et al. (1990)
		seeds	*Alstonia macrophylla*	Philippines	Quiniones (1987)
		seeds	*Anogeissus pendula*	Costa Rica	Mathur (1974) and Mittal et al. (1990)
		seeds	*Anthocephalus cadamba*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Bauhinia* sp.	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Bauhinia variegata*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Bombax ceiba*	India	Mathur (1974) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Callistephus chinensis*	China	Gloyer (1931) and Crosier and Heit (1948)
		seeds	*Cassia fistula*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia siamea*	Philippines	Quiniones (1985) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Cedrela odorata*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Cedrela serrata*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Cedrela serrulata*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Chukrasia tabularis*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Cordia alliodora*	Colombia	Mathur (1974) and Anderson (1986a)
		seeds	*Cryptomeria japonica*	Madagascar	Mathur (1974) and Anderson (1986a)
		seeds	*Cupressus cashmeriana*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Cupressus lusitanica*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Cupressus* spp.	Syria	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b) and Mittal et al. (1990)
		seeds	*Delonix regia*	India, Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
		seeds	*Eucalyptus alba*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus camaldulensis*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Eucalyptus grandis*	India, South Africa	Mathur (1974), Anderson (1986a) and Jimu et al. (2016)
		seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seeds	*Eucalyptus tereticornis*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Eucommia ulmoides*	USA	Mathur (1974) and Anderson (1986a)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013) and Hayatgheibi (2013)
		seeds	*Gliricidia sepium*	Philippines	Quiniones (1987)
		seeds	*Gmelina arborea*	India, Philippines	Mathur (1974) and Anderson (1986a) and Quiniones (1987)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Hovenia dulcis*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Jacaranda mimosifolia*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Kydia calycina*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Lagerstroemia speciosa*	India, Philippines	Mathur (1974), Anderson (1986a) and Quiniones (1987)
		seeds	*Leucaena leucocephala*	Philippines	Quiniones (1985, 1987) and Mittal et al. (1990)
		Seeds	*Leucaena leucocephala* var. *Cunningham*	Cuba	Mathur (1974) and Anderson (1986a)
		seeds	*Leucaena* spp.	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Leucdena diversifolia*	Guatemala	Mathur (1974) and Anderson (1986a)
		seeds	*Maesopsis eminii*	Malaysia	Mittal et al. (1990)
		seeds	*Mimosa caesalpiniafolia*	Brazil	Mathur (1974) and Anderson (1986a)
		seeds	*Ougeinia dalbergioides*	-	Mathur (1974) and Anderson (1986a)
		seeds	*Parkia roxburghii*	Philippines	Quiniones (1987)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Picea abies*	Italy	Motta et al. 1996
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
		seeds	*Pinus caribaea* var. *hondurensis*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus insularis*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus kesiya*	Philippines	Quiniones (1987)
		seeds	*Pinus khasya*	Philippines, Zambia	Mathur (1974), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus merkusii*	Zambia	Chalermpongse et al. (1984) and Anderson (1986a)
		seeds	*Pinus oocarpa*	Central America	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus* spp.	Japan	Homechin et al. 1986 and Anderson (1986a)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Polyscias nodosa*	Philippines	Agmata (1979) and Mittal et al. (1990)
		seeds	*Pongamia pinnata*	India	Jamaluddin et al. (1983) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pterospermum acerifolium*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Quercus robur*	Germany	Schroder et al. (2004)
		seeds	*Samanea saman*	Philippines, Thailand	Chalermpongse et al. (1984), Quiniones (1987) and Mittal et al. (1990)
		seeds	*Sequoia sempervirens*	USA	Davidson (1970) and Mittal et al. (1990)
		seeds	*Serialbizia acle*	Philippines	Quiniones (1987)
		seeds	*Sesbania sesban*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Shorea materialis*	Malaysia	Mittal et al. (1990)
		seeds	*Shorea robusta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Swietenia macrophylla*	Philippines	Agmata (1979), Anderson (1986a) and Quiniones (1987)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Taxodium mucronatum*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Tectona grandis*	India, Philippines	Mathur (1974) and Mittal et al. (1990) and Mohanan et al. (2005)
		seeds	*Toona calantas*	Philippines	Quiniones (1987)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
		seeds	*Wallaceodendron celibcum*	Philippines	Quiniones (1987)
Phoma strobiligena Desm.	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Phragmotrichum chailletii Kunze[#]	Melanommataceae, Dothideomycetes, Ascomycota	**cones**	***Abies* sp.**	**Switzerland**	**Schmidt and Kunze 1823**
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Phyllosticta aucubae-japonicae N. Zhou and L. Cai[#]	Phyllostictaceae, Dothideomycetes, Ascomycota	**fruit**	***Aucuba japonica***	**Japan**	**Hernandez-Restrepo et al. (2016)**
Phyllosticta cocoicola (Bat.) Sivan.	Phyllostictaceae, Dothideomycetes, Ascomycota	fruits	*Diplospora dubia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
Phyllosticta osteospora* var. *samaricola D. Sacc.	Phyllostictaceae, Dothideomycetes, Ascomycota	seeds	*Fraxinus* sp.	USSR	Anderson (1986a)
Phyllosticta platanoides* f. *negundinis Sacc.	Phyllostictaceae, Dothideomycetes, Ascomycota	seeds	*Acer* sp.	USSR	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Phyllosticta spp.	Phyllostictaceae, Dothideomycetes, Ascomycota	seeds	*Acer* sp.	-	Noble et al. (1958) and Anderson (1986a)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
Physalidiella elegans (Luppi Mosca) Rulamort [as *Physalidium elegans* Luppi Mosca]	*Incertae sedis*, *Incertae sedis*, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Physalospora obtusa (Schwein.) Cooke	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
Physocladia obscura (Sparrow) Sparrow	Chytriomycetaceae, Chytridiomycetes, Chytridiomycota	seeds	*Zantedeschia aethiopica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
***Pichia kluyveri* var. kluyveri** Bedford ex Kudryavtsev	Pichiaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
***Pichia kluyveri*-like**	Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
***Pichia membranifaciens*-like**	Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
***Pichia muscicola*-like**	Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Pichia sargentensis-like	Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Pilaira anomala (Ces.) J. Schröt.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Rosa mollis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Pilobolus sp.	Pilobolaceae, Mucoromycetes, Mucoromycota	fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
Pilocintractia adriana Vánky[#]	Anthracoideaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Fimbristylis miliacea***	**India**	**Vánky (2006)**
Pilophora agaricina Wallr.	Rhizopodaceae, Mucoromycetes, Mucoromycota	pod	*Canavalia cathartica*	India	Anita and Sridhar (2009)
Piptocephalis freseniana de Bary	Piptocephalidaceae, Zoopagomycetes, Mucoromycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Pithomyces alabamensis (Matsush.) P.M. Kirk	Astrosphaeriellaceae, Dothideomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Pithomyces cynodontis M.B. Ellis	Astrosphaeriellaceae, Dothideomycetes, Ascomycota	seeds	*Casuarina* spp., *Thuja* spp.	India	Sahai and Otra (1982)
Pithomyces spp.	Astrosphaeriellaceae, Dothideomycetes, Ascomycota	seeds	*Tectona grandis*	India	Anderson (1986a)
Pithyella hispida Rativ. and R Galán[#]	Helotiaceae, Leotiomycetes, Ascomycota	**fruit**	***Quercus agrifolia***	**USA**	**Galán et al. (1994)**
Pleiochaeta sp.	Dothidotthiaceae, Dothideomycetes, Ascomycota	seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
Pleogibberella calamia (Cooke) Berl. and Voglino [as *Gibberella calamia* Cooke]	Nectriaceae, Sordariomycetes, Ascomycota	fruit	*Calamus fasciculatus*	India	Cooke (1884)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Pleohelicoon fagi Jayasiri, E.B.G. Jones and K.D. HydeK[#**]	Pleomonodictydaceae, Dothideomycetes, Ascomycota	**cupule**	***Fagus sylvatica***	**UK**	**Jayasiri et al. (2019)**
Pleospora infectoria Fuckel	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
Pleospora laricina Rehm	Pleosporaceae, Dothideomycetes, Ascomycota	cones	*Pinus mugo* 'Hesse'	Canada	Vujanovic et al. (2000)
Pleospora spp.	Pleosporaceae, Dothideomycetes, Ascomycota	cones, seeds	*Pinus ponderosa*	Canada	Vujanovic et al. (2000)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
Pleosporales spp.	Dothideomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
Pleurophoma italica Tibpromma, Camporesi and K.D. Hyde[#]	Lentitheciaceae, Sordariomycetes, Ascomycota	**cone**	***Pinus nigra***	**Italy**	**Tibpromma et al. (2017)**
Pleurophragmium sp.	*Incertae sedis*, Sordariomycetes, Ascomycota	fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
Podospora bulbillosa (W. Gams and Mouch.) X. Wei Wang and Houbraken [as *Cladorrhinum bulbillosum* W. Gams and Mouch.]	Podosporaceae, Sordariomycetes, Ascomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
Polydesmia turbinata Raitv. and R. Galán[#]	Amorphothecaceae, Leotiomycetes, Ascomycota	**fruit capsule**	***Eucalyptus globulus***	**Spain**	**Raitviír and Galán (1995)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Polyphagus euglenae (Bail) Nowak.	Polyphagaceae, Chytridiomycetes, Chytridiomycota	seeds	*Atropa belladonna*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa caucasica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa pallidiflora*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus albus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Paris quadrifolia*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Podophyllum peltatum*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Polyspora lini Laff.	Saccotheciaceae, Dothideomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)
Propolis faginea (Schrad.) P. Karst.	Marthamycetaceae, Leotiomycetes, Ascomycota	seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Propolis occulta Chlebická[#]	Marthamycetaceae, Leotiomycetes, Ascomycota	**cones**	***Pinus sylvestris***	**Czech Republic**	**Chlebická (2014)**
Propolis rhodoleuca (Sommerf.) Fr.	Marthamycetaceae, Leotiomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Protrudomyces lateralis (A. Braun) Letcher [as *Rhizophydium laterale* (A. Braun) Rabenh.]	Protrudomycetaceae, Rhizophydiomycetes, Chytridiomycota	seeds	*Hyoscyamus niger*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ilex aquifolium*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Prosopidicola mexicana Crous and C.L. Lennox[#**]	Prosopidicolaceae, Sordariomycetes, Ascomycota	**pods**	***Prosopis glandulosa***	**USA**	**Lennox et al. (2004)**
Pseudoanthostomella pini-nigrae Daranag., Camporesi and K.D. Hyde[#]	*Incertae sedis*, Sordariomycetes, Ascomycota	**cones**	***Pinus nigra***	**Italy**	**Daranagama et al. (2016)**
Pseudoberkleasmium acaciae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Pseudoberkleasmiaceae, Dothideomycetes, Ascomycota	**pod**	***Acacia* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Pseudoboubovia benkertii (B. Perić) U. Lindem., M. Vega, B. Perić and R. Tena[#] [as *Kotlabaea benkertii* B. Perić]	Pulvinulaceae, Pezizomycetes, Ascomycota	**cones**	***Cupressus sempervirens, Pinus halepensis***	**Montenegro**	**Lindemann et al. (2015)**
Pseudocamarosporium piceae Wijayaw., Camporesi and K.D. Hyde[#]	Montagnulaceae, Dothideomycetes, Ascomycota	**cones**	***Picea excelsa***	**Italy**	**Wijayawardene, Hyde et al. (2014)**
Pseudocercospora mapelanensis J.A. Osorio and Jol. Roux[#]	Mycosphaerellaceae, Dothideomycetes, Ascomycota	**fruits**	***Barringtonia racemosa***	**South Africa**	**Osorio et al. (2015)**
Pseudocercospora ulei (Henn.) B.T. Hora and Mizubuti [as *Microcyclus ulei* (Henn.) Arx]	Mycosphaerellaceae, Dothideomycetes, Ascomycota	seeds	*Hevea brasiliensis*	South and Central America, Caribbean	Mittal et al. (1990)
Pseudochaetosphaeronema siamensis Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Macrodiplodiopsidaceae, Dothideomycetes, Ascomycota	**pod**	***Tamarindus* sp.**	**Thailand**	**Jayasiri et al. (2019)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Pseudocoleophoma bauhiniae Jayasiri, E.B.G. Jones and K.D. Hyde#	Dictyosporiaceae, Dothideomycetes, Ascomycota	**pod**	***Bauhinia* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Pseudodictyosporium wauense Matsush.	Dictyosporiaceae, Dothideomycetes, Ascomycota	fruit cupule	*Fagus sylvatica*	UK	Jayasiri et al. (2019)
Pseudofusicoccum calophylli Jayasiri, E.B.G. Jones and K.D. Hyde#	Phyllostictaceae, Dothideomycetes, Ascomycota	**fruit**	***Calophyllum inophyllum***	**Thailand**	**Jayasiri et al. (2019)**
Pseudohalonectria fagicola R.H. Perera, E.B.G. Jones and K.D. Hyde#	Pseudohalonectriaceae, Sordariomycetes, Ascomycota	**cupule**	***Fagus sylvatica***	**UK**	**Perera, Maharachchikumbura, Ariyawansa et al. (2016a)**
Pseudohalonectria hampshirensis R.H. Perera, E.B.G. Jones and K.D. Hyde#	Pseudohalonectriaceae, Sordariomycetes, Ascomycota	**cupule**	***Fagus sylvatica***	**UK**	**Perera, Maharachchikumbura, Ariyawansa et al. (2016)**
Pseudohelicomyces aquaticus Y.Z. Lu, Boonmee and K.D. Hyde	Tubeufiaceae, Dothideomycetes, Ascomycota	pod	*Tamarindus indica*	Thailand	Jayasiri et al. (2019)
Pseudohelicomyces menglunicus J.F. Li, Rungtiwa Phookamsak and	Tubeufiaceae, Dothideomycetes, Ascomycota	**seed**	**undetermined plant**	**China**	**Phookamsak et al. (2019)**
Pseudohelicomyces quercus Jayasiri, E.B.G. Jones and K.D. Hyde#	Tubeufiaceae, Dothideomycetes, Ascomycota	**cupule**	***Quercus* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Pseudohelicomyces talbotii (Goos) Y.Z. Lu and K.D. Hyde	Tubeufiaceae, Dothideomycetes, Ascomycota	fruits	Meliaceae plant	Thailand	Jayasiri et al. (2019)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Pseudopithomyces chartarum (Berk. and M.A. Curtis) Jun F. Li, Ariyaw. and K.D. Hyde [as *Sporidesmium bakeri* Syd. and P. Syd.]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	fruits	*Magnolia grandiflora*	Thailand	Jayasiri et al. (2019)
		pod	*Bauhinia* sp.	Thailand	Jayasiri et al. (2019)
		pod	*Leucaena* sp.	Thailand	Jayasiri et al. (2019)
		pod	*Radermachera sinica*	Thailand	Jayasiri et al. (2019)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Pseudopithomyces chartarum (Berk. and M.A. Curtis) Jun F. Li, Ariyaw. and K.D. Hyde [as *Pithomyces chartarum* (Berk. and M.A. Curtis) M.B. Ellis]		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
Pseudopithomyces entadae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	**pod**	***Entada phaseoloides***	**Thailand**	**Jayasiri et al. (2019)**
Pseudopithomyces maydicus (Sacc.) Jun F. Li, Ariyaw. and K.D. Hyde [as *Pithomyces maydicus* (Sacc.) M.B. Ellis]	Didymellaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Pseudothielavia terricola (J.C. Gilman and E.V. Abbott) X. WeiWang and Houbraken [as *Thielavia terricola* (J.C. Gilman and E.V. Abbott) C.W. Emmons]	Chaetomiaceae, Sordariomycetes, Ascomycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Puccinia salihae Krigbag and aime[#]	Pucciniaceae, Pucciniomycetes, Basidiomycota	**fruit**	***Thymelaea aucheri***	**Turkey**	**Kirbag et al. (2011)**
Pucciniastrum areolatum (Fr.) G.H. Otth	Pucciniastraceae, Pucciniomycetes, Basidiomycota	seeds	*Picea* spp.	Germany	Anderson (1986a)
Pucciniastrum epilobii (Pers.) G.H. Otth	Pucciniastraceae, Pucciniomycetes, Basidiomycota	cone	*Abies lasiocarpa*	Canada	Conners (1967)
Pullularia pullulans (de Bary and Löwenthal) Berkhout	Saccotheciaceae, Dothideomycetes, Ascomycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Pullularia spp.	Saccotheciaceae, Dothideomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Anderson (1986a)
Purpurepitheciu m murisporum Jayasiri and K.D. Hyde[#]	Gloniaceae, Dothideomycetes, Ascomycota	**cone**	***Pinus* sp.**	**Italy**	**Jayasiri, Hyde, Jones, Ariyawansa et al. (2017)**
Pyrenochaeta globosa Ts. Watanabe[#]	*Incertae sedis*, Dothideomycetes, Ascomycota	**seeds**	***Pinus thunbergii***	**Japan**	**Watanabe (1992)**
Pyrenochaeta spp.	*Incertae sedis*, Dothideomycetes, Ascomycota	seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Quercus robur*	Germany	Schroder et al. (2004)
Pyrenophora dematioidea (Bubák and Wróbl.) Rossman and K.D. Hyde [as *Drechslera dematioidea* (Bubák and Wróbl.) Scharif]	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Quercus robur*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Pyrofomes demidoffii (Lév.) Kotl. and Pouzar	Polyporaceae, Agaricomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Pyronema omphalodes (Bull.) Fuckel	Pyronemataceae, Pezizomycetes, Ascomycota	seeds	*Pinus* spp.	Poland	Richardson (1979) and Anderson (1986a)
		seeds	*Pinus sylvestris*	Poland	Garbowski (1936) and Mittal et al. (1990)
Quercicola fusiformis Jayasiri, E.B.G. Jones and K.D. Hyde[#**]	Astrosphaeriellaceae, Dothideomycetes, Ascomycota	**fruit**	***Quercus* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Quercicola guttulospora Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Astrosphaeriellaceae, Dothideomycetes, Ascomycota	**fruit**	**Fagaceae plant**	**Thailand**	**Jayasiri et al. (2019)**
Racodium therryanum Thüm.	Racodiaceae, Dothideomycetes, Ascomycota	seeds	*Abies koreana*	Korea	Cho et al. (2007)
		seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
Radulidium subulatum (de Hoog) Arzanlou, W. Gams and Crous [as *Ramichloridium subulatum* de Hoog]	*Incertae sedis*, Dothideomycetes, Ascomycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
Ramichloridium anceps (Sacc. and Ellis) de Hoog	Dissoconiaceae, Dothideomycetes, Ascomycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Ramichloridium sp.	Dissoconiaceae, Dothideomycetes, Ascomycota	seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Ramularia coleosporii Sacc.	Mycosphaerellaceae, Dothideomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Ramularia spp.	Mycosphaerellaceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus* sp.	Australia	Drake (1974) and Mittal et al. (1990)
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Rectifusarium ventricosum (Appel and Wollenw.) L. Lombard and Crous [as *Fusarium ventricosum* Appel and Wollenw.]	Nectriaceae, Sordariomycetes, Ascomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
Remotididymella bauhiniae Jayasiri, E.B.G. Jones and K.D. Hyde[#**]	Didymellaceae, Dothideomycetes, Ascomycota	**pod**	***Bauhinia* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Repetoblastiella olivacea R.F. Castañeda, Minter and M. Stadler[#**]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**nuts**	***Couroupita guianensis***	**Cuba**	**Castañeda-Ruíz et al. (2010)**
Resinicium bicolor (Alb. and Schwein.) Parmasto	Rickenellaceae, Agaricomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Restilago capensis Vánky[#**]	*Incertae sedis*, *Incertae sedis*, Basidiomycota	**nutlets**	***Ischyrolepis capensis***	**South Africa**	**Vánky (2008a)**
Restiosporium anarthriae Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Anarthria laevis***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium apodasmiae Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Apodasmia eremophila***	**Australia**	**Vánky and Shivas (2006)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Restiosporium baloskionis Vánky and R.G. Shivas[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Baloskion tetraphyllum***	**Australia**	**Vánky and Shivas (2003)**
Restiosporium chaetanthi Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Chaetanthus aristatus***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium dapsilanthi Vanky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Dapsilanthus elatior***	**Australia**	**Vánky (2003)**
Restiosporium desmocladi Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Desmocladus elongatus***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium eurychordae Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Eurychorda complanata***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium flexuosum Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Desmocladus flexuosus***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium guringaliae Vánky and R.G. Shivas[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Guringalia dimorpha***	**Australia**	**Vánky (2007)**
Restiosporium hypolaenae Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Hypolaena fastigiata***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium lepyrodiae Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Lepyrodia scariosa***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium pallentis Vánkyand R.G. Shiva[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Baloskion pallens***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium patei Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Lepidobolus densus***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium proliferum Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Anarthria prolifera***	**Australia**	**Vánky and Shivas (2006)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Restiosporium spathacei Vánky. R.G. Shivas and C. Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**capsules**	***Dapsilanthus spathaceus***	**Australia**	**Vánky and Shivas (2006)**
Restiosporium sphacelatum Vánky[#]	Websdaneaceae, Ustilaginomycetes, Basidiomycota	**nutlets**	***Chordifex sphacelatus***	**Australia**	**Vánky and Shivas (2006)**
Rhinocladiella spp.	Herpotrichiellaceae, Eurotiomycetes, Ascomycota	seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
Rhinotrichum repens Preuss	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Rhizidium lignicola Lindau	Chytriomycetaceae, Chytridiomycetes, Chytridiomycota	seeds	*Polygonum amphibium*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Rhizidium richmondense Willoughby	Chytriomycetaceae, Chytridiomycetes, Chytridiomycota	seeds	*Atropa caucasica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Rhizoctonia solani J.G. Kühn	Ceratobasidiaceae, Agaricomycetes, Basidiomycota	seeds	*Abies balsamea*	USA	Mittal et al. (1990)
		seeds	*Abies fraseri*	USA	Mittal et al. (1990)
		seeds	*Abies* spp	USA	Heit and Natti 1969 and Mittal et al. (1990)
		seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria bidwillii*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria heterophylla*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Callistephus chinensis*	China	Gloyer (1931) and Crosier and Heit (1948)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Fagus sylvatica*	France, Poland	Richardson (1983), Anderson (1986a) and Krol et al. (2015)
		seeds	*Leucaena* spp.	Philippines	Mathur (1974) and Anderson (1986a)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus nigra*	Italy	Turchetti (1982) and Mittal et al. (1990)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Ulmus americana*	USA	Mittal et al. (1990)
		seeds	*Ulmus* spp.	Denmark	Richardson (1979) and Anderson (1986a)
Rhizoctonia spp.	Ceratobasidiaceae, Agaricomycetes, Basidiomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	Taiwan	Rowan and Debarr (1974) and Mittal et al. (1990)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Rhizomarasmius setosus (Sowerby) Antonín and A. Urb. [as *Marasmius recubans* Quél. as '*reenbans*']	Physalacriaceae, Agaricomycetes, Basidiomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Rhizomucor pusillus (Lindt) Schipper [as *Mucor pusillus* Lindt]	Lichtheimiaceae, Mucoromycetes, Mucoromycota	seeds	*Cupressus* spp., *Sapium* spp.	India	Sahai and Otra (1982)
Rhizophlyctis rosea (de Bary and Woronin) A. Fisch.	Rhizophlyctidaceae, Chytridiomycetes, Chytridiomycota	seeds	*Armeria maritima* ssp. *maritima*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa belladonna*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa caucasica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa komarovii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Atropa pallidiflora*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cicuta virosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cornus australis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Cuscuta europaea*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Ginkgo biloba*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus albus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus aureus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Lotus uliginosa*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Prunella grandiflora* ssp. *pyrenaia*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rosa mollis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ulex europaeus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Rhizophydium ampullaceum (A. Braun) A. Fisch.	Rhizophydiaceae, Rhizophydiomycetes, Chytridiomycota	seeds	*Atropa belladonna*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Bryonia cretica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Polygonum amphibium*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Rhizophydium carpophilum Zopf	Rhizophydiaceae, Rhizophydiomycetes, Chytridiomycota	seeds	*Lonicera periclymenum*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rhododendron insigne*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Rhizophydium coronum A.M. Hanson	Rhizophydiaceae, Rhizophydiomycetes, Chytridiomycota	seeds	*Bryonia cretica*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Rhizophydium globosum (A. Braun) Rabenh.	Rhizophydiaceae, Rhizophydiomycetes, Chytridiomycota	seeds	*Hyoscyamus gyoerffyi*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus muticus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Sambucus ebulus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Rhizophydium olla H.E. Petersen	Rhizophydiaceae, Rhizophydiomycetes, Chytridiomycota	seeds	*Paris quadrifolia*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Rhizopus arrhizus A. Fisch.	Rhizopodaceae, Mucoromycetes, Mucoromycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus patula*	Kenya	Gibson (1957) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Poland, USSR	Garbowski (1936) and Anderson (1986a)
		seeds	*Pinus taeda*	USA	Mason and van Arsdel (1978) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
Rhizopus betivorus Nevod	Rhizopodaceae, Mucoromycetes, Mucoromycota	seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
Rhizopus cohnii Berl. and De Toni	Rhizopodaceae, Mucoromycetes, Mucoromycota	seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
Rhizopus nigricans Ehrenb.	Rhizopodaceae, Mucoromycetes, Mucoromycota	cones	*Picea glauca*	Canada	Mittal and Wang (1987)
		cones, seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Casuarina equisetifolia*	India	Anju et al. (2012)
		seeds	*Casuarina* spp.	India	Sahai and Otra (1982)
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seeds	*Pinus nigra*	Hungary	Hangyal (1973) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Hungary, Poland, UK , USSR	Hangyal (1973), Whittle (1977), Mittal et al. (1990) and Krol et al. (2015)
		seeds	*Pinus wallichiana*	Pakistan	Farooq (2000)
		seeds	*Quercus rubra*	Poland	Krol et al. (2015)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
		seeds	*Shorea robusta*	Thailand	Mittal and Sharma (1982b) and Mittal et al. (1990)
Rhizopus nodosus Namysł.	Rhizopodaceae, Mucoromycetes, Mucoromycota	seeds	*Crataegus azarolus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Rhizopus oryzae Went and Prins. Geerl.	Rhizopodaceae, Mucoromycetes, Mucoromycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Larix* sp.	Japan	Watanabe (2010)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Albizia lebbeck*	India	Mittal and Sharma (1982a) and Mittal et al. (1990)
		seeds	*Cassia fistula*	India	Mittal and Sharma (1981a) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cedrus deodara*	India	Mittal (1983)
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b) and Mittal et al. (1990)
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India, Pakistan	Mittal and Sharma (1982b), Mittal et al. (1990) and Farooq (2000)
		seeds	*Shorea robusta*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Rhizopus spp.	Rhizopodaceae, Mucoromycetes, Mucoromycota	fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
		pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Abies lasiocarpa*	Canada	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Georgia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Acacia confusa*	Philippines	Agmata (1979) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Acer saccharum*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Albizia falcataria*	Philippines	Dayan (1986) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Mohanan et al. (2005)
		seeds	*Araucaria angustifolia*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula papyrifera*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Bombax ceiba*	Bangladesh, India	Mittal et al. (1990)
		seed	*Canavalia cathartica*	India	Anita and Sridhar (2009)
		seeds	*Cassia fistula*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
		seeds	*Eucalyptus deglupta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus grandis*	Uruguay	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Gmelina arborea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Leucaena leucocephala*	Bangladesh, Thailand	Chalermpongse et al. (1984), Mittal et al. (1990) and Islam et al. (2008)
		seeds	*Picea engelmannii*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia, Uruguay, USA	Anderson (1986a), Huang and Kuhlman (1990) and Fraedrich and Miller (1995)
		seeds	*Pinus lambertiana*	USA	Anderson (1986a) and Schubert (1961)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus patula*	East Africa	Gibson (1957) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus ponderosa*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus taeda*	Georgia, USA	Covington et al. (1982) and Huang and Kuhlman (1990)
		seeds	*Pinus taiwanensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus thunbergii* [= *Pinus thunbergiana*]	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada, USA	Anderson (1986a), Bloomberg (1966) and James (1984)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
		seeds	*Swietenia macrophylla*	Philippines	Dayan (1986) and Mittal et al. (1990)
Rhizopus stolonifer (Ehrenb.) Vuill.	Rhizopodaceae, Mucoromycetes, Mucoromycota	fruit	*Artocarpus communis*	Nigeria	Amusa et al. (2002)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seed	*Stylosanthes guianensis*	Australia	Nik and Parbery (1977)
		seed	*Stylosanthes humilis*	Australia	Nik and Parbery (1977)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Rhizopus tonkinensis Vuill.	Rhizopodaceae, Mucoromycetes, Mucoromycota	seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Phleum pratense*	Canada	Conners (1967)
Rhodotorula sp.	Sporidiobolaceae, Microbotryomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Rhytidhysteron rufulum (Spreng.) Speg.	Hysteriaceae, Dothideomycetes, Ascomycota	fruit	*Swietenia mahagoni*	Thailand	Jayasiri et al. (2019)
Rosellinia limonispora Ellis and Everh. [as '*limoniiformis*']	Xylariaceae, Sordariomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Bromus inermis*	Canada	Conners (1967)
		seed	*Festuca rubra*	Canada	Conners (1967)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
Rosellinia obliquata* var. *americana (Sommerf.) Sacc.	Xylariaceae, Sordariomycetes, Ascomycota	cone	*Pinus ponderosa*	Canada	Conners (1967)
Saccharomycopsis amapae (P.B. Morais, C.A. Rosa, S.A. Mey., Mend.-Hagler and Hagler) Casarég. and N. Jacques[#] [as *Candida amapae* P.B. Morais, C.A. Rosa, S.A. Mey., Mend.-Hagler and Hagler]	Saccharomycopsidaceae, Saccharomycetes, Ascomycota	**fruit**	***Parahancornia amapa***	**Brazil**	**Morais et al. (1995)**
Sarcinomyces sp.	*Incertae sedis*, Eurotiomycetes, Ascomycota	seeds	*Pinus monticola*	USA	Ganley and Newcombe (2006)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Sarocladium kiliense (Grütz) Summerb. [as *Acremonium kiliense* Grütz]	Sarocladiaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Sarocladium strictum (W. Gams) Summerb. [as *Acremonium strictum* W. Gams]	Sarocladiaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seeds	*Eucalyptus* sp.	India	Mittal et al. (1990)
		seeds	*Fraxinus excelsior*	Sweden	Reddy et al. (1982) and Hayatgheibi (2013)
		seeds	*Quercus robur*	Poland	Jankowiak (2008)
Sarocladium strictum (W. Gams) Summerb. [as *Cephalosporium acremonium* Corda]		seeds	*Melia* spp.	India	Sahai and Otra (1982)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus kesiya*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Sarocladium zeae (W. Gams and D.R. Sumner) Summerb. [as *Acremonium zeae* W. Gams and D.R. Sumner]	Sarocladiaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
Saturnispora diversa (Ohara, Nonom. and Yunome ex van Uden and Buckley) Kurtzman [as *Candida diversa* Ohara, Nonom. and Yunome ex van Uden and Buckley]	Pichiaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Stauronematopsis sojae (Uecker and Kulik) Abbas, B. Sutton and Ghaffar [as *Pseudorobillarda sojae* Uecker and Kulik]	*Incertae sedis*, *Incertae sedis*, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
Schizophyllum alneum (L.) J. Schröt.	Schizophyllaceae, Agaricomycetes, Basidiomycota	seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Schizophyllum commune Fr.	Schizophyllaceae, Agaricomycetes, Basidiomycota	seeds	*Cassia fistula*	India	Goswami and Ojha (2004)
		seeds	*Cassia javanica* [= *Cassia nodosa*]	India	Goswami and Ojha (2004)
		seeds	*Elaeis guineensis*	Malaysia	Turner (1981) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pseudotsuga menziesii*	USA	Rediske and Shea (1965) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
		seeds	*Shorea assamica*	Malaysia	Hong (1981) and Mittal et al. (1990)
		seeds	*Shorea robusta*	India	Goswami and Ojha (2004)
Schizothecium curvisporum (Cain) N. Lundq. [as *Sordaria curvispora* Cain]	Lasiosphaeriaceae, Sordariomycetes, Ascomycota	seed	*Apium graveolens* var. *dulce*	USA	Conners (1967)
Schwanniomyces etchellsii (Kreger-van Rij) M. Suzuki and Kurtzman [as *Pichia etchellsii* Kreger-van Rij]	Debaryomycetaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Schwanniomyces vanrijiae (Van der Walt and Tscheuschner) M. Suzuki and Kurtzman [as *Debaryomyces vanrijiae* var. *yarrowii* (Santa María and C. García) Kreger-van Rij]	Debaryomycetaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Sclerophoma spp.	Dothioraceae, Dothideomycetes, Ascomycota	seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Abies nordmanniana*	Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
Sclerophoma pithyophila (Corda) Höhn.	Dothioraceae, Dothideomycetes, Ascomycota	cones	*Pinus sylvestris*	UK	Whittle (1977)
		cones, seeds	*Pinus* × *schwerinii* (*P. strobus* × *P. wallichiana*)	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus nigra* ssp. *laricio*	Canada	Vujanovic et al. (2000)
		pods	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seeds	*Pinus sylvestris*	UK	Whittle (1977)
Sclerotinia betulae Woronin	Sclerotiniaceae, Leotiomycetes, Ascomycota	seed	*Betula papyrifera*	Canada	Conners (1967)
Sclerotinia libertiana Fuckel	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Sclerotinia pseudotuberosa (Rehm) Rehm	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Sclerotinia sclerotiorum (Lib.) de Bary	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Sclerotium spp.	Sclerotiniaceae, Leotiomycetes, Ascomycota	seeds	*Abies* spp.	-	Ono (1974) and Anderson (1986a)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Prunus serrulata*	Japan	Watanabe (2010)
		seed	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Scolecobasidium constrictum E.V. Abbott	*Incertae sedis*, Dothideomycetes, Ascomycota	seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
Scolecobasidium humicola G.L. Barron and L.V. Busch	*Incertae sedis*, Dothideomycetes, Ascomycota	seed	*Prunus serrulata*	Japan	Watanabe (2010)
Scopulariopsis brevicaulis Bainier	Microascaceae, Sordariomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Scopulariopsis canadensis F.J. Morton and G. Sm.	Microascaceae, Sordariomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
Scutellinia pseudovitreola W.Y. Zhuang and Zhu L. Yang[#]	Pyronemataceae, Pezizomycetes, Ascomycota	**fruits**	***Platanus* sp.**	**China**	**Zhuang (2013)**
Scytalidium lignicola Pesante	Hyaloscyphaceae, Leotiomycetes, Ascomycota	pod	*Sesbania bispinosa*	India	Anita et al. (2009)
Scytalidium spp.	Hyaloscyphaceae, Leotiomycetes, Ascomycota	fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
Scytinostroma mediterraneense Boidin and Lanq.[#]	Peniophoraceae, Agaricomycetes, Basidiomycota	**cones**	***Pinus halepensis***	**France**	**Boidin and Lanquetin (1987)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Sebacina sp.	Sebacinaceae, Agaricomycetes, Basidiomycota	seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
Seimatosporium caninum (Brunaud) B. Sutton	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Ardisia crenata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ardisia punctata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)
Seimatosporium spp.	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Microcos paniculata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Viburnum sempervirens*	Hong Kong	Tang, Hyde et al. (2003)
Seiridium cardinale (W.W. Wagener) B. Sutton and I.A.S. Gibson	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Chamaecyparis lawsoniana*	France, Italy	Motta and Saponaro (1983) and Mittal et al. (1990)
		seeds	*Cupressus abramsiana*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus arizonica*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus glabra*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus goveniana*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Cupressus lusitanica*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus lusitanica* var. *benthamii*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus macrocarpa*	Italy	Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus sempervirens*	France, Italy	Motta (1984) and Mittal et al. (1990)
		seeds	*Cupressus* spp.	Italy	Mittal et al. (1990)
		seeds	*Cupressus torulosa*	France, Italy	Saponaro and Motta (1984) and Mittal et al. (1990)
		seeds	*Thuja orientalis*	Italy, France	Motta (1984) and Mittal et al. (1990)
Seiridium herteri = *Pestalotia herteri* Petr. [as '*hertigii*']	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
'*Seiridium kawakamii*' = *Pestalotia kawakamii* Sawada [as '*Pestalotiopsis kawakamii*']	Sporocadaceae, Sordariomycetes, Ascomycota	fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
'***Seiridium parrotiae***' [as *Pestalotia parrotiae* T.M. Achundov]	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Parrotia persica*	USSR	Akhundov and Papusha (1981) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Seiridium spp. [as *Pestalotia*]	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Acer palmatum*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Adenanthera microsperma*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Albizia falcataria*	Philippines	Mathur (1974) and Mittal et al. (1990)
		seeds	*Albizia procera*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Araucaria cunninghamii*	Australia	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Araucaria excelsa*	USA	Kahn et al. (1965) and Mittal et al. (1990)
		seeds	*Callistemon viminalis*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Casuarina equisetifolia*	Philippines, USA	Mathur (1974), Mittal et al. (1990) and Bayman et al. 1998
		seeds	*Eucalyptus deglupta*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Grevillea robusta*	Rwanda	Mathur (1974) and Anderson (1986a)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Leucaena leucocephala*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Manilkara bidentata*	USA	Bayman et al. (1998)
		seeds	*Mimosa caesalpiniafolia*	Brazil	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Madagascar	Mathur (1974) and Anderson (1986a)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)
		seeds	*Pinus elliottii*	USA	Rowan and Debarr (1974) and Anderson (1986a)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus insularis*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus khasya*	Zambia, Madagascar	Mathur (1974) Mittal et al. (1990)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus merkusii*	Zambia	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus oocarpa*	Zambia	Mathur (1974) and Anderson (1986a)
		seeds	*Pinus patula*	Madagascar	Gibson (1957) and Anderson (1986a)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus taeda*	Georgia, USA, Uruguay	Mason and van Arsdel (1978), Huang and Kuhlman (1990) and Mittal et al. (1990)
		seeds	*Pinus thunbergii* [= *Pinus thunbergiana*]	Japan, Taiwan	Jong and Chen (1966), Mittal et al. (1990) and Watanabe (2010)
		seeds	*Pinus taiwanensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Prosopis juliflora*	Brazil	Mathur (1974) and Mittal et al. (1990)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Pterocarpus indicus*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pterospermum acerifolium*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Sequoia sempervirens*	USA	Davidson (1970) and Mittal et al. (1990)
		seeds	*Swietenia macrophylla*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Taxodium mucronatum*	India	Mathur (1974) and Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Tectona grandis*	India	Anderson (1986a) and Mohanan et al. (2005)
		seeds	*Terminalia myriocarpa*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Thuja* spp.	Spain	Anderson (1986a)
		seeds	*Triplaris cumingiana*	Philippines	Quiniones (1985) and Anderson (1986a)
		seeds	*Ulmus davidiana*	South Korea	Mathur (1974) and Anderson (1986a)
Seiridium quercina [as *Pestalotia quercina* Guba]	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Selenophoma bromigena (Sacc.) R. Sprague and Aar.G. Johnson	Saccotheciaceae, Dothideomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Bromus inermis*	Canada	Conners (1967)
Selenophoma donacis (Pass.) R. Sprague and Aar.G. Johnson	Saccotheciaceae, Dothideomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
		seed	*Festuca elatior*	Canada	Conners (1967)
Selenophoma obtusa R. Sprague and Aar.G. Johnson	Saccotheciaceae, Dothideomycetes, Ascomycota	seed	*Bromus inermis*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Selenosporella curvispora G. Arnaud ex MacGarvie	*Incertae sedis*, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
Selenosporella sp.	*Incertae sedis*, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Sepedonium chrysospermum (Bull.) Fr.	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Sepedonium sp. [as '*Sepedonicum*']	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
Septobasidium sabal-minor Couch ex L.D. Gómez and Henk[#]	Septobasidiaceae, Pucciniomycetes, Basidiomycota	**fruits**	***Sabal minor***	**USA**	**Gómez and Henk (2004)**
Septochytrium variabile Berdan	Septochytriaceae, Chytridiomycetes, Chytridiomycota	seeds	*Bryonia cretica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Crataegus azarolus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Hyoscyamus gyoerffyi*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Juniperus oxycedrus*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Vicia sativa*	Poland	Kiziewicz (2005)
		seeds	*Zantedeschia albo-maculata*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Septoria spp.	Mycosphaerellaceae, Dothideomycetes, Ascomycota	cones	*Pinus ayacahuite*	Canada	Vujanovic et al. (2000)
		fruits	*Dichroa febrifuga*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Acer palmatum*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013) and Hayatgheibi (2013)
		seeds	*Mimosa caesalpiniaf olia*	Brazil	Mathur (1974) and Anderson (1986a)
Shiraia spp.	Shiraiaceae, Dothideomycetes, Ascomycota	seeds	*Phyllostachy s edulis*	China	Shen et al. (2014)
Simocybe panamensis R. Singer[#]	Crepidotaceae, Agaricomycetes, Basidiomycota	**fruit**	**undetermin ed plant**	**Panama**	**Singer (1989)**
Simplicillium sp.	Cordycipitaceae, Sordariomycetes, Ascomycota	seeds	*Phyllostachy s edulis*	China	Shen et al. (2014)
Sirococcus conigenus (Pers.) P.F. Cannon and Minter	Gnomoniaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus nigra* ssp. *laricio*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus ponderosa*	Canada	Vujanovic et al. (2000)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Picea abies*	Italy	Motta et al. (1996)
Sirococcus conigenus (Pers.) P.F. Cannon and Minter [as *S. strobilinus* Preuss][#]		cones	***Pinus abies***	**Germany**	**Preuss (1855)**
		seeds	*Picea abies*	Canada	Sutherland et al. (1981) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Picea engelmannii*	Canada, USA	Sutherland et al. (1981) and Anderson (1986a)
		seeds	*Picea glauca*	Canada	Sutherland et al. (1981) and Mittal et al. (1990)
		seeds	*Picea glauca* × *P. engelmannii*	Canada	Sutherland et al. (1981) and Mittal et al. (1990)
		seeds	*Picea sitchensis*	Canada	Salt (1964) and Mittal et al. (1990)
		seeds	*Picea* spp.	Canada	Sutherland et al. (1981) and Anderson (1986a)
Sirococcus piceicola Rosssman, Castl., DF Farr and Stanosz[#]	Gnomoniaceae, Sordariomycetes, Ascomycota	**cone scales**	***Picea sitchensis***	**Canada**	**Rossman et al. (2008)**
Soloacrosporiella acaciae Crous and M.J. Wingf.[#**]	*Incertae sedis*, Dothideomycetes, Ascomycota	**pods**	***Acacia mangium***	**Malaysia**	**Crous, Wingfield, Guarro et al. (2015)**
Sordaria alcina N. Lundq.	Sordariaceae, Sordariomycetes, Ascomycota	seeds	*Abies lasiocarpa*	Norway	Talgø et al. (2010)
Sordaria fimicola (Roberge ex Desm.) Ces. and De Not.	Sordariaceae, Sordariomycetes, Ascomycota	seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seed	*Bromus* sp.	Canada	Conners (1967)
		seed	*Festuca rubra*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
Sordaria nodulifera TsuneoWatanabe [#]	Sordariaceae, Sordariomycetes, Ascomycota	**seeds**	***Prunus jamasakura***	**Japan**	**Watanabe (1989)**
Sordaria tamaensis Ts. Watan[#]	Sordariaceae, Sordariomycetes, Ascomycota	**seeds**	***Prunus jamasakura***	**Japan**	**Watanabe (1989)**
Spegazzinia flabellata S.M. Leão and Gusmão[#]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	**fruit**	**undetermined plant**	**Brazil**	**Leão-Ferreira and Gusmão (2010)**
Spegazzinia radermacherae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Didymosphaeriaceae, Dothideomycetes, Ascomycota	**pod**	***Radermachera sinica***	**Thailand**	**Jayasiri et al. (2019)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Spegazzinia tessarthra (Berk. and M.A. Curtis) Sacc.	Didymosphaeriaceae, Dothideomycetes, Ascomycota	seed	*Cercis chinensis*	Japan	Watanabe (2010)
Sphaeronaema sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota,	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Sphaeropsis sapinea (Fr.) Dyko and B. Sutton	Botryosphaeriaceae, Dothideomycetes, Ascomycota	cones	*Pinus nigra*	Sweden	Oliva et al. (2013)
		cones	*Pinus patula*	South Africa	Smith et al. (1996)
		cones	*Pinus radiate*	South Africa	Smith et al. (1996)
		cones	*Pinus sylvestris*	Sweden	Oliva et al. (2013)
		cones, seeds	*Pinus albicaulis Engelm.*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus resinosa*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris*	Canada	Vujanovic et al. (2000)
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seeds	*Pinus caribaea*	Australia	Rees and Webber (1988)
		seeds	*Pinus devoniana* [= *Pinus michoacana*]	Zambia	Rees and Webber (1988)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus oocarpa*	Honduras, Zambia	Rees and Webber (1988)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Sphaeropsis sapinea (Fr.) Dyko and B. Sutton [as *Diplodia pinea* (Desm.) J. Kickx f.]		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus* spp.	UK, USA	Anderson (1986a)
		seeds	*Pinus taeda*	Uruguay	Anderson (1986a)
		seeds	*Pinus wallichiana*	Pakistan	Farooq (2000)
Sphaeropsis sapinea (Fr.) Dyko and B. Sutton [*Diplodia sapinea* (Fr.) Fuckel]		cones	*Pinus nigra*	The Netherlands	Phillips et al. (2013)
		cone	*Pinus* sp.	China	Jayasiri et al. (2019)
		cones, seeds	*Pinus nigra* ssp. *laricio*	France	Decourcelle et al. (2015)
		cones	*Pinus sylvestris*	France	Decourcelle et al. (2015)
Sphaeropsis sapinea (Fr.) Dyko and B. Sutton [as *Macrophoma sapinea* (Fr.) Petr.]		seeds	*Pinus oocarpa*	UK	Rees (1982) and Mittal et al. (1990)
		seeds	*Pinus pseudostrobus*	UK	Rees (1982) and Mittal et al. (1990)
Sphaeropsis spp.	Botryosphaeriaceae, Dothideomycetes, Ascomycota	seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus elliottii*	Taiwan, USA	Rowan and Debarr (1974) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia	Huang and Kuhlman (1990)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus taeda*	Georgia, USA	Covington et al. (1982), Huang and Kuhlman (1990) and Mittal et al. (1990)
		seeds	*Pinus taiwanensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus thunbergii* [= *Pinus thunbergiana*]	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
Sphaerostilbella penicillioides (Corda) Rossman, L. Lombard and Crous [as *Gliocladium penicillioides* Corda]	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Sphaerulina mimosae-pigrae H.C. Evans and G. Carrión[#]	Mycosphaerellaceae, Dothideomycetes, Ascomycota	**pods**	***Mimosa pigra***	**Australia**	**Evans et al. (1993)**
Spicaria elegans (Corda) Harz	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Spicaria simplicissima Oudem.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Albizia lebbeck*	India	Mittal and Sharma (1982a) and Mittal et al. (1990)
Spicaria sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)
Spondylocladiella sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
Spondylocladium sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Sporidesmium britannicum B. Sutton[#]	Sporidesmiaceae, Sordariomycetes, Ascomycota	**cupule**	***Fagus sylvatica***	**UK**	**Minter (1986)**
Sporobolomyces roseus Kluyver and C.B. Niel	Sporidiobolaceae, Microbotryomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Sporobolomyces spp.	Sporidiobolaceae, Microbotryomycetes, Basidiomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seed	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seeds	*Pinus thunbergii*	Japan	Watanabe (2010)
Sporoschisma hemipsilum (Berk. and Broome) Zelski, A.N. Mill. and Shearer	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
[as *Melanochaeta hemipsila* (Berk. and Broome) E. Müll., Harr and Sulmont]					
Sporoschisma hemipsilum (Berk. and Broome) Zelski, A.N. Mill. and Shearer [as *Sporoschisma saccardoi* E.W. Mason and S. Hughes]	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Sporoschisma nigroseptatum D. Rao and P.Rag. Rao	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Sporoschismopsis sp.	Reticulascaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Sporothrix dimorphospora (Roxon and S.C. Jong) Madrid, Gené, Cano and Guarro [as *Humicola dimorphospora* Roxon and S.C. Jong]	Ophiostomataceae, Sordariomycetes, Ascomycota	seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Sporothrix spp.	Ophiostomataceae, Sordariomycetes, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Sporothrix stenoceras (Robak) Z.W. de Beer, T.A. Duong and M.J. Wingf.	Ophiostomataceae, Sordariomycetes, Ascomycota	seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
[as *Ophiostoma stenoceras* (Robak) Nannf.]					
Sporotrichum roseum Link	Fomitopsidaceae, Agaricomycetes, Basidiomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Sporotrichum spp.	Fomitopsidaceae, Agaricomycetes, Basidiomycota	seed	*Betula papyrifera*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Pinus thunbergii*	Japan	Watanabe (2010)
Stachybotrys alternans Bonord.	Stachybotryaceae, Sordariomycetes, Ascomycota	seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Larix decidua*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c) and Mittal et al. (1990)
Stachybotrys chartarum (Ehrenb.) S. Hughes	Stachybotryaceae, Sordariomycetes, Ascomycota	seed	*Eucalyptus* sp.	India	Reddy et al. (1982) and Mittal et al. (1990)
		seeds	*Linum usitatissimum*	Canada	Conners (1967)
Stachybotrys chartarum (Ehrenb.) S. Hughes		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
= *Stachybotrys atrus* Corda [as '*atra'*]					
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Stachybotrys chartarum (Ehrenb.) S. Hughes = *Stachybotrys lobulatus* Berk. [as '*lobulata*']		seeds	*Pinus sylvestris*	Poland, USSR	Garbowski (1936) and Mittal et al. (1990)
Stachybotrys parvisporus S. Hughes [as '*parvispora*']	Stachybotryaceae, Sordariomycetes, Ascomycota	fruits	*Ardisia punctata*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Ilex cinerea*	Hong Kong	Tang, Hyde et al. (2003)
		seeds	*Cedrus deodara*	India	Mittal (1983)
Stachybotrys phaeophialis L. Lombard and Crous[#]	Stachybotryaceae, Sordariomycetes, Ascomycota	**seed**	**undetermined plant**	**China**	**Lombard, Houbraken et al. (2016)**
Stachybotrys spp.	Stachybotryaceae, Sordariomycetes, Ascomycota	seeds	*Callistephus chinensis*	imported to Taiwan	Wu et al. (2006)
		seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)
		seeds	*Dahlia* × *hybrida*	imported to Taiwan	Wu et al. (2006)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus globulus*	India	Anderson (1986a)
		seeds	*Primula* × *polyantha*	imported to Taiwan	Wu et al. (2006)
Stagonospora arenaria (Sacc.) Sacc.	Massarinaceae, Dothideomycetes, Ascomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
Stagonospora spp.	Massarinaceae, Dothideomycetes, Ascomycota	seeds	*Phragmites australis*	Germany	Ernst et al. (2003)
Stagonosporopsis pini Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Didymellaceae, Dothideomycetes, Ascomycota	**cone**	***Pinus* sp.**	**China**	**Jayasiri et al. (2019)**
Staphylotrichum sp.	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Stemphylium botryosum Wallr.	Pleosporaceae, Dothideomycetes, Ascomycota	seed	*Anethum graveolens*	Canada	Conners (1967)
		seed	*Apium graveolens* var. *dulce*	Canada	Conners (1967)
		seed	*Asparagus officinalis* var. *altilis*	Canada	Conners (1967)
		seeds	*Casuarina equisetifolia*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seed	*Festuca rubra*	Canada	Conners (1967)
		seed	*Linum usitatissimum*	Canada	Conners (1967)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seed	*Salvia officinalis*	Canada	Conners (1967)
		seed	*Setaria viridis*	Canada	Conners (1967)
Stemphylium ilicis Tengwall	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Stemphylium parasiticum (Thüm.) J.A. Elliott	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Callistephus chinensis*	China	Gloyer (1931) and Crosier and Heit (1948)
Stemphylium paxianum (Szabó) Lindau	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Stemphylium pyriforme Bonord. [as '*piriforme*']	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Stemphylium radicinum (Meier, Drechsler and E.D. Eddy) Neerg.	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Pinus insularis*	Philippines	Agmata (1979) and Anderson (1986a)
Stemphylium spp.	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize	Hocking (1968) and Mittal et al. (1990)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Stemphylium vesicarium (Wallr.) E.G. Simmons	Pleosporaceae, Dothideomycetes, Ascomycota	seeds	*Callistephus chinensis*	imported to Taiwan	Wu et al. (2006)
		seeds	*Cosmos sulphureus*	imported to Taiwan	Wu et al. (2006)
		seeds	*Cupressus sempervirens*	Egypt	Farag et al. (1977) and Mittal et al. (1990)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Dianthus* spp.	Taiwan	Li and Wu (2002)
		seeds	*Tagetes patula*	imported to Taiwan	Wu et al. (2006)
Stereum hirsutum (Willd.) Pers. [as '*Sterum*']	Stereaceae, Agaricomycetes, Basidiomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Sterile mycelia	Fungi	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Abies koreana*	Korea	Cho et al. (2007)
		seeds	*Eucalyptus globulus*	India	Sharma and Mohanan (1980) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Picea engelmannii*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968) and Mittal et al. (1990)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	South Africa, Taiwan, USA	Rowan and Debarr (1974), Mittal et al. (1990) and Cilliers et al. (1995)
		seeds	*Pinus insularis*	Philippines	Agmata (1979) and Anderson (1986a)
		seeds	*Pinus luchuensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus nigra*	Hungary	Hangyal (1973) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus taiwanensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus thunbergii* [= *Pinus thunbergiana*]	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seeds	*Sapium* spp.	India	Sahai and Otra (1982)
		seeds	*Swietenia macrophylla*	Philippines	Agmata (1979) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Sharma and Mohanan (1980) and Mittal et al. (1990)
Stictis fimbriata Schwein.	Stictidaceae, Lecanoromycetes, Ascomycota	seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Stilbum nanum (Ehrenb.) Spreng. [as '*Stilbella nanum*']	Chionosphaeraceae, Agaricostilbomycetes, Basidiomycota	seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
Stomiopeltis phyllanthi Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Micropeltidaceae, Dothideomycetes, Ascomycota	**fruit**	***Phyllanthus emblica***	**China**	**Jayasiri et al. (2019)**
Stomiopeltis sinensis Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Micropeltidaceae, Dothideomycetes, Ascomycota	**fruit**	***Harpephyllum* sp.**	**China**	**Jayasiri et al. (2019)**
Strobiloscypha keliae N.S. Weber and Denison[#**]	Strobiloscyphaceae, Pezizomycetes, Ascomycota	**cones**	***Chamaecyparis lawsoniana***	**USA**	**Weber and Denison (1995)**
Strobilurus diminutivus Desjardin[#]	Physalacriaceae, Agaricomycetes, Basidiomycota	**cone scales**	***Pinus* sp.**	**USA**	**Desjardin (2000)**
Strobilurus esculentus (Wulfen) Singer	Physalacriaceae, Agaricomycetes, Basidiomycota	cones	*Picea smithiana*	India	Goswami and Ojha (2004)
Strobilurus stephanocystis (Kühner and Romagn. ex Hora) Singer	Physalacriaceae, Agaricomycetes, Basidiomycota	cones	*Pinus* sp.	India	Goswami and Ojha (2004)
Stysanus medius Sacc.	Microascaceae, Sordariomycetes, Ascomycota	seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Poland	Garbowski (1936) and Mittal et al. (1990)
Stysanus microsporus Sacc.	Microascaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Stysanus stemonitis (Pers.) Corda	Microascaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Stysanus stemonitis (Pers.) Corda [as '*stemonites*']		seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
Sydowia spp.	Dothioraceae, Dothideomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Sydowia polyspora (Bref. and Tavel) E. Müll.	Dothioraceae, Dothideomycetes, Ascomycota	seeds	*Abies koreana*	Korea	Cho et al. (2005) and Cho et al. (2007)
		seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Symmetrospora coprosmae (Hamam. and Nakase) Q.M. Wang, F.Y. Bai, M. Groenew. and Boekhout[#] [as *Bullera coprosmae* Hamam. and Nakase]	Symmetrosporaceae, Cystobasidiomycetes, Basidiomycota	**fruit**	***Coprosma tenuifolia***	**New Zealand**	**Hamamoto and Nakase (1996)**
Symphyosira clematidis Baral[#]	Helotiaceae, Leotiomycetes, Ascomycota	**fruit**	***Clematis vitalba***	**Germany**	**Weber (1992)**
Symphyosirinia chaerophylli M. Svrček[#]	Helotiaceae, Leotiomycetes, Ascomycota	**seeds**	***Chaerophyllum hirsutum***	**former Czechoslovakia**	**Svrcek (1989)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Sympodiella goidanichii (Rambelli) Crous and Hern.-Restr.[#] [as *Ceratosporella goidanichii* Rambelli]	*Incertae sedis*, *Incertae sedis*, Ascomycota	**cupule**	***Fagus sylvatica***	**Italy**	**Crous et al. (2019)**
Syncephalastrum cinereum Bainier	Syncephalastraceae, Mucoromycetes, Mucoromycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Syncephalastrum. racemosum Cohn ex J. Schröt	Syncephalastraceae, Mucoromycetes, Mucoromycota	seeds *s*	*Acacia auriculiformi*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Cassia fistula*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seeds	*Eucalyptus alba*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Gmelina arborea*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus merkusii*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Mason and van Arsdel (1978) and Anderson (1986a)
		seeds	*Samanea saman*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Shorea robusta*	Thailand	Chalermpongse et al. (1984) and Mittal et al. (1990)
Syncephalastrum sp.	Syncephalastraceae, Mucoromycetes, Mucoromycota	seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Tainosphaeria crassiparies F.A. Fernández and Hundorf[#**]	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	**pod**	***Hymenaea* sp.**	**USA**	**Fernández and Huhndorf (2005)**
Tainosphaeria siamensis Jiao Yang, K.D. Hyde and Jian K. Liu	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
Talaromyces aculeatus (Raper and Fennell) Samson, N. Yilmaz, Frisvad and Seifert [as *Penicillium aculeatum* Raper and Fennell]	Trichocomaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus taeda*	Georgia	Huang and Kuhlman (1990)
Talaromyces coalescens (Quintan.) Samson, N. Yilmaz and Frisvad [as *Penicillium coalescens* Quintan.]	Trichocomaceae, Eurotiomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
Talaromyces diversus (Raper and Fennell) Samson, N. Yilmaz and Frisvad [as *Penicillium diversum* Raper and Fennell]	Trichocomaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus sylvestris*	UK	Whittle (1977)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Talaromyces funiculosus (Thom) Samson, N. Yilmaz, Frisvad and Seifert [as *Penicillium funiculosum* Thom]	Trichocomaceae, Eurotiomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Talaromyces islandicus (Sopp) Samson, N. Yilmaz, Frisvad and Seifert = *Penicillium islandicum* Sopp [as '*islandium*']	Trichocomaceae, Eurotiomycetes, Ascomycota	seeds	*Quercus* spp.	India	Sahai and Otra (1982)
Talaromyces palmae (Samson, Stolk and Frisvad) Samson, N. Yilmaz, Frisvad and Seifert[#] [as *Penicillium palmae* Samson, Stolk and Frisvad]	Trichocomaceae, Eurotiomycetes, Ascomycota	**seeds**	***Chrysalidocarpus lutescen***	**The Netherlands**	**Samson et al. (1989)**
Talaromyces purpureogenus Samson, N. Yilmaz, Houbraken, Spierenb., Seifert, Peterson, Varga and Frisvad [as *Penicillium purpureogenum* Stoll]	Trichocomaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Talaromyces ruber (Stoll) N. Yilmaz, Houbraken, Frisvad and Samson [as *Penicillium rubrum* Stoll]	Trichocomaceae, Eurotiomycetes, Ascomycota	seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Larix occidentalis*	USA	James et al. (1996)
		seeds	*Pinus roxburghii*	India	Mittal and Sharma (1982c)
Talaromyces ruber (Stoll) N. Yilmaz, Houbraken, Frisvad and Samson = *Penicillium rubrum* Stoll [as '*ruber*']		seed	*Macroptiliu m atropurpure um*	Australia	Nik and Parbery (1977)
		seed	*Macroptiliu m lathyroides*	Australia	Nik and Parbery (1977)
		seed	*Trifolium repens*	Australia	Nik and Parbery (1977)
Talaromyces rugulosus (Thom) Samson, N. Yilmaz, Frisvad and Seifert [as *Penicillium rugulosum* Thom]	Trichocomaceae, Eurotiomycetes, Ascomycota	seeds	*Pinus sylvestris*	UK	Whittle (1977)
Talaromyces variabilis (Sopp) Samson, N. Yilmaz, Frisvad and Seifert [as *Penicillium variabile* Sopp]	Trichocomaceae, Eurotiomycetes, Ascomycota	seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Picea glauca*	Canada	Mittal and Wang 1986 and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	UK	Whittle (1977)
Talaromyces verruculosus (Peyronel) Samson, N. Yilmaz, Frisvad and Seifert [as *Penicillium verruculosum* Peyronel]	Trichocomaceae, Eurotiomycetes, Ascomycota	seed	*Medicago sativa*	Canada	Conners (1967)
Talaromyces wortmannii (Klöcker) C.R. Benj [as *Penicillium wortmannii* Klöcker]	Trichocomaceae, Eurotiomycetes, Ascomycota	seeds	*Cedrus deodara*	India	Mittal (1983)
Taphrina alni-incanae (J.G. Kühn) Magnus	Taphrinaceae, Taphrinomycetes, Ascomycota	seeds	*Alnus* sp.	Poland	Anderson (1986a)
Taphrina sp.	Taphrinaceae, Taphrinomycetes, Ascomycota	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Teichospora thailandica (Thambug. and K.D. Hyde) Jaklitsch and Voglmayr [as *Ramusculicola thailandica* Thambug. and K.D. Hyde]	Teichosporaceae, Dothideomycetes, Ascomycota	pod	*Acacia* sp.	Thailand	Jayasiri et al. (2019)
Teratosphaeria zuluensis (M.J. Wingf., Crous and T.A. Cout.) M.J. Wingf. and Crous	Teratosphaeriaceae, Dothideomycetes, Ascomycota	seed capsules, seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Tetracoccosporium sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Thamnidium elegans Link	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Thamnostylum lucknowense (J.N. Rai, J.P. Tewari and Mukerji) Arx and H.P. Upadhyay	Lichtheimiaceae, Mucoromycetes, Mucoromycota	seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
Thecaphora hosackiae Vánky[#]	Glomosporiaceae, Ustilaginomycetes, Basidiomycota	**pods**	***Hosackia parviflora***	**USA**	**Vánky (2008b)**
Thecaphora maireanae R.G. Shivas and Vánky[#]	Glomosporiaceae, Ustilaginomycetes, Basidiomycota	**fruits**	***Maireana pentagona***	**Australia**	**Vánky and Shivas (2003)**
Thecaphora oberwinkleri K. Vánky[#]	Glomosporiaceae, Ustilaginomycetes, Basidiomycota	**seeds**	***Androsace fedtschenkoi***	**China**	**Vánky 1988**
Thecaphora oxytropis S.R. Wang[#]	Glomosporiaceae, Ustilaginomycetes, Basidiomycota	**seeds**	***Oxytropis ochrocephala***	**China**	**Wang and Zeng (2006)**
Thecaphora pakistanica Vánky, S.H. Iqbal and Khalid[#]	Glomosporiaceae, Ustilaginomycetes, Basidiomycota	**capsules**	***Androsace rotundifolia***	**Pakistan**	**Vánky et al. (2007)**
Thecaphora ulicis Vánky[#]	Glomosporiaceae, Ustilaginomycetes, Basidiomycota	**seeds**	***Ulex minor***	**UK**	**Vánky (2008b)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Thekopsora padi (Kunze and J.C. Schmidt) Kleb. [as '*Thecospora padi*']	Pucciniastraceae, Pucciniomycetes, Basidiomycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Thekopsora areolata (Fr.) Magnus	Pucciniastraceae, Pucciniomycetes, Basidiomycota	cones	*Picea abies*	Finland	Kaitera (2013) and Kaitera et al. (2009, 2014)
		cones	*Picea engelmannii*	Finland	Kaitera et al. (2014)
		cones	*Picea glauca*	Finland	Kaitera et al. (2014)
Thielaviopsis sp.	Ceratocystidaceae, Sordariomycetes, Ascomycota	seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
Thielavia spp.	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Bombax ceiba*	India	Mittal et al. (1990)
Thozetella cristata Piroz. and Hodges	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
Thozetella fabacearum R.H. Perera and K.D. Hyde#	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	**pod**	**Fabaceae plant**	**Thailand**	**Perera, Maharachchikumbura, Bhat et al. (2016)**
Thozetella lithocarpi R.H. Perera and K.D. Hyde#	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	**fruit**	***Lithocarpus* sp.**	**Thailand**	**Phookamsak et al. (2019)**
Thozetella nivea (Berk.) Kuntze	Chaetosphaeriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Tilletia brachypodii-mexicani Vánky#	Tilletiaceae, Exobasidiomycetes, Basidiomycota	**seeds**	***Brachypodium mexicanum***	**Venezuela**	**Vánky (1995)**
Tilletia colombiana Vánky#	Tilletiaceae, Exobasidiomycetes, Basidiomycota	**seeds**	***Brachypodium mexicanum***	**Colombia**	**Vánky (1995)**
Tilletia laguri G.M. Zhang, G.X. Linand J.R Deng#	Tilletiaceae, Exobasidiomycetes, Basidiomycota	**seeds**	***Lagurus ovatus***	**Italy**	**Zhang et al. (1995)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Tilletia walkeri Castl. and Carris[#]	Tilletiaceae, Exobasidiomycetes, Basidiomycota	**seeds**	***Lolium multiflorum*** **[= *Festuca perennis*]**	**USA**	**Castlebury and Carris (1999)**
Tomentella afrostuposa Yorou[#]	Thelephoraceae, Agaricomycetes, Basidiomycota	**pods**	***Afzelia africana***	**Guinea**	**Yorou et al. (2011)**
Torula convoluta Harz	Torulaceae, Dothideomycetes, Ascomycota	seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Torula fici Crous	Torulaceae, Dothideomycetes, Ascomycota	fruit	*Garcinia* sp.	Thailand	Jayasiri et al. (2019)
Torula herbarum (Pers.) Link	Torulaceae, Dothideomycetes, Ascomycota	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Mittal et al. (1990)
Torula spp.	Torulaceae, Dothideomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		seed	*Cercis chinensis*	Japan	Watanabe (2010)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Anderson (1986a)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Torulomyces lagena Delitsch	Aspergillaceae, Eurotiomycetes, Ascomycota,	seed	*Cryptomeria japonica*	Japan	Watanabe (2010)
Tremellales	Tremellomycetes, Basidiomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Trichaegum sp.	*Incertae sedis*, *Incertae sedis*, Ascomycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Trichocladium griseum (Traaen) X. Wei Wang and Houbraken [as *Humicola grisea* Traaen]	Chaetomiaceae, Sordariomycetes, Ascomycota	seeds	*Casuarina equisetifolia*	India	Anju et al. (2012)
		seeds	*Dalbergia sissoo*	India	Mittal and Sharma (1981b) and Mittal et al. (1990)
Trichoderma asperellum Samuels, Lieckf. and Nirenberg	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Abies koreana*	Korea	Cho et al. (2007)
'*Trichoderma conispora*'[as *Hypocrea conispora* Y. Doi and G.J. Samuels][#]	Hypocreaceae, Sordariomycetes, Ascomycota	**fruit**	**undetermined plant**	**Indonesia**	**Samuels et al. (1990)**
Trichoderma deliquescens (Sopp) Jaklitsch [as *Gliocladium deliquescens* Sopp]	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Sapium* spp.	India	Sahai and Otra (1982)
Trichoderma hamatum (Bonord.) Bainier	Hypocreaceae, Sordariomycetes, Ascomycota	pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
Trichoderma harzianum Rifai	Hypocreaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		pod	*Sesbania bispinosa*	India	Anita et al. (2009)
		seed	*Pinus densiflora*	Japan	Watanabe (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus elliottii*	South Africa	Cilliers et al. (1995)
		seed	*Prunus serrulata*	Japan	Watanabe (2010)
		seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
Trichoderma koningii Oudem.	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Alnus glutinosa*	Poland	Krol et al. (2015)
		seeds	*Betula pendula*	Poland	Krol et al. (2015)
		seeds	*Betula verrucosa*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)
		seeds	*Picea abies*	Poland	Krol et al. (2015)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
		seeds	*Quercus pedunculata*	USSR	Kozlowska (1968) and Mittal et al. (1990)
		seeds	*Quercus rubra*	Poland	Krol et al. (2015)
Trichoderma koningii Oudem. [as '*koeningi*']		seeds	*Pinus patula*	Kenya	Gibson (1957) and Mittal et al. (1990)
Trichoderma lignorum (Tode) Harz	Hypocreaceae, Sordariomycetes, Ascomycota	seeds	*Abies sibirica*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Larix sibirica*	USSR	Prisyazhnyuk (1960)
		seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus elliottii* var. *elliottii*	Georgia	Huang and Kuhlman (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Anderson (1986a)
		seeds	*Quercus* spp.	USSR	Urosevic (1959) and Mittal et al. (1990)
Trichoderma spp.	Hypocreaceae, Sordariomycetes, Ascomycota	cones	*Pinus ponderosa*	USA	James (1995)
		cones, seeds	*Pinus* spp.	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pseudotsuga menziesii* var. *glauca*	USA	James (1995)
		fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012)
		fruits	*Avicennia marina*	India	Mehdi and Saifullah (2000)
		pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Abies lasiocarpa*	Canada, Norway	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Austria, Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Albizia lebbeck*	India	Mohanan et al. (2005)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seeds	*Dianthus caryophyllus*	Taiwan	Li and Wu (2002)
		seeds	*Larix occidentalis*	USA	James et al. 1996
		seeds	*Picea engelmannii*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968) and Mittal et al. (1990)
		seeds	*Pinus contorta*	USA	Fuller and Hildebrand (1985) and Mittal et al. (1990)
		seeds	*Pinus elliottii*	South Africa, USA	Mittal et al. (1990) and Cilliers et al. (1995)
		seeds	*Pinus elliottii* var. *elliottii*	USA	Fraedrich and Miller (1995)
		seeds	*Pinus nigra*	Hungary	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Pinus patula*	East Africa	Gibson (1957) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	Fuller and Hildebrand (1985), Mittal et al. (1990) and Cilliers et al. (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus oocarpa*	Honduras	Mittal et al. (1990)
		seeds	*Pinus sylvestris*	Hungary	Garbowski (1936) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Anderson (1986a)
		seeds	*Pseudotsuga menziesii*	Canada	Salisbury (1955) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)
Trichoderma viride Pers.	Hypocreaceae, Sordariomycetes, Ascomycota	acorns	*Quercus robur*	Poland	Jankowiak (2008)
		cones	*Pinus ponderosa*	USA	James (1983a)
		cones	*Pinus sylvestris*	UK	Whittle (1977)
		seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seed	*Agropyron cristatum*	Canada	Conners (1967)
		seeds	*Betula pendula*	Finland	Lilja (1979) and Mittal et al. (1990)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Eucalyptus citriodora*	India	Mittal and Sharma (1984) and Mittal et al. (1990)
		seeds	*Eucalyptus* hybrid	India	Mittal (1986) and Mittal et al. (1990)
		seeds	*Eucalyptus maidenii*	Uruguay	Anderson (1986a)
		seed	*Festuca elatior*	Canada	Conners (1967)
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seed	*Linum usitatissimum*	Canada	Conners (1967)
		seed	*Medicago sativa*	Canada	Conners (1967)
		seed	*Phleum pratense*	Canada	Conners (1967)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus roxburghii*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	UK	Whittle (1977)
		seeds	*Pinus wallichiana*	India	Munjal and Sharma (1975) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		seeds	*Pseudotsuga menziesii*	Canada, USA	Bloomberg (1966), Anderson (1986a) and James (1984)
		seeds	*Quercus* spp.	India	Sahai and Otra (1982)
		seed	*Setaria viridis*	Canada	Conners (1967)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)
Trichophaea abundans (P. Karst.) Boud. [as *Patella abundans* (P. Karst.) Seaver]	Pyronemataceae, Pezizomycetes, Ascomycota	seed	*Linum usitatissimum*	Canada	Conners (1967)
Trichosporon sp.	Trichosporonaceae, Tremellomycetes, Basidiomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Trichosporum cerealis (Thüm.) Sacc.	Piedraiaceae, Dothideomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
Trichosporum olivatrum Sacc.	Piedraiaceae, Dothideomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Trichothecium roseum (Pers.) Link	Myrotheciomycetaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus leucodermis*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus mugo*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus mugo* 'Hesse'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus mugo* var. *pumilio*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus nigra*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus nigra* ssp. *laricio*	Canada	Vujanovic et al. (2000)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		cones, seeds	*Pinus nigra* ssp. *nigra*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus strobus*	Canada	Mittal and Wang (1987)
		cones, seeds	*Pinus sylvestris* 'Euro-Asia'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus uncinata*	Canada	Vujanovic et al. (2000)
		seeds	*Abies alba*	Poland	Krol et al. (2015)
		seed	*Abies balsamea*	Canada	Conners (1967)
		seeds	*Abies lasiocarpa*	Canada	Talgø et al. (2010)
		seeds	*Abies nordmanniana*	Georgia, Russia	Talgø et al. (2010)
		seeds	*Abies procera*	Norway	Talgø et al. (2010)
		seeds	*Acer pseudoplatanus*	Poland	Krol et al. (2015)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Betula pendula*	Finland, Poland	Lilja (1979), Mittal et al. (1990) and Krol et al. (2015)
		seeds	*Cedrus deodara*	Uruguay	Manoharachary et al. (1978) and Anderson (1986a)
		seeds	*Dalbergia sissoo*	India	Kumar (2014)
		seeds	*Eucalyptus* sp.	India	Saxena (1985) and Mittal et al. (1990)
		seeds	*Fagus sylvatica*	Poland	Krol et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Larix occidentalis*	USA	James et al. (1996)
		seeds	*Picea abies*	Poland	Krol et al. (2015)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Picea glauca*	Canada	Mittal and Wang (1987)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)
		seeds	*Pinus nigra*	Hungary	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus sylvestris*	Hungary, Poland, USSR	Hangyal (1973) and Anderson (1986a)
		seeds	*Pinus taeda*	Uruguay	Anderson (1986a)
		seed	*Poa compressa*	Canada	Conners (1967)
		seeds	*Pseudotsuga menziesii*	USA	Gordon (1967) and Mittal et al. (1990)
		seeds	*Quercus castaneifolia*	Iran	Kavosi et al. (2013)
		seeds	*Quercus robur*	Germany	Schroder et al. (2004)
		seeds	*Quercus* spp.	India, USSR	Urosevic (1959), Sahai and Otra (1982) and Mittal et al. (1990)
		seed	*Setaria viridis*	Canada	Conners (1967)
		seeds	*Thuja* spp.	India	Sahai and Otra (1982)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Trichothecium spp.	Myrotheciomycetaceae, Sordariomycetes, Ascomycota	seeds	*Araucaria bidwillii*	Egypt	Kamara et al. (1981) and Mittal et al. (1990)
		seeds	*Pinus patula*	East Africa	Gibson (1957) and Mittal et al. (1990)
		seeds	*Pinus taeda*	USA	Covington et al. (1982) and Anderson (1986a)
		seeds	*Pseudotsuga menziesii*	Canada	Bloomberg (1969) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Anderson (1986a)
Tripospermum myrti (Lind) S. Hughes	Neodevriesiaceae, Dothideomycetes, Ascomycota	seed	*Pinus thunbergii*	Japan	Watanabe (2010)
Tripospermum sp.	Neodevriesiaceae, Dothideomycetes, Ascomycota	seed	*Pinus densiflora*	Japan	Watanabe (2010)
Tritirachium spp.	Tritirachiaceae, Tritirachiomycetes, Basidiomycota	seeds	*Picea jezoensis*	Japan	Cheng and Igarashi (1987)
		seeds	*Pinus taeda*	Uruguay	Anderson (1986a, b)
Truncatella angustata (Pers.) S. Hughes	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Larix decidua*	Poland	Krol et al. (2015)
		seeds	*Picea abies*	Poland	Krol et al. (2015)
		seeds	*Pinus sylvestris*	Poland	Krol et al. (2015)
Truncatella angustata (Pers.) S. Hughes [as *Pestalotia truncata* Lév.]		seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)
Truncatella hartigii (Tubeuf) Steyaert	Sporocadaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus contorta*	Canada	Vujanovic et al. (2000)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		cones, seeds	*Pinus densiflora*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris* 'Argentea-Compacta'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris* 'Beuvronensis'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris* 'Fastigiata'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus sylvestris* 'Watereri'	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus tabulaeformis*	Canada	Vujanovic et al. (2000)
		seeds	*Abies* spp	UK	Batko (1956) and Anderson (1986a)
		seeds	*Nothofagus* sp.	UK	Anderson (1986a)
Truncatella laurocerasi (Westend.) Steyaert	Sporocadaceae, Sordariomycetes, Ascomycota	seeds	*Pyrus* spp.	Romania	Richardson (1979)
Tubaria keralensis K.P.D. Latha and Manim.[#]	Tubariaceae, Agaricomycetes, Basidiomycota	**fruits**	***Casuarina* sp.**	**India**	**Latha et al. (2016)**
Tubercularia spp.	Icmadophilaceae, Lecanoromycetes, Ascomycota	cones, seeds	*Pinus* × *schwerinii* (*P. strobus* × *P. wallichiana*)	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus ayacahuite*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus parviflora*	Canada	Vujanovic et al. (2000)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		cones, seeds	*Pinus peuce*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus ponderosa*	Canada	Vujanovic et al. (2000)
Tubeufia dictyospora Y.Z. Lu, Boonmee and K.D. Hyde	Tubeufiaceae, Dothideomycetes, Ascomycota	pod	*Delonix regia*	Thailand	Jayasiri et al. (2019)
Tubeufia entadae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Tubeufiaceae, Dothideomycetes, Ascomycota	**pod**	***Entada phaseoloides***	**Thailand**	**Jayasiri et al. (2019)**
Typhula peronata (Pers.) Fr.	Typhulaceae, Agaricomycetes, Basidiomycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Umbelopsis isabellina (Oudem.) W. Gams [as *Mortierella isabellina* Oudem.]	Umbelopsidaceae, *Incertae sedis*, Mucoromycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		seed	*Pinus thunbergii*	Japan	Watanabe (2010)
		seeds	*Pinus wallichiana*	India	Mittal and Sharma (1982b) and Mittal et al. (1990)
Umbelopsis ramanniana (Möller) W. Gams [as *Mortierella ramanniana* (Möller) Linnem.]	Umbelopsidaceae, *Incertae sedis*, Mucoromycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Umbelopsis ramanniana (Möller) W. Gams [as *Mucor ramannianus* Möller]		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus caribaea*	Belize [as British Honduras]	Hocking (1968) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Urosevic (1961) and Anderson (1986a)
Umbelopsis sp.	Umbelopsidaceae, *Incertae sedis*, Mucoromycota	seeds	*Pinus taeda*	USA	Anderson (1986a, b)
Undetermined Ascomycete	-	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Undetermined Basidiomycete	-	seeds	*Fraxinus excelsior*	Sweden	Hayatgheibi (2013)
Undetermined fungi	-	seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Calypso bulbosa*	Canada	Zelmer et al. (1996)
		seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
		seeds	*Platanthera hyperborea*	Canada	Zelmer et al. (1996)
Urceolella pinicola Raitv. and R. Galán[#]	Calloriaceae, Leotiomycetes, Ascomycota	**cone**	***Pinus halepensis***	**Spain**	**Raitviír and Galán (1993)**
Urceolella triseptata Raitv. and R. Galán[#]	Calloriaceae, Leotiomycetes, Ascomycota	**cupule**	***Quercus rotundifolia***	**Spain**	**Raitviír and Galán (1993)**
Urocystis aurea Vánky[#]	Urocystidaceae, Ustilaginomycetes, Basidiomycota	**capsules**	***Hypoxis aurea***	**India**	**Vánky (2004)**
Uromycladium naracoortense Berndt [as '*naracoortensis*'][#]	Pileolariaceae, Pucciniomycetes, Basidiomycota	**pods**	***Acacia* cf. *iteaphylla***	**Australia**	**Berndt (2010)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Ustilago echinochloae L. Guo and Y.-c. Wang[#]	Ustilaginaceae, Ustilaginomycetes, Basidiomycota	**seeds**	***Echinochloa crus-galli***	**China**	**Vánky and Guo (1987)**
Ustilago hordei (Pers.) Lagerh.	Ustilaginaceae, Ustilaginomycetes, Basidiomycota	seed	*Agropyron cristatum*	Canada	Conners (1967)
Vaginatispora nypae Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Lophiostomataceae, Dothideomycetes, Ascomycota	**fruit**	***Nypa* sp.**	**Thailand**	**Jayasiri et al. (2019)**
Valsa pini (Alb. and Schwein.) Fr.	Valsaceae, Sordariomycetes, Ascomycota	cones, seeds	*Pinus flexilis*	Canada	Vujanovic et al. (2000)
		cones, seeds	*Pinus peuce*	Canada	Vujanovic et al. (2000)
Valsa spp.	Valsaceae, Sordariomycetes, Ascomycota	seeds	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Vargamyces aquaticus (Dudka) Tóth	Amniculicolaceae, Dothideomycetes, Ascomycota	fruit cupule	*Fagus sylvatica*	UK	Jayasiri et al. (2019)
Verruculina enalia (Kohlm.) Kohlm. and Volkm.-Kohlm.	Testudinaceae, Dothideomycetes, Ascomycota	fruit	*Pandanus* sp.	Thailand	Jayasiri et al. (2019)
Verticillium albo-atrum Reinke and Berthold	Plectosphaerellaceae, Sordariomycetes, Ascomycota	seed	*Apium graveolens* var. *dulce*	USA	Conners (1967)
		seeds	*Eucalyptus* sp.	India	Lee and Ahmad (1982) and Mittal et al. (1990)
		seeds	*Picea excelsa*	USSR	Urosevic (1961) and Anderson (1986a)
		seeds	*Pinus sylvestris*	USSR	Dolejs (1964) and Anderson (1986a)
Verticillium epimyces Berk. and Broome	Plectosphaerellaceae, Sordariomycetes, Ascomycota	seeds	*Quercus* spp.	USSR	Urosevic (1962) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Verticillium glaucum Bonord.	Plectosphaerellaceae, Sordariomycetes, Ascomycota	seeds	*Picea abies*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
		seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Verticillium spp.	Plectosphaerellaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
		seeds	*Acer campestre*	South Korea	Mathur (1974) and Anderson (1986a)
		seeds	*Azadirachta indica*	India	Mathur (1974) and Mittal et al. (1990)
		seeds	*Betula alleghaniensis*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Dalbergia sissoides*	India	Mohanan et al. (2005)
		seeds	*Eucalyptus grandis*	Uruguay	Anderson (1986a)
		seeds	*Fagus* spp.	former Czechoslovakia	Urosevic (1964) and Mittal et al. (1990)
		seeds	*Ficus benjamina*	India	Mathur (1974) and Anderson (1986a)
		seeds	*Picea abies*	UK	Mittal et al. (1990)
		seeds	*Picea sitchensis*	UK	Salt (1964) and Mittal et al. (1990)
		seeds	*Picea* spp.	UK	Anderson (1986a)
		seeds	*Pinus armandii* var. *mastersiana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Pinus elliottii*	Taiwan, USA	Rowan and Debarr (1974), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pinus elliottii* var. *elliottii*	Uruguay	Anderson (1986a)
		seeds	*Pinus massoniana*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		seeds	*Pinus taeda*	USA	Anderson (1986a, b)
		seeds	*Pinus taiwanensis*	Taiwan	Jong and Chen (1966) and Mittal et al. (1990)
		seeds	*Pseudotsuga menziesii*	Canada, UK, USA	Gordon (1967), Anderson (1986a) and Mittal et al. (1990)
		seeds	*Pterocarpus indicus*	Philippines	Mathur (1974) and Anderson (1986a)
		seeds	*Quercus robur*	Germany	Schroder et al. (2004)
		seeds	*Quercus* spp.	USSR	Urosevic (1983) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mathur (1974), Anderson (1986a) and Mohanan et al. (2005)
		seeds	*Tsuga heterophylla*	UK	Anderson (1986a)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Vishniacozyma carnescens (Verona and Luchetti) Xin Zhan Liu, F.Y. Bai, M. Groenew. and Boekhout [as *Cryptococcus carnescens* (Verona and Luchetti) M. Takash., Sugita, Shinoda and Nakase] Andrés, S. Ferrer, Torr.-Rodr. and J. Guinea]	Bulleribasidiaceae, Tremellomycetes, Basidiomycota	seeds	*Fraxinus excelsior*	Sweden	Cleary et al. (2013)
Volutella ciliata (Alb. and Schwein.) Fr.	Nectriaceae, Sordariomycetes, Ascomycota	cone	*Abies balsamea*	Canada	Conners (1967)
Volutella sp.	Nectriaceae, Sordariomycetes, Ascomycota	pods	*Delonix regia*	Thailand	Somrithipol, Jones et al. (2002)
Vuilleminia comedens (Nees) Maire	Vuilleminiaceae, Bartheletiomycetes, Basidiomycota	seeds	*Quercus* spp.	USSR	Mittal et al. (1990)
White, sterile fungi	-	seeds	*Acer rubrum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharinum*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Acer saccharum*	USA	Friedrich (1969) and Mittal et al. (1990)
		seeds	*Albizia lebbeck*	India	Mohanan et al. (2005)
		seeds	*Cedrus deodara*	India	Munjal and Sharma (1975) and Mittal et al. (1990)
		seeds	*Dalbergia sissoo*	India	Naz et al. (2015)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		seeds	*Fraxinus americana*	USA	Friedrich et al. (1971) and Mittal et al. (1990)
		seeds	*Tectona grandis*	India	Mohanan et al. (2005)
Wickerhamiella fructicola Pagnocca, C.A. Rosa, Dayo-Owoy. and A. Rodrigues[#]	Trichomonascaceae, Saccharomycetes, Ascomycota	**fruits**	***Hedychium coronarium***	**Brazil**	**Dayo-Owoyemi et al. (2014)**
Wickerhamiella sergipiensis (R.C. Trindade, M.A. Resende, Lachance and C.A. Rosa) C. Vega and Lachance[#] [as *Candida sergipensis* R.C. Trindade, M.A. Resende, Lachance and C.A. Rosa]	Trichomonascaceae, Saccharomycetes, Ascomycota	**frozen fruit pulp**	***Hancornia speciosa***	**Brazil**	**Trindade et al. (2004)**
Wickerhamiella versatilis (Etchells and T.A. Bell) de Vega and Lachance [as *Candida versatilis* (Etchells and T.A. Bell) S.A. Mey. and Yarrow]	Trichomonascaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Wickerhamomyces anomalus (E.C. Hansen) Kurtzman, Robnett and Bas.-Powers [as *Hansenula anomala* (E.C. Hansen) Syd. and P. Syd.]	Phaffomycetaceae, Saccharomycetes, Ascomycota	seeds	*Atropa komarovii*	Poland or/ imported to Poland	Czeczuga et al. (2009)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Wickerhamomyces pijperi (Van der Walt and Tscheuschner) Kurtzman, Robnett and Bas.-Powers [as *Pichia pijperi* Van der Walt and Tscheuschner]	Phaffomycetaceae, Saccharomycetes, Ascomycota	fruits	*Parahancornia amapa*	Brazil	Morais et al. (1995)
Wiesneriomyces javanicus Koord.	Wiesneriomycetaceae *Incertae sedis*, Ascomycota	fruit	*Scheelea zonensis*	Panama	Goos and Pirozynski (1975)
Xenocamarosporium acaciae Crous and M.J. Wingf.	Didymosphaeriaceae, Dothideomycetes, Ascomycota	pod	*Leucaena* sp.	Thailand	Jayasiri et al. (2019)
Xylaria aethiopica J. Fourn., Y.M. Ju, H.M. Hsieh and U. Lindem.[#]	Xylariaceae, Sordariomycetes, Ascomycota	**pods**	***Millettia ferruginea***	**Ethiopia**	**Fournier et al. (2018)**
Xylaria alata F. San Martín and J.D. Rogers[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruit**	**undetermined plant**	**Mexico**	**San Martín González and Rogers (1989)**
Xylaria arbuscula Sacc	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Quercus* sp.	Mexico	San Martín González and Rogers (1989)
Xylaria aristata Mont.	Xylariaceae, Sordariomycetes, Ascomycota	pod	*Guazuma ulmifolia*	Mexico	San Martín González and Rogers (1989)
Xylaria beilschmiediae G. Huang and L. Guo[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruit**	***Beilschmiedia percoriacea***	**China**	**Huang et al. (2014a)**
Xylaria byttneriae G. Huang, L. Guo and Na Liu[#]	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Byttneria integrifolia*	China	Huang et al. (2014b)
		fruits	***Byttneria pilosa***	**China**	**Huang et al. (2014b)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Xylaria carpophila (Pers.) Fr.	Xylariaceae, Sordariomycetes, Ascomycota	fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012)
Xylaria duranii F. San Martín and Vanoye[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruit remaining**	***Quercus polymoroha***	**Mexico**	**San Martín et al. (2001)**
***Xylaria euphorbiicol*a** Rehm[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruits**	***Euphorbia* sp.**	**Brazil**	**Rehm (1901)**
Xylaria guazumae González and Rogers[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruits**	***Guazuma ulmifolia***	**Mexico**	**San Martín González and Rogers (1989)**
Xylaria heloidea Penz. and Sacc.[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruits**	**Legume plant**	**Indonesia**	**Penzig and Saccardo (1897)**
***Xylaria himalayensi*s** Narula and Rawla[#]	Xylariaceae, Sordariomycetes, Ascomycota	**seeds**	**angiosperm ous plant**	**India**	**Narula et al. (1984)**
Xylaria jaliscoensis F. San Martín, J.D. Rogers and Y.M. Ju[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruits**	***Magnolia iltisiana***	**Mexico**	**Rogers et al. (2002)**
Xylaria karyophthora Husbands, Urbina and Aime[#]	Xylariaceae, Sordariomycetes, Ascomycota	**seeds**	***Chlorocardi um rodiei***	**Guyana**	**Husbands et al. (2018)**
Xylaria liquidambaris J.D. Rogers, Y.M. Ju and F. San Martín [as '*liquidambar*'][#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruits**	***Liquidamba r styraciflua***	**USA**, Mexico, China	Rogers (1979b), San Martín González and Rogers (1989) and **Rogers et al. (2002)**
Xylaria magnoliae J.D. Rogers[#]	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Magnolia grandiflora*	USA	Rogers (1979b)
		fruits	*Magnolia schiedeana*	Mexico	San Martín González and Rogers (1989)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	***Magnolia* sp.**	**USA**	**Rogers (1979b)**
Xylaria magnoliae* var. *microspora J.D. Rogers, Y.M. Ju and Whalley[#]	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Talauma ovata*	Brazil	Trierveiler-Pereira et al. (2009)
		fruit	***Magnolia* sp.**	**Thailand**	**Rogers et al. (2002)**
Xylaria oxyacanthae Tul. and C. Tul.	Xylariaceae, Sordariomycetes, Ascomycota	seeds	*Crataegus monogyna*	USA, Mexico	Rogers et al. (2008) and San Martín González and Rogers (1989)
		pod	Fabaceae plant	Mexico	San Martín González and Rogers (1989)
		seeds	Vitaceae plant	USA, Mexico	Rogers et al. (2008) and San Martín González and Rogers (1989)
Xylaria persicaria (Schwein.) Berk. and M.A. Curtis	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Liquidambar formosana*	Korea	Han and Shin (2007)
		fruits	*Liquidambar styraciflua*	Korea	Han and Shin (2007)
Xylaria rhizocola (Mont.) Mont.	Xylariaceae, Sordariomycetes, Ascomycota	seed	Palm	Brazil	Ju et al. (2018)
		seeds	undetermined plant	France [as French Guiana]	Ju et al. (2018)
Xylaria rossmaniae Y.M. Ju, J.D. Rogers and H.M. Hsieh [as '*rossmanae*'][#]	Xylariaceae, Sordariomycetes, Ascomycota	**pod**	***Elizabetha* sp.**	**Venezuela**	**Ju et al. (2018)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Xylaria spp.	Xylariaceae, Sordariomycetes, Ascomycota	cones	*Pinus densiflora*	Japan	Kasai et al. (1995)
		fruit cupules	*Fagus crenata*	Japan	Fukasawa et al. (2012) and Tateno et al. (2015)
		seeds	*Casuarina equisetifolia*	USA	Bayman et al. (1998)
		seeds	*Eucalyptus globulus*	Uruguay	Lupo et al. (2001)
		seeds	*Phyllostachys edulis*	China	Shen et al. (2014)
		seeds	*Platanus occidentalis*	USA	Fakir et al. (1971) and Mittal et al. (1990)
Xylaria terminaliae-bellericae A. Pande and Waing.[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruits**	***Terminalia bellerica***	**India**	**Pande and Waingankar (2004)**
Xylaria terminaliae-crenulatae A. Pande and Waing.[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruits**	***Terminalia crenulata***	**India**	**Pande and Waingankar (2004)**
Xylaria vivantii Y.M. Ju, J.D. Rogers, J. Fourn. and H.M. Hsieh	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Magnolia dodecapetala*	French West Indies	Ju et al. (2018)
		fruits	*Magnolia* sp.	Brazil	Ju et al. (2018)
Xylaria vivantii Y.-M. Ju, J. D. Rogers, J. Fournier and H.-M. Hsieh[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruits**	***Magnolia dodecapetala***	**French West Indies**	**Ju et al. (2018)**
Xylaria xanthinovelutina (Mont.) Mont. [as '*ianthino-velutina*']	Xylariaceae, Sordariomycetes, Ascomycota	fruit	*Couroupita guianensis*	Brazil	Ju et al. (2018)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	***Magnolia* sp.**	**French West Indies**	**Ju et al. (2018)**
		fruits	*Swietenia macrophylla*	French West Indies	Ju et al. (2018)
		fruits	*Talauma* sp.	Brazil	Ju et al. (2018)
		pod	*Ebenopsis ebano* [= *Pithecellobium flexicaule*]	Mexico	Trierveiler-Pereira et al. (2009)
		pod	Fabaceae plant	Trinidad	San Martín González and Rogers (1989)
		pod	*Guazuma ulmifolia*	Mexico	Trierveiler-Pereira et al. (2009)
		pod	undetermined plant	Mexico, Brazil, USA, Philippines, USA, Venezuela	Rogers (1979b), San Martín González and Rogers (1989) and Trierveiler-Pereira et al. (2009)
		pods	*Acacia* sp.	Brazil	Ju et al. (2018)
		pods	*Eperua* sp.	Guyana	Ju et al. (2018)
		pods	Legume plant	Brazil, Congo, France [as French Guiana], Venezuela	Ju et al. (2018)
Xylaria luzonensis Henn.	Xylariaceae, Sordariomycetes, Ascomycota	pods	*Bauhinia cumingiana*	Philippines	Ju et al. (2018)
Xylaria magnoliae* var. *magnoliae J.D. Rogers[#]	Xylariaceae, Sordariomycetes, Ascomycota	**fruits**	***Magnolia* sp.**	**USA**	**Rogers (1979b)**

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Xylaria oxyacanthae Tul. and C. Tul.	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Cornus florida*	USA	Ju et al. (2018)
		fruits	*Cornus sanguinea*	France	Ju et al. (2018)
		seeds	*Carpinus betulus*	France	Ju et al. (2018)
		seeds	*Carpinus* sp.	France	Ju et al. (2018)
Xylaria palmicola G. Winter	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Patrisia* sp.	Brazil	Ju et al. (2018)
		seeds	*Euterpe globosa*	USA	Ju et al. (2018)
		seeds	*Euterpe* sp.	Brazil	Ju et al. (2018)
		seeds	Palm	Brazil	Ju et al. (2018)
Xylaria warburgii Henn.	Xylariaceae, Sordariomycetes, Ascomycota	fruits	*Sloanea berteroana*	USA	Ju et al. (2018)
		fruits	*Sloanea* sp.	Papua New Guinea	Ju et al. (2018)
		fruits	undetermined plant	Taiwan	Ju et al. (2018)
Xylariales spp.	Sordariomycetes, Ascomycota	seed capsules	*Eucalyptus grandis*	South Africa	Jimu et al. (2016)
Xylohyphites verrucosa Kalgutkar and Sigler[#**]	Fossil fungus	**permineralized fruit**	***Viracarpon* sp.**	**India**	**Kalgutkar and Sigler (1995)**
Xylosphaera carpophila (Pers.) Dumort.	Xylariaceae, Sordariomycetes, Ascomycota	fruit cupules	*Fagus sylvatica*	UK	Carré (1964)
Yeats	-	seeds	*Pinus ponderosa*	USA	James and Genz (1982) and Anderson (1986a)
		acorns	*Quercus robur*	Poland	Jankowiak (2008)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
Yelsemia arthropodii J. Walker[#]	Melanotaeniaceae, Ustilaginomycetes, Basidiomycota	**capsules**	***Arthropodium minor***	**Australia**	**Walker 2001**
Yelsemia droserae R.G. Shivas, Vánky and Athip.[#]	Melanotaeniaceae, Ustilaginomycetes, Basidiomycota	**capsules**	***Drosera burmanni***	**Thailand**	**Vánky et al. (2006)**
Zeloasperisporium pterocarpi Jayasiri, E.B.G. Jones and K.D. Hyde[#]	Zeloasperisporiaceae, Dothideomycetes, Ascomycota	**pod**	***Pterocarpus* sp.**	**Thailand**	**Jayasiri, Hyde, Jones, Peršoh et al. (2018b)**
Zoophagus insidians Sommerst.	Zoopagaceae, Zoopagomycetes, Mucoromycota	seeds	*Atropa belladonna*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Bryonia cretica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Canna indica*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Ficus pumila*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Kalmia latifolia*	Poland or/ imported to Poland	Czeczuga et al. (2009)
		seeds	*Rhododendron smirnowii*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Zygorhynchus heterogamus (Vuill.) Vuill.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Rosa mollis*	Poland or/ imported to Poland	Czeczuga et al. (2009)
Zygorhynchus vuilleminii Namysł.	Mucoraceae, Mucoromycetes, Mucoromycota	seeds	*Pinus sylvestris*	USSR	Prisyazhnyuk (1960) and Mittal et al. (1990)
Zygosporium gibbum (Sacc., M. Rousseau and E. Bommer) S. Hughes	Zygosporiaceae, Sordariomycetes, Ascomycota	fruits	*Cleistocalyx operculatus*	Hong Kong	Tang, Hyde et al. (2003)

Table 6.2 (continued)

Species	Taxonomy	Substrate	Host	Country	References
		fruits	*Ilex pubescens*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Litsea rotundifolia*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Psychotria asiatica*	Hong Kong	Tang, Hyde et al. (2003)
		fruits	*Rhodomyrtus tomentosa*	Hong Kong	Tang, Hyde et al. (2003)

Note Fungi are listed in alphabetical order after the Phylum.

Taxonomy based on Index Fungorum (2020) and Wijayawardene et al. (2020)

[#] New species, [**] New genera

Substrate, host, country and references related to new species described from seed/fruits are in bold text.

6.5 Discussion

6.5.1 Diversity of Fungi on Wild Seeds and Fruits

In this study we review the fungal taxa described from wild fruit substrates until December 2019 (Table 6.2). Currently 300 new fungal species have been described from wild seeds/fruit substrates, from 54 countries (Index Fungorum, 2020). Fungi reported from wild seeds and fruits belong to 609 fungal genera of different fungal families and included 28 novel genera (Table 6.2). Ascomycota and Basidiomycota are the major fungal phyla reported from wild seeds and fruits with significantly fewer Mucoromycota, Chytridiomycota, and Blastocladiomycota reported (Figure 6.79). The highest number of fungi on wild seed/fruit substrates, belong to Ascomycota with 82% reported (Figure 6.79). The dominant genera include: *Alternaria*, *Aspergillus*, *Candida*, *Chaetomium*, *Cladosporium*, *Colletotrichum*, *Curvularia*, *Diaporthe*, *Drechslera*, *Fusarium*, *Mucor*, *Penicillium*, *Pestalotiopsis*, *Restiosporium*, *Rhizopus*, *Talaromyces*, *Trichoderma* and *Xylaria*. (Figure 6.81). Most were recorded as asexual morphic taxa, with fewer sexual

morphs. Wild seed and fruit fungi belong to 27 fungal classes (Figure 6.80). The number of Sordariomycetes taxa (30%) and Dothideomycetes taxa (26%) associated with forest seeds and fruits are significantly higher than other classes (Figure 6.80). Lichenization is one of the major lifestyles among fungi, and are classified in the Ascomycota and Basidiomycota (Lücking et al., 2017). There are three novel lichen fungi, *Cladonia lacryma*, *Lecanora shangrilaensis* and *Lecanora substrobilina*, described from wild seed/fruit substrates (Table 6.2).

Forest tree seeds have vast diversity in their size, shape and texture (Sutherland et al., 2002). The size and texture of tree seeds ranging from small and hard to the relatively large and fleshy (Sutherland et al., 2002) may influence the fungal diversity. The highest number of new wild seed/fruit fungi are from Thailand (18%), while Australia, China, USA and India also have significant numbers of novel species (Figure 6.83). Fruit diversity in tropical regions is higher than in temperate regions which may lead to an increase in the availability and variety of resources or substrates for fungal colonisation (Hyde et al., 2005). Mittal et al. (1990) indicated that the climate conditions in the tropics also facilitate the development of seed-borne fungi in the region. Most of the new fungi have been described from wild fruits and coniferous cones (246 taxa), when compared to seeds (54 taxa).

Wild seed and fruit fungi have been described from 80 plant families, although most were collected from the legume family, Fabaceae (Figure 6.84, Table 6.2). Fabaceae is the third largest flowering plant family with worldwide distribution (Gepts et al., 2005). Pinaceae, Fagaceae, Restionaceae, and Poaceae are the other plant host families from where the novel wild seed/fruit fungi were mostly described (Figure 6.84).

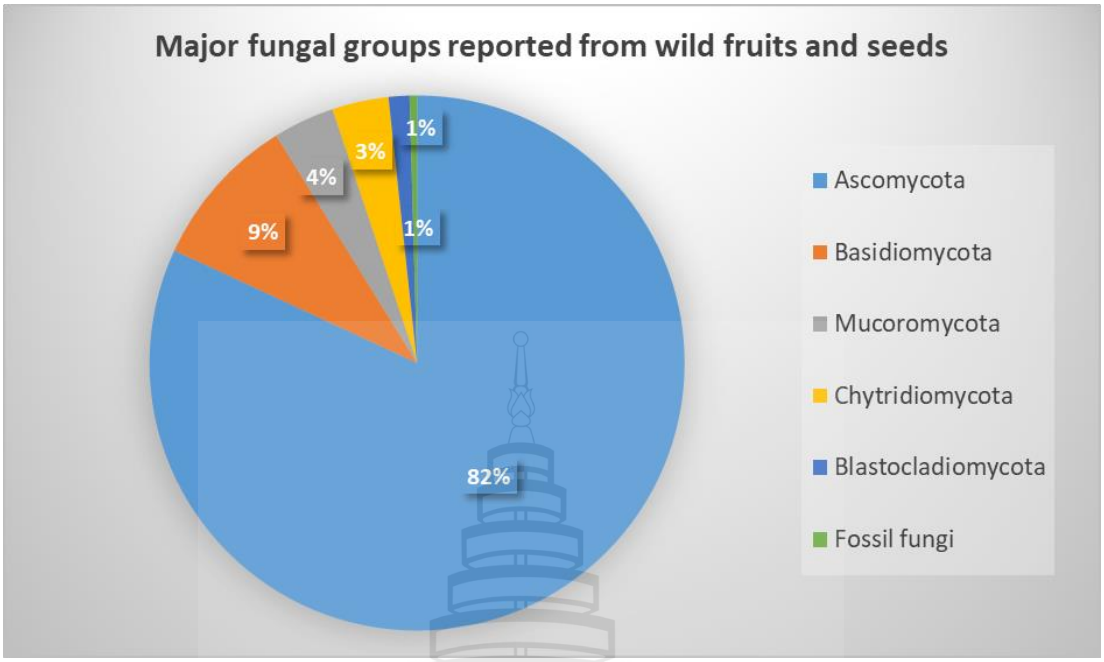


Figure 6.79 Percentage of species belonging to major fungal phyla reported from wild seeds and fruits

Fusarium species isolated from wild fruits in our study are mainly belonging to *Fusarium lateritium* species complex (Figure 6.38). Species of this complex prefer seed and fruit substrates. They are commonly reported from fruits of commercially important plants, for example, *Fusarium stilboides* associated with fruits of banana, bell pepper (*Capsicum annum*) and *Coffea arabica* (Geiser et al., 2005; Sandoval-Chávez et al., 2011; Zeng et al., 2013), while *Fusarium lateritium* was isolated from fruits of banana, *Coffea arabica*, dragon plant (*Cereus undatus*) and hazelnut (*Corylus avellana*) (Abo-El-Dahab and El-Goorani, 1969; To et al., 1999; Geiser et al., 2005; Vitale et al., 2011). *Fusarium lateritium*, *F. sarcochroum* and *F. stilboides* are also reported from seeds of various forest plants and acorns of *Quercus robur* (Table 6.2).

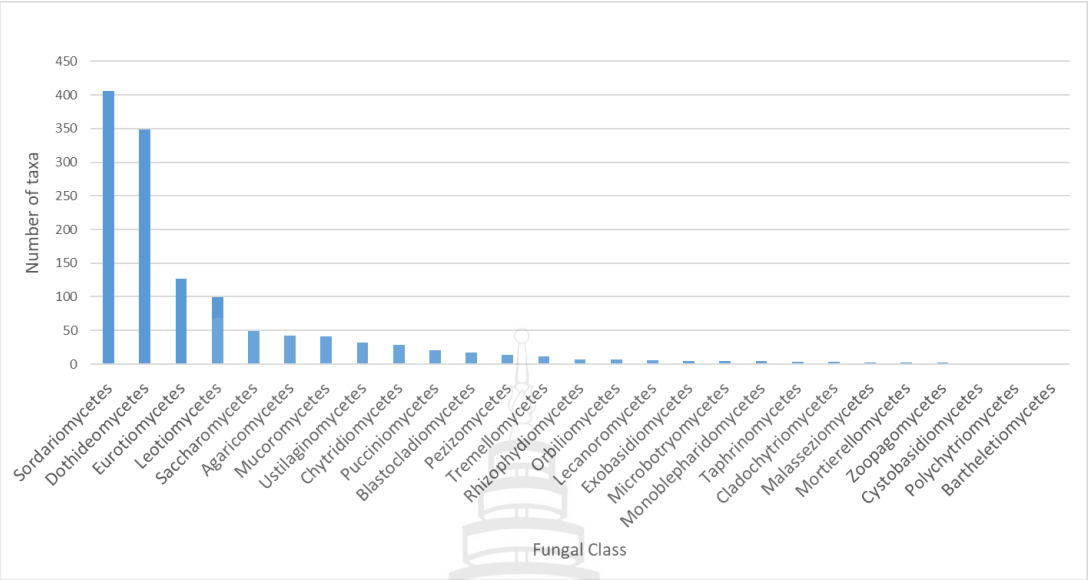


Figure 6.80 Number of wild seeds/fruit inhabiting fungi belonging to different fungal classes

Basidiomycota

The second largest group of fungi reported from wild seeds and fruits is Basidiomycota (9%), including 65 new species (Figure 6.79). This group includes several classes such as Agaricomycetes, Cystobasidiomycetes, Exobasidiomycetes, Microbotryomycetes, Pucciniomycetes and Ustilaginomycetes.

Discomycetes

Discomycetes are a group of apothecia-producing fungi, having operculate or inoperculate asci, in the phylum Ascomycota (Ekanayaka et al., 2017). There were 20 discomycete species newly introduced from wild seeds and fruits (Table 6.2).

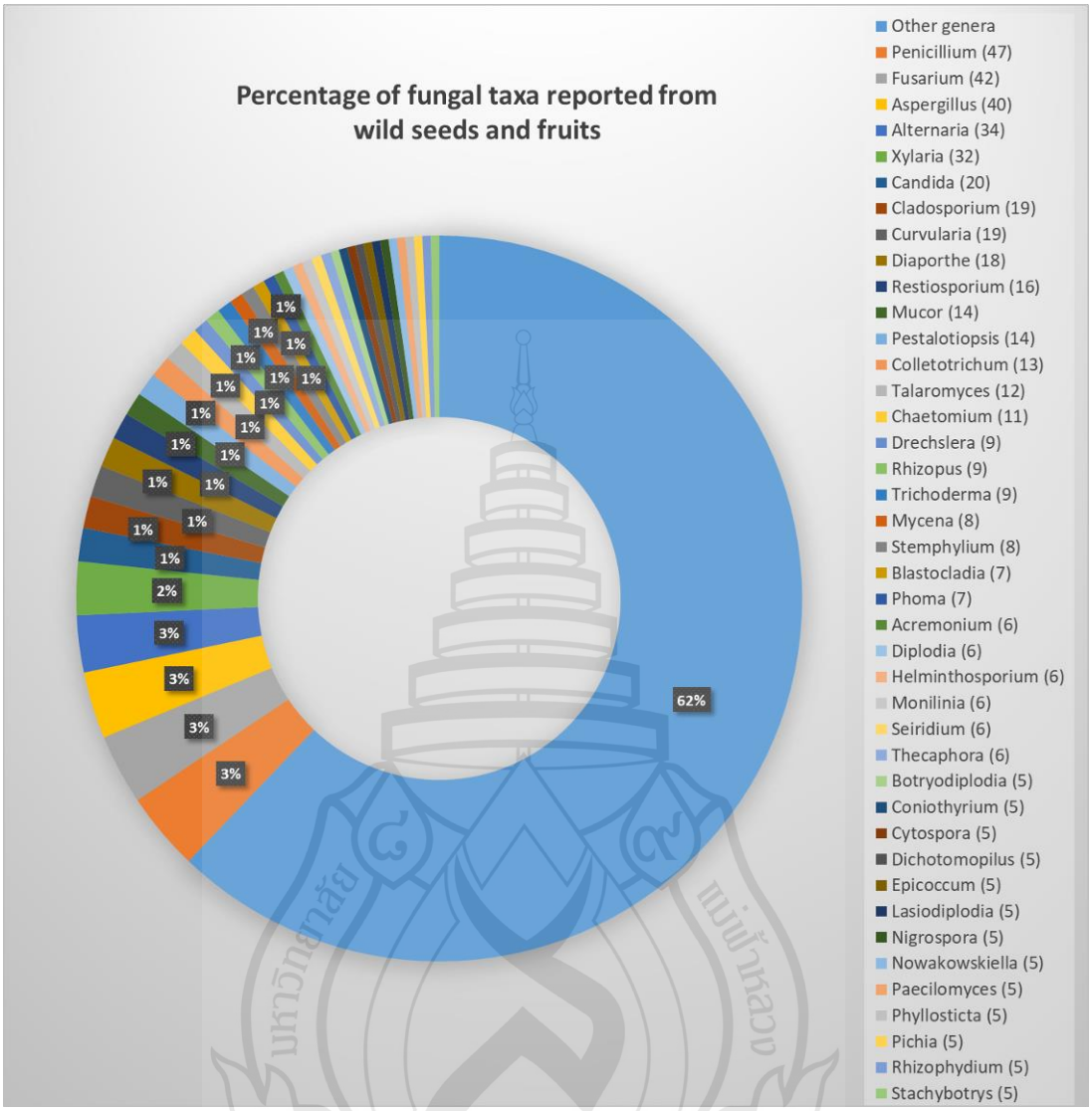


Figure 6.81 Percentage of fungal species in different genera reported from wild seeds and fruits (number of species reported for each genus are given in brackets)

Rust fungi

Rust fungi (Pucciniales, Pucciniomycetes) are biotrophic pathogenic fungi with a narrow host range (Niks, 1987). They are less likely to infect seeds/fruits however, they can also be found from fruits (Walker & van der Merwe, 2009; Berndt, 2011). *Aecidium acanthocarpi* and *Endoraecium kauaianum* were described from fruits of *Acanthocarpus verticillatus* and *Acacia koa*, respectively (Walker & van der Merwe,

2009; Berndt, 2011). We list four rust fungi described from wild seeds/fruits substrates including the above two species (Table 6.2).

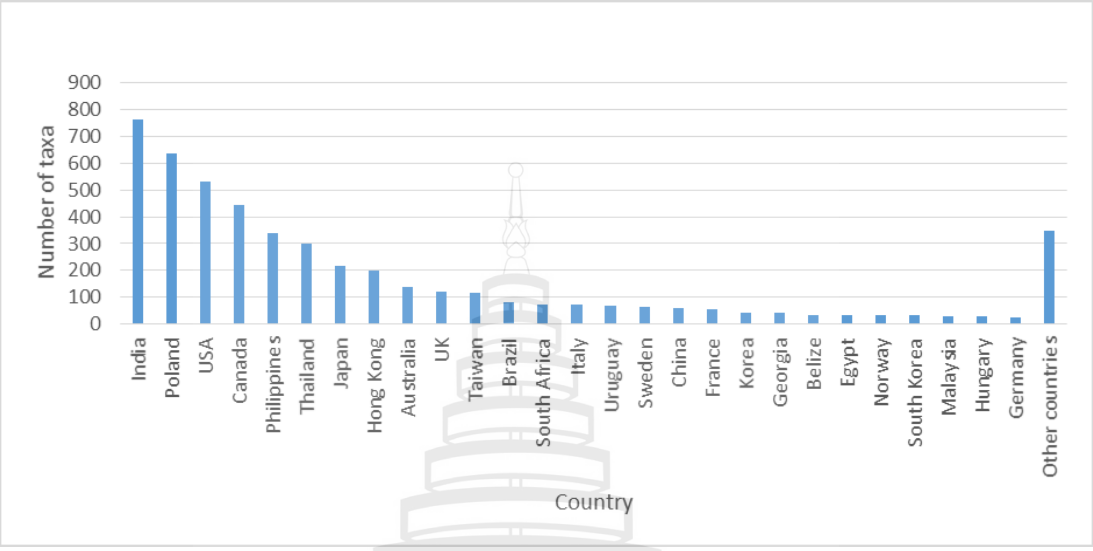


Figure 6.82 Number of wild seeds/fruit inhabiting fungi reported from different countries

Smut fungi

Many smuts produce spores in seeds (Table 6.2). We list 36 new smut fungi reported from wild seed and fruits worldwide (Table 6.2). They belong in Urocystidales, Ustilaginales (Ustilaginomycetes), Microbotryales (Microbotryomycetes) and Tilletiales (Exobasidiomycetes) (Table 6.2). *Centrolepidosporium* was described from fruits of *Centrolepis exserta* in Australia (Shivas & Vánky 2007). Restionaceae plants are the most common hosts for many seed/fruit inhabiting smut fungi, while others were found on Fabaceae, Cyperaceae, Poaceae, Araliaceae, Amaranthaceae, Primulaceae, Hypoxidaceae, Asparagaceae, Asteraceae, Droseraceae, Primulaceae and Montiaceae hosts (Figure 6.84).

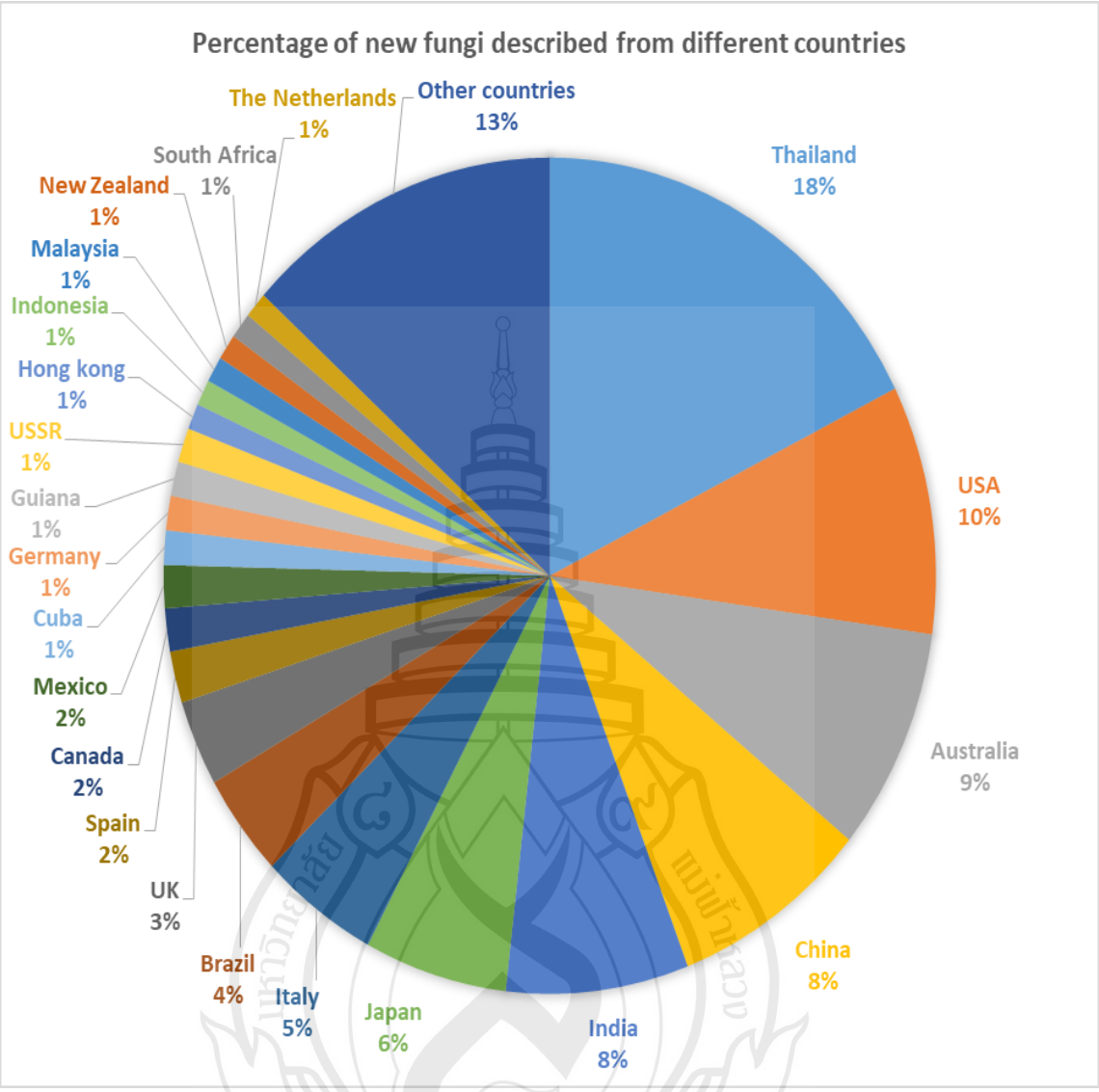


Figure 6.83 Percentage of new seed and fruit fungi described from different countries

Clavicipitaceous fungi

Five new clavicipitaceous parasites have been described from seeds and fruits since 1981 and, three (*Claviceps bothriochloae*, *C. microspora* and *C. panicoidearum*) were from non-commercial grass seeds collected in Japan (Tanda, 1985, 1991; Tanda & Harada, 1989). Generally, clavicipitaceous species have a narrow host range (Rodriguez et al., 2009).

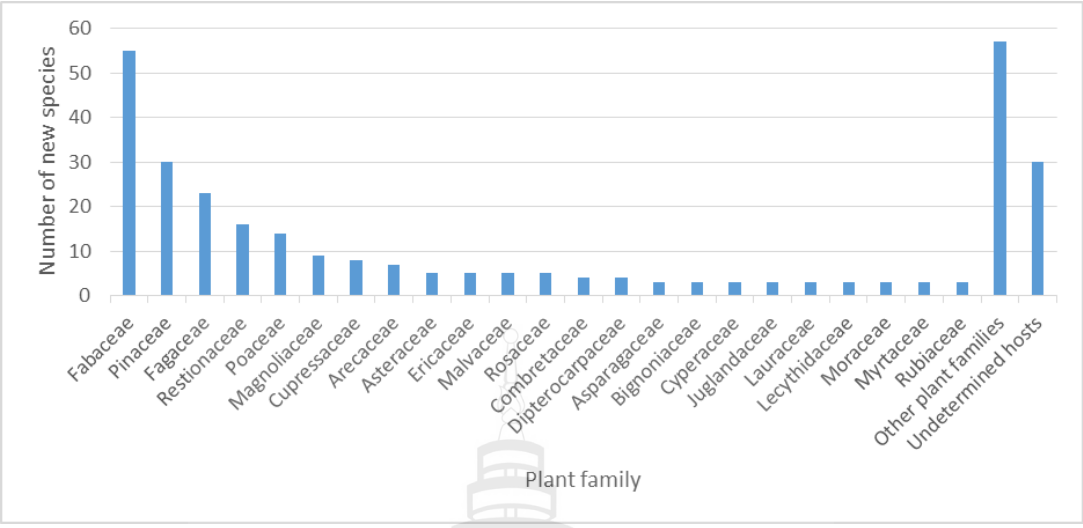


Figure 6.84 Number of new wild seed and fruit fungi reported from different plant host families

Yeasts

We listed 13 new yeast species belonging to 8 genera namely *Candida*, *Cyberlindnera*, *Hanseniaspora*, *Hyphopichia*, *Kuraishia*, *Metschnikowia*, *Saccharomycopsis* and *Wickerhamiella* described from wild seeds and fruits (Table 2). The succession of yeast species colonizing the fallen ripe fruit of amapa (*Parahancornia amapa*) and *Clusia grandiflora* in tropical forests was examined by Morais et al. (1995). Fruits with sugary, soft, fleshy inner layer are prone to yeast colonisation during the first few days of fruit fall (Miller & Phaff, 1962; Morais et al., 1995).

6.5.2 Host-specificity

It has been reported that xylariaceous taxa have specific and distinct relationships with their hosts (Rogers, 1979a, 2000; Laessøe & Lodge, 1994; Ju et al., 2018). Some of the seed/fruit associated species of *Xylaria* appear to be host-specific, as they are restricted to one host species, genus or family (Husbands et al., 2018; Ju et al., 2018). *Xylaria carpophila* occurs only on *Fagus sylvatica* and *X. karyophthora* on *Chlorocardium* and *X. liquidambar* on *Liquidambar* and *X. magnoliae* var. *magnolia* and var. *microspora* on *Magnolia*, and *X. warburgii* on *Sloanea* (Rogers et al., 1992, 2002; Husbands et al., 2018; Ju et al., 2018). *Xylaria palmicola* and *X. rhizocola* are probably

associated only with palm seeds (Ju et al., 2018). In contrast, Ju et al. (2018) collected *X. oxyacanthae* from fruits/seeds of plants in various families, such as *Carpinus* (Betulaceae), *Carya* (Juglandaceae), and *Cornus* (Cornaceae), *Crataegus* (Rosaceae), and *Prunus* (Rosaceae). However, whether seed and fruit fungi are host-specific is doubtful for most species associated with seeds and fruits, especially if they have been collected only once or twice (Ju et al., 2018). There are other species such as *X. clusiae*, *X. duranii*, and *X. heloidea* not only grow on fallen fruits or seeds, but also can be found on fallen leaves as well (Ju et al., 2018). *Xylaria xanthinovelutina* (= *X. ianthino-velutina*), probably the most commonly found fruit inhabiting *Xylaria* species, usually occurs on woody pods of legumes but has also been found on dead woody substrates (Martín, 1970 and Ju et al., 2018). Clavicipitaceous grass fungi are known to be specific at the family level (Petrini, 1996; Zhou & Hyde, 2001). Most *Epichloë* and *Neotyphodium* species are host-specific and show symbiotic relationships with C3 grasses (Bacon & White, editors, 2000).

6.5.3 Production of Bioactive Compounds

Shen et al. (2014) revealed that some wild seed fungi can be potential sources of bioactive compounds and plant defense activators. They screened 49 endophytic fungal strains from seeds of moso bamboo (*Phyllostachys edulis*) in China for production of bioactive substances and identified *Cladosporium* sp., *Curvularia* sp., undefined fungal genus 1, *Penicillium* sp. and *Shiraia* sp. with antimicrobial activity against clinical bacteria and yeasts. *Shiraia* sp. produced hypocrellin which has promising antileishmanial properties (Ma et al., 2004; Shen et al., 2014).

6.5.4 Decomposition of wild seeds and fruits and fungal succession

Decomposition and nutrient cycling play a crucial role in the balance of ecosystems. Saprobic fungi are vital for decomposition and nutrient cycling processes on the forest floor (Somrithipol, Chatmala et al., 2002; Bucher et al., 2004; Fukasawa et al., 2012). Fungi secrete extracellular enzymes and play an important role in decomposition of lignocellulose substrates in forest ecosystems (Pointing et al., 2005; Fukasawa et al. 2012). In forest ecosystems the wild seed/fruit litter (especially the woody seed covering organs) is quantitatively important, since it contributes to total carbon in forest soils (Fukasawa et al., 2012). Mast-seeding (masting), the periodic synchronous production of

seed crops by a plant population (Kelly, 1994), can be observed in many forest tree species (Suzuki et al., 2005) (Figure 60). Mast seeding of *Fagus crenata* (Japanese beech) occurs every 5–7 years (Hiroki & Matsubara, 1995; Suzuki et al., 2005; Fukasawa et al., 2012). Cupules are the second largest component of beech litter and comprises up to 28% of total annual litter fall in mast-seeding years (Kawada & Maruyama, 1986). Pine cones are one component of coniferous litter (Kasai et al., 1995). A study conducted in a coniferous forest (giant sequoia, white fir and sugar pine) in USA revealed 4–10% of the total litter fall was cones (Stohlgren, 1988).

Nutrient rich substrates (cereals, fruits, berries) are usually colonised by rapidly growing asexual filamentous fungi such as *Colletotrichum* spp., *Fusarium* spp., *Diaporthe* spp. (Marasas et al., 1998; Somrithipol, Jones et al., 2002; Torp & Nirenberg, 2004; Prihastuti et al., 2009; Weir et al., 2012; Udayanga et al., 2013; Crous, Schumacher et al., 2015). Woody substrates such as cupules of beech, legume pods, cones and woody seeds are rich in lignin and celluloses and provide substrates for saprobic fungi (eg. *Xylaria carpophila, Pseudohalonectria fagicola, P. hampshirensis* on cupules of *Fagus* spp. and *Thozetella nivea* on seed pods of *Delonix regia* and *Lecanora substrobilina* on cones of *Pinus and Xylaria magnoliae* on magnolia fruits (Rogers, 1979b; Rogers et al., 1992; Printzen, 2001; Somrithipol, Jones et al., 2002; Fukasawa et al. 2012; Perera, Maharachchikumbura, Ariyawansa et al., 2016). Furthermore, all Helotiales sexual morphic taxa collected from wild fruits/seeds are reported from woody substrates (Table 6.2).

The fungal assemblages associated with seeds/fruits, in different stages of decomposition also vary (Somrithipol, Jones et al., 2002; Fukasawa et al., 2012). Fungi with different decay abilities successively colonise fruits/seeds and therefore enhance the decay process and is time dependent (Rayner and Boddy, 1988; Somrithipol, Jones et al., 2002; Fukasawa et al., 2012). Loss of weight as fruits/seeds are decomposed can be observed during the fungal succession process (Somrithipol, Jones et al., 2002; Fukasawa et al., 2012). Few fungal succession studies have focused on seeds and fruits (Carré, 1964; Kuthubutheen, 1984; Somrithipol, Jones et al., 2002; Fukasawa et al., 2012). Fukasawa et al. (2012) studied litter decomposition patterns by fungal colonisers on beech cupules, while Somrithipol, Jones et al. (2002) reported succession on seed pods of *Delonix regia*.

Fukasawa et al. (2012) found that the major and early stage holocellulose decomposers in beech cupule litter are *Xylaria* spp. Xylariaceous taxa are recognised as endophytes of live beech plants (Chapela, 1989; Sahashi et al., 1999; Osono & Mori, 2003) including cupules (Fukasawa et al., 2012). Following the selective holocellulose decay process, acid-unhydrolyzable residues are decomposed by Basidiomycetes that replaced *Xylaria* spp. (Fukasawa et al., 2012). In contrast, fallen fruits of *Delonix regia* were dominated by litter fungi such as *Dictyochaeta*, *Helicosporium*, *Phaeoisaria*, *Phoma* and *Sporoschisma* species (Somrithipol, Jones et al., 2002). Surprisingly, *Aspergillus*, *Chaetomium*, *Penicillium*, and *Rhizopus* species, were the main groups of fungi on *D. regia* seed pods when samples were collected directly from the tree (with no contact with soil). Similar fungi (*Aspergillus niger*, *Aspergillus flavus*, *Penicillium* sp., and *Rhizopus* sp.) were associated with decaying *Artocarpus communis* (breadfruit) kept in storage (Amusa et al., 2002). Kasai et al. (1995) observed that *Xylaria* sp. and *Phomopsis* sp. are frequently associated with *Pinus densiflora* cones when attached to the tree. Conversely *Mortierella* spp. and *Trichoderma* spp. were the early stage decomposers of cones on the ground (Kasai et al., 1995).

Resin acids, an important group of extractives found in conifers, were identified in seed cones of *Picea glauca* and *Pinus* spp. (Hafizoglu and Holmbom, 1987 and Eberhardt et al., 1994). Some of these resin acids can inhibit fungal decay of seed cones of *Pinus* spp. by imparting water repellency or by inhibiting white rot-fungi (Eberhardt et al., 1994). Takahashi et al. (2010) studied the effects of tannin (polyphenolic compounds) content in *Quercus serrata* acorns, on the pathogenic fungus *Ciboria batschiana*. They revealed acorns with higher tannin contents were more resistant to *Ciboria batschiana* infection (Takahashi et al., 2010). Collectively, the determining factors for the fungal community after death of fallen seed/fruit tissues include the size of the tissue, nutrients, secondary metabolites (antimicrobial compounds such as resin acids, polyphenols), contents of the tissues, moisture content, existing endophytic fungi, and also the life cycles of fungal decomposers (Rayner and Boddy, 1988 and Somrithipol, Jones et al., 2002 and Tang, Hyde et al., 2003 and Fukasawa et al., 2012).

Sarmiento et al. (2017) mentioned that communities of fallen seed-associated fungi are structured predominantly by host plant species other than by soil type, forest characteristics, or time in the soil. Carré (1964) indicated that the occurrence pattern of

fruiting bodies of fungi on fallen fruits was mostly affected by the weather rather than accumulation and availability of food materials. However, the pattern of occurrence of fruiting bodies was not considered as a proper index for fungal succession in internal tissues (Rayner and Boddy, 1988 and Fukasawa et al., 2012). Osono (2011) observed that decomposition rate of fungal species was higher in warmer climates than in cooler locations. Tang, Hyde et al. (2003) indicated that the surface area of the fruit does not significantly correlate with the number of fungal species. Tang et al. (2005) also observed less diversity and different groups of fungi occurring on persistent fruits of *Ardisia* spp., *Dichroa febrifuga*, *Sarcandra glabra*, and *Wikstroemia nutans* that cling to the branches and do not drop, when compared to non-persistent fruits.

A study of succession of yeast species colonizing *Parahancornia amapa* fruits found that the common fruit-associated genera *Kloeckera* and *Hanseniaspora* spp., *Candida guilliermondii*, and *Candida krusei* colonised fruits during the first three days after fruit fall (Morais et al., 1995). They also reported that the succession of yeasts species on fallen fruits is determined by both competitive interactions of yeast species (such as production of killer toxins) and the selective dispersion of yeast species by vectors such as *Drosophila* spp.

6.5.5 Effects of Fungi on Seed Germination and Survival of Forest Plants

Biological factors causing mortality of buried seeds in natural forest communities are not widely understood (Blaney and Kotanen, 2001). Few field experiments have addressed this topic although fungi are believed to be most responsible cause of buried seed mortality (Kremer, 1993 and Blaney and Kotanen, 2001). Soil fungi such as *Fusarium* spp., *Lasiodiplodia* spp. and *Trichoderma* spp. infect forest seeds (Gallery et al., 2007 and Sarmiento et al., 2017). Knowledge of host-specific nature of fungi that infect seeds of tropical trees is limited (Gallery et al., 2007 and Sarmiento et al., 2017).

Different assemblages of fungi usually colonise pine cone scales and seeds on the forest floor (Lilja et al., 1995 and Vujanovic et al., 2000). Anderson et al. (1984) reported that some of these fungi destroy embryos and gametophyte tissues of the pine seeds, kill seeds, or damage cones. This damage happens in both mature and premature cones in natural forests and as well as cone collections in storage conditions (Fraedrich and Miller, 1995 and Vujanovic et al., 2000). *Sphaeropsis sapinea* often infects cones and seeds, and

is considered one of the most destructive pathogens of *Pinus* causing die-back and canker diseases (Smith et al., 1996 and Vujanovic et al., 2000).

Note (a–c) *Pinus* spp. (d, e) Unidentified fruits. (f) Fir cone with a bright coloured discomycete. (g, h) *Fagus sylvatica* (h. with a *Xylaria* sp.).

Figure 6.85 Fruits on the forest floor (a, b in Sri Lanka, c, d in Thailand, e Taiwan, f–h UK)

Note (a) *Quercus* fruits on forest floor. (b) Fruits infect by a fungus while still on the palm tree. (c) Fallen *Terminalia catappa* (sea alomond) fruits on forest floor colonised by *Schizophyllum commune*. (d) Close up of *Schizophyllum commune* colonising *Terminalia catappa* fruits. (e) *Fagus sylvatica* (beech) cupules and seeds on forest floor. (f) *Pseudotsuga menziesii* cone.

Figure 6.86 Fruits on the forest floor (a, b, e, f in UK, c, d in Singapore)

Cram and Fraedrich (2010) listed several seed-borne pathogens of coniferous forest trees in North America. *Caloscypha fulgens, Fusarium circinatum, F. oxysporum, F. moniliforme* var. *moniliforme*, *F. proliferatum*, *Lasiodiplodia theobromae*, *Sirococcus conigenus*, *Diplodia pinea* and *Trichothecium roseum* are reported as seed-borne pathogens of *Abies grandis*, *Picea* spp., *Pinus* spp., *Pseudotsuga menziesii*, *Tsuga heterophylla* and are responsible for seed diseases, cotyledon blight, damping-off, shoot dieback, cankers and root rot of coniferous plants in North America (Fraedrich et al., 1994 and Cram and Fraedrich, 2010).

Pathogenic fungi damage fruits/cones, infect seeds, destroy internal tissues, endosperm and the embryo leading to reduction in storage lifespan, seed vigour and seedling germination in forests and nurseries (Anderson et al., 1984 and Cram and Fraedrich, 2010). Moreover, some fungi can weaken and make seeds susceptible to a number of soil-borne pathogens (Mamatha et al., 2000 and Gure, 2004). Mittal and Wang (1987) indicated that saprobic fungi do not affect seed viability or vigor as they colonise dead plant material. However, saprobic fungi also can behave as seed pathogens under some conditions, following seed or seed coat injuries, favorable moisture and temperature conditions in seeds or fruits/cones (Singh and Mittal, 1989 and Gure, 2004). These fungi can impact on the reproduction of forest trees and potentially contribute to maintaining diversity in terrestrial communities (Sarmiento et al., 2017). *In vitro* experiments found that most of the fungi associated with *Quercus* seeds inhibited their germination (Sahai and Otra, 1982). The incubation time period of fungal culture filtrates and different fungal strains have different inhibitory effects on seed germination (Armolik and Dickson, 1956 and Sahai and Otra, 1982). Sahai and Otra (1982) attributed that to the amount of toxin production by fungi in different incubation stages.

Some seed-inhabiting fungi have a positive effect on seed germination. Mittal and Wang (1993) and Gure, Wahlstrom et al. (2005) observed a significant increase in germination in seeds of *Pinus strobus* by *Alternaria alternata*, *Cladosporium cladosporioides*, *Epicoccum purpurascens* and *Mucor hiemalis* and and seeds of *Podocarpus falcatus* by *Diaporthe* sp.

6.5.6 Seed/fruit Fungi Dispersal and Quarantine Aspects

Fruits play an important role in seed dispersal (Tang, Hyde et al., 2003). Various agents are involved in the dispersal of seeds and fruits, such as animals, wind, water, self-dispersal and creeping diaspores (creeping diaspores occur with variation in humidity) (Howe and Smallwood, 1982). Dispersal of seeds/fruits also brings about dispersal of their inhabiting microbes. Infected plant seeds might introduce plant diseases to a new area by long distance dispersal of pathogens (Gure, 2014).

Unintentional or deliberate introduction of fungi through human activities leads to extensive spread of plant diseases, sometimes causing epidemics (Blaney and Kotanen, 2001 and Palm, 2001 and Wingfield et al., 2001 and Desprez-Loustau, 2009). Many plant diseases often emerge during the initial stages of establishment of exotic species (Palm, 2001 and Wingfield et al., 2001 and Desprez-Loustau, 2009). Fungal pathogens are most likely introduced with planting stock, seeds, or cones (Wingfield et al., 2001). Alien fungal invasions through seeds is poorly researched, hence the need for greater future attention (Palm, 2001 and Wingfield et al., 2001 and Desprez-Loustau, 2009). Repeated introductions of *Sphaeropsis sapinea* infected seeds of different pine species from a wide range of countries, apparently explains the high genetic diversity of this fungus in South Africa (Smith et al., 2000 and Wingfield et al., 2001 and Burgess and Wingfield, 2002). Exotic *Pinus* species were introduced to New Zealand with the implementation of afforestation projects at the end of the 19th Century (Burgess and Wingfield, 2002). However, comparatively low genetic diversity of *Sphaeropsis sapinea* was observed in New Zealand as they reduced the import of pine seeds after the local seeds became abundant (Wingfield et al., 2001). The quantity of imported pine seeds to South Africa was higher and it occurred repeatedly over a longer period of time leading to a higher genotypic diversity of *Sphaeropsis sapinea* (Burgess and Wingfield, 2002). Western Australia also imported pine seeds for plantations mostly from other Australian states and New Zealand. Very low genotypic diversity of *Sphaeropsis sapinea* in South and Western Australia was observed due to a small amount of exotic pine seeds importation over a shorter period (Burgess and Wingfield, 2002). Wernham (1942) reported an incident of introduction of *Epichloë typhina* infected seeds of *Festuca rubra* from Hungary to Pennsylvania, USA. Dogwood anthracnose caused by *Discula destructiva* may have entered USA through imported seeds of kousa dogwood (*Cornus kousa*) from Asia

(native region) (Palm, 2001). Pitch canker disease of wild pines (*Pinus radiata*) caused by the seed-borne fungus *Fusarium circinatum* was first discovered in California in 1986 (Dick, 1998 and Gordon, 2006). Infected pinus forestry seeds imported from California are one of the pathways the disease was introduced into North America, New Zealand and many other countries (Dick 1998 and Gordon 2006). The seed-borne fungus *Fusarium subglutinans* f. sp. *pini*, the causative agent of pine pitch canker disease (Dick and Dobbie, 2002), has the potential of becoming a serious threat to *Pinus radiata* plantations if introduced to New Zealand (Storer et al., 1998 and Dick and Dobbie, 2002).

Transmission of diseases through international transport of seeds is of concern and preventive measures are needed (Neergaard, 1977). Hence, quarantine regulations have been introduced by governments to control or prevent the spread of pests and diseases entering through its borders via seeds (Tanner, 1997 and Wingfield et al., 2001 and Sharma and Thakur, 2007). The risk of introducing harmful pathogens through transport of seeds, and the need of take action to overcome these risks must be recognised (Cleary et al., 2013). Even though governments have introduced quarantine regulations, they need the support of the public and industry to fulfill their aims (Wingfield et al., 2001 and Cleary et al., 2013). Morphological and molecular identification of wild seed/fruit fungi and knowledge of the fungal biodiversity will lead to better assessment of risks associated with seed transport and plant diseases. Such databases, as provided in this paper, will be advantageous for effective quarantine decisions and policies in trading agricultural commodities between countries, and in order to safeguard plant resources (Palm, 2001, Burgess and Wingfield, 2002).

6.5.7 Taxonomic Studies of Seed Fruit Fungi

In this study, we introduce two new species of *Thozetella* and *Chaetosphaeria*, and one new record of *Tainosphaeria* for Thailand. Here we illustrate Tainosphaeria siamensis, which is the first record on Fabaceae seed pods. Fungal identifications are based on morphology and analysis of combined LSU, ITS and TUB2 sequence data. *Thozetella fabacearum* is distinct from other *Thozetella* species, since it produces sporodochia on natural substrates and synnemata in vitro on MEA. This has only been observed in *Thozetella tocklaiensis* (Agnihothr.) Piroz. and Hodges (Paulus et al., 2004 and Barbosa et al., 2011). *Chaetosphaeria* species seems to be polyphyletic

within the family, and these finding are similar to those obtained by Jeewon et al. (2009) and Crous et al. (2012) using ITS and LSU sequence data. The generic type strain of *Chaetosphaeria* (*C. innumera*) lacks ex-type sequence data. Therefore, it is essential to re-collect, epitypify (*sensu* Ariyawansa et al., 2014) and sequence the types of genera to resolve the phylogenetic confusion.

The phylogenetic placement of *Liberomyces* was discussed by Pažoutov et al. (2012). They pointed out the possibility of the existence of a new family of Xylariales or even a new related order, that is shown by its sister position to the entire Xylariales clade (Pažoutov et al. 2012). They emphasized the absence of tandem repeats of the CTACCCTGTAG type in the ITS region of *Liberomyces.* Those were found in ITS region of all xylariaceous families (Platas et al., 2001). By considering the molecular data analysis and morphological and life mode resemblance to Xylariales, here we introduce the new order Delonicicolales with a new family *Delonicicolaceae* to accommodate the taxa in the *Liberomyces-Delonicicola* clade. In our analysis, sequence data of *Asteromella pistaciarum* clustered with the *Liberomyces-Delonicicola* clade. A new order Delonicicolales is introduced in this study based on phylogenetic analysis and molecular clock analysis, the latter providing additional support. The use of divergence times as a universal criterion for ranking taxa (temporal banding) was suggested and applied in several recent studies including fungi (Lücking, 2009 and Beimforde et al., 2014 and Phukhamsakda et al., 2016 and Samarakoon et al., 2016 and Hongsanan et al., 2016 and Liu et al., 2017 and Hyde, Maharachchikumbura et al., 2017). The phylogenetic close relation between *Liberomyces* and *Asteromella pistaciarum* was previously shown by Pažoutová et al. (2012) based on ITS sequence data. However, *Asteromella pistaciarum* has smaller conidiomata than *Liberomyces*, viz. 45–90 µm vs. 100–500 µm diam. (Bremer and Petrak 1947 and Pažoutová et al. 2012). Another sequenced *Asteromella* species, *A. tiliae* (CBS 265.94) has been placed in Pleosporales based on LSU/SSU data analysis by de Gruyter et al. (2009), suggesting the genus *Asteromella* is polyphyletic. There is already a family available for *Asteromella* (*Asteromellaceae* Melnik, Mikol. Fitopatol. 20(2): 101 (1986)). The type species of *Asteromella* is however, *Asteromella ovata* Thüm. which was described from a dead leaf of *Acer* sp. (as *pseudoplatani*) collected in Austria and is a coelomycete. There is presently no way to establish if *A. ovata* is related to *A. pistaciarum*. Thus, as the genus is polyphyletic and until the former

species is epitypified and sequenced it is advisable to assume they are unrelated. Therefore, we introduce a new family and order to accommodate our new genus, *Delonicicola*.

Parascedosporium putredinis has been isolated from different countries with different habitats. Strains have been isolated from living plant leaves, seeds of Tectona grandis, other plant debris and soil or dung. In the Center of Excellence in Fungal Research (Mae Fah Luang University), we are investigating diversity of microfungi on wild seeds and fruits in Thailand. However, this is the first record of *P. putredinis* on *Delonix regia* seed pods and first record from Thailand. It is possible that *P. putredinis* is a species complex but this requires further study with more genes. Currently There are only ITS and SSU sequence data available for *P. putredinis* in GenBank. Our study provides additional LSU and TEF1 sequences for future studies.

Species belonging to *Pseudohalonectria* have been recorded from temperate, subtropical and tropical regions (Shearer, 1989 and Hyde et al., 1999 and Kane et al., 2002 and Hyde and Fröhlich, 2003 and Tsui and Hyde, 2004 and Kohlmeyer et al., 2005 and Shenoy et al., 2005). *Pseudohalonectria* species are lignicolous, generally colonizing partially or completely submerged, or water-soaked woody substrates or leaf litter in aquatic habitats, or less commonly in terrestrial habitats (Shearer, 1989 and Hyde et al., 1999 and Kohlmeyer et al., 2005). Only *P. halophila* Kohlm. and Volkm.-Kohlm. has been recorded from marine herbaceous material (Kohlmeyer et al., 2005). Most species of *Pseudohalonectria* are soft-rot degraders of wood (Shearer, 1989 and Kane et al., 2002). *Pseudohalonectria palmicola* K.D. Hyde, Joanne E. Taylor and J. Fröhl. was collected from a dead stem of Calamus in a terrestrial habitat (Hyde et al., 1999). *Pseudohalonectria miscanthicola* Shenoy, Jeewon and K.D. Hyde and *P. tayloriae* K.D. Hyde and J. Fröhl. were also isolated from terrestrial habitats. In our study we have collected two new *Pseudohalonectria* species from the cupules of beech nut (*Fagus sylvatica*) and an unidentified wood in slightly anoxic, stagnant water. Cupules of beech are a woody substrate, rich in lignocellulose and its composition is similar to that of coarse woody debris (Fukasawa et al., 2012). In this study we introduce two new *Pseudohalonectria* species based on analysis of combined LSU, SSU and TEF1 sequence data with support from morphological characters. In our phylogenetic analysis two ex-type strains of

Ophioceras (*O. leptosporum* (CBS 894.70) and *O. chiangdaoense* (CMU26633) clustered distantly from *Ophioceras sensu stricto*. *Pseudohalonectria suthepensis* Promp. was isolated from dead leaves of *Magnolia liliifera* in Thailand (Promputtha et al., 2004). In our phylogenetic analyses of combined LSU, SSU and TEF1 sequenced data, LSU (data not shown) and SSU (data not shown), *P. suthepensis* does not group with other *Pseudohalonectria* species. It clusters in a separate clade in a basal position in the phylogenetic tree within the Magnaporthales, which supports the phylogenetic analysis of Thongkantha et al. (2009) using SSU data. This confirms the opinion expressed by Thongkantha et al. (2009), that *Pseudohalonectria* is polyphyletic. Although it shares morphological characters with *Pseudohalonectria*, some differences can be observed in ascomata and ascospore characters. Ascospores and asci of this species are longer and narrower than those of most *Pseudohalonectri*a species, with the exception of *P. hampshirensis*, *P. falcata* and *P. lutea*. *Pseudohalonectria suthepensis* is characterized by dark brown ascomata. *Pseudohalonectria* species generally have bright yellow to orange brown, membranous ascomata, except for *P. palmicola* and *P. eubenangeensis*, which have dark brown ascomata (Shearer, 1989 and Hyde et al., 1999). Furthermore, in *P. suthepensis*, the outer cell layer of the ascomata is less distinct and fuses with the host, while *Pseudohalonectria* species usually have membranous ascomata (Shearer, 1989 and Cai et al., 2002 and Promputtha et al., 2004). Based on the molecular evidence and morphological differences, we suggest that the *P. suthepensis* should be excluded from *Pseudohalonectria* and introduce a new genus *Tropohalonectria* to accommodate it. Although the dark brown ascomata and longer ascospores of *P. suthepensis* are characteristic of *Ophioceras*, a close relationship between *P. suthepensis* and *Ophioceras* is not supported by molecular data. Therefore *P. suthepensis* is distinct from *Pseudohalonectria* and *Ophioceras*, and is placed in a new genus. Although, only 13 species are recorded for *Pseudohalonectria*, most of the described species lack molecular data in GenBank, since most previous studies were based on morphological observations (Shearer, 1989 and Hyde et al., 1999 and Cai et al., 2002 and Kohlmeyer et al., 2005). Some of the sequences for *P. lignicola* deposited in GenBank are likely to be wrongly named. Therefore, species of *Pseudohalonectria* need to be re-collected, epitypified and sequenced to resolve the

affinities within the genus. *Pseudohalonectria* species form a well-supported clade in the combined LSU, SSU and TEF1 phylogenetic tree, and this might indicate that a new family should be introduced for the genus. However, *Ceratosphaeria lampadophora* and *Tropohalonectria suthepensis* might also need their own families. Although Klaubauf et al. (2014) introduced three families in Magnaporthales, this may have been premature and we prefer to leave the addition of new families until more sequenced taxa become available.

Diaporthe species are plant pathogens, endophytes or saprobes, found on a wide range of hosts (Gomes et al., 2013 and Gao et al., 2014 and Dissanayake, Camporesi, Hyde, Zhang et al., 2017 and Dissanayake, Phillips et al., 2017 and Dissanayake, Zhang et al., 2017). Previously species of this genus were considered as host-specific. However, as the same species can be found on more than one host this is no longer valid (Rehner and Uecker, 1994 and Gomes et al., 2013 and Dissanayake, Phillips et al., 2017). Currently, 171 species of *Diaporthe*, with molecular data, were described from various plant hosts worldwide (Gomes et al., 2013 and Dissanayake, Camporesi, Hyde, Zhang et al., 2017 and Dissanayake, Phillips et al., 2017 and Dissanayake, Zhang et al., 2017 and Gao et al., 2017). However, most old epithets of *Diaporthe* lack molecular data and some morphological descriptions lack informative data (Dayarathne et al., 2016 and Gao et al., 2017, Index Fungorum 2017). Taxonomy of the genus relies largely on molecular phylogenies (Udayanga et al., 2012 and Gomes et al., 2013), as few morphological characters can be used in species delimitation (Sutton, 1980 and Rehner and Uecker, 1994 and Chi et al., 2007 and Hyde et al. 2011 and Dissanayake, Phillips et al., 2017 and Gao et al., 2017). Currently, the pairwise dissimilarities of the internal transcribed spacer (ITS), translation elongation factor 1-α (TEF1), partial beta tubulin (TUB2), histone H3 (HIS3) and calmodulin (CAM) loci are useful when defining a new species (Udayanga et al., 2012 and Gomes et al., 2013 and Jeewon and Hyde, 2016 and Dissanayake, Phillips et al., 2017 and Gao, 2017 and Santos et al., 2017). In Thailand and made several collections of *Diaporthe* from wild fruits such as *Magnolia champaca* and *Senna siamea*. The sexual morph of *D. rosae* were linked to the asexual morphs based on molecular data, and morphological similarity with the asexual morph produced on PDA. The asexual morph of *D. rosae* was previously reported from a dead pedicel of *Rosa* sp. (Rosaceae) from the same location as its sexual morph. The sexual morph is

characterized by 34–46 × 6.7–9 µm asci and 10–12.5 × 2.8–3.6 µm, ellipsoidal ascospores. We also provide LSU, ITS, TUB2 and TEF1 sequence data of *D. rosae* strains which are deposited in GenBank. The molecular analyses were performed in the ARB software environment and the pipeline is provided as supplementary data. There are two strains of *Diaporthe subclavata* available in the GenBank including the ex-type. However, ex-type ZJUD95 and the putative strain of *D. subclavata* (ZJUD83) clustered distantly in our analysis. Isolate ZJUD83 was collected from fruit of *C. maxima* cv. Shatianyou in Guangdong province, China, while the ex-type stain of *D. subclavata* (ZJUD95) was collected from *C. unshiu* in Fujian Province, China (Huang et al., 2015). We delved into pairwise dissimilarities of DNA sequences of both isolates and noted that there are significant differences in ITS, TEF1, TUB2 and CAL gene regions. There are 106 noticeable nucleotide differences including 14 in ITS, 52 in TEF1, 9 in TUB2, and 31 in CAL were observed between *D. subclavata* isolates ZJUD95 and ZJUD83, which means ZJUD83 isolate is probably a different species. However, no morphological descriptions are available for ZJUD83 for the comparison with holotype of *D. subclavata* (Huang et al. 2015). Hence, we would like to acknowledge the importance of a new collection or study of existing herbarium material of ZJUD83 to identify morphological differences and confirm the fact. In the current study, an undescribed species of *Diaporthe* was recognized by DNA sequence analysis, together with morphological characterization of asexual morphic structures.

CHAPTER 7

ADDITIONS TO THE FUNGAL WORLD

7.1 Introduction

We are investigating the microfungi from various substrate and aim of clarifying their taxonomy based on morphology coupled with multi-gene phylogeny. In addition to Sordariomycetes we were able to study some taxa in class Dothideomycetes. Dothideomycetes is the largest class of Ascomycota characterized by ascolocular ascoma development and bitunicate, fissitunicate asci (Hyde et al., 2013). The largest order in this class is Pleosporales (Hyde et al., 2013).

Astrocystis is a genus mostly confined to monocotyledons and has uni- rarely multi-peritheciate stromata, which may develop beneath the host cuticle and appear superficial. The asci have a relatively short stipe and the ascal ring is relatively small, amyloid and stopper-shaped (Smith et al., 2001). The genus *Diplodia* was introduced based on *D. mutila* by Montagne (1834). The genus comprises 31 species with sequence data (Dissanayake et al., 2016). Species of *Diplodia*, are pathogens, endophytes or saprobes on a wide range of woody hosts (Crous et al., 2006; Slippers & Wingfield, 2007; Phillips et al., 2012). Two types of conidia can be observed in *Diplodia* species (Phillips et al., 2005, 2012). Conidia remain hyaline for a long time before they become brown and 1-septate, but in some species, conidia become pigmented before discharge from the conidiomata and mostly remain aseptate (Phillips et al., 2005, 2012). *Lasiodiplodia* comprises 53 species (Dissanayake, Camporesi, Hyde, Yan et al., 2017). Both sexual and asexual morphs have been reported within the genus (Alves et al., 2008). For the species differentiation morphology is not a reliable character and species can be resolved using combined ITS and TEF1 sequence data (Phillips et al., 2013; Slippers et al., 2014). *Camarosporium* was established by Schulzer (1870) based on *Camarosporium*

quaternatum. The genus has been referred to different families for decades (Ariyawansa, Thambugala et al., 2015; Liu et al., 2015; Wijayawardene et al., 2016). Based on multi-gene analysis Wijayawardene, Bhat et al. (2014) placed *Camarosporium* in Pleosporineae, Pleosporales. *Keissleriella* was introduced by Höhnel (1919) to accommodate *Keissleriella aesculi* (*Pyrenochaeta aesculi* Höhn.) as the type. The genus was placed in Lophiostomataceae, Pleosporaceae, Pleosporaceae, Melanommataceae and Massarinaceae by various authors (von Arx & Muller, 1975; Barr, 1990a; Lumbsch & Huhndorf, 2007). Later, Zhang et al. (2009b) accepted *Keissleriella* in Lentitheciaceae, and this has been followed by many authors (Hyde et al., 2013; Tanaka et al., 2015; Wijayawardene, Crous et al., 2014).

De Gruyter et al. (2010) introduced *Neosetophoma* based on a pathogen *N. samararum* causing leaf spots of various plant hosts (Phookamsak et al., 2014). *Neosetophoma garethjonesii* is the first report of the sexual morph of the genus was introduced by Tibpromma et al. (2017).

For the study, specimens were collected from Italy, Russia and Thailand. We present herein comprehensive morphological descriptions and phylogenetic investigation of the new species or new host or geographical records.

7.2 Materials and Methods

7.2.1 Sample Collection, Morphological Studies and Isolation

Specimens were collected from plant substrates in Italy, Thailand and Russia. Macroscopic and microscopic characters of the specimens were observed in the laboratory. Specimens were examined using a Motic dissecting microscope (SMZ 168). Free-hand sections of fungal fruiting bodies were mounted in water, KOH and Melzer's reagents for microscopic studies and photomicrography. Fungal characters were observed with a Nikon Eclipse E600 DIC microscope and images recorded with a Nikon DS-U2 camera. Measurements were made with Tarosoft (R) Image Frame Work software. The images used for photo plates were processed with Adobe Photoshop CS6 portable version software (Adobe Systems, USA). Single ascospore isolations were carried out following the method described in Chomnunti et al. (2014). Germinated ascospores were transferred

individually to PDA or MEA and incubated at 16°C, 25°C or 28°C. Colony characters were observed and colony diameters were recorded.

Herbarium material was preserved in the Mae Fah Luang University (MFLU) herbarium, Chiang Rai, Thailand. Living cultures were stored in the Culture Collection at Mae Fah Luang University (MFLUCC). Facesoffungi and Index Fungorum numbers were registered as outlined in Jayasiri et al. (2015) and Index Fungorum.

7.2.2 DNA Extraction and PCR Amplification

Genomic DNA was extracted from fungal colonies growing on MEA or directly from the fruiting bodies on the natural substrate, using the Ezup DNA Extraction Kit (Sangon Biotech, Shanghai, China) according to the manufacturer's protocol. PCR was performed in a 25 µl reaction volume containing, 12.5 µl 2×PCR Master Mix (TIANGEN Co., China), 9.5 µl ddH2O, 1 µl DNA. DNA was amplified by polymerase chain reaction (PCR). LSU region gene was amplified by using the primer pairs of LR0R and LR5 (Vilgalys & Hester, 1990; Rehner & Samuels, 1994); SSU region was amplified with NS1 and NS4 (White et al., 1990), ITS region was amplified with primers ITS5 and ITS4 (White et al., 1990), TUB2 region was amplified using BT2a and BT2b (Glass & Donaldson, 1995), and TEF1 gene was amplified using the primers EF1-983F and EF1-2218R. PCR was performed in a 25 µl reaction volume containing, 12.5 µl 2×PCR Master Mix (TIANGEN Co., China), 9.5 µl ddH2O, 1 µl DNA. The PCR thermal cycle program of ITS, LSU, SSU, TUB2 and TEF1 were processed initially at 94°C for 3 minutes, followed by 35 cycles of denaturation at 94°C for 30 seconds, annealing at 55°C for 50 seconds, elongation at 72°C for 1 minute and a final extension at 72°C for 10 minutes. Purification and sequencing of PCR products were done by Invitrogen Biotechnology Co. Ltd., Beijing, China.

7.2.3 Phylogenetic Analysis

The sequences obtained in this study were supplemented with the additional sequences retrieved from GenBank. The sequences were aligned using MAFFT v. 7 online server (http://mafft.cbrc.jp/alignment/server/) and, rechecked visually and improved manually using BioEdit v. 7.0.5.2 (Hall, 1999). Ambiguous regions were excluded from the analyses and gaps were treated as missing data.

Phylogenetic analyses were based on Bayesian inference (BI), maximum

likelihood (ML) and maximum parsimony (MP) methods. ML analysis was performed at the CIPRES web portal (Miller et al., 2010) using RAxML v. 8.2.12 as part of the "RAxML-HPC2 on TG" tool (Stamatakis, 2006). BI was performed in MrBayes v. 3.2.0 (Ronquist & Huelsenbeck, 2003). MP analysis was performed using PAUP (Phylogenetic Analysis Using Parsimony) v.4.0b10 (Swofford, 2002). The trees were inferred using the heuristic search option with 1000 random taxa additions and tree bisection and reconnection (TBR) as the branch-swapping algorithm.

All phylogenetic trees were viewed in FigTree version 1.4.0 and modified using Microsoft PowerPoint. Before combining, single gene phylogenetic analyses were conducted for each locus to compare the tree topology and clade stability. The names of the isolates obtained in this study are printed in blue font and names of ex-type and ex-epitype taxa are printed in black bold font in the trees. Maximum likelihood bootstrap support values and Bayesian posterior probabilities are given at the nodes respectively.

7.3 Results and Discussion

7.3.1 Phylogenetic Analysis and Taxonomy

Botryosphaeriales C.L. Schoch, Crous & Shoemaker

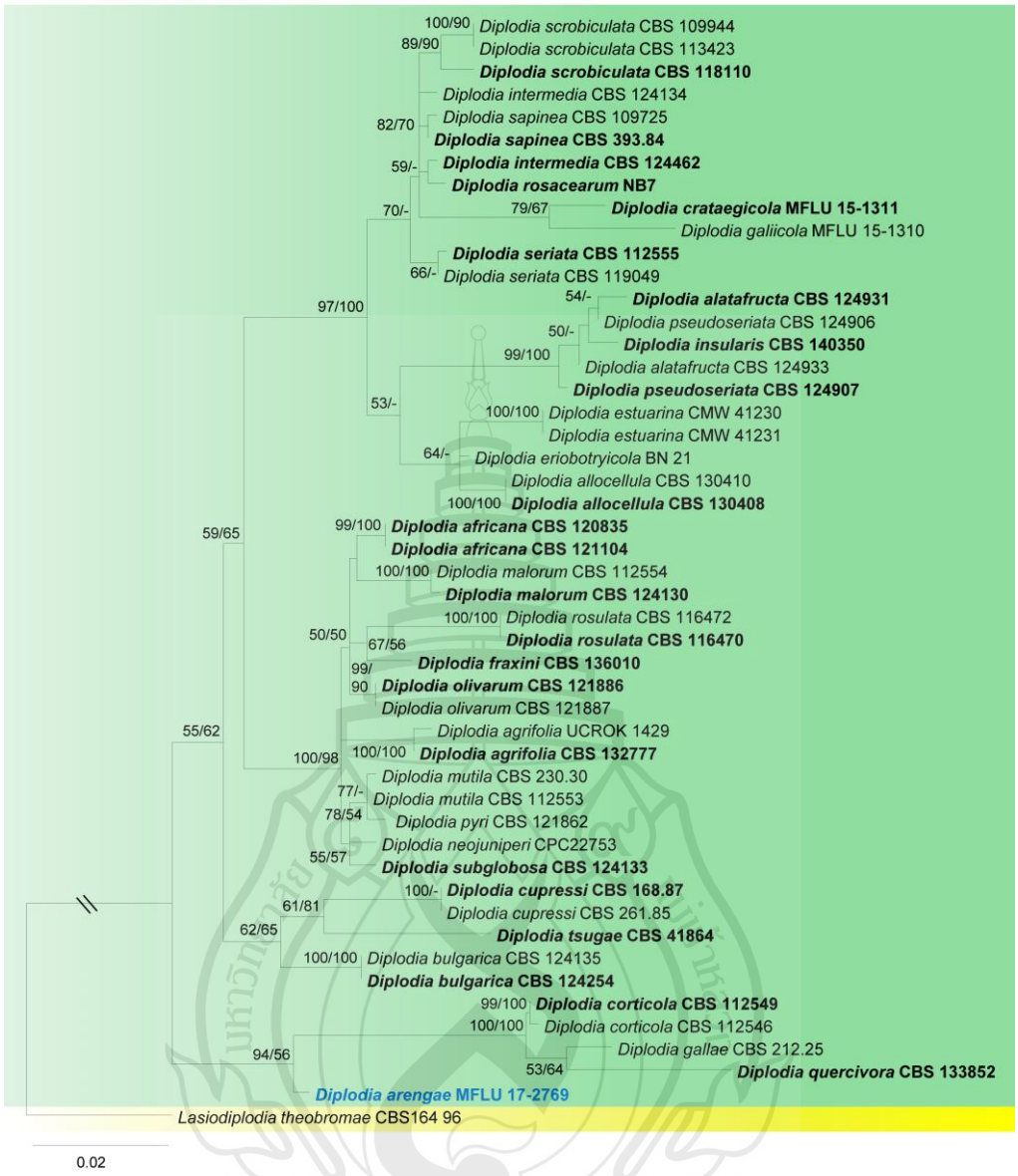
Botryosphaeriaceae Theiss. & Syd.

Diplodia Fr.

Diplodia arengae R.H. Perera, Wanas. & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF554057; Facesoffungi number: FoF03908; Figure 7.2

Etymology: name reflects the host genus *Arenga*.



Note Related sequences were obtained from GenBank. The tree is rooted with *Lasiodiplodia theobromae* (CBS 164.96). RAxML and maximum parsimony bootstrap support values ≥50% (BT) are shown respectively near the nodes. The ex-type strains are in bold and new isolates in blue. The scale bar indicates 0.02 changes.

Figure 7.1 Phylogenetic tree generated by maximum likelihood analysis of combined ITS and TEF1 sequence data of *Diplodia* species

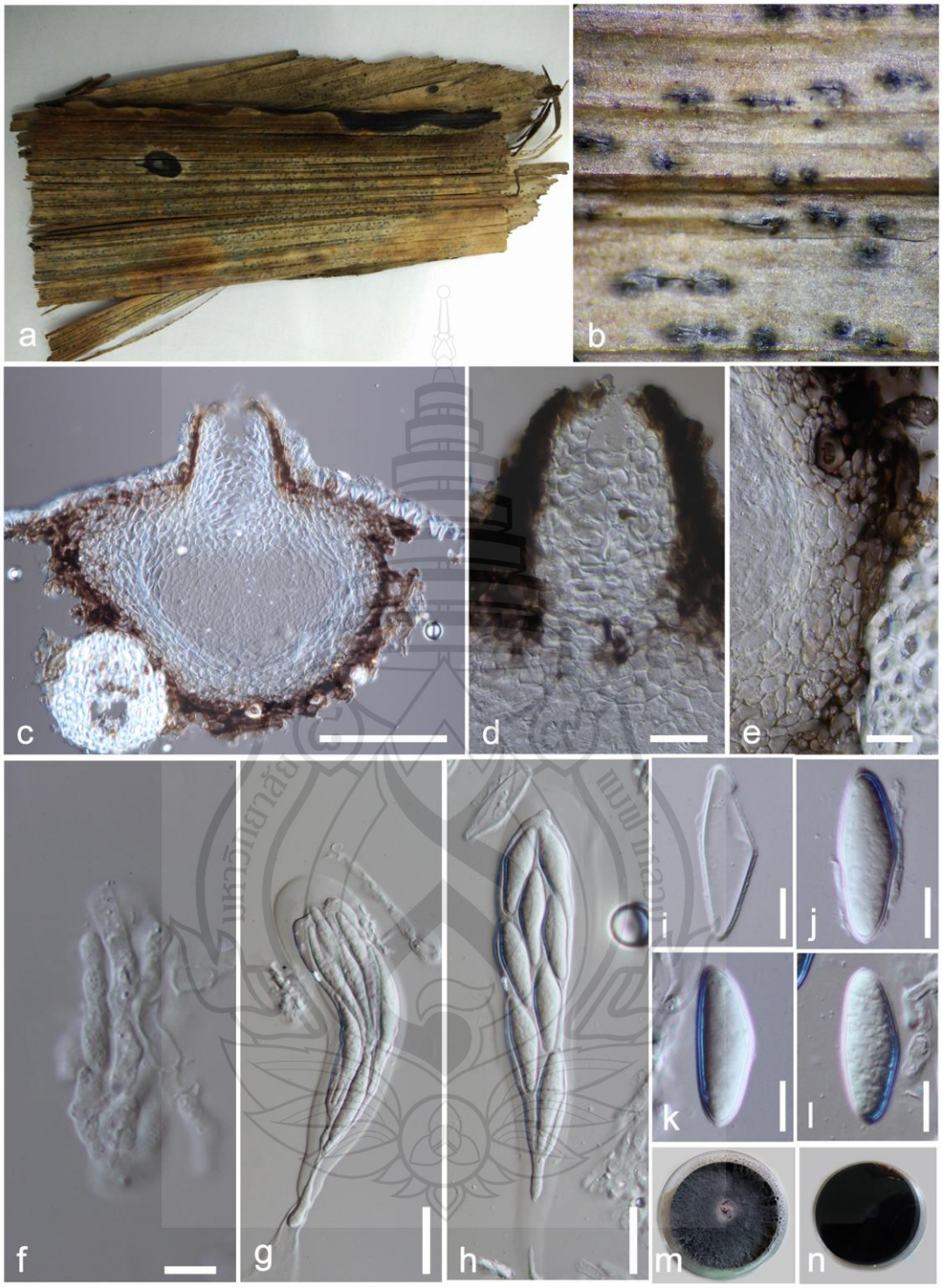
Saprobic on dead leaves of *Arenga hookeriana*. **Sexual morph:** *Ascomata* 240–280 µm high, 250–300 µm diam. ($\bar{x}$ = 262.9 × 271.3 µm, n = 5), scattered, immersed, globose to subglobose, glabrous, brown to dark brown, ostiolate. *Ostiole* 60–90 µm long 55–75 µm diameter, short papillate, black, smooth, filled with hyaline cells. *Peridium* 30–40 µm wide at the base, 35–60 µm wide at the sides, comprising 4–5 layers, outer layer pigmented, comprising reddish-brown to dark brown, thin-walled cells of *textura angularis*, inner layer composed of hyaline, thin-walled cells of *textura angularis*. *Hamathecium* comprising numerous, 3.5–4.5 µm wide, filamentous, branched, septate, pseudoparaphyses. *Asci* 130–160 × 25–35 µm ($\bar{x}$ = 144.6 × 30.5 µm, n = 30), 8-spored, bitunicate, fissitunicate, cylindric-clavate to clavate, with a pedicel 20– 30 µm long, apically rounded, with broad ocular chamber. *Ascospores* 25–35 × 10–12 µm ($\bar{x}$ = 30.8 × 11.3 µm, n = 40), overlapping biseriate to triseriate, ellipsoidal, hyaline, aseptate, smooth-walled, guttulate, ends remaining cone-shaped, with pointed ends, not surrounded by a mucilaginous sheath. **Asexual morph:** Undetermined.

Culture characteristics: Colonies on PDA reaching 3 cm diameter after 30 days at 25°C, circular, smooth margin white at first, dark coffee after 4 weeks, flat on the surface, without aerial mycelium, reverse black. Hyphae septate branched, hyaline, thin, smooth-walled. We could not manage to maintain a living culture as subsequent attempts to subculture failed and hence a living culture is unavailable.

Material examined: CHINA, Mengla, Menglun, Xishuangbanna Tropical Botanical Garden, on dead leaf of Arenga hookeriana (Arecaceae), 21 December 2013, D.N. Wanasinghe, XTBG28 (MFLU 17-2769, holotype).

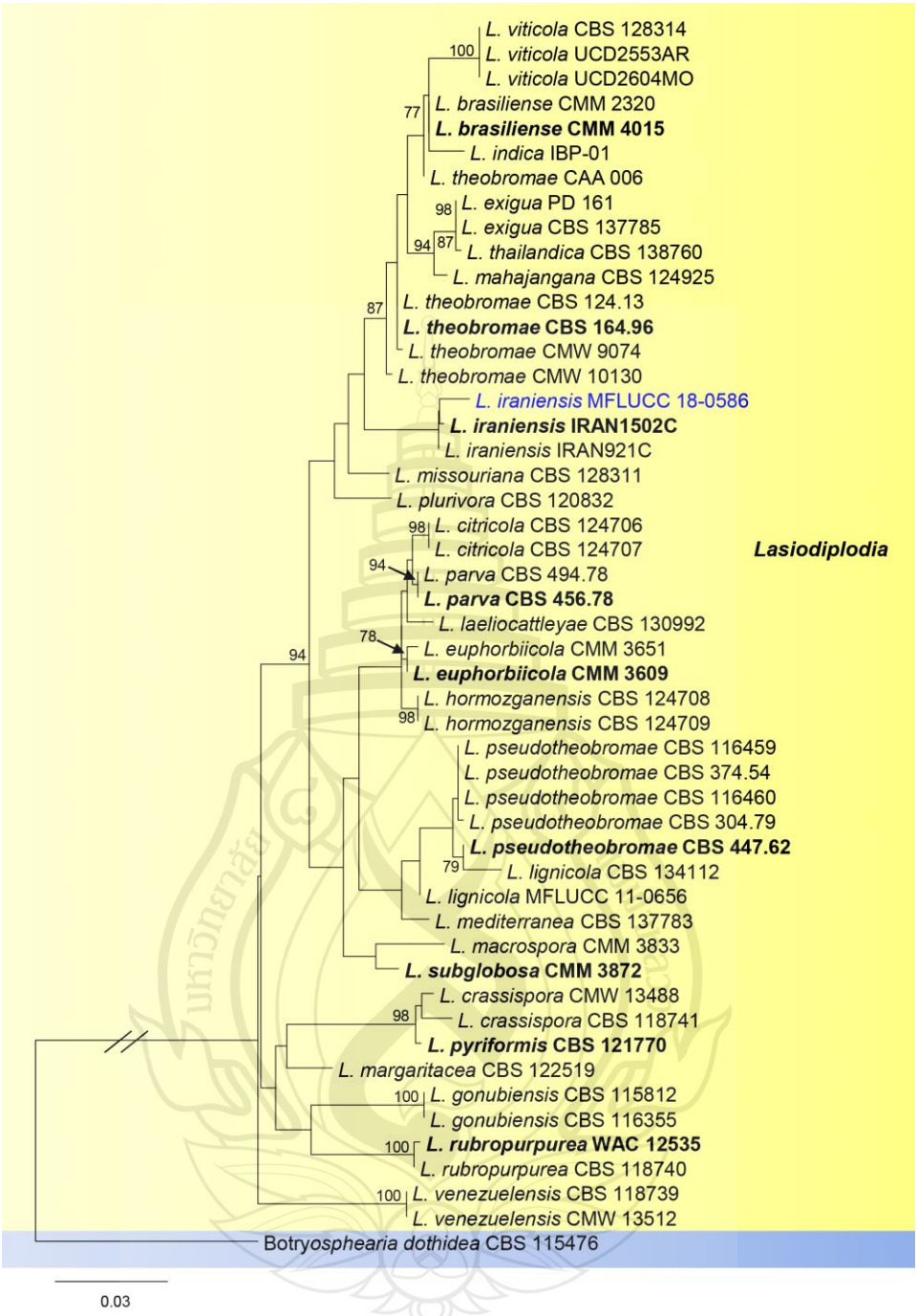
GenBank numbers: TUB2: MG783039, ITS: MG762771, LSU: MG762772, SSU: MG762773, TEF1: MG762774.

Notes: *Diplodia arengae* forms a well-supported independent lineage sister to *D. corticola*, *D. gallae* and *D. quercivora*. *Diplodia arengae* differs from *D. corticola* by possessing unilocular, smaller ascomata (vs. multiloculate, 1 mm diameter), longer asci (vs. 160–250 µm) and narrower ascospores (vs. 14.6–15.3 µm) (Alves et al., 2004). There is no sexual morph reported for *D. quercivora* for morphological comparison with *D. arengae* (Linaldeddu et al., 2013; Phillips et al., 2013). However, those two species are phylogenetically distant in our analysis (Figure 7.1).



Note (a, b) Appearance of ascomata on dead leaf of *Arenga hookeriana*. (c) Section of ascoma. (d) Close up of ostiole. (e) Peridium. (f) Pseudoparaphyses. (g, h) Asci. (i–l) Ascospores. Scale bars: c = 100 µm, d, e, g, h = 20 µm, f, i–l = 10 µm.

Figure 7.2 *Diplodia arengae* (MFLU 17-2769, holotype)



Note Maximum likelihood bootstrap values ≥75% (MLBT) are given near the nodes. Tree is rooted to *Botryosphearia dothidea* CBS 115476. The ex-type strains are in bold. The newly generated sequence is indicated blue.

Figure 7.3 Phylogram generated from maximum parsimony analysis based on combined ITS and TEF1 sequence data for *Lasiodiplodia*

Lasiodiplodia Ellis & Everh.

Lasiodiplodia iraniensis Abdollahz., Zare & A.J.L. Phillips [as 'iranensis'], Persoonia 25: 8 (2010)

Facesoffungi number: FoF 04922, Figure 7.4

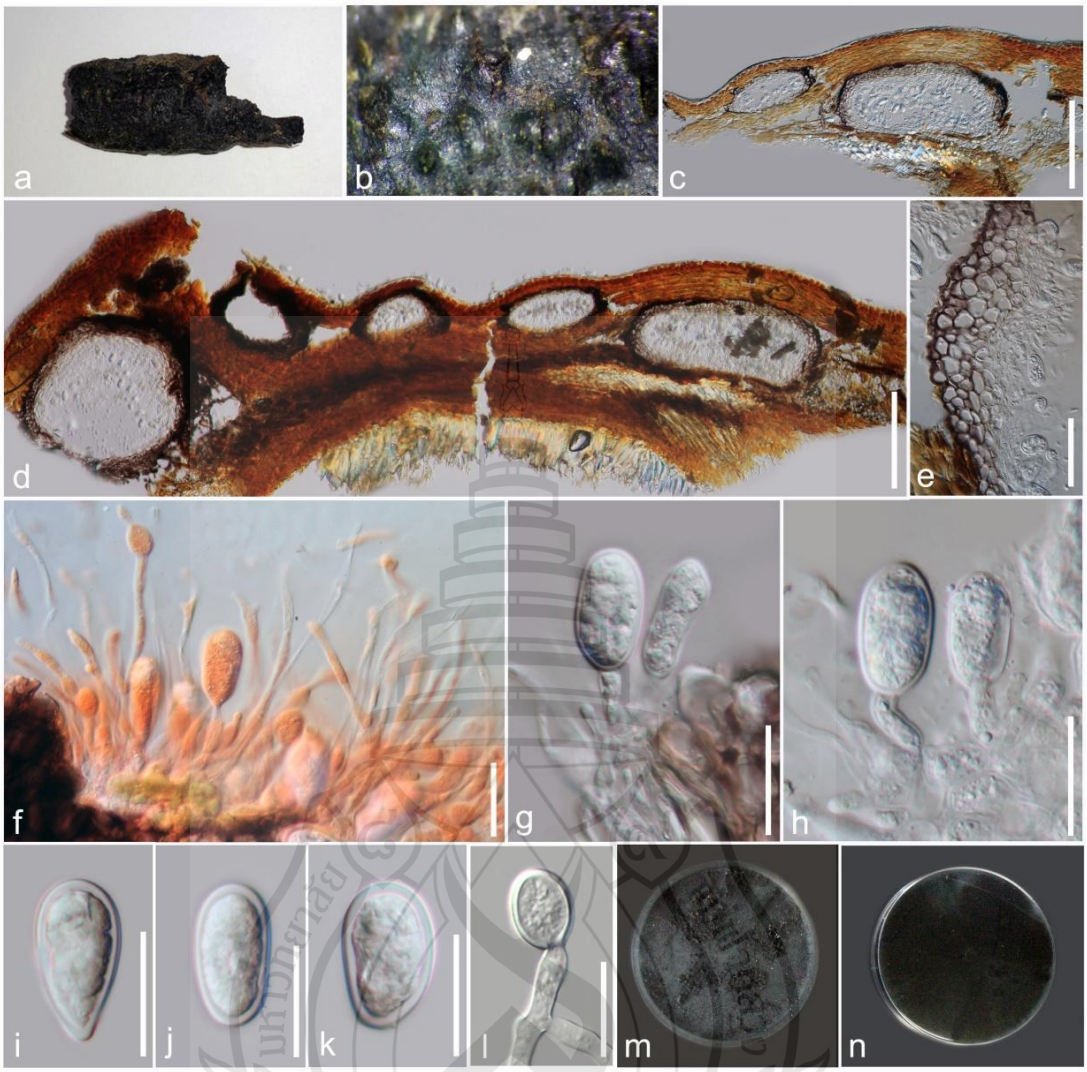
Saprobic on dried pods of *Cassia* sp. **Sexual morph:** Undetermined. **Asexual morph:** Appearing as raised spots on the host. Coelomycetous. *Conidiomata* 210–405 µm high × 90–336 µm diam. ($\bar{x}$ = 283 × 194 µm, n = 10), stromatic, pycnidial, immersed, aggregated, unilocular, globose to depressed globose. *Peridium* 20–55 µm wide, composed of 3–6 layers of pale brown to brown, smooth-walled cells of *textura angularis*. *Pseudoparaphyses* 2.1–3.9 µm wide, aseptate, hyaline. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* 10–22 × 3–6.3 µm ($\bar{x}$ = 13 × 4.4 µm, n = 20), lining the pycnidial cavity, holoblastic, subcylindrical, hyaline, smooth-walled. *Conidia* 14–28 × 8–14.5 µm ($\bar{x}$ = 22.5 × 12, n = 25) ovoid, rarely subovoid to ellipsoid-ovoid, with a broadly rounded apex and truncate base, hyaline, thick-walled, smooth-walled.

Culture characteristics: Colonies on PDA reaching 55 mm diam. after 7 days at 25°C, circular, smooth margin, white at first, ash to greenish black after 2 weeks, flat on the surface, with aerial mycelium, reverse black.

Material examined: THAILAND, Chiang Rai Province, on dried pods of *Cassia* sp. (Fabaceae), 22 December 2016, R.H. Perera, RHP 37 (MFLU 17-2847), living culture (MFLUCC 18-0586).

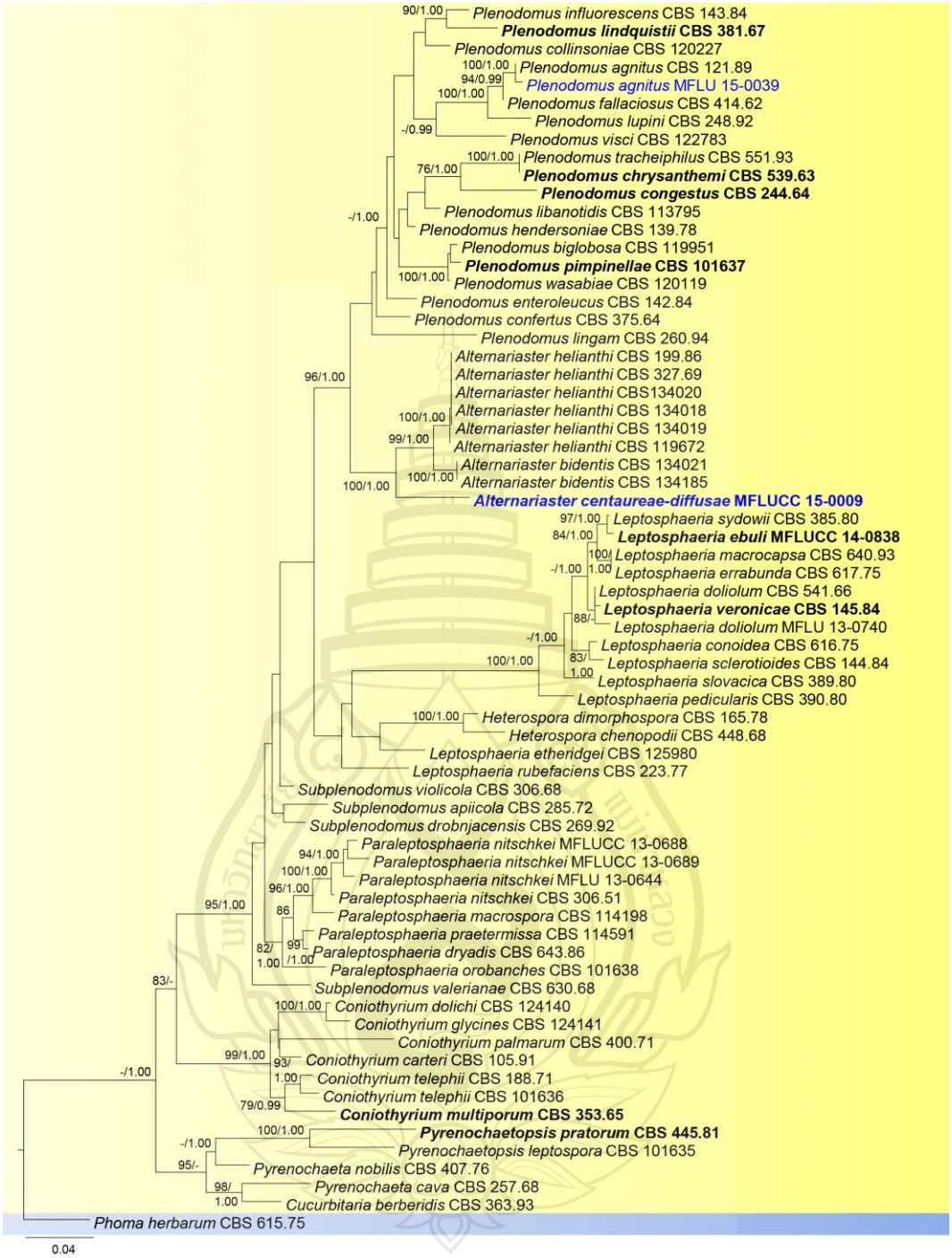
GenBank numbers: LSU: MH107832, ITS: MH107831, TEF1: MH107833, TUB2: MH107834.

Notes: The new collection is a typical *Lasiodiplodia* species, and it shares the similar morphology with *Lasiodiplodia iraniensis* which the dimensions of their conidiophores and conidia are almost identical (Abdollahzadeh et al., 2010). Conidia of *L. iraniensis* become 1-septate and dark brown with longitudinal striations with the time (Abdollahzadeh et al., 2010). However, we did not observe released mature conidia in our collection. The multi-gene phylogenetic analysis showed that our newly obtained strain (MFLUCC 18-0586) clustered together with *Lasiodiplodia iraniensis* (Figure 7.3). Therefore, we identify our collection as *L. iraniensis* and it is reported here as a new record to Thailand and *Cassia* sp.



Note (a) Herbarium material. (b) Conidiomata on host substrate. (c, d) Sections through conidiomata. (e) Peridium. (f) Paraphyses in Congo red. (g, h) Conidiophores with conidia. (i–k) Conidia. (l) Germinating conidia. (m, n) Colony on PDA. Scale bars: c, d = 200 μm, e = 50 μm, f–i = 20 μm.

Figure 7.4 *Lasiodiplodia iraniensis* (MFLU 17-2847)



Note Maximum likelihood bootstrap support values ≥75 % are indicated above or below the nodes, and branches. The ex-types in bold and the new isolates are in blue. The tree is rooted with *Phoma herbarum* CBS 615.75.

Figure 7.5 Phylogram generated from Maximum likelihood (RAxML) analysis based on combined LSU and ITS sequence data of Leptosphaeriaceae

Pleosporales Luttr. ex M.E. Barr

Leptosphaeriaceae M.E. Barr

Alternariaster E.G. Simmons

Alternariaster centaureae-diffusae R.H. Perera, Bulgakov, Ariyawansa & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF551462, Facesoffungi number: FoF01155, Figure 7.6

Etymology: The specific epithet centaureae-diffusae is based on the host plant species from which the fungus was isolated.

Saprobic on dead stems of *Centaurea diffusa* Lam. **Sexual morph:** *Ascomata* 170–360 μm high, 146– 290 μm diam., solitary or in groups of 2–10, erumpent through host tissue, semi-immersed or nearly superficial, uniloculate, globose to subglobose, coriaceous, black, ostiolate. *Ostiole* periphysate, papillate, black. *Periphyses* aseptate, wide, with a blunt apex, hyaline. *Peridium* 40–70 μm ($\bar{x}$= 50 μm, n = 10) wide, composed of 5–10 rows of scleroplectenchymatous cells, outer part thin, amorphous and black, central part widest, comprising thick-walled cells of textura globularis, inner layer composed of flattened cells of *textura angularis*. *Hamathecium* comprising 3–4 μm wide, dense, hyaline, distinctly septate, branched, cellular pseudoparaphyses, embedded in a gelatinous matrix. *Asci* 130–170 × 11–13 μm ($\bar{x}$ = 150 × 12 μm, n = 20), 8-spored, bitunicate, fissitunicate, cylindrical to cylindric-subclavate, with a short bulbous pedicel, rounded at the apex. *Ascospores* 76–132 × 2.2– 4 μm ($\bar{x}$= 104 × 3.2 μm, n = 40), fasciculate, filiform, multi-septate, constricted at the apical septum, apical cell swollen, conical, yellowish brown, smooth-walled, with a mucilaginous cap. **Asexual morph:** undetermined.

Material examined: Russia, Rostov region, Shakhty city, 20th anniversary of Red Army urban microdistrict, Solyonaya Balka hollow, steppe on stony slope, on dead stems of *Centaurea diffusa* Lam. (Asteraceae), 17 June 2014, T. Bulgakov, RU-83 (MFLU 15-1521, holotype); *ibid*., (GZAAS, isotype); ex-type living cultures MFLUCC 14-0992.

GenBank numbers: LSU: KT454715, ITS: KT454723, SSU: KT454730

Notes: *Alternariaster centaureae-diffusae* is the first report of a sexual morph in the genus *Alternariaster* and is introduced as a new species based on both morphology and phylogeny. *Alternariaster centaureae-diffusae* forms a robust clade sister to *A.*

bidentis and *A. helianthi* with high bootstrap support (Figure 7.5). *Alternariaster centaureae-diffusae* shares similarities with the family type of Leptosphaeriaceae, *Leptosphaeria doliolum* in having ascomata with a peridium of scleroplectenchymatous cells. *Alternariaster centaureaediffusae* differs from *Leptosphaeria* and other genera in the family in having long filiform, multi-septate ascospores.

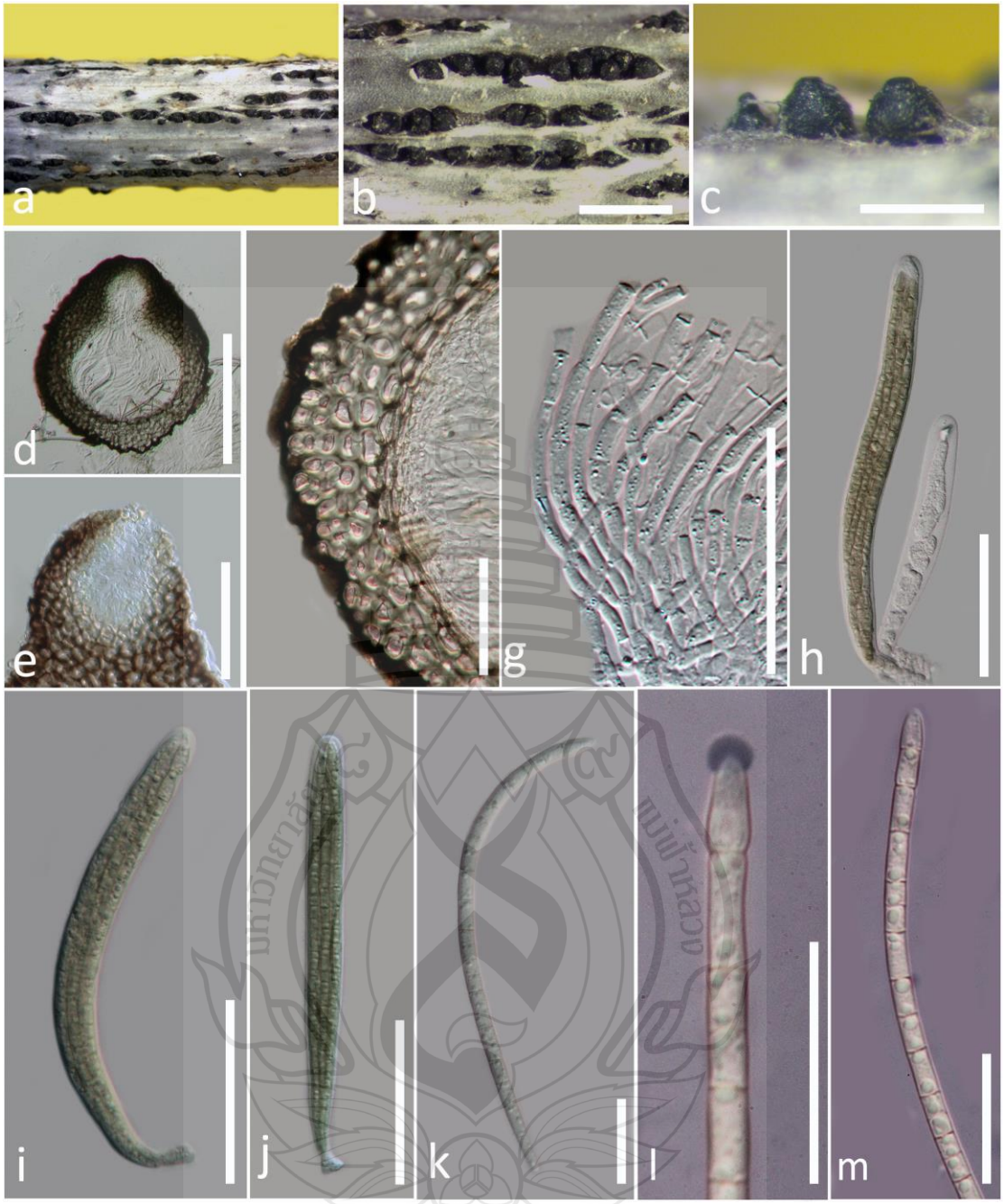
Plenodomus Preuss

Plenodomus agnitus (Desm.) Gruyter et al., Stud. Mycol. 75: 21 (2012)

Facesoffungi number: FoF00411; Figure 7.7

Basionym: *Sphaeria agnita* Desm., Annls Sci. Nat., Bot., sér. 2 15: 18 (1841) ≡ *Leptosphaeria agnita* (Desm.) Ces. & De Not., Comm. Soc. crittog. Ital. 1(4): 236 (1863)

Saprobic on dead stems of *Eupatorium cannabinum*. **Sexual morph:** *Ascomata* 137–250 μm high, 235–453μm diam., solitary, scattered, or in small groups of 1–3, semi-immersed, subglobose to ovoid, with a flattened base, smooth, easily removed from host substrate, black. *Ostiole* papillate, black. *Peridium* 37–107 μm ($\bar{x}$ = 71 μm, n = 10) wide, composed of three layers, externally with a 5–14μm thick layer of dark brown to black, opaque cells, central layer composed of hyaline, small, thick-walled cells of *textura angularis*, inner layer composed of pale brown, *textura prismatica*. *Hamathecium* comprising 1–3μm wide, dense, hyaline, broad, septate, cellular pseudoparaphyses, branching above asci and embedded in gelatinous matrix. *Asci* 66–115 × 7–10 μm ($\bar{x}$ = 94 × 9 μm, n=20), 8-spored, bitunicate, cylindricsubclavate, with a short, furcate pedicel, rounded at the apex. *Ascospores* 26–32 × 3–6μm ($\bar{x}$ = 29 × 4 μm, n=40), overlapping uniseriate, narrowly fusoid with sharp to narrowly rounded ends, 6–8-septate, constricted at third or fourth septum, upper third or fourth cell enlarged, pale yellowish-ash, smooth-walled. **Asexual morph:** Undetermined.



Note (a, b) Appearance of ascomata on host substrate. (c) Vertical section through ascoma. (d) Close-up of the peridium. (e) Cellular pseudoparaphyses (f–h) Immature and mature asci. (i) Ascospore. (j, k) Ascospores in Indian ink. Scale bars: b = 500 µm, c = 200 µm, d– I = 50 µm, j, k = 20 µm.

Figure 7.6 *Alternariaster centaureae-diffusae* (MFLU 15- 1521)

Material examined: GERMANY, Senckenberganlage 25, D-60325 Frankfurt (Main), on dead stem of *Eupatorium cannabinum* L. (Asteraceae), 13 November 2013, H.A. Ariyawansa (MFLU 15-0039, reference specimen designated here). The DNA was extracted from fruiting body.

GenBank numbers: ITS: KP744459; LSU: KP744504.

Notes: *Leptosphaeria agnita* was transferred to *Plenodomus agnitus* by de Gruyter et al. (2013) based on the sequence data. The putative strain of *Plenodomus agnitus* (CBS 121.89) clustered with our new collection from Germany, on dead stem of *Eupatorium cannabinum* (Figure 7.6). Saccardo (1883) originally described *Plenodomus agnitus* as *Leptosphaeria agnita* and mentioned the different hosts including dry stems of *Eupatorium cannabinum* in France, Germany, Britain, Italy and Netherlands. The ascomata, size of asci and ascospores are typical of *P. agnitus* (Saccardo, 1883) and the molecular data is identical to the putatively named CBS 121.89 strain. We therefore designate our collection as a reference specimen (*sensu* Ariyawansa et al., 2014) of *P. agnitus* to stabilize the application of this name.

Camarosporiaceae Wanas., Wijayaw., K.D. Hyde & Crous

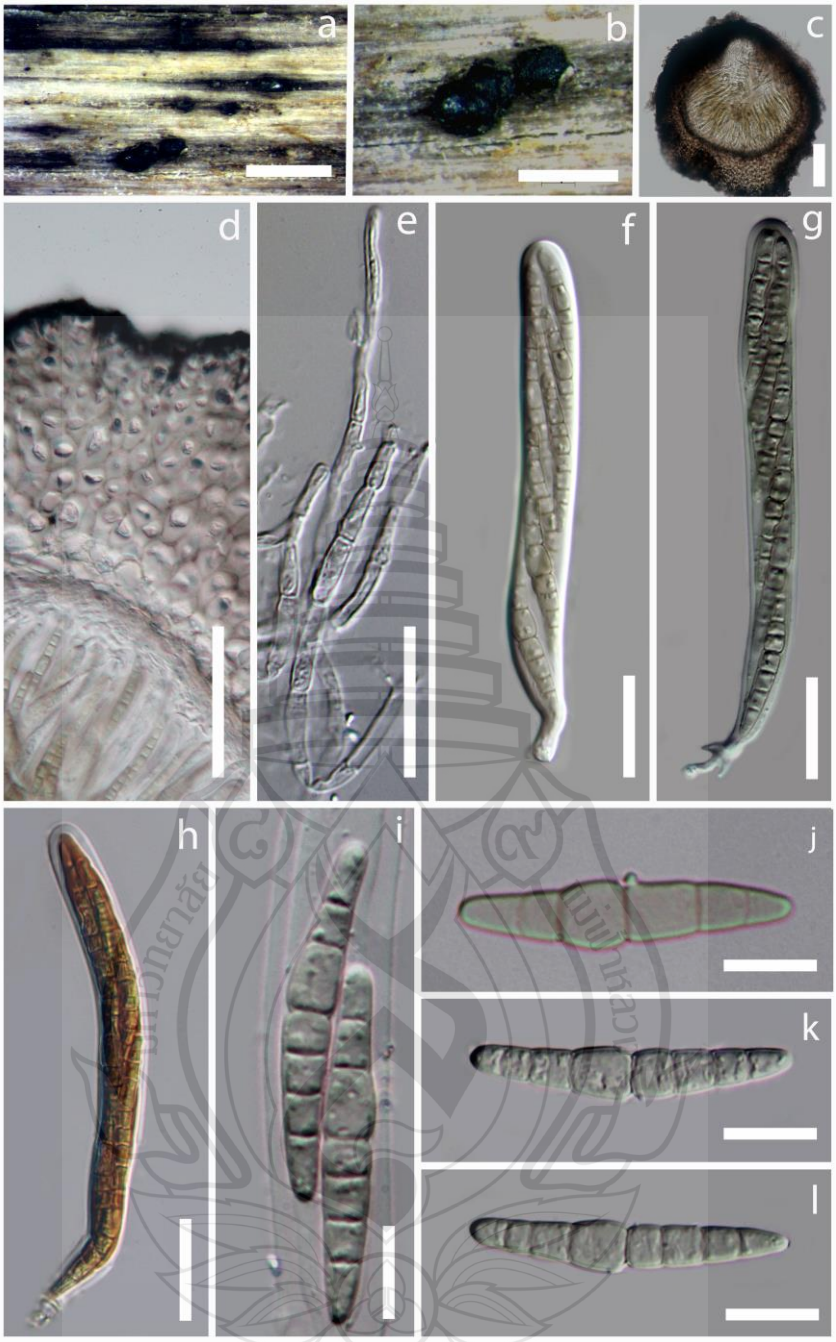
Camarosporium Schulzer

Camarosporium laburnicola R.H. Perera, Bulgakov, & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF552706; Facesoffungi number: FoF 2784; Figure 7.9

Etymology: Named after the host genus on which the fungus occurs.

Saprobic on branches of *Laburnum anagyroides*. **Sexual morph:** *Ascomata* 280–370 µm high, 220–320 µm diam. ($\bar{x}$ = 331.4 × 274.2 µm, n = 5), erumpent through the host epidermis, globose to subglobose or obovoid, solitary or arranged in groups of 2–22, black, *Ostioles* central, short, periphysate. *Periphyses* cellular, aseptate, with a blunt apex, hyaline. *Peridium* 22–69 µm wide, thick, comprising 8–14 layers, outer layer heavily pigmented, thin- walled, comprising dark brown cells of *textura globulosa* to *textura angularis*, inner layer composed of hyaline to brown thin-walled cells of *textura globulosa* to *textura angularis*. *Hamathecium* comprising numerous, 1.1–3.1 µm (n = 30) wide, filamentous, branched, aseptate, pseudoparaphyses.



Note (a, b) Ascomata on host substrate. (c) Vertical section of ascoma. (d) Close up of the peridium. (e) Cellular pseudoparaphyses. (f, g) Asci. (h) Ascus in Melzer's reagent. (i) Ascospores in the ascus. (j–l) Ascospores. Scale bars: a = 1 cm, b = 500µm, c = 100 µm, d = 50 µm, e–h = 20 µm, i–l = 10 µm.

Figure 7.7 *Plenodomus agnitus* (MFLU 15-0039)

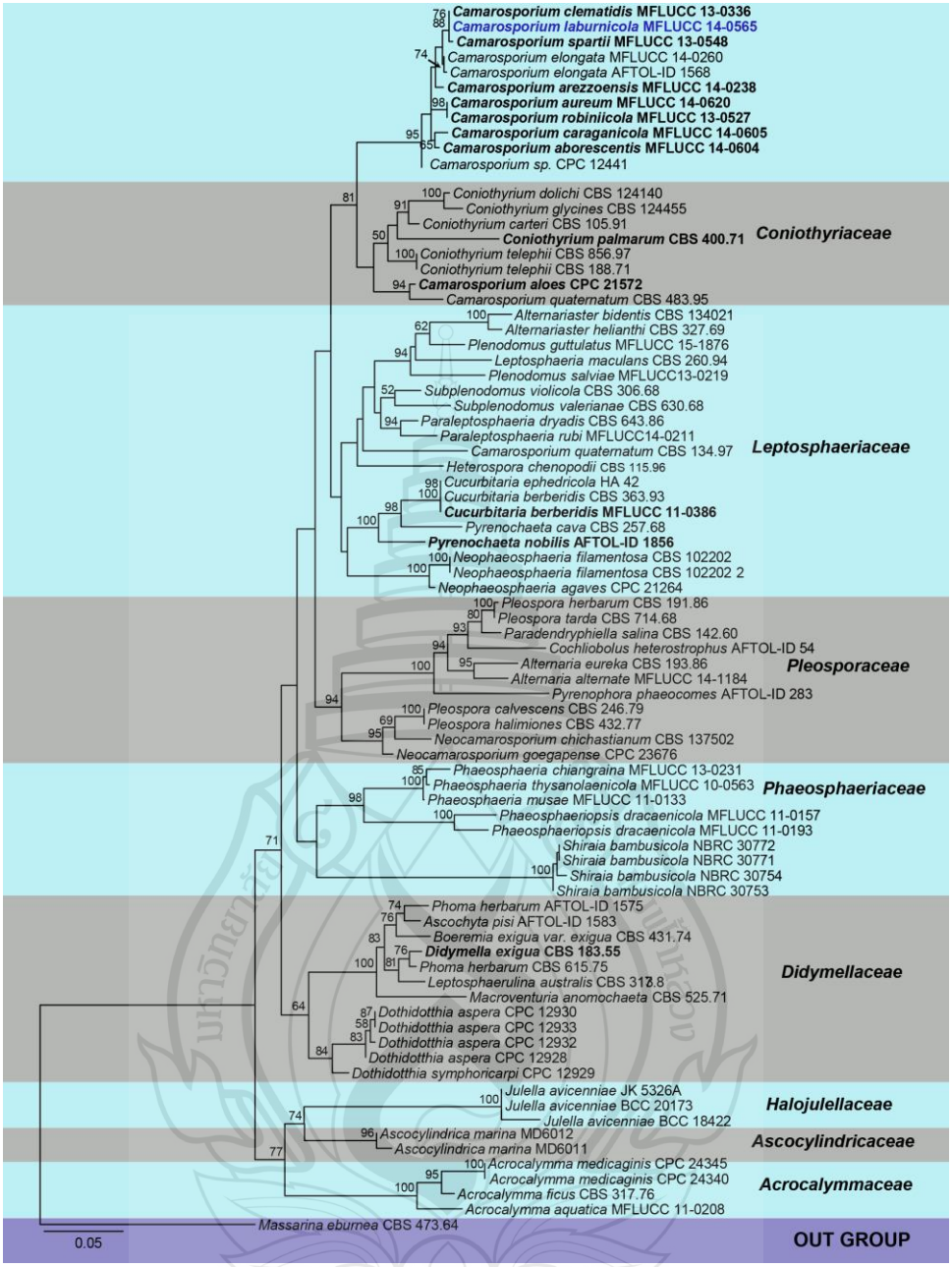
Asci 125–150 × 9–11 µm ($\bar{x}$ = 134 × 9.8 µm, n = 30), 8-spored, bitunicate, fissitunicate, cylindrical, thick-walled at the apex, with a minute ocular chamber. *Ascospores* 15–21 × 6–8 µm ($\bar{x}$ = 17.4 × 6.6 µm, n = 40), uniseriate to overlapping uniseriate, muriform, ellipsoidal, 6–7 transversely septate, with 5–6 vertical septa constricted at the septa, initially hyaline, becoming yellowish-brown at maturity, conical and narrowly rounded at the ends, without a mucilaginous sheath. **Asexual morph:** Undetermined.

Culture characteristics: Colonies on PDA reaching 40–45 mm diam. in 28 days, pinkish-grey, spreading with moderate aerial mycelium, slightly irregular, margins smooth, with underneath pinkish-grey.

Material examined: RUSSIA, Rostov Region, Rostovna-Donu City, Botanical garden of Southern Federal University, Higher Park, dead branches of *Laburnum anagyroides* Medik. (= *Cytisus laburnum* L.), 5 March 2014, T. Bulgakov, T-81 (MFLU 15-1522, holotype; *ibid.* HKAS 89691, isotype); ex-type living culture MFLUCC 14-0565).

GenBank Numbers LSU: KY497779, SSU: KY497781, ITS: KY497784, TEF1: KY497785.

Notes: *Camarosporium uniseriatum* clusters with two coelomycetous species, *C. clematidis* and *C. spartii* with high bootstrap support (Figure 7.8). *Camarosporium uniseriatum*, *C. elongatum* and *C. arezzoensis*, are the sexual morphs reported for the genus *Camarosporium* (Mirza, 1968; Hyde et al., 2013; Tibpromma et al., 2016; Thambugala et al., 2016). *Camarosporium laburnicola* differs from *C. elongatum* and *C. arezzoensis* in having smaller asci and ascospore with a different number of longitudinal and transverse septa.



Note Maximum likelihood and parsimony bootstrap support values >50% are indicated near the nodes, and branches with Bayesian posterior probabilities >0.95 are given in bold. The ex-types are in bold and newly introduced species are in blue. The tree is rooted with *Pyrenochaeta lycopersici* (CBS 306.65). The scale bar indicates 0.01 changes.

Figure 7.8 Maximum likelihood tree based on combined LSU, SSU and ITS sequenced data of *Camarosporium sensu stricto*

Even though asci and ascospore sizes overlap, *C. laburnicola* can be distinguished from *C. uniseriatum* which has 3–5 transverse septa and 1–2(–3) longitudinal septa; (Thambugala et al., 2016). However, there are three coelomycetous *Camarosporium* species (i.e. *C. cytisi*, *C. laburni*, *C. laburnicum*) reported from the same host (*Laburnum* spp.) for which molecular data are unavailable (Saccardo, 1882, 1892).

Lentitheciaceae Y. Zhang ter, C.L. Schoch, J. Fourn., Crous & K.D. Hyde

Keissleriella Höhn.

Keissleriella cirsii R.H. Perera, Bulgakov, Wanasinghe & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF552705; Facesoffungi number: FoF 2767; Figure 7.11

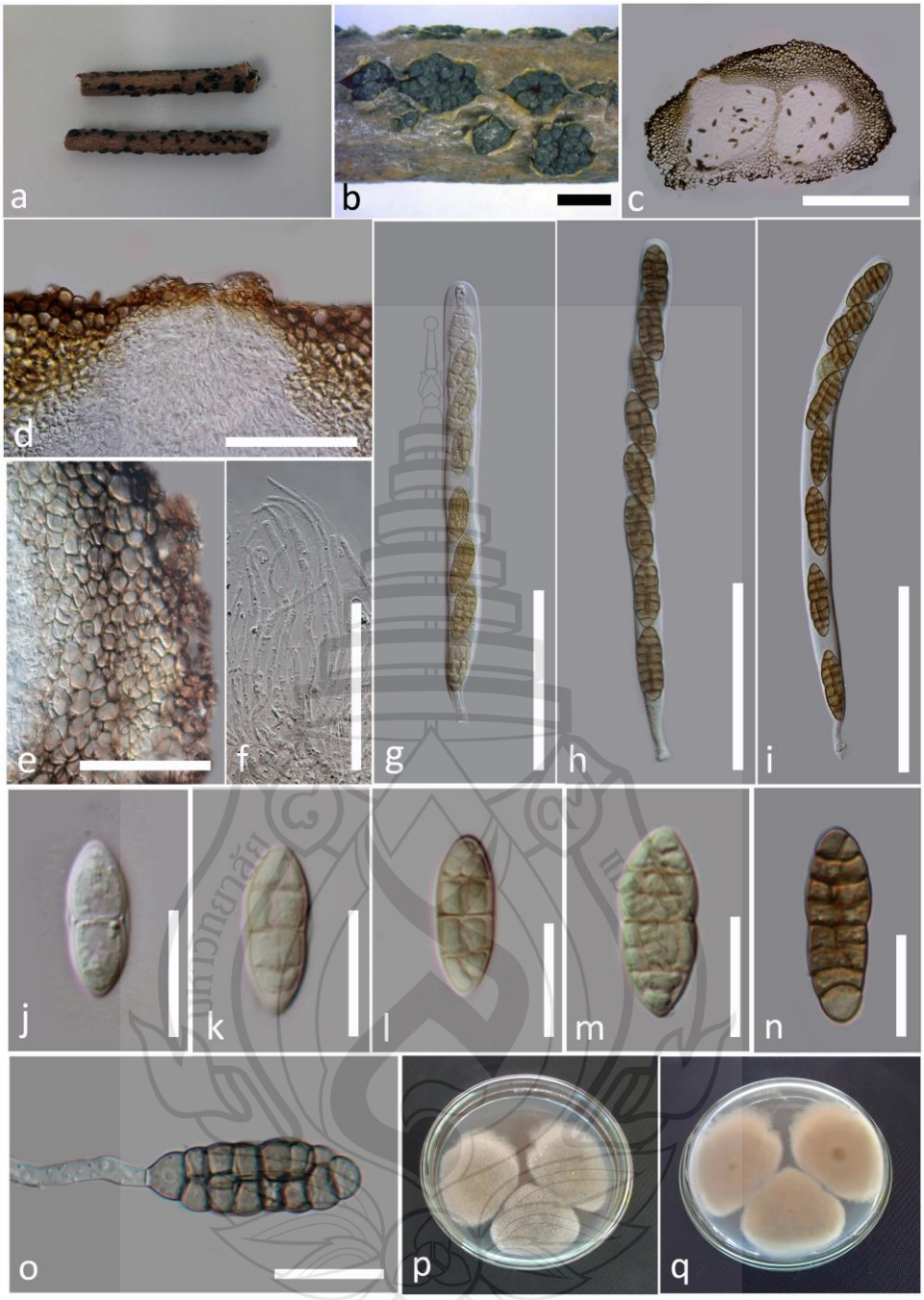
Etymology: Named after the host genus.

Saprobic on *Cirsium* sp. **Sexual morph:** *Ascomata* 245– 370 µm high, 180–368 µm diam. ($\bar{x}$ = 285 × 255 µm, n = 10), semi-immersed, appearing as black raised spots on the host, solitary, globose to subglobose, wall black, uniloculate, black, ostiolate. *Ostioles* with dark brown to black setae, *Peridium* 30–67 µm wide, composed of 4–6 layers of pale brown to brown cells of *textura angularis*. *Hamathecium* comprising numerous, 1.5–2.2 lm (n = 25) wide, filamentous, branched, septate, pseudoparaphyses. *Asci* 110–147 9 6–8.5 µm ($\bar{x}$ = 130 9 8 µm, n = 30), 8- spored, bitunicate, clavate, with a short furcate pedicel, rounded at the apex. *Ascospores* 23.5–29 × 5–7 µm ($\bar{x}$ = 27 × 6 µm, n = 40), uniseriate to biseriate, fusiform, 3–5-septate, constricted at the septa, hyaline, inequilateral, with a mucilaginous sheath. **Asexual morph:** Undetermined.

Culture characteristics: Colonies on PDA reaching 50–55 mm diam. in 21 days, white, spreading, with moderate aerial mycelium, slightly irregular, with smooth margins.

Material examined: RUSSIA, Voronezh Oblast, Lysogorka, on stems of *Cirsium vulgare* (Savi) Ten., 25 July 2015, T. Bulgakov, T 755 (MFLU 15-2900, holotype); extype living cultures MFLUCC 16-0454, MFLUCC 16-0455.

GenBank numbers: MFLUCC 16-0454: LSU: KY497780, SSU: KY497782, ITS: KY497783, TEF1: KY497786, RPB2: KY497787.



Note (a, b) Appearance of ascomata on host substrate. (c) Vertical section through ascomata. (d) Close up of ostiole. (e) Close up of the peridium. (f) Pseudoparaphyses. (g–i) Immature and mature asci. (j–n) Immature and mature ascospores. (o) Germinating ascospore. (p, q) Colonies on MEA. Scale bars b = 2 cm, b = 200 µm, d–i = 50 µm, j–o = 10 µm.

Figure 7.9 *Camarosporium laburnicola* (MFLU 15-1522, holotype)

Notes: *Keissleriella cirsii* is typical of *Keissleriella* in its ostiolar neck covered by short dark setae (Munk, 1953; Tanaka et al., 2015). *Keissleriella cirsii* is a distinct species in the genus, supported by molecular and morphological characteristics. *Keissleriella cirsii* clustered as sister to *K. taminensis* with 100% bootstrap support (Figure 7.10). *Keissleriella cirsii* differs from *K. taminensis* in having larger ascomata and ascospores with fewer longitudinal septa (3–4 vs. 4–5) (Tanaka et al., 2015).

Phaeosphaeriaceae M.E. Barr

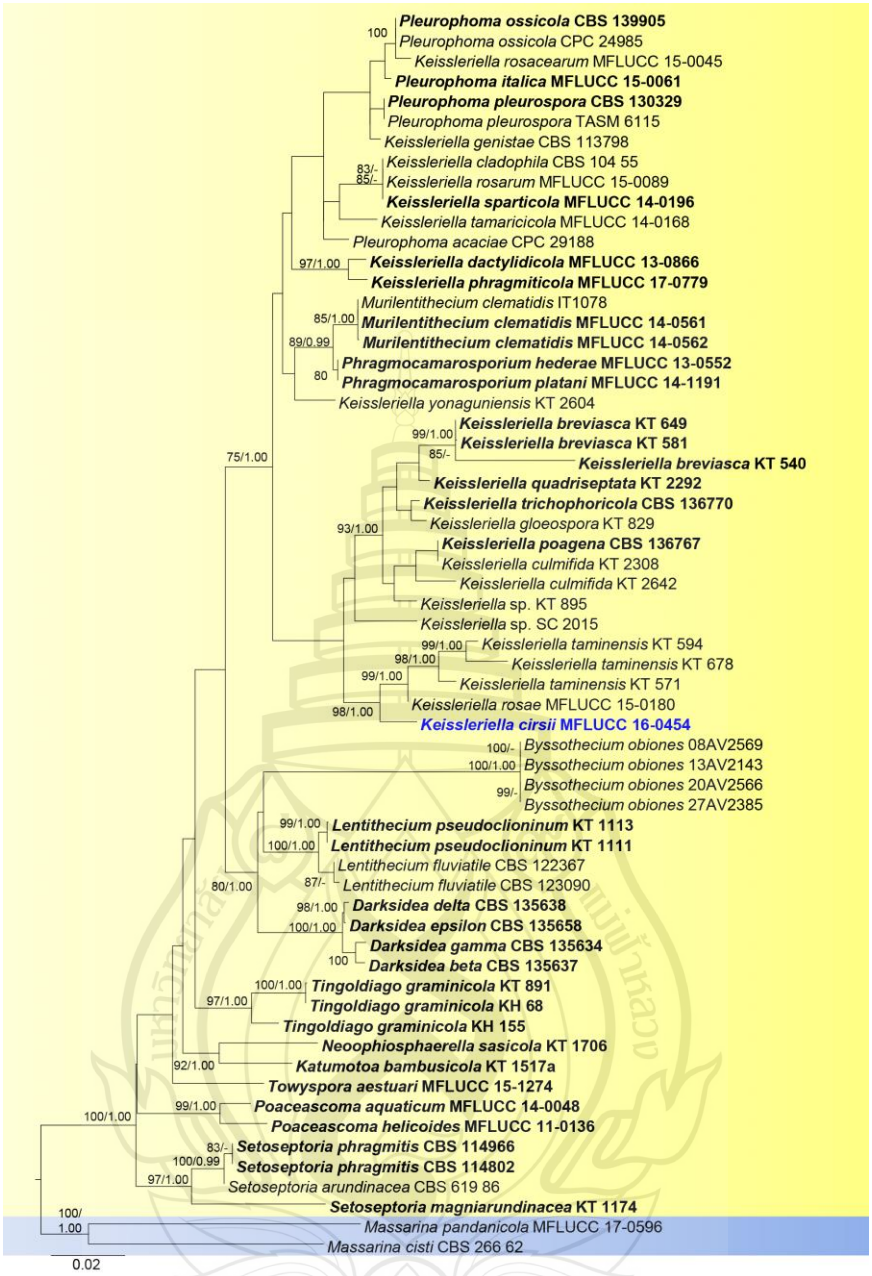
Neosetophoma Gruyter, Aveskamp & Verkley

Neosetophoma rosarum R.H. Perera, Wanas., Camporesi & K.D. Hyde, ***sp. nov.***

Index Fungorum number: IF553965; Facesoffungi number: FoF 04027, Figure 7.13

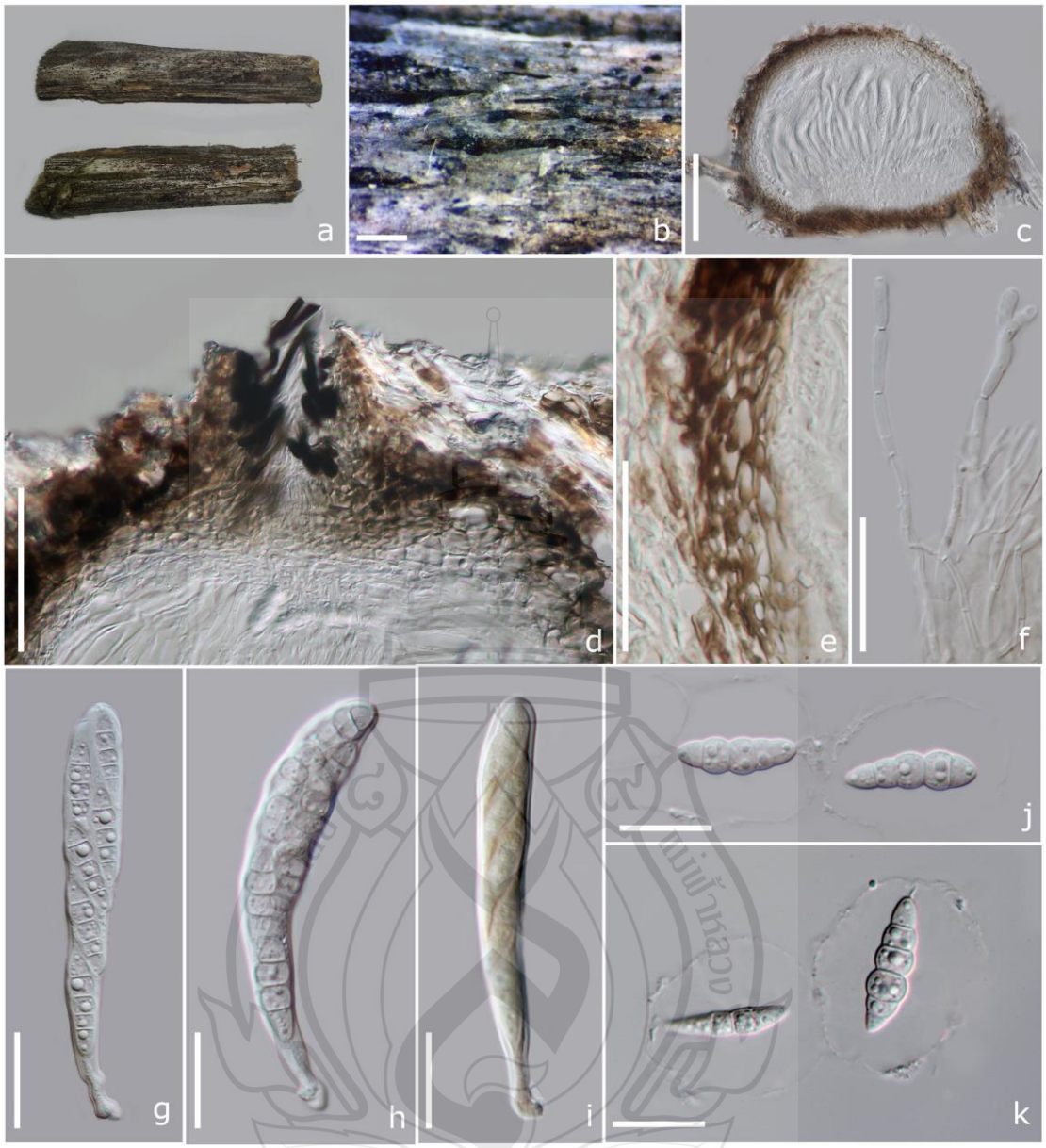
Etymology: The specific epithet reflects the host genus Rosa

Saprobic on *Rosa canina*. **Sexual morph:** Undetermined. **Asexual morph:** *Conidiomata* 66–120 µm diam., 55–100 µm high, pycnidial, immersed, globose to subglobose, black, gregarious, unilocular, but occasionally multilocular, ostiolate. *Peridium* 6–10 lm wide, comprising thick-walled, brown to dark brown cells of *textura angularis*, inner layer comprising hyaline cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* 4.6–6 × 3–3.4 µm, lining the inner cavity of the conidiomata, doliiform to ampulliform, simple, integrated, enteroblastic, phialidic, hyaline, smoothwalled. *Conidia* 5.6–8.2 × 1.6–2.3 µm ($\bar{x}$ = 7.1 × 1.8 µm, n = 25), pale brown, straight to curved, subcylindrical, apex obtusely rounded, with a bluntly rounded to truncate base, 1(2,3)-euseptate, smooth-walled, thick-walled, guttulate.



Note Maximum likelihood bootstrap support values ≥75% and Bayesian posterior probabilities ≥0.99 are given near the nodes. The ex-types are in bold and newly introduced species are in blue. The tree is rooted to *Massarina cisti* and *M. pandanicola* in Massarinaceae. The scale bar indicates 0.02 changes.

Figure 7.10 Maximum likelihood tree based on combined LSU, SSU, ITS and TEF1 sequences of Lentitheciaceae



Note (a) Type material. (b) Appearance of ascomata immersed in host substrate. (c) Section through ascoma. (d) Section through ostiole with internal setae. (e) Close up of the peridium. (f) Pseudoparaphyses. (g, h) Asci. (i) Ascus in Melzer's reagent. (j, k) Ascospores. Scale bars b = 500 µm, c = 100 µm, d = 50 µm, e, f = 10 µm, g–k = 20 µm.

Figure 7.11 *Keissleriella cirsii* (MFLU 15-2900, holotype)

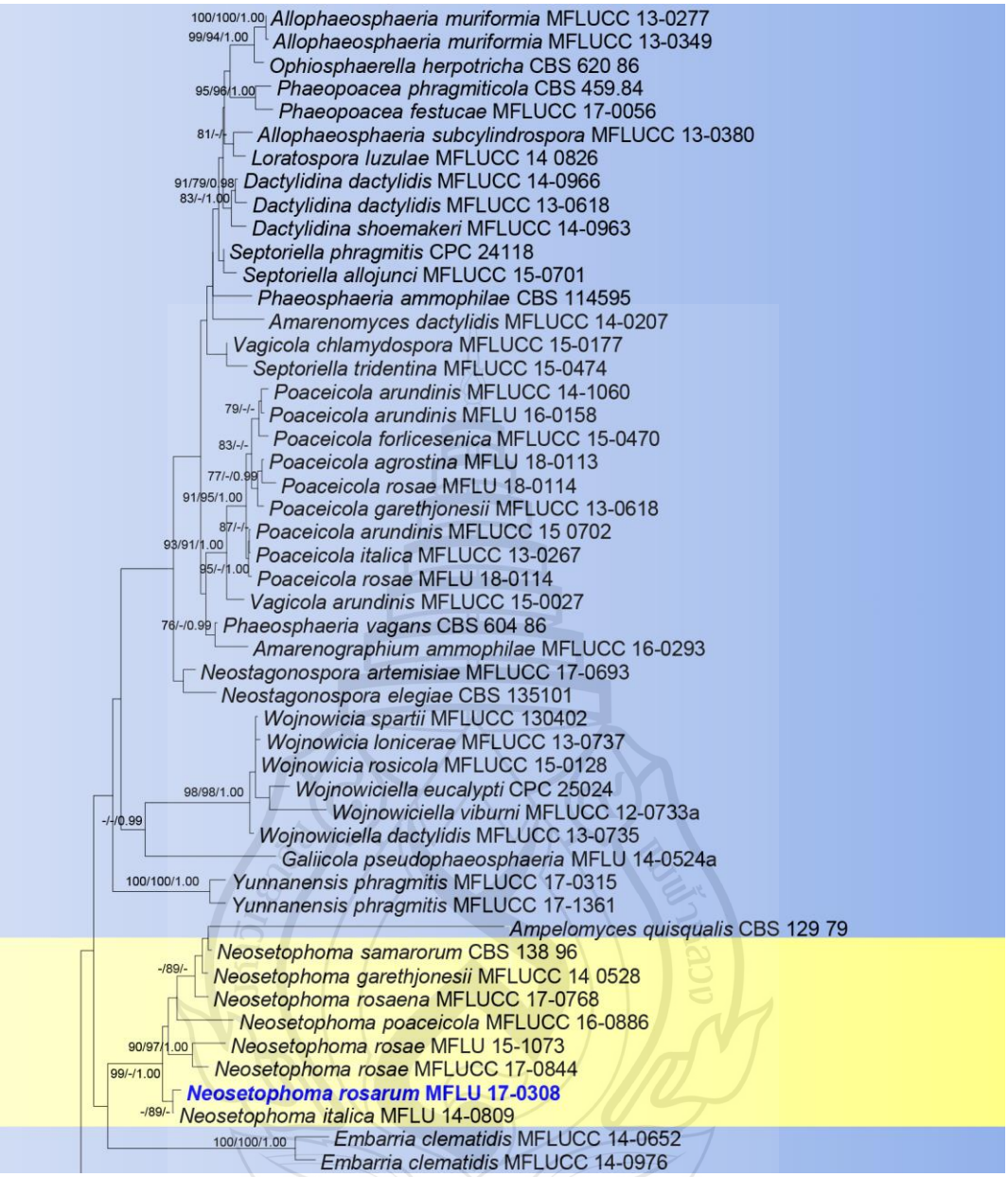


Figure 7.12 Phylogram generated from maximum likelihood analysis based on combined LSU, SSU, ITS and TEF1 sequenced data of Phaeosphaeriaceae

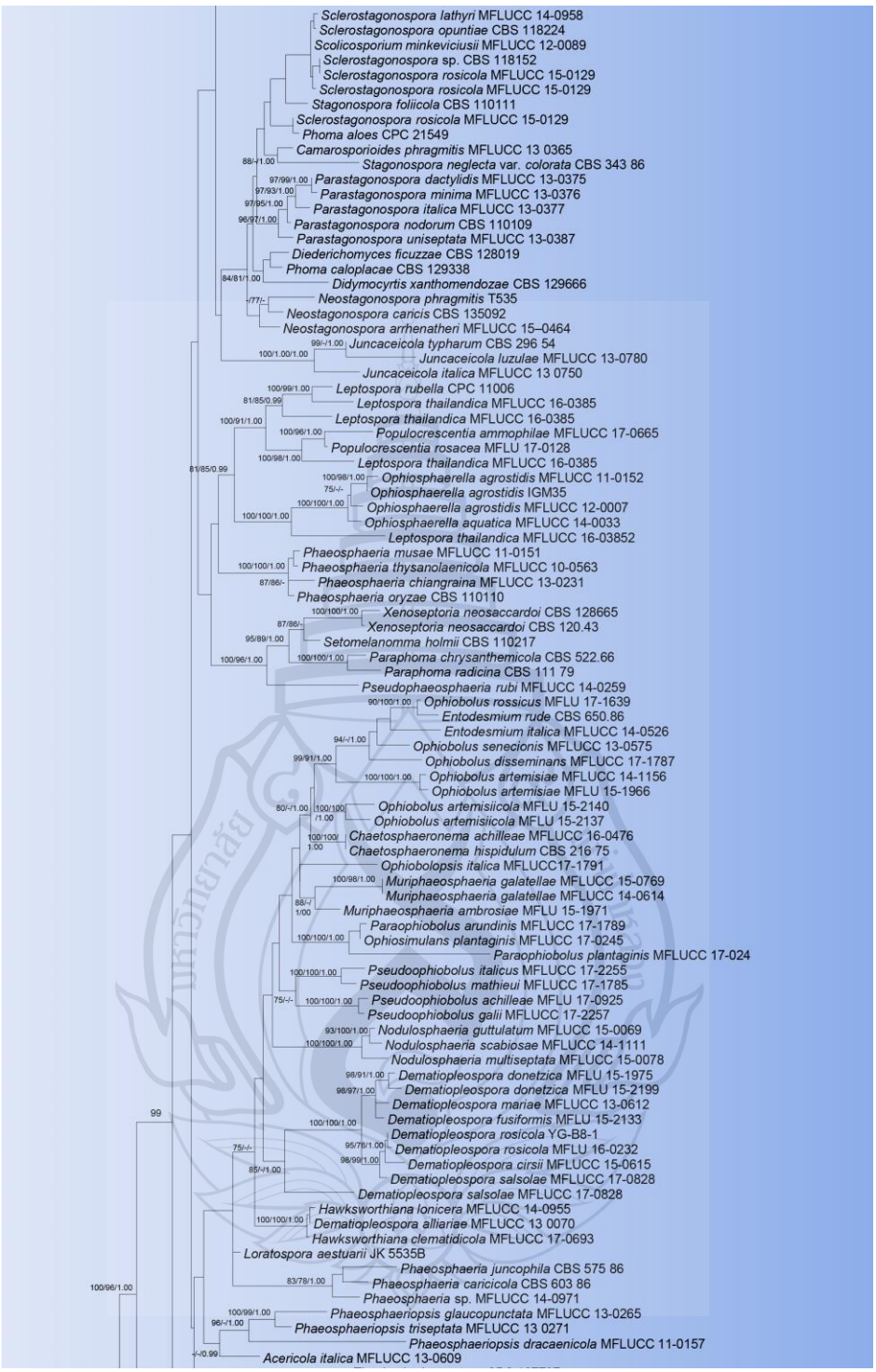
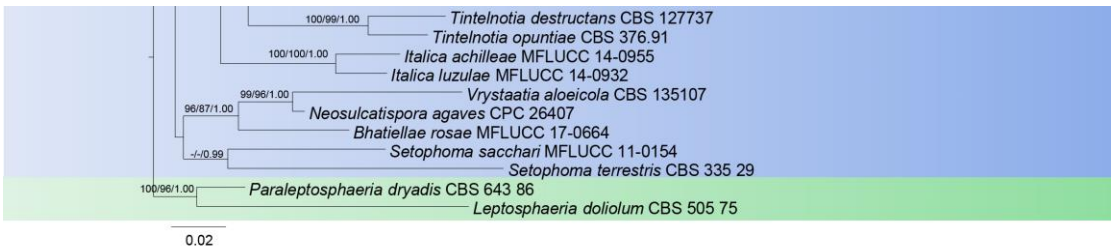


Figure 7.12 (continued)



Note Bootstrap support values for ML (first set) and MP ≥75%, BYPP ≥0.99 are given above or below the nodes. Newly generated sequences are in blue. *Leptosphaeria doliolum* (CBS 505.75) and *Paraleptosphaeria dryadis* (CBS 643.86) are used as the outgroup taxa.

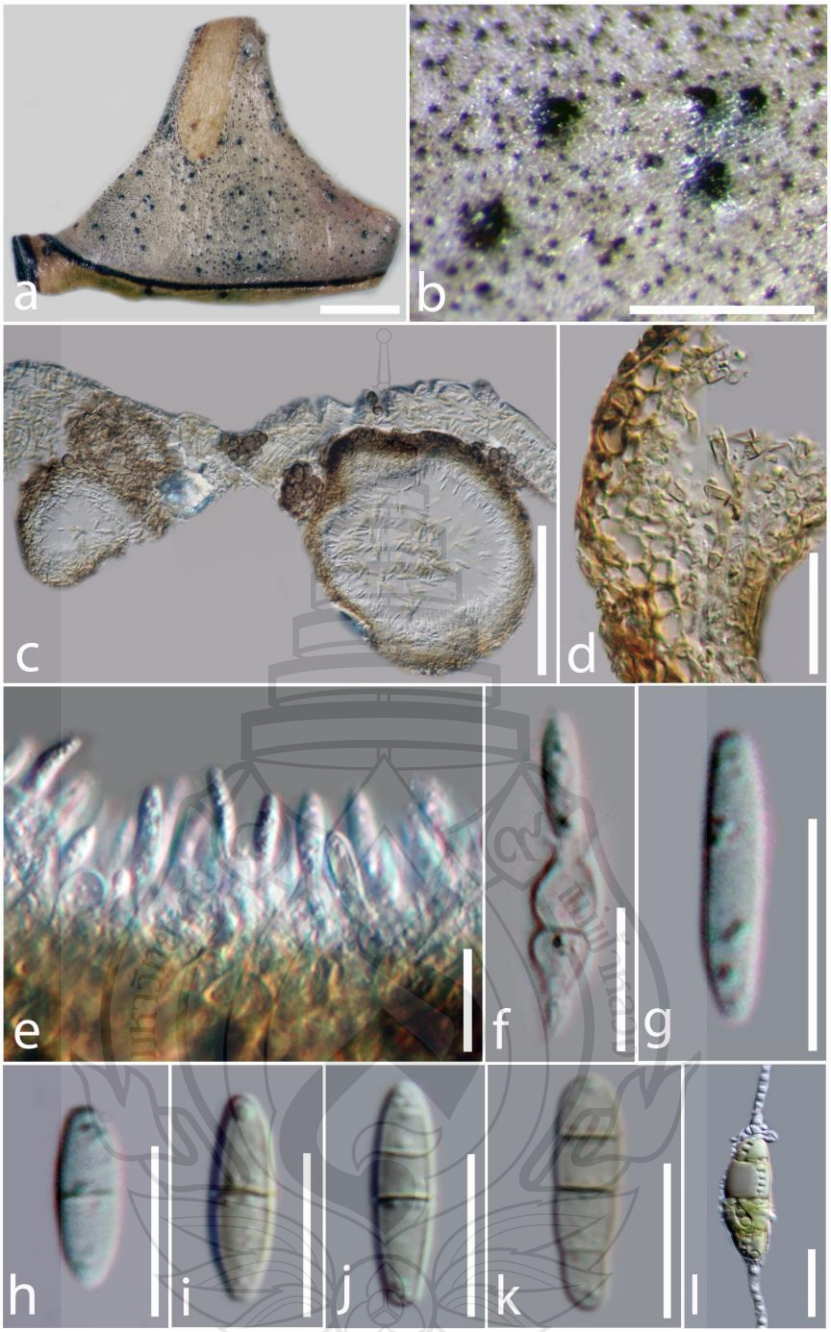
Figure 7.12 (continued)

Culture characters: Colonies on PDA reaching up to 30 mm diam. after 14d at 25 C, circular, flat, margins smooth, with a moderate amount of aerial mycelium, white from above and greyish white from reverse.

Material examined: Italy, Forlı`-Cesena Province, Collina, on dead aerial spines of *Rosa canina* L. (Rosaceae), 11 November 2014, Erio Camporesi, IT 2225 (MFLU 17-0308, holotype).

GenBank numbers: ITS: MG828927, LSU: MG829036, SSU: MG829142.

Notes: Our new isolate MFLU 17-0308 clustered within *Neosetophoma* (Clade E, Figure 7.12) in a separate clade with 99% ML, 65% MP, 1.00 PP bootstrap support. *Neosetophoma rosarum* shows some morphological similarities to *N. italica* which was isolated from *Iris germanica* L. (Liu et al., 2015). However, *N. rosarum* can be distinguished from N. italica by larger conidiomata (vs. 50–60 9 40–75 µm) and smaller conidia (vs. 6–1193–4 µm) (Liu et al., 2015). DNA was obtained from isolates which however did not survive the preservation process.



Note (a) Herbarium material. (b) Conidiomata on host substrate. (c) Transverse section through conidiomata. (d) Transverse section through conidiomatal wall. (e–f) Conidiogenous cells with mature and immature conidia. (g–k) Conidia. (l) Germinating conidium. Scale bars: a = 2 mm, b = 1 mm, c = 100 µm, d = 20 µm, e–h = 10 µm.

Figure 7.13 *Neosetophoma rosarum* (MFLU 17-0308, holotype)

CHAPTER 8

CONCLUSIONS

8.1 Overall Conclusion

The main aim of this research is to study the diversity and taxonomy of selected families of Sordariomycetes with emphasis on seeds and fruits and study those species in terms of morphological and molecular data and multigene phylogeny. This study was carried out under several sections including literature review, check list preparation, collection and the study of fresh materials, the study of type herbarium specimens and phylogenetic analyses in different orders, families and genera in the class Sordariomycetes.

My first objective was to provide up-to-date phylogenies of Hypocrealean taxa and a monograph of genera in Bionectriaceae, Calcarisporiaceae, Hypocreaceae, Nectriaceae and Tilachlidiaceae based on type herbarium materials and fresh specimens collected from Italy, Russia, Thailand and Ukraine. Chapter 2 provides outlines for the Bionectriaceae, Calcarisporiaceae, Hypocreaceae, Nectriaceae, Tilachlidiaceae, Ijuhyaceae, Stromatonectriaceae and Xanthonectriaceae with taxonomic treatments. We provide up-to-date DNA sequence-based phylogenies including combined gene analysis of ITS, LSU, RPB2, TEF1 and TUB2 for Hypocreales and accepted 17 families. Three new families and 14 new species are introduced with descriptions and illustrations, while 14 new records and one new species combination are provided. The newly described species are *Clonostachys leucaenae*, *C. spinulosa*, *Cosmosporella pruni*, *Gliocladiopsis siamensis*, *Nectria synnematosa*, *Neocosmospora leucaenae*, *N. striatispora*, *N. thailandica*, *Stephanonectria chromolaenae*, *Thelonectria siamensis*, *Trichoderma bambusicola* and *Volutella leucaenae*. The new host and geographical records are *Albonectria rigidiuscula*, *Corinectria fuckeliana*, *Macronectria asiatica*, *Nectria cinnabarina*, *Nectria dematiosa*, *Nectria pseudotrichia*,

Neonectria coccinea, *Neonectria punicea*, *Sarcopodium vanilla*, *Stilbocrea gracilipes*, *Thyronectria sinopica* and *Xanthonectria pseudopeziza*. Here we mainly detail the taxonomy of Bionectriaceae, Hypocreaceae, Nectriaceae and Tilachlidiaceae. Ijuhyaceae, Stromatonectriaceae and Xanthonectriaceae are introduced in this study based on phenotypic and molecular analyses. For each family, I provided a list of accepted genera, the taxonomic history, morphological descriptions, taxonomic placement based on DNA molecular data and illustrated the type genus. Representatives of each family are illustrated based on the type herbarium material or fresh specimens where available or provide relevant references. Summaries on the ecological and economic importance of the families are also given. Furthermore, *Peristomialis* was considered as a synonym of *Ijuhya* in this study. Based on current phylogenetic inference, the genera *Ijuhya* and *Kallichroma* were accommodated in a distinct family Ijuhyaceae. The new family Xanthonectriaceae was introduced to accommodate *Xanthonectria* and *Bullanockia*, while *Stromatonectria* was accepted in a new family Stromatonectriaceae due to the unique pycnidial asexual morphs and phylogenetic analysis. Based on phylogenetic analysis *Globonectria* was transferred to Nectriaceae. Furthermore, *Trichonectria* which was hitherto accepted in Bionectriaceae is left in Hypocreales *incertae sedis*. *Septofusidium*, which was previously placed in Nectriaceae and then in Tilachlidiaceae, was transferred to Bionectriaceae based on the combined gene analysis. The current study accepts 40 genera in Bionectriaceae. *Murinectria* was excluded from Nectriaceae. Furthermore, *Sulcatistroma* was suppressed over *Thyronectria* and a new combination for *Sulcatistroma nolinae* is proposed as *Thyronectria nolinae*. The present study accepts 77 genera in Nectriaceae. *Verticimonosporium*, which was previously treated as a member of Hypocreaceae, was transferred to Calcarisporiaceae, based on multi-gene analysis. The current study accepts two genera in Calcarisporiaceae and 16 genera in Hypocreaceae. The family Cylindriaceae is excluded from Hypocreales based on phylogenetic analysis. Cylindriaceae showed phylogenetic affinities to Amphisphaeriales, and this needs to be confirmed by further studies.

Chapters 3 and 4 support my second objective of reviewing selected families of Sordariomycetes and providing taxonomic notes. Chapter 3 introduced the new order

Falcocladiales and reviews ten families of the class Sordariomycetes. The monotypic order Falcocladiales in the subclass Hypocreomycetidae is introduced to accommodate the family Falcocladiaceae. The order presently includes one hyphomycetous asexual genus *Falcocladium*. Chapter three brings together descriptions, notes on the history, and illustrations of type or representative taxa of each family, a list of accepted genera and a key to the accepted taxa of Apiosporaceae, Chaetosphaeriaceae, Catabotrydaceae, Cylindriaceae, Delonicicolaceae, Flammocladiaceae, Phaeochoraceae, Pseudotruncatellaceae, Thyridiaceae and Obryzaceae. Chapter 4 reviews phytopathogenic fungal genera, *Calonectria*, *Dactylonectria*, *Ilyonectria*, *Fusarium* and *Neonectria* in Nectriaceae. This chapter brings together notes on the taxonomic history, classification, hosts, distribution, a brief guide to morphology based and molecular based identification and recommended the genetic markers for the identification of fungi in these genera. We provided up-to-date phylogenies of these genera using molecular data and the latest taxonomic insights.

My third objective was to study species in Diaporthomycetidae, Sordariomycetidae and Xylariomycetidae and evaluate the species in terms of morphology and multi-gene phylogenies. Chapter 5 incorporates updated backbone trees and natural classification for genera in Diaporthomycetidae, Sordariomycetidae and Xylariomycetidae. This study introduced three new genera *Eriocamporesia*, *Pseudotruncatella* and *Tropohalonectria*, and two new species. In addition, one host record, two geographical records and the first sexual morph records for *Seimatosporium cornii* and *Dissoconium eucalypti* are provided. Furthermore, the genus *Neotruncatella* is synonymized under *Monochaetinula*. New species described are *Astrocystis bambusicola*, *Chaetosphaeria jonesii*, *Diatrype thailandica*, *Ditopella biseptata*, *Eriocamporesia aurantia*, *Marsupiomyces epidermoidea* and *Pseudotruncatella arezzoensis*. The sexual morph of *Seimatosporium cornii* was collected from dead stems of *Cornus sanguinea* in Italy and is reported in this study. It was linked to *Seimatosporium cornii* based on the analysis of combined LSU and ITS sequence data. This study also reported on species of *Chaetosphaeria* from decorticated wood, collected in Thailand. Phylogenetic analysis of combined LSU, ITS and TUB sequence data provides evidence for a new species of *Chaetosphaeria* (*Chaetosphaeria jonesii*) and a new record of *Chaetosphaeria*

panamensis from *Pinus* twigs as the first record for Thailand. A truncatella-like coelomycete fungus was isolated from dead branches of *Cytisus* and *Helichrysum* species from Italy. DNA sequence analyses of a combined LSU, ITS and SSU dataset indicated a close phylogenetic affinity of our isolate to *Hyponectria buxi* (Hyponectriaceae). Herein we described it as a new genus with *Pseudotruncatella arezzoensis* sp. nov. However, it cannot be referred to an appropriate familial position and therefore we referred it to Amphisphaeriales genera *incertae sedis*. *Neotruncatella* is relegated to synonymy of *Monochaetinula*.

Chapter 6 supports my fourth and fifth objectives to study Sordariomycetes inhabiting wild seeds and fruits in Thailand, Italy and UK and evaluate fungal species in terms of morphological characters and multi-gene phylogenies and provide a checklist of fungi on wild seeds and fruits. The present study gives an idea of the different groups of fungi occurring on wild seeds and fruits, documents, discusses their role and importance, and illustrates some sordariomycete taxa. This study reviews and determines the fungi growing on seeds and fruits of wild plants in various habitats. Such fungi colonise a wide range of substrates, with the most reported from cones, cupules, and leguminous pods that are high in cellulose and lignin content. There are 1348 fungal species (belonging to 230 families and 609 genera) reported from wild seeds and fruits in 84 countries, listed in this paper. Of these, 300 fungi were described from wild seeds and fruit substrates. Members of the Fabaceae support the highest number of taxa, namely 19% of the novel wild fruit fungi. Twenty-eight genera, including five fossil fungal genera have been described from wild seeds and fruits: *Agarwalomyces*, *Amorocoelophoma*, *Anisogenispora*, *Archephoma*, *Centrolepidosporium*, *Cylindroaseptospora*, *Cylindromyces*, *Davidhawksworthia*, *Delonicicola*, *Discotubeufia*, *Glaxoa*, *Kionocephala*, *Leucaenicola*, *Naranus*, *Neolindgomyces*, *Pleohelicoon*, *Quercicola*, *Remotididymella*, *Repetoblastiella*, *Restilago*, *Soloacrosporiella*, *Strobiloscypha* and *Tainosphaeria*. *Archephoma*, *Meniscoideisporites*, *Palaeodiplodites*, *Palaeopericonia* and Xylohyphites are the new fossil fungal genera. Fungal asexual morphs predominate on wild seeds and fruits rather than the sexual morphs. The dominant fungal genera on wild seeds and fruits include *Alternaria*, *Aspergillus*, *Candida*, *Chaetomium*, *Cladosporium*, *Colletotrichum*, *Curvularia*, *Diaporthe*, *Drechslera*, *Fusarium*, *Mucor*, *Penicillium*, *Pestalotiopsis*,

Restiosporium, Rhizopus, Talaromyces, Trichoderma and *Xylaria*. Certain assemblages of fungi have specific and distinct relationships with their hosts, especially *Xylaria* species (e.g. *Xylaria magnoliae* on Magnolia fruits; *X. xanthinovelutina* (= *X. ianthino-velutina*) on Fabaceae pods; *X. carpophila* on Fagus cupules; *X. persicaria* on liquidambar fruits). Whether these species occur as endophytes and become saprobes following fruit fall requires further investigation. In this study, we also made several sexual morph collections of sordariomycetous taxa from different seed and fruit substrates mainly from Thailand, with a few from the UK. These include one new order, one new family, one new genus, 22 new species, 16 new host and geographical records. The new species are described and illustrated. The newly described species are *Chaetosphaeria garethjonesii, Chaetosphaeria garethjonesii, Clonostachys swieteniae, Delonicicola siamense, Diaporthe collariana, Diaporthe delonicis, Diatrypella delonicis, Dictyochaeta coryli, Dictyochaeta lithocarpi, Fusarium cassiae, Fusarium magnoliae-champaca, Fusicolla cassiae-fistulae, Fusicolla siamensis, Gliocladiopsis swieteniae, Hypoxylon delonicis, Neocosmospora magnoliae, Pseudohalonectria fagicola, Pseudohalonectria hampshirensis, Sarcopodium durantae, Thozetella fabacearum, Volutella delonicis, Xylaria fabacearum* and *Xylaria fabaceicola.* New host records and geographical records are *Menisporopsis theobromae, Tainosphaeria siamensis, Cytospora diopuiensis, Gliocladiopsis tenuis, Diaporthe rosae, Clonostachys rogersoniana, Clonostachys rosea, Trichothecium roseum, Fusarium salinense, Xylaria arbuscula, Allodiatrype thailandica, Parascedosporium putredinis, Sarcopodium flocculentum, Gliocladiopsis aquaticus, Macronectria asiatica* and *Nectria synnematosa*.

My sixth objective was to contribute to the fungal taxonomy and phylogeny by studying fungi in other classes such as Dothideomycetes. Chapter 7 provides an updated backbone tree and natural classification for dothideomycete taxa. This chapter introduces five new species *Alternariaster centaureae-diffusae, Camarosporium laburnicola, Diplodia arengae, Keissleriella cirsii* and *Neosetophoma rosarum* from different hosts. *Lasiodiplodia iraniensis* is reported as a new host and geographical record from *Cassia* sp. in Thailand. *Plenodomus agnitus* is designated as a reference specimen, which was collected from the same locality as the type specimen.

8.2 Significance of the Thesis

This study of Sordariomycets on different substrates including wild seeds and fruits is very interesting research as this will not only to discover new species, but also this leads to observe host specific fungi, new host and geographical records study and their geographical distributions. This study expanded the knowledge on fungal diversity in Thailand, Italy, UK, Russia and Ukraine and provided up-to-date phylogenies and several taxonomic treatments of Sordariomycetes.

The study acknowledges the importance of studying wild seeds and fruits inhabiting fungi and their diversity. My study provides the first comprehensive review and checklist of fungi inhabiting wild seeds and fruits. In this research, we collected wild seeds and fruits inhabiting Sordariomycetes and presented them in one research article. Therefore, anyone who will study wild seeds and fruits inhabiting fungi in the future, need to follow my research papers for a better understanding. Fresh collections of wild seeds and fruit inhabiting fungi led to identify unrevealed taxa including one new order in Xylariomycetidae is a turning point of the taxonomy of the subclass. Morphological and molecular identification of wild seed/fruit fungi and the knowledge of fungal biodiversity will lead to precise assessment of risks associate with diseases. Accurate identification of fungi is advantageous for effective quarantine decisions and policies in trading agricultural commodities between individual countries, and also safeguard their own plant resources. Finally, this study expanded the knowledge on fungal diversity in wild seeds and fruits.

Revision of the families of order Hypocreales monographed and reveal the profile of Bionectriaceae, Calcarisporiaceae, Hypocreaceae, Nectriaceae and Tilachlidiaceae based on type herbarium material and fresh collections together with comprehensive morphology and multi-gene analyses. That led to provide up-to-date phylogenies of order Hypocreales and added three new families to the order. Examination and illustration of the type or representative specimens of poorly known genera are really important for future mycologists as this stimulates recollection and sequencing of those taxa and identification of their natural classification. This study

also treated selected *incertae sedis* taxa in Hypocreales. Therefore, anyone who will study taxa in order Hypocreales in the future, need to follow my research papers for a better understanding.

This study also contributed to introducing the genus *Pseudotruncatella* in order Amphisphaeriales. Before introducing *Pseudotruncatella*, the appendage bearing conidial taxa in Amphisphaeriales were restricted to family Sporocadaceae and *incertae sedis* genera *Bleptosporium*, *Griphosphaerioma* and *Hyalotiopsis*. However, *Pseudotruncatella* is not related to Sporocadaceae and it was not referred to an appropriate familial position and therefore left in Amphisphaeriales *incertae sedis*.

One chapter of thesis brings together descriptions, notes on the history, and illustrations of type or representative taxa and of selected families of Sordariomycetes. This study provided a list of accepted genera and a key to the accepted genera of Apiosporaceae, Chaetosphaeriaceae, Catabotrydaceae, Cylindriaceae, Delonicicolaceae, Flammocladiaceae, Phaeochoraceae, Pseudotruncatellaceae, Thyridiaceae and Obryzaceae. That is very important for beginner researchers to obtain an idea about all these families, characteristics and their outline.

In this research I have contributed numerous new taxa including new species, new genera, new families and a new order to the fungal world with DNA sequence data and this will lead to a better understanding of the fungal taxonomy and biodiversity around the world. This study expanded the knowledge on fungal diversity in Thailand, Italy, Russia, UK and Ukraine. Furthermore, a lot of DNA sequence data from different genes were generated and contributed for future phylogenetic studies using epitypes, authentic specimens and fresh collections. Furthermore, this study established sexual-asexual morph relationships of Sordariomycetes fungi. Several important sordariomycetous and some dothideomycetous taxa were revisited and a natural classification is provided. As a result of my study, I have an h-Index of 30 in the Google Scholar with 4606 citations.

8.3 Future Directions

To obtain further knowledge supporting the phylogeny and taxonomy of Sordariomycetes, more research is required on the following topics.

8.3.1 Many lineages in the Hypocreales remain uncertain and wider collecting, modern descriptions and illustrations along with sequence data are required in order to give a better understanding of the order. There are 131 genera listed in Hypocreales *incertae* sedis. It is therefore, imperative to expand this research to study *incertae sedis* taxa in Hypocreales based on type herbarium materials, fresh specimens and molecular phylogeny.

8.3.2 There are 16 genera of *Bionectriaceae*, 11 genera of *Nectriaceae*, 4 genera of *Hypocreaceae* lack molecular data. The number of sequence data is limited for some Sordariomycetes taxa and they need to be revisited based on epitypes with multi-gene sequence data. In the case of unavailability of ex-type sequence data, identification of reliable putatively named strains for phylogenetic analyses is very important.

8.3.3 Future studies on plant-inhabiting Sordariomycetes in various habitats including fresh water and marine habitats, soil and air would be appropriate since they appear to have a greater contribution to the fungal world. Long term applications of secondary metabolites discovery, the geographical distribution, ecological importance, the patterns of evolution and the roles of species in their natural environment should be studied other than the general taxonomy of this class.

8.3.4 Although research studies have mainly focused on the saprobic fungi on wild seeds and, it is very important to expand this research to study other types including pathogens and endophytes. Observation of the endophytic species in wild seeds and fruits and establishing the relationships with recorded saprobic fungal species is important. Therefore, more collections of wild seeds and fruits inhabiting fungi will lead to a high fungal diversity and for a better understanding of wild seeds and fruits fungi.

8.3.5 Use a combination of culture-dependent and culture-independent (high-throughput DNA sequencing) approaches to obtain better insights into diversity of the fungi inhabiting wild seeds and fruits.

8.3.6 Expand experiment studies to reveal the fungal succession of selected wild seeds and fruits.

8.4 Publications

Ten papers as first author have been published in international journals as a result of this study. Co-author contributions have also been made in 33 additional publications.

8.4.1 First Author Publications

Perera, R. H., Hyde, K. D., Dissanayake, A. J., Jones, E. B., Liu, J. K., Wei, D., & Liu, Z. Y. (2018). *Diaporthe collariana* sp. nov., with prominent collarettes associated with *Magnolia champaca* fruits in Thailand. *Studies in Fungi*, *3*, 141–151.

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Perera, R. H., Hyde, K. D., Jones, E. B. G., Maharachchikumbura S. S. N., Bundhun D., Camporesi, E., . . . Liu, Z. Y. (2022). Profile of Bionectriaceae, Calcarisporiaceae, Hypocreaceae, Nectriaceae, Tilachlidiaceae, Ijuhyaceae fam. nov., Stromatonectriaceae fam. nov. and Xanthonectriaceae fam. nov. *Fungal Diversity*, (In press)

8.4.2 Co-author Publications

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APPENDICES

APPENDIX A

CHEMICAL REAGENTS AND MEDIA

1. Potassium hydroxide (KOH) used in the rehydration of dried specimens and observe ascomatal wall or stromata reactions. 3% aqueous solution

2. Lactoglycerol used for maintaining semipermanent slides

Lactic acid 10 ml

Glycerol 10 ml

Distilled water 10 ml

Mix 10 ml lactic acid, 10 ml glycerol, and add 10 ml distilled water

3. Lactic acid which preserves fungal structures and for getting a true color image of the fungal spore and structures without staining. This is helpful for some of the darker colored organisms.

85% Lactic acid 100 ml

3. Lactophenol-Cotton Blue used to highlight fungal structures for viewing with the compound light microscope. Cotton blue is the most popular stain for observe pseudoparaphyses, septate or ascus walled. This is gives excellent clarity and is also suitable for most fungal groups

Phenol (crystals) 20 g

Lactic acid 16 ml

Glycerol 31 ml

Dissolve phenol in distilled water, add lactic acid, glycerol and 0.05 g of Poirrier's (cotton) blue or acid fuchsin.

4. Melzer's Reagent is a good general mounting medium that clears the material somewhat and allows particularly brilliant resolution with a microscope, and used for identification of ascomycete fungi. Amyloid reaction of asci changed to blue or heavily purple colours.

Chloral hydrate 100 g

Potassium iodide 5 g

Iodine 1.5 g

Distilled water 100 ml

5. Malt Extract Agar (MEA) used for fungal cultivation

Agar 15 g

Peptone 0.78 g

Glycerol 2.35 g

Dextrin 2.75 g

Maltose, Technical 12.75 g

Suspend 33.6 g of malt extract agar in distilled water and mix thoroughly. Heat with frequent agitation and boil for 1 minute to completely dissolve the power and bring volume to 1000 ml. Autoclave at 121^{o}C for 15 minutes

6. Potato dextrose agar (PDA) used for fungal cultivation

Potato starch (from infusion) 4 g

Dextrose 20 g

Agar 15 g

Suspend 39 g of Potato dextrose agar in distilled water and mix thoroughly. Heat with frequent agitation and boil for 1 minute to completely dissolve the power and bring volume to 1000 ml. Autoclave at 121^{o}C for 15 minutes.

APPENDIX B

PUBLICATIONS

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New species of *Thozetella* and *Chaetosphaeria* and new records of *Chaetosphaeria* and *Tainosphaeria* from Thailand

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Abstract

We are studying seed and fruit-borne fungi in Thailand and in this paper report on species of *Tainosphaeria*, *Thozetella* and *Chaetosphaeria* from *Fabaceae* seed pods and decorticated wood, collected in Chiang Mai and Phang-nga provinces. Phylogenetic analysis of combined LSU, ITS and TUB sequence data provides evidence for new species of *Thozetella* and *Chaetosphaeria*. These new taxa are introduced and compared with closely related species in these genera. We provide a morphological and illustrated account of *Chaetosphaeria panamensis* isolated from *Pinus* twigs as a first record for Thailand.

Key words – *Chaetosphaeriales* – morphology – phylogeny – seed/fruit fungi – Sordariomycetes

Introduction

The hyphomycetous genus *Thozetella* Kuntze was introduced by Kuntze (1891) based on *T. nivea* (Berk.) Kuntze. The genus presently includes 19 epithets (Index Fungorum 2016) and is characterized by sporodochial or synnematous conidiomata, phialidic conidiogenesis, and aseptate conidia, with unbranched setula at each end and sterile microawns (Sutton & Cole 1983, Paulus et al. Hyde 2004). *Thozetella* species have been reported from soil and decaying plant parts in terrestrial and freshwater habitats from temperate and tropical regions (Morris 1956, Agnihothrudu 1958, 1962, Waipara et al. 1996, Sivichai et al. 2002, Allegrucci et al. 2004, Delgado-Rodrígues & Mena-Portales

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Additions to wild seed and fruit fungi 2: *Parascedosporium putredinis*: a new Thailand record from *Delonix regia* seed pods

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Abstract

We are studying seed pod fungi associated with *Delonix regia* in Thailand and in this paper we provide an illustrated account of *Parascedosporium putredinis*, which is a new record for Thailand. Phylogenetic analysis of combined ITS and LSU sequence data and morphological similarities provide evidence for its identification. We illustrate the synnematal stage and lateral, solitary conidiophores of *P. putredinis* obtained *in vitro* on MEA. We also provide ITS, LSU, SSU, and *tef* sequence data for *P. putredinis*, which are deposited in GenBank.

Key words – *graphium*-like – Microascaceae – morphology – phylogeny – Sordariomycetes

Introduction

The genus *Parascedosporium* (Microascaceae, Microascales) is characterized by sympodial conidia produced from denticulate conidiogenous cells (Gilgado et al. 2007). *Parascedosporium* synanamorphs bear conidiophores that are solitary and emerge from aerial mycelium and have *graphium*-like synnemata (Gilgado et al. 2007). *Parascedosporium* was introduced by Gilgado et al. (2007) based on an authentic strain of *Graphium tectonae* C. Booth (CBS 127.84). *Graphium tectonae* was combined and renamed as *Parascedosporium tectonae* (C. Booth) Gilgado, Gené, Cano & Guarro (Gilgado et al. 2007). This strain had been isolated from *Tectona grandis* seeds in Jamaica (Lackner & de Hoog 2011). Later this species was considered as a synonym of *Parascedosporium putredinis* (Corda) M. Lackner & de Hoog (Lackner & de Hoog 2011) based on analysis of ITS sequence data and examination of the ex-type culture (CBS 127.84), and this treatment was accepted by de Beer et al. (2013). A sexual morph has not been identified for the genus (Gilgado et al. 2007, Lackner & de Hoog 2011, Wijayawardene et al. 2017).

A number of fungi have been collected from *Delonix regia* seed pods (Somrithipol et al. 2002, Sahu et al. 2003, Perera et al. 2016, 2017). One new genus, *Delonicicola*, and two new species, *Cirrenalia nigrospora* and *Delonicicola siamense*, have been described from northern Thailand (Somrithipol et al. 2002, Perera et al. 2017). A fungal succession study by Somrithipol et

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Delonicicola siamense gen. & sp. nov. (*Delonicicolaceae* fam. nov., Delonicicolales ord. nov.), a saprobic species from *Delonix regia* seed pods

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Abstract – This paper introduces a new genus *Delonicicola*, to accommodate *D. siamense* sp. nov., which was found associated with *Delonix regia* seed pods, collected in Chiang Rai Province, Thailand. ITS sequence data confirmed a close relationship of *Delonicicola* with *Liberomyces* and *Asteromella* in Xylariomycetidae. Phylogenetic and molecular clock analyses of combined LSU, SSU and RPB2 sequence data provide evidence for a new family *Delonicicolaceae* and a new order Delonicicolales in Xylariomycetidae. Members of *Delonicicolaceae* are saprobes, endophytes or pathogens of angiosperms and it is characterized by pseudostromatal immersed, papillate ascomata, short pedicellate asci with a simple apex and 1-septate, hyaline ascospores. The asexual morph is coelomycetous with pycnidial conidiomata and allantoid, filiform or bacilloid, hyaline conidia.

morphology / phylogeny / seed/fruit fungi / Sordariomycetes / Xylariomycetidae

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Additions to wild seed and fruit fungi 1: The sexual morph of *Diaporthe rosae* on *Magnolia champaca* and *Senna siamea* fruits in Thailand

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Abstract

We are studying seed and fruit fungi in Thailand and made several sexual morph collections of *Diaporthe rosae* from dried fruits of *Magnolia champaca* and *Senna siamea*. The sexual morphs were linked to the asexual morphs based on molecular data, and morphological similarity with the asexual morph produced on PDA. The asexual morph of *D. rosae* was previously reported from a dead pedicel of *Rosa* sp. (Rosaceae) from the same location as its sexual morph. The sexual morph is characterized by 34–46 × 6.7–9 µm asci and 10–12.5 × 2.8–3.6 µm, ellipsoidal ascospores. We also provide LSU, ITS, *tub2* and *tef* sequence data of *D. rosae* strains which are deposited in GenBank. The molecular analyses were performed in the ARB software environment and the pipeline is provided as supplementary data.

Key words – ARB analysis – Diaporthaceae – saprobes – seed/fruit fungi

Introduction

Diaporthe is a well-known plant pathogenic genus, but species may also occur as endophytes or saprobes (Udayanga et al. 2011, 2012, 2014b, 2015, Gao et al. 2014, Dissanayake et al. 2017a, b, c). *Diaporthe* species can be found worldwide on a wide range of host plants (Gao et al. 2014, Dissanayake et al. 2017a, b, c). Dissanayake et al. (2017b) provided an account of species in the genus *Diaporthe*, listing 171 species with associated molecular data. Thirteen *Diaporthe* species, including an epitype, have been collected in Thailand, from different hosts and substrates (Udayanga et al. 2012, 2015, Liu et al. 2015, Doilom et al. 2016, Hyde et al. 2016, Dissanayake et al. 2017b, Perera et al. 2018, Wanasinghe et al. 2018).

Phenotypic plasticity, cryptic diversification, and a vast range of host associations of *Diaporthe* species have resulted in complications with the accurate identification of species within

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Diaporthe collariana sp. nov., with prominent collarettes associated with *Magnolia champaca* fruits in Thailand

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Perera RH, Hyde KD, Dissanayake AJ, Jones EB, Liu JK, Wei D, Liu ZY 2018 – *Diaporthe collariana* sp. nov., with prominent collarettes associated with *Magnolia champaca* fruits in Thailand. Studies in Fungi 3(1), 141–151, Doi 10.5943/sif/3/1/16

Abstract

We are studying seed and fruit inhabiting fungi in Thailand and this paper introduces a new species, *Diaporthe collariana*, from *Magnolia champaca* fruits, collected in Chiang Rai Province. Molecular analysis of a combined ITS, TEF1, TUB and CAL sequence DNA and morphological data provide evidence to justify the new species. *Diaporthe collariana* is characterized by producing alpha and beta conidia, and conidiogenous cells with prominent, flared collarettes. The new species is compared with closely related species in the genus.

Key words – *Diaporthaceae* – morphology – new species – phylogeny – seed/fruit fungi

Introduction

Diaporthe species are plant pathogens, endophytes or saprobes, found on a wide range of hosts (Gomes et al. 2013, Gao et al. 2014, Dissanayake et al. 2017a, b, c). Previously species of this genus were considered as host-specific. However, as the same species can be found on more than one host, this is no longer valid (Rehner & Uecker 1994, Gomes et al. 2013, Dissanayake et al. 2017b). Currently, 171 species of *Diaporthe*, have been described from various plant hosts worldwide and species rank supported with molecular data (Gomes et al. 2013, Dissanayake et al. 2017a, b, c, Gao et al. 2017). However, most old epithets of *Diaporthe* lack molecular data and some morphological descriptions lack informative data (Dayarathne et al. 2016, Gao et al. 2017, Index Fungorum 2017). Taxonomy of the genus relies largely on molecular phylogenies (Udayanga et al. 2012, Gomes et al. 2013), as few morphological characters can be used in species delimitation

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An appendage-bearing coelomycete *Pseudotruncatella arezzoensis gen.* and *sp. nov.* (Amphisphaeriales genera *incertae sedis*) from Italy, with notes on *Monochaetinula*

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Abstract

A *Truncatella*-like coelomycete fungus was isolated from dead branches of *Cytisus* and *Helichrysum* species from Arezzo Province, Italy. DNA sequence analyses of a combined LSU, ITS and SSU dataset indicated a close phylogenetic affinity of our isolate to *Hyponectria buxi* (Hyponectriaceae). Herein we describe it as a new genus with *Pseudotruncatella arezzoensis sp. nov*. However it cannot be referred to an appropriate familial position and therefore we refer it to Amphisphaeriales genera *incertae sedis*. *Pseudotruncatella* is characterized by holoblastic, annellidic, conidiogenous cells; 3-septate, fusiform to clavate conidia with 3 apical appendages, dark brown median cells and hyaline apical and basal cells. *Neotruncatella* is relegated to synonymy of *Monochaetinula*.

Key words: morphology, phylogenetic analysis, Sordariomycetes, Xylariomycetidae

Introduction

Based on phylogeny, molecular clock analysis and morphological data, 12 families are currently included in Amphisphaeriales D. Hawksw. & O.E. Erikss. (Senanayake *et al*. 2015, Maharachchikumbura *et al*. 2015, 2016, Hongsanan *et al*. 2017, Hyde *et al*. 2017). Beltraniaceae Nann., Pestalotiopsidaceae Maharachch. & K.D. Hyde, Robillardaceae Crous, and Sporocadaceae Corda were recognized as families with appendage-bearing, brown conidia producing coelomycete fungi in Amphisphaeriales (Senanayake *et al*. 2015, Maharachchikumbura *et al*. 2016, Wijayawardene *et al*. 2016). However, those families were treated as synonymies of Sporocadaceae by Jaklitsch *et al*. in 2016. Most of the Sporocadaceae members represent asexual morph genera of acervular coelomycetes, with holoblastic conidiogenesis and hyaline, pale or dark brown, phragmo- or didymosporous conidia, with appendages (Nag Raj 1993, Jeewon *et al*. 2002, Tanaka *et al*. 2011, Senanayake *et al*. 2015, Jaklitsch *et al*. 2016). Currently, 18 genera producing appendage-bearing conidia: *Adisciso*, *Bartalinia*, *Broomella*, *Ciliochorella*, *Discosia*, *Ellurema*, *Immersidiscosia*, *Monochaetia*, *Morinia*, *Neopestalotiopsis*, *Pestalotiopsis*, *Pseudopestalotiopsis*, *Robillarda*, *Sarcostroma*, *Seimatosporium*, *Seiridium*, *Truncatella*, and *Zetiasplozna*, are accomodated in Sporocadaceae (Senanayake *et al*. 2015, Jaklitsch *et al*. 2016, Wijayawardene *et al*. 2016). Further, 4 coelomycete genera, which

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Fungi on wild seeds and fruits

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Abstract

This paper reviews and determines the fungi growing on seeds and fruits of wild plants in various habitats. Such fungi colonise a wide range of substrates with most reported from cones, cupules, and leguminous pods that are high in cellulose and lignin content. There are 1348 fungal species (belonging to 230 families and 609 genera) reported from wild seeds and fruits in 84 countries, listed in this paper. Of these, 300 fungi were described from wild seeds and fruit substrates. Members of the Fabaceae support the highest number of taxa, namely 19% of the novel wild fruit fungi. Twenty-eight genera, including 5 fossil fungal genera have been described from wild seeds and fruits: *Agarwalomyces*, *Amorocoelophoma*, *Anisogenispora*, *Archephoma*, *Centrolepidosporium*, *Cylindroaseptospora*, *Cylindromyces*, *Davidhawksworthia*, *Delonicicola*, *Discotubeufia*, *Glaxoa*, *Kionocephala*, *Leucaenicola*, *Naranus*, *Neolindgomyces*, *Pleohelicoon*, *Quercicola*, *Remotididymella*, *Repetoblastiella*, *Restilago*, *Soloacrosporiella*, *Strobiloscypha* and *Tainosphaeria*. *Archephoma*, *Meniscoideisporites*, *Palaeodiplodites*, *Palaeopericonia* and

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Sexual morph of *Seimatosporium cornii* found on *Cornus sanguinea* in Italy

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Abstract

The sexual morph of *Seimatosporium cornii*, collected from dead stems of *Cornus sanguinea* in Arezzo, Italy, is reported in this paper. It was linked to *S. cornii* based on analysis of combined LSU and ITS sequence data. The sexual morph is characterized by minutely stromatic ascomata, cylindrical to clavate asci, with a J+, apical apparatus and 1–3-septate, fusiform ascospores. *Seimatosporium cornii* can be distinguished from the closely related species, *Discostroma fuscellum*, by the structure of the peridium, shape and septation of the ascospores and also its asexual morph. The sexual morph of *S. cornii* is reported from the same host and location as its asexual morph. We also provide data of SSU, TEF1-α and β-TUB genes of our strain, deposited in GenBank.

Key words: *Discosiaceae*, morphology, phylogeny, *Sordariomycetes*

Introduction

Corda (1833) introduced the genus *Seimatosporium* based on *S. rosae* Corda. This genus was previously placed in *Amphisphaeriaceae* (Shoemaker & Müller 1964, Brockmann 1976, Paulus *et al*. 2006, Maharachchikumbura *et al*. 2015). Recently, based on analysis of combined LSU and ITS sequence data, Senanayake *et al*. (2015) placed *Seimatosporium* in a novel family, *Discosiaceae* (*Amphisphaeriales*) with the genera *Adisciso*, *Discosia*, *Discostroma* and *Sarcostroma*. Tanaka *et al*. (2011) recognised *Seimatosporium sensu lato* as a monophyletic genus, although the type of *Seimatosporium* was not sequenced at that time. The generic type, *S. rosae* was subsequently epitypified and ex-epitype sequence data provided by Norphanphoun *et al*. (2015). *Seimatosporium* has been linked to *Discostroma* in several studies (Shoemaker & Müller 1964, Brockmann 1976, Nag Raj 1993, Okane *et al*. 1996, Hatakeyama & Harada 2004, Paulus *et al*. 2006, Hyde *et al*. 2011). *Discostroma* is characterized by stromatic and/or clypeate, ostiolate ascomata, unitunicate asci, with a J+/ J- apical ring, and usually uniseriate, ellipsoid, transversely septate or muriform, hyaline or pigmented ascospores (Paulus *et al*. 2006). Species of *Seimatosporium* and *Discostroma* are mainly obligate pathogens, although some are saprobes (Sutton 1980, Paulus *et al*. 2006, Tanaka *et al*. 2011). Recent phylogenetic analyses have also confirmed the link between *Discostroma* and *Seimatosporium* (Jeewon *et al*. 2002, Barber *et al*. 2011, Tanaka *et al*. 2011, Norphanphoun *et al*. 2015). Although the holomorph has not been recorded in nature, *Discostroma* and *Seimatosporium* are recognised as homothallic (culture based) by several authors (Brockmann 1976, Okane *et al*. 1996, Hatakeyama & Harada 2004). However, molecular data are not available to prove the link

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Two new *Pseudohalonectria* species on beech cupules *(Fagus sylvatica)* and a new genus to accommodate *P. suthepensis*

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Abstract

We are studying the fungi on seeds and fruits and identified two *Pseudohalonectria* species from cupules of beech nut (*Fagus sylvatica*), collected from slightly anoxic, stagnant water in the moat in Bishops Palace, Hampshire, UK. Phylogenetic analysis of combined LSU, SSU and *TEF1* sequence data provides evidence that they are new species in the genus. *Pseudohalonectria hampshirensis* and *P. fagicola spp. nov*. are introduced in this paper with descriptions, photomicrographs and molecular evidence. They are compared with closely related species in the genus and a key to the genus is provided. As a result of the phylogenetic analyses *P. suthepensis* is excluded from *Pseudohalonectria* and a new genus, *Tropohalonectria* is introduced to accommodate the species.

Keywords: Magnaporthales, morphology, phylogeny, *Sordariomycetes*, systematics

Introduction

The genus *Pseudohalonectria* was introduced to accommodate *P. lignicola* Minoura & T. Muroi (Minoura & Muroi 1978), without being assigned to an order or family. Its similarity with lignicolous taxa in the Sordariales and particularly to *Ophioceras*, prompted Shearer (1989) to place *Pseudohalonectria* in the Lasiosphaeriaceae, Sordariales. This was supported by preliminary phylogenetic analysis of SSU sequence data by Chen *et al*. (1999). However, Chen *et al*. (1999) also observed the close relationships between *Pseudohalonectria*, *Ophioceras* and *Gaeumannomyces*. Both genera were provisionally transferred to the Magnaporthaceae by Shearer *et al*. (1999). Thongkantha *et al*. (2009) treated *Pseudohalonectria* as polyphyletic and confirmed its placement by individual and combined analyses of SSU and LSU sequence data. In the phylogenetic analysis of Klaubauf *et al*. (2014), *Pseudohalonectria* clustered basal to the Magnaporthaceae, Pyriculariaceae and Ophioceraceae within the Magnaporthales. Similar results were obtained by Maharachchikumbura *et al*. (2015, 2016) who maintained *Pseudohalonectria* in Magnaporthales genera, *incertae sedis*.

Subsequent to its introduction, several species were added to *Pseudohalonectria* (Shearer 1989, Hyde *et al*. 1999, Ono and Kobayashi 2001, Cai *et al*. 2002, Kohlmeyer *et al*. 2005), and currently 13 epithets are listed in the genus in Index Fungorum (2016). *Pseudohalonectria* is characterized by bright yellow to brown ascomata, with long cylindrical, periphysate necks; unitunicate, cylindrical to clavate asci, with a non-amyloid, thimble-shaped, refractive apical rings, paraphysate and cylindrical, hyaline to slightly pigmented, and usually septate ascospores (Shearer 1988). Although a hyphomycetous, phialidic anamorph has been linked to *P. phialidica* by Shearer (1989), this species was later transferred to *Ceratosphaeria* by Huhndorf *et al*. (2008) based on LSU sequence data. Ono and Kobayashi (2001) reported a similar anamorph for *P. aomoriensis* Yas. Ono & Tak. Kobay.

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