



## Refined families of Dothideomycetes: orders and families incertae sedis in Dothideomycetes

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### Abstract

Numerous new taxa and classifications of Dothideomycetes have been published following the last monograph of families of Dothideomycetes in 2013. A recent publication by Hongsanan et al. in 2020 expanded information of families in Dothideomycetidae and Pleosporomycetidae with modern classifications. In this paper, we provide a refined updated document on orders and families *incertae sedis* of Dothideomycetes. Each family is provided with an updated description, notes, including figures to represent the morphology, a list of accepted genera, and economic and ecological significances. We also provide phylogenetic trees for each order. In this study, 31 orders which consist 50 families are assigned as orders *incertae sedis* in Dothideomycetes, and 41 families are treated as families *incertae sedis* due to lack of molecular or morphological evidence. The new order, Catinellales, and four new families, *Catinellaceae*, *Morenoiaceae*, *Neobuelliellaceae* and *Thyrinulaceae* are introduced. Seven genera (*Neobuelliella*, *Pseudomicrothyrium*, *Flagellostrigula*, *Swinscowa*, *Macroconstrictolumina*, *Pseudobogoriella*, and *Schumma*) are introduced. Seven new species (*Acrospermum urticae*, *Bogoriella complexoluminata*, *Dothiorella ostryae*, *Dyfronomyces distoseptatus*, *Macroconstrictolumina megalateralis*, *Patellaria microspora*, and *Pseudomicrothyrium thailandicum*) are introduced base on morphology and phylogeny, together with two new records/reports and five new collections from different families. Ninety new combinations are also provided in this paper.

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Extended author information available on the last page of the article

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## Introduction

Dothideomycetes were previously known as Loculoascomycetes, and is the largest class of ascomycetes (Nannfeldt 1932; Luttrell 1955; Janex-Favre 1971; Barr 1979a, b; Eriksson 1981; Reynolds 1971; Tehler 1990, 1995; Letrouit-Galinou et al. 1994; Barr and Huhndorf 2001; Liu and Hall 2004; Hyde et al. 2013; Hongsanan et al. 2020). Members of this class mostly have bitunicate, fissitunicate asci (Nannfeldt 1932; Luttrell 1955; Eriksson 1981; Barr and Huhndorf 2001; Hyde et al. 2013; Hongsanan et al. 2020). Hyde et al. (2013) provided descriptions, notes and discussed taxonomic placement of families in Dothideomycetes. They also confirmed that Dothideomycetes comprises two subclasses *viz.* Dothideomycetidae and Pleosporomycetidae, while other uncertain orders and families were treated as *incertae sedis* in Dothideomycetes. Based on morphology and phylogeny, Dothideomycetidae comprised Capnodiiales, Dothideales, and Myrangiiales, and Pleosporomycetidae comprised Gloniales, Hysteriales, Mytiliniidiales, and Pleosporales (Hyde et al. 2013, Hongsanan et al. 2020). Hongsanan et al. (2020) provided a monograph of families in Dothideomycetidae and Pleosporomycetidae based on ‘Families of Dothideomycetes’ (Hyde et al. 2013) which was the latest update and the most complete monograph of families in Dothideomycetes, included in Wijayawardene et al.

(2017a) who provided ‘Notes for genera: Ascomycota’ and Wijayawardene et al. (2020) who provided ‘Outline of Fungi and fungus-like taxa’. Hongsanan et al. (2020) provided an updated description, notes, including figures to represent the morphology, list of accepted genera, and economic and ecological significance of families in Dothideomycetidae and Pleosporomycetidae. They accepted three orders with 25 families in Dothideomycetidae and four orders with 94 families in Pleosporomycetidae (Hongsanan et al. 2020). Liu et al. (2017) established guidelines of using divergence estimates in the classification of Dothideomycetes, and this was followed by Hongsanan et al. (2020) who provided an updated divergence estimation of families in Dothideomycetes using two representative strains from each family. In our paper, we used the divergence time estimation from Hongsanan et al. (2020) to discuss orderal and familial status of *incertae sedis* groups.

The aim of this paper is to bring together data of orders and families which were not assigned to Dothideomycetidae nor Pleosporomycetidae due to their uncertain phylogenetic placement or lack of sequence data. We included all published data that we could locate in 2019 and have also included some data that we were aware of up to the date of publication. This work refined account of the families of Dothideomycetes and will provide a baseline for research on Dothideomycetes over the next decade. As an online database, dothideomycetes.org (Pem et al. 2019b) and fungalgenera.org (Monkai et al. 2019), the contents will be continually refined and updated and stay abreast of classification changes as new data and additional evidence are published.

## Materials and methods

### *Layout of the paper*

Each family which is currently not assigned to Dothideomycetidae and Pleosporomycetidae is introduced with descriptions and important notes. Accepted genera including the type species, and notes are provided with basionyms (other synonyms can be found in Index Fungorum 2020). Faces of Fungi and Index Fungorum numbers are provided as in Jayasiri et al. (2015) and Index Fungorum (2020). Estimated numbers of species for each genus is provided mainly based on data in Species Fungorum (2020), with species transferred to other genera or species not being included. The number of species with sequence data available in GenBank is provided. The morphology of each family is illustrated by representative photographic plates from type herbarium specimens, or new species/new collections with sequence data. We provide drawing for families which we were unable to obtain herbarium specimens or fresh collections. Notes on the ecological and economic significance are also provided.

**Molecular phylogeny**

Phylogenetic trees of each order are provided, except for orders where too little sequence data is available. Trees for each order include representatives from all genera that have sequence data (Supplemental material 1). The methods below were applied for most of the phylogenetic trees shown in this paper. Other additional methods are mentioned in the legend of each analysis.

Gene regions used in each analysis were selected based on the most recent study or the availability of sequence data. Datasets for each partition were aligned using MAFFT (Katoh et al. 2019), and adjusted manually using Bioedit (Hall 2004). All missing genes were coded as missing data. Phylogenetic trees based on individual gene partitions (data not shown) were congruent with the combined data sets. The phylogenetic analyses of the combined dataset were performed using maximum likelihood algorithms in RAxML and Bayesian analyses.

Maximum likelihood analysis (ML) was carried out by using raxmlGUIv.0.9b2 (Silvestro and Michalak 2012). The search strategy was set to bootstrapping and the analysis performed using the GTRGAMMAI model. The number of replicates was inferred using the stopping criterion (Pattengale et al. 2009). The bootstrap values expressed from 1,000 repetitions by RAxML analysis which are equal or greater than 70% are given on each node. The best fit model of evolution was selected by MrModeltest 2.2 (Nylander et al. 2008). Bayesian phylogenetic analyses, posterior probabilities (PP) were set by MCMC sampling in MrBayes v3.1.2 (Huelsenbeck and Ronquist 2001; Zhaxybayeva and Gogarten 2002), following the details in Cai et al. (2008). The first 20% were discarded, and the remaining trees were used for calculating posterior probabilities. Posterior probabilities values (PP) from Bayesian analysis which are equal or greater than 0.90 are given on each node. Phylogenetic tree was viewed in FigTree v.1.4.0 (Rambaut 2014).

**Order of Dothideomycetes**

For the subclasses Dothideomycetidae and Pleosporomycetidae see Hongsanan et al. (2020) and Dothideomycetes genera *incertae sedis* see Wijayawardene et al. (2020).

**Abrothallales** Pérez-Ort. & Suija

**Lichenoconiaceae** Diederich & Lawrey (= *Abrothallaceae* Pérez-Ort. & Suija) (57)

*Abrothallus* De Not.

*Lichenoconium* Petr. & Syd.

**Acrospermales** Minter et al.

**Acrospermaceae** Fuckel

*Acrospermum* Tode

*Gonatophragmium* Deighton

*Oomyces* Berk. & Broome

*Pseudovirgaria* H.D. Shin et al.

**Asterinales** M.E. Barr ex D. Hawksw. & O.E. Erikss. (= *Asterotexales* Firmino et al.)

**Asterinaceae** Hansf.

*Asterina* Lév.

*Asterinella* Theiss.

*Asterolibertia* G. Arnaud

*Asterostomella* Speg.

*Batistinula* Arx

*Cirsosia* G. Arnaud

*Dothidasteromella* Höhn.

*Echidnodella* Theiss. & Syd.

*Halbania* Racib.

*Meliolaster* Höhn.

*Parasterinopsis* Bat.

*Platypeltella* Petr.

*Prillieuxina* G. Arnaud

*Pycnocarpon* Theiss.

*Schenckiella* Henn.

*Trichasterina* G. Arnaud

*Trichopeltospora* Bat. & Cif.

*Uleothyrium* Petr.

*Vizellopsis* Bat. et al.

**Asterotexaceae** Firmino et al.

*Asterotexis* Arx

**Hemigraphaceae** D.Q. Dai & K.D. Hyde

*Hemigrapha* (Müll. Arg.) D. Hawksw.

**Lembosiaceae** Luttrell ex P.M. Kirk et al.

*Lembosia* Lév.

**Melaspileellaceae** D.Q. Dai & K.D. Hyde

*Melaspilella* (P. Karst.) Vain.

**Morenoiaceae** Hongsanan & K.D. Hyde

*Morenoina* Theiss.

**Neobuelliellaceae** Hongsanan & K.D. Hyde

*Neobuelliella* Hongsanan & K.D. Hyde

**Stictographaceae** D.Q. Dai & K.D. Hyde

*Buelliella* Fink

*Karschia* Körb.

*Labrocarpon* Etayo & Pérez-Ort.

*Melaspileopsis* (Müll. Arg.) Ertz & Diederich

*Stictographa* Mudd

**Asterinales** genera *incertae sedis*

*Andamanomyces* Hosag.

*Caribaeomyces* Cif.

*Caudella* Syd. & P. Syd.

*Discopycnothyrium* Hongsanan & K.D. Hyde

- Hazslinszkyia* Körb.  
*Inocyclus* Theiss. & Syd.  
*Melanographa* Müll. Arg.  
*Pirozynskiella* S. Hughes  
*Vishnumyces* Hosag.
- Botryosphaeriales** C.L. Schoch et al.  
**Aplosporellaceae** Slippers et al.  
*Alanomyces* Sharma  
*Aplosporella* Speg.
- Botryosphaeriaceae** Theiss. & H. Syd.  
*Alanphillipsia* Crous & M.J. Wingf.  
*Barriopsis* A.J.L. Phillips et al.  
*Botryobambusa* Phook. et al.  
*Botryosphaeria* Ces. & De Not.  
*Cophinforma* Doilom et al.  
*Diplodia* Fr.  
*Dothiorella* Sacc.  
*Endomelanconiopsis* Rojas & Samuels  
*Eutiarosporella* Crous  
*Lasiodiplodia* Ellis & Everh.  
*Macrophomina* Petr.  
*Marasasiomyces* Crous  
*Mucoharknessia* Crous et al.  
*Neodeightonia* C. Booth  
*Neofusicoccum* Crous et al.  
*Neoscytalidium* Crous & Slippers  
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*Phaeobotryon* Theiss. & Syd.  
*Sakireeta* Subram. & K. Ramakr.  
*Sardiniella* Linaldeddu et al.  
*Sphaeropsis* Sacc.  
*Tiarosporella* Höhn.
- Melanopsaceae** Phillips et al.  
*Melanops* Nitschke ex Fuckel
- Phyllostictaceae** Fr.  
*Phyllosticta* Pers.  
*Pseudofusicoccum* Mohali et al.
- Planistromellaceae** M.E. Barr  
*Kellermania* Ellis & Everh.  
*Mycosphaerellopsis* Höhn.  
*Planistroma* A.W. Ramaley  
*Umthunziomyces* Crous & M.J. Wingf.
- Saccharataceae** Slippers et al.  
*Pileospora* Tanney & Seifert  
*Saccharata* Denman & Crous (= *Neoseptorioides* Crous et al.)
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- Botryosphaeriales** genera *incertae sedis*  
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*Metameris* Theiss. & Syd.  
*Phyllachorella* Syd.  
*Pilgeriella* Henn.  
*Sivanesia* W.H. Hsieh & C.Y. Chen  
*Vestergrenia* Rehm
- Catinellales** Ekanayaka et al.  
**Catinellaceae** Ekanayaka et al.  
*Catinella* Boud.
- Cladoriellales** Crous  
**Cladoriellaceae** Crous  
*Cladoriella* Crous
- Collemopsidiales** Perez-Ortega et al.  
**Xanthopyreniaceae** Zahlbr.  
*Collemopsidium* Nyl.  
*Didymellopsis* (Sacc.) Clem. & Shear  
*Frigidopyrenia* Grube  
*Rhagadodidymellopsis* Fdez.-Brime et al.  
*Xanthopyrenia* Bachm.  
*Zwackhiomyces* Grube & Hafellner  
*Zwackhiomacromyces* Etayo & van den Boom
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*Melomastia* Nitschke ex Sacc.  
*Pleurotrema* Müll. Arg.
- Eremithallales** Lücking & Lumbsch  
**Melaspileaceae** W. Watson (= *Eremithallaceae* Lücking & Lumbsch)  
*Encephalographa* A. Massal.  
*Melaspilea* Nyl.
- Eremomycetales** Crous et al.  
**Eremomycetaceae** Malloch & Cain  
*Eremomyces* Malloch & Cain  
*Rhexothecium* Samson & Mouch.
- Eremomycetales** genus *incertae sedis*  
*Arthrographis* G. Cochet ex Sigler & J.W. Carmich.

**Jahnulales** Pang et al.**Aliquandostipitaceae** Inderbitzin

- Aliquandostipite* Inderbitzin  
*Brachiosphaera* Nawawi  
*Jahnula* Kirschst.  
*Megalohypha* A. Ferrer & Shearer  
*Neojahnula* W. Dong et al.  
*Pseudojahnula* W. Dong et al.  
*Xylomyces* Goos et al.

**Manglicolaceae** Suetrong & E.B.G. Jones

- Manglicola* Kohlm. & E. Kohlm.

**Kirschsteiniotheliales** Hern.-Restr. et al.**Kirschsteiniotheliaceae** Boonmee & K.D. Hyde

- Kirschsteiniothelia* D. Hawksw.

**Kirschsteiniotheliales** genus *incertae sedis*

- Brachysporiella* Bat. (*Brachysporiella sensu lato*)  
*Taeniolella* S. Hughes *sensu lato*

**Lembosinales** Crous**Lembosinaceae** Crous

- Lembosina* Theiss.

**Lichenotheliales** K. Knudsen et al.**Lichenotheliaceae** Henssen

- Lichenothelia* D. Hawksw.  
*Endococcus* Nyl.

**Microthyriales** G. Arnaud**Microthyriaceae** Sacc.

- Arnaudiella* Petr.  
*Calothyriopsis* Höhn.  
*Chaetothyriotheceium* Hongsanan & K.D. Hyde  
*Hamatispora* L.T.H. Yen et al.  
*Microthyrium* Desm.  
*Neoanungitea* Crous  
*Paramicrothyrium* H.X. Wu & K.D. Hyde  
*Pseudomicrothyrium* X.Y. Zeng et al.  
*Pseudopenidiella* Crous & Koukol  
*Seynesiella* G. Arnaud  
*Tumidisporea* Hongsanan & K.D. Hyde

**Microthyriales** genera *incertae sedis*

- Heliocephala* V. Rao et al.  
*Mitopeltis* Speg.  
*Neoscoleobasidium* Crous  
*Parazalerion* Madrid et al.  
*Thyriodictyella* Cif.  
*Tothia* Bat.

**Minutisphaerales** Raja et al.**Acrogenosporaceae** Jayasiri & K.D. Hyde.

- Acrogenospora* M.B. Ellis

**Minutisphaeraceae** Raja et al

- Minutisphaera* Shearer et al.

**Monoblastiales** Lücking et al.**Monoblastiaceae** Walt. Watson (= *Eriomycetaceae* Huanraluek & K.D. Hyde)

- Acrocordia* A. Massal.  
*Anisomeridium* (Müll. Arg.) M. Choisy  
*Caprettia* Bat. & H. Maia  
*Eriomyces* Huanraluek, Thambugala & K.D. Hyde  
*Funbolia* Crous & Seifert  
*Heleiosa* Kohlm. et al.  
*Megalotremis* Aptroot  
*Monoblastia* Riddle  
*Phellinocrescentia* Crous & Decock  
*Pseudopassalora* Crous  
*Trypetheliopsis* Asahina

**Murramarangomycetales** Crous**Murramarangomycetaceae** Crous

- Phaeothyriolum* Syd.

**Muyocoprionales** Mapook et al.**Muyocoproneae** K.D. Hyde

- Arxiella* Papendorf  
*Leptodiscella* Papendorf  
*Muyocopron* Speg.  
*Mycocoleptodiscus* Ostaz.  
*Neocochlearomyces* Pinruan et al.  
*Neomycocoleptodiscus* Hern.-Restr. et al.  
*Paramycocoleptodiscus* Crous & M.J. Wingf.  
*Pseudopalawania* Mapook & K.D. Hyde  
*Setoapiospora* Mapook & K.D. Hyde

**Natipusillales** Raja et al.**Natipusillaceae** Raja et al.

- Natipusilla* A. Ferrer

**Parmulariales** D.Q. Dai & K.D. Hyde**Parmulariaceae** E. Müll. & Arx ex M.E. Barr

- Aldona* Racib.  
*Aldonata* Sivan. & A.R.P. Sinha  
*Antoniomyces* Inácio  
*Aulacostroma* Syd. & P. Syd.  
*Campoa* Speg.  
*Cirsosiosis* Butin & Speer

*Cocconia* Sacc.  
*Cycloshizon* P. Henn.  
*Cyclostomella* Pat.  
*Dothidasteroma* Höhn.  
*Ferrarisia* Sacc.  
*Hysterostomella* Speg.  
*Kiehlia* Viégas  
*Mintera* Inácio & P.F. Cannon  
*Pachypatella* Theiss. & Syd.  
*Palawaniella* Doidge  
*Parmularia* Lév.  
*Parmulariopsisella* Sivan.  
*Parmulariopsis* Petr.  
*Parmulina* Theiss. & Syd.  
*Placoasterella* Sacc. ex Theiss. & Syd  
*Placosoma* Syd.  
*Placostromella* Petr.  
*Pleostomellina* Bat. et al.  
*Polycyclina* Theiss. & Syd.  
*Polycyclus* Höhn.  
*Protothyrium* G. Arnaud  
*Pseudolembosia* Theiss.  
*Rhagadolobiosis* Guatim. & R.W. Barreto  
*Rhagadolobium* P. Henn. & Lindau  
*Rhipidocarpon* (Theiss.) Theiss. & Syd.  
*Symphaeophyma* Speg.  
*Syrropeltis* Bat. et al.  
*Thallomyces* H.J. Swart  
*Viegasiella* Inácio & P.F. Cannon

**Patellariales** D. Hawksw. & O.E. Erikss.

**Patellariaceae** Corda

*Baggea* Auersw.  
*Banhegyia* L. Zeller & Tóth  
*Colensoniella* Hafellner  
*Endotryblidium* Petr.  
*Glyphium* Nitschke ex F. Lehm.  
*Haematomyxa* Sacc  
*Holmiella* Petrini et al.  
*Hysteropatella* Rehm  
*Hysteropeltella* Petr.  
*Lahmiomyces* Cif. & Tomas.  
*Lecanidiella* Sherwood  
*Lirellodisca* Aptroot  
*Murangium* Seaver  
*Patellaria* Fr.  
*Poetschia* Körb.  
*Pseudoparodia* Theiss. & Syd.  
*Rhizodiscina* Hafellner  
*Rimula* Velen.  
*Schrakia* Hafellner  
*Stratisporella* Hafellner  
*Tryblidaria* (Sacc.) Sacc.

**Phaeotrichales** Ariyaw. et al.

**Phaeotrichaceae** Cain

*Echinoascotheca* Matsush.  
*Phaeotrichum* Cain & M.E. Barr  
*Trichodelitschia* Munk

**Stigmatodiscales** Voglmayr & Jaklitsch

**Stigmatodiscaceae** Voglmayr & Jaklitsch

*Stigmatodiscus* Voglmayr & Jaklitsch

**Strigulales** Lücking et al.

**Strigulaceae** Zahlbr. (= *Phyllobatheliaceae* Bitter & F. Schill.)

*Dichoporis* Clem.  
*Flagellostrigula* Lücking et al.  
*Flavobathelium* Lücking et al.  
*Phyllobathelium* (Müll. Arg.) Müll. Arg  
*Phyllocharis* Fée,  
*Phyllocraterina* Sérus. & Aptroot  
*Phylloporis* Clem.  
*Puiggariella* Speg.  
*Raciborskiella* Höhnel  
*Racoplaca* Fée  
*Serusiauxiella* S.H. Jiang et al.  
*Strigula* Fr.  
*Swinscowia* S.H. Jiang et al.

**Tenuitholiascaceae** S.H. Jiang et al.

*Tenuitholiascus* S.H. Jiang et al.

**Superstratomycesales** van Nieuwenhuijzen et al.

**Superstratomycesaceae** van Nieuwenhuijzen et al.

*Superstratomyces* van Nieuwenhuijzen et al.

**Trypetheliales** Lücking et al.

**Polycoccaceae** Ertz et al.

*Clypeococcum* D. Hawksw.  
*Polycoccum* Saut. ex Körb.

**Trypetheliaceae** Zenker

*Alloarthopyrenia* Phukhams. et al.  
*Aptrootia* Lücking & Sipman  
*Architrypethelium* Aptroot  
*Astrothelium* Eschw.  
*Bathelium* Ach.  
*Bogoriella* Zahlbr.  
*Constrictolumina* Lücking et al.  
*Dictyomeridium* Aptroot et al.  
*Macroconstrictolumina* Lücking et al.  
*Marcelaria* Aptroot  
*Nigrovothelium* Lücking et al.  
*Polymeridium* (Müll. Arg.) R.C. Harris  
*Polypyrenula* D. Hawksw.



*Pseudobogoriella* Lücking et al.  
*Pseudopyrenula* Müll. Arg.  
*Schummi* Lücking et al.  
*Trypethelium* Sprengel  
*Viridothelium* Lücking et al.

### **Tubeufiales** Boonmee & K.D. Hyde

#### **Bezerromycetaceae** J.D.P. Bezerra et al.

*Bezerromyces* J.D.P. Bezerra et al.  
*Neorhamphoria* Boonmee et al.  
*Xiliomyces* J.D.P. Bezerra et al.

#### **Tubeufiaceae** M.E. Barr

*Acanthohelicospora* Boonmee & K.D. Hyde  
*Acanthophiobolus* Berl.  
*Acanthostigma* De Not.  
*Acanthostigmia* Höhn.  
*Acanthotubeufia* Y.Z. Lu & K.D. Hyde  
*Aquaphila* Goh et al.  
*Artocarpomyces* Subram.  
*Berkleasmium* Zobel  
*Bifrontia* Norman  
*Boerlagiomyces* Butzin  
*Camporesiomyces* D.P. Wei & K.D. Hyde  
*Chaetosphaerulina* I. Hino  
*Chlamydotubeufia* Boonmee & K.D. Hyde  
*Dematiohelicoma* Y.Z. Lu et al.  
*Dematiohelicomyces* Y.Z. Lu et al.  
*Dematiohelicosporium* Y.Z. Lu et al.  
*Dematitubeufia* Y.Z. Lu et al.  
*Dictyospora* Brahamanage et al.  
*Discotubeufia* Jayasir et al.  
*Helicangiospora* Boonmee et al.  
*Helicoarctatus* Y.Z. Lu et al.  
*Helicodochium* J.S. Monteiro et al.  
*Helicohyalinum* Y.Z. Lu et al.  
*Helicoma* Corda  
*Helicomycetes* Link  
*Helicosporium* Nees  
*Helicotrunctatum* Y.Z. Lu et al.  
*Helicotubeufia* Y.Z. Lu & J.K. Liu  
*Kamalomyces* R.K. Verma et al.  
*Kevinhydea* N.G. Liu et al.  
*Manoharachariella* Bagyan. et al.  
*Muripulchra* Z.L. Luo et al.  
*Neocanthostigma* Boonmee et al.  
*Neochlamydotubeufia* Y.Z. Lu et al.  
*Neohelicoma* Y.Z. Lu et al.  
*Neohelicomyces* Z.L. Luo et al.  
*Neohelicosporium* Y.Z. Lu et al.  
*Neotubeufia* Chaiwan et al.  
*Pleurohelicosporium* Y.Z. Lu et al.  
*Podonectria* Petch

*Pseudohelicomyces* Y.Z. Lu et al.  
*Pseudohelicoon* Y.Z. Lu & K.D. Hyde  
*Tamhinispora* Rajeshkumar & Rahul Sharma  
*Thaxteriella* Petr.  
*Thaxteriellopsis* Sivan. et al.  
*Tubeufia* Penz. & Sacc.

#### **Wiesneriomycetaceae** Suetrong et al.

*Parawiesneriomyces* Crous & M.J. Wingf.  
*Phalangispora* Nawawi & J. Webster  
*Pseudogliophragma* Phadke & V.G. Rao  
*Setosynnema* D.E. Shaw & B. Sutton  
*Speiropsis* Tubaki  
*Wiesneriomyces* Koord.

### **Valsariales** Jaklitsch et al.

#### **Valsariaceae** Jaklitsch et al.

*Bambusaria* Jaklitsch et al.  
*Myrmaecium* Nitschke ex Fuckel  
*Valsaria* Ces. & De Not.

### **Venturiales** Y. Zhang ter et al.

#### **Symptoventuriaceae** Y. Zhang ter et al.

*Acroconidiellina* M.B. Ellis  
*Clavatispora* Boonmee & K.D. Hyde  
*Echinocatena* R. Campb. & B. Sutton  
*Fusicladium* Bonord.  
*Matsushimaea* Subram.  
*Mycosisymbrium* Carris  
*Ochroconis* de Hoog & Arx  
*Scolecobasidiella* M.B. Ellis  
*Scolecobasidium* E.V. Abbott  
*Symptoventuria* Crous & Seifert  
*Veronaepsis* Arzanlou & Crous  
*Verruconis* Samerp. et al.  
*Yunnanomyces* Tibpromma & K.D. Hyde

#### **Venturiaceae** E. Müll. & Arx ex M.E. Barr

*Apiosporina* Höhn.  
*Atopospora* Petr.  
*Caproventuria* U. Braun  
*Coleroa* (Fr.) Rabenh.  
*Cylindrosymposium* W.B. Kendr. & R.F. Castañeda  
*Dimeriella* Speg.  
*Dimerosporiopsis* Henn.  
*Magnohelicospora* R.F. Castañeda et al.  
*Metacoleroa* Petr.  
*Neocoleroa* Petr.  
*Protoventuria* Berl. & Sacc.  
*Pseudoanungitea* Crous  
*Pseudoparodiella* F. Stevens  
*Sympodiella* W.B. Kendr.  
*Tyrannosorus* Unter. & Malloch

- Venturia* Sacc.
- Venturiales** genus *incertae sedis*  
*Cylindrosympodioides* Crous & M.J. Wingf.  
*Lasiobotrys* Kunze
- Zeloasperisporiales** Hongsanan & K.D. Hyde  
**Zeloasperisporiaceae** Crous  
*Zeloasperisporium* R.F. Castañeda
- Dothideomycetes** families *incertae sedis*  
**Alinaceae** Boonmee & K.D. Hyde  
*Alina* Racib.
- Argynnaceae** Shearer & J.L. Crane  
*Argynna* Morgan  
*Lepidopterella* Shearer & J.L. Crane
- Ascoporiaceae** Kutorga & D. Hawksw.  
*Ascoporia* Samuels & A.I. Romero
- Aulographaceae** Luttr. ex P.M. Kirk et al.  
*Aulographum* Lib.  
*Echidnodes* Theiss. & Syd.  
*Lembosiella* Sacc.  
*Thyriopsis* Theiss. & Syd.
- Balladynaceae** Boonmee & K.D. Hyde  
*Balladyna* Racib.  
*Balladynocallia* Bat.  
*Balladynopsis* Theiss. & Syd.
- Cleistosphaeraceae** Boonmee & K.D. Hyde  
*Cleistosphaera* Syd. & P. Syd.
- Coccoideaceae** P. Henn. ex Sacc. & D. Sacc.  
*Coccoidea* P. Henn.  
*Coccoidella* Höhn.  
*Englerodothis* Theiss. & Syd.
- Cookellaceae** Höhn. ex Saccardo & Trotter  
*Cookella* Sacc.  
*Pycnoderma* Syd. & P. Syd.
- Dimeriaceae** E. Müll. & Arx ex Arx & E. Müll.  
*Dimerium* (Sacc. & P. Syd.) McAlpine
- Dubujianaceae** D. Pem et al.  
*Dubujiana* D.R. Reynolds & G.S. Gilbert
- Dysrhynchisceae** Boonmee & K.D. Hyde  
*Dysrhynchis* Clem.
- Endosporiaceae** D. Pem  
*Endosporium* Tsuneda
- Englerulaceae** P. Henn.  
*Allosoma* Syd.  
*Digitosarcinella* S. Hughes  
*Englerula* P. Henn.  
*Goosia* B. Song  
*Parenglerula* Höhn.  
*Rhytidenglerula* Höhn.  
*Schiffnerula* Höhn.  
*Thrauste* Theiss.
- Homortomycetaceae** Thambug. et al.  
*Homortomyces* Crous & M.J. Wingf.
- Hyalomeliolinaceae** Boonmee & K.D. Hyde  
*Hyalomeliolina* F. Stevens
- Leptopeltidaceae** Höhn. ex Trotter  
*Dothiopeltis* E. Müll.  
*Leptopeltis* Höhn.  
*Ronnigeria* Petr.  
*Staibia* Bat. & Peres
- Macrovalsariaceae** D. Pem et al.  
*Macrovalsaria* Petr.
- Meliolinaceae** S. Hughes  
*Briania* D.R. Reynolds  
*Meliolina* Syd. & P. Syd.
- Mesnieraceae** Arx & E. Müll.  
*Bondiella* Piroz.  
*Mesniera* Sacc. & P. Syd.  
*Stegasphaeria* Syd. & P. Syd.
- Naetrocymbaceae** Höhn. ex R.C. Harris  
*Bonaria* Bat.  
*Jarxia* D. Hawksw.  
*Leptorhaphis* Körb.  
*Naetrocymbe* Körb.  
*Tomasellia* A. Massal.
- Nematotheciaceae** Boonmee & K.D. Hyde  
*Nematothecium* Syd. & P. Syd.  
*Nematostigma* Syd. & P. Syd.  
*Ophioparodia* Petr. & Cif.
- Neoparodiaceae** Boonmee & K.D. Hyde  
*Neoparodia* Petr. & Cif.

**Palawaniaceae** Mapook & K.D. Hyde*Palawania* (Niessl) Syd. & P. Syd.**Paranectriellaceae** Boonmee & K.D. Hyde*Paranectriella* (Henn. ex Sacc. & D. Sacc.) Magnus. (= *Araneomyces* Höhn.)  
*Puttemansia* Henn.**Parodiellaceae** Theiss. & H. Syd. ex M.E. Barr*Parodiella* Speg.**Perisporiopsidaceae** E. Müll. & Arx ex R. Kirschner & T.A. Hofm. (= *Parodiopsidaceae* Toro)*Asteronia* (Sacc.) Henn.  
*Byssocallis* Syd.  
*Chevalieropsis* G. Arnaud  
*Parodiellina* Henn. ex G. Arnaud  
*Perisporiopsis* Henn.**Phaeodimeriellaceae** Boonmee et al.*Phaeodimeriella* Speg.**Pododimeriaceae** Boonmee & K.D. Hyde*Chaetoscutula* E. Müll.  
*Pododimeria* E. Müll.**Polyclypeolinaceae** Boonmee & K.D. Hyde*Polyclypeolina* Bat. & I.H. Lima**Polystomellaceae** Theiss. & H. Syd.*Dermatodothella* Viégas  
*Dothidella* Speg.  
*Munkiella* Speg.  
*Parastigmatia* Doidge**Protoscyphaceae** Kutorga & D. Hawksw.*Protoscypha* Syd.**Pseudoperisporiaceae** Toro*Bryomyces* Döbbeler  
*Eudimeriolum* Speg.  
*Lasiostemma* Theiss.  
*Nematostoma* Syd. & P. Syd.**Pseudorobillardaceae** Crous*Pseudorobillarda* M. Morelet**Pyrenidiaceae** Zahlbr.*Pyrenidium* Nyl.**Seynesiopeltidaceae** K.D. Hyde*Seynesiopeltis* F. Stevens & R.W. Ryan**Stomatogeneaceae** Boonmee & K.D. Hyde*Stomatogene* Theiss.**Thyrinulaceae** X.Y. Zeng et al.*Blastacervulus* H.J. Swart  
*Paraopeba* V.P. Abreu et al.  
*Thyrinula* Petr. & Syd.**Toroaceae** Boonmee & K.D. Hyde*Toroa* Syd.**Trichopeltinaceae** Bat. et al.*Acrogenotheca* Cif. & Bat.  
*Brefeldiella* Speg.  
*Saccardinula* Speg.  
*Trichopeltella* Höhn.  
*Trichopeltthea* Bat.  
*Trichopeltina* Theiss.  
*Trichothyrynula* Petr.**Trichothyriaceae** Theiss.*Lichenopeltella* Höhn.  
*Macrographa* Etayo  
*Pachythyrium* G. Arnaud ex Spooner & P.M. Kirk  
*Trichothyrium* Speg.**Vizellaceae** H.J. Swart*Acarella* Syd.  
*Blasdalea* Sacc. & P. Syd.  
*Vizella* Sacc.**Abrothallales** Pérez-Ort. & Suija.

= Lichenoconiales Diederich, Lawrey &amp; K.D. Hyde.

*Index Fungorum* number: IF 805297; *Facesoffungi* number: FoF 08045.

Abrothallales was established by Pérez-Ortega and Suija (in Pérez-Ortega et al. 2014) based on its monophyletic placement and morphological distinctness within the class Dothideomycetes. Diederich et al. (in Hyde et al. 2013) had introduced Lichenoconiales, which Liu et al. (2017) recovered as a sister clade of Abrothallales, raising the question of whether both orders should be maintained. Diederich et al. (2018) synonymized Lichenoconiales with Abrothallales and tentatively *Lichenoconiaceae* with *Abrothallaceae*. Pérez-Ortega and Suija agreed with Diederich et al. (2018) to use the name Abrothallales since *Abrothallus* is the most outstanding, easily recognizable and better-known genus of the group. *Lichenoconiaceae* is the older name, therefore, we retain *Lichenoconiaceae* over *Abrothallaceae*. Abrothallales contains species which are lichenicolous, parasymbiotic or parasitic on macrolichens from a single family *Abrothallaceae* (Pérez-Ortega et al. 2014; Wijayawardene et al.

2017a). The divergence time for Abrothallales is estimated as 204 MYA (stem age, Hongsanan et al. 2020) (Fig. 1).

Accepted families: *Lichenconiaceae*.

**Lichenconiaceae** Diederich & Lawrey, in Hyde et al., Fungal Diversity 63: 131 (2013).

= *Abrothallaceae* Pérez-Ort. & Suija, in Pérez-Ortega, Suija, Crespo & Ríos, Fungal Diversity 64(1): 303 (2014).

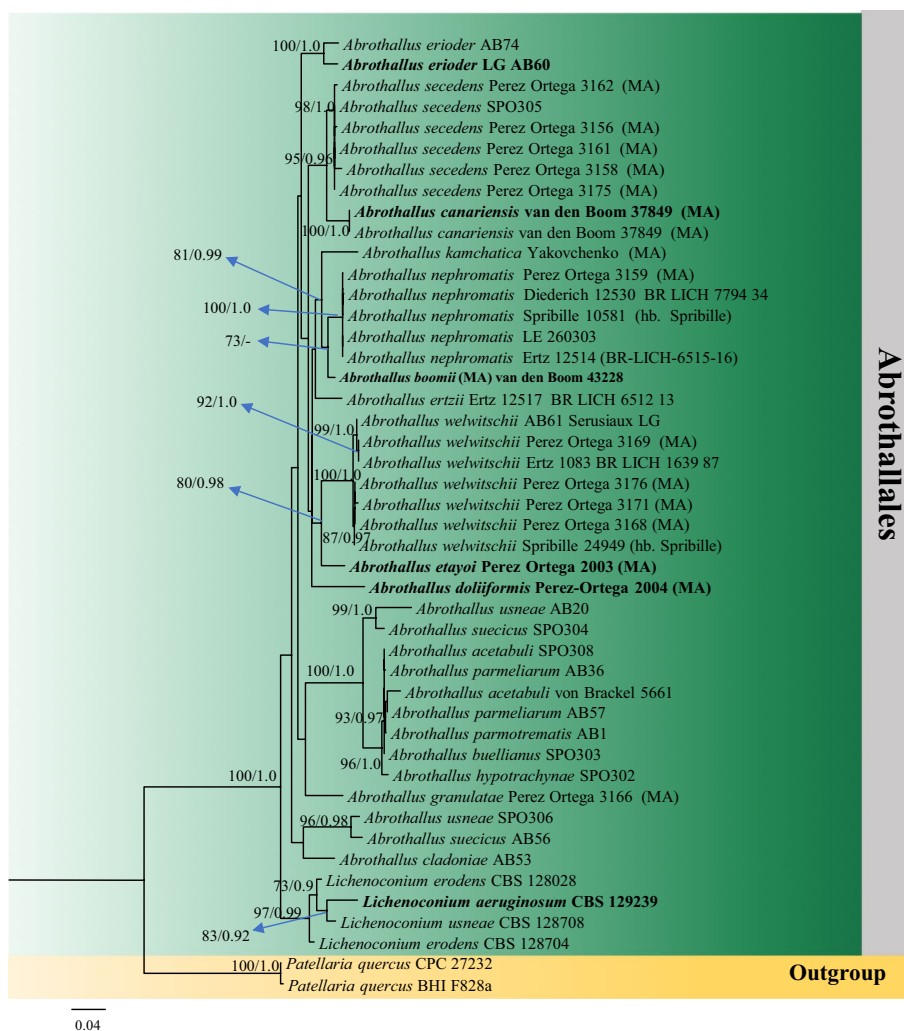
*Index Fungorum* number: IF 803667; *Facesoffungi* number: FoF 08046, 58 species.

*Parasitic* or parasymbiotic on lichen thalli. *Vegetative hyphae* immersed in lichen thallus, usually hyaline, I+ violet in some species. **Sexual morph**: *Ascomata* apothecioid, solitary or in groups, superficial, rounded, convex to almost globose, rarely flattened, black or dark brown, some species with greenish pruina, at least in young stages. *Proper exciple* thin, usually disappearing when mature, composed of radiating hyphae. *Hymenium* hyaline or greenish in upper part, covered with light to dark brown or reddish granules dissolving in KOH. *Hypothecium* light to dark brown, composed

of isodiametric cells (*textura angularis* type). *Hamathecium* comprising septate, anastomosed and irregularly dichotomously branching interascal filaments. *Asci* 4–8-spored, thick-walled, bitunicate, functionally fissitunicate, ovate to clavate, apedicellate, with a distinct ocular chamber, I-. *Ascospores* 2-seriate, irregularly or 2-seriately arranged within the ascus, ellipsoid to broadly ellipsoid, light to dark brown, 1- to 3-septate, asymmetric and soleiform, splitting into part-spores within the ascus in some species, wall finely ornamented to verrucose. **Asexual morph**: Coelomycetous. *Vouauxiomyces*-type, pycnidium immersed, semi-immersed or almost superficial, black, with a small ostiole. *Pycnidial wall* thick-walled, comprises isodiametric cells (*textura angularis*-type). *Conidiophores* reduced. *Conidiogenous cells* percurrently proliferating, ampulliform to lageniform, lining the cavity of the pycnidium, hyaline, smooth-walled. *Conidia* holoblastic, clavate to obpyriform or almost roundish, hyaline to dark brown, smooth to slightly echinulate, usually embedded in mucilage.

*Type*: *Lichenonium* Petr. & Syd.

**Fig. 1** Phylogram generated from maximum likelihood analysis (RAxML) of Abrothallales based on combined ITS, LSU and tef1 sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Patellaria quercus* (CPC 27232 and BHI F828a). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



*Notes:* Lawrey et al. (2011) studied the phylogenetic affinities of *Lichenocodium*, a genus of lichenicolous fungi known only in its asexual morph. They found that *Lichenocodium* is also a member of Dothideomycetes, and subsequently Hyde et al. (2013) introduced a new order Lichenoconiales to accommodate it. Pérez-Ortega et al. (2014) introduced *Abrothallaceae* and the new order Abrothallales for the lichenicolous genus *Abrothallus*. The classification of this genus had long been debated. This is one of the few Dothideomycetes genera having apothecioid ascomata, but the bitunicate asci and the shape of interascal filaments clearly segregates it from other similar groups (Pérez-Ortega et al. 2014). Pérez-Ortega et al. (2011) established the connection between the sexual morph *Abrothallus* and the asexual morph *Vouauxiomyces*. *Vouauxiomyces* and *Lichenocodium* share many features, such as the mode of conidiogenesis and shape of conidia (detailed descriptions in Hawksworth 1981b), although the conidia are hyaline in *Abrothallus* (except in *Abrothallus kamchatica*) and dark brown in *Lichenocodium*. Recent phylogenetic analyses recovered *Abrothallus* and *Lichenocodium* as sister genera, with a relatively young split (9 MYA) raising the question of the need to keep two separate orders (Liu et al. 2017). Diederich et al. (2018) in their review of lichenicolous fungi treated Lichenoconiales as a synonym of Abrothallales, and *Lichenocodiaceae* as a possible synonym of *Abrothallaceae*.

***Lichenocodium*** Petr. & Syd., Beih. Reprint nov. Spec. Regni veg. 42(1): 432 (1927) [1926].

*Index Fungorum number:* IF 8772; *Facesoffungi number:* FoF 08047; 16 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species:* ***Lichenocodium lichenicola*** (P. Karst.) Petr. & Syd. [as ‘lichenicolum’], Beih. Reprint nov. Spec. Regni veg. 42(1): 432 (1927) [1926].

≡ *Dactylium dendroides* subsp. *lichenicola* P. Karst., Meddn Soc. Fauna Flora fenn. 14: 107 (1887).

*Notes:* *Lichenocodium* species are distributed worldwide as lichenicolous taxa on a variety of lichen hosts (Lawrey et al. 2011; Hyde et al. 2013; Wijayawardene et al. 2017a; Diederich et al. 2018). Many are host-specific, while others occur on disparate genera (Lawrey et al. 2011). The asexual morph is characterized by coelomycetous, immersed to sessile, dark brown pycnidia, an undifferentiated pycnidial ostiole, simple conidia, globose to ellipsoid, basally often truncate, thick-walled, brown and commonly verrucose and conidiogenous cells that are hyaline or poorly pigmented, holoblastic, elongate and annellidic (Lawrey et al. 2011). The sexual morph has not been recorded.

#### Other genera included

***Abrothallus*** De Not. Giorn. Bot. Ital. 1: 194 (1846).

= *Vouauxiomyces* Dyko & D. Hawksw., Lichenologist 11(1): 57 (1979).

*Index Fungorum number:* IF 4; *Facesoffungi number:* FoF 08048; – 42 morphological species (Species Fungorum 2020), 20 species with molecular data.

*Type species:* ***Abrothallus bertianus*** De Not. Giorn. Bot. Ital. 1: 194 (1846).

*Notes:* De Notaris described *Abrothallus* as a lichenized taxon (De Notaris 1846, 1849). Tulasne (1852) and Lindsay (1857) unequivocally established its lichenicolous habit. Suija et al. (2018) fixed the nomenclatural problems concerning the exact date of publication, confirming *A. bertianus* as the type species. They also reviewed the material described by Giuseppe De Notaris, Søren Christian Sommerfelt, and Ignaz Kotte lectotypifying *Abrothallus* species described by these authors (Suija et al. 2018). These authors also introduced the combination *A. santessonii* (≡ *Vouauxiomyces santessonii*), providing an updated description for this taxon. Pérez-Ortega et al. (2011) established the connection between the sexual and asexual morphs. The number of species is tentative since there are numerous single collections occurring on unusual hosts that may represent new species and there are only a few collections from certain regions, e.g. from Africa and Asia. Recent studies focused on the taxonomy of species growing on Peltigerales (Suija et al. 2011, 2015). However, species delimitation, especially those on specimens growing on *Parmeliaceae*, is difficult and in need of a thorough revision (Suija et al. 2018). For morphology of the type species, see Suija et al. (2018) (Fig. 2).

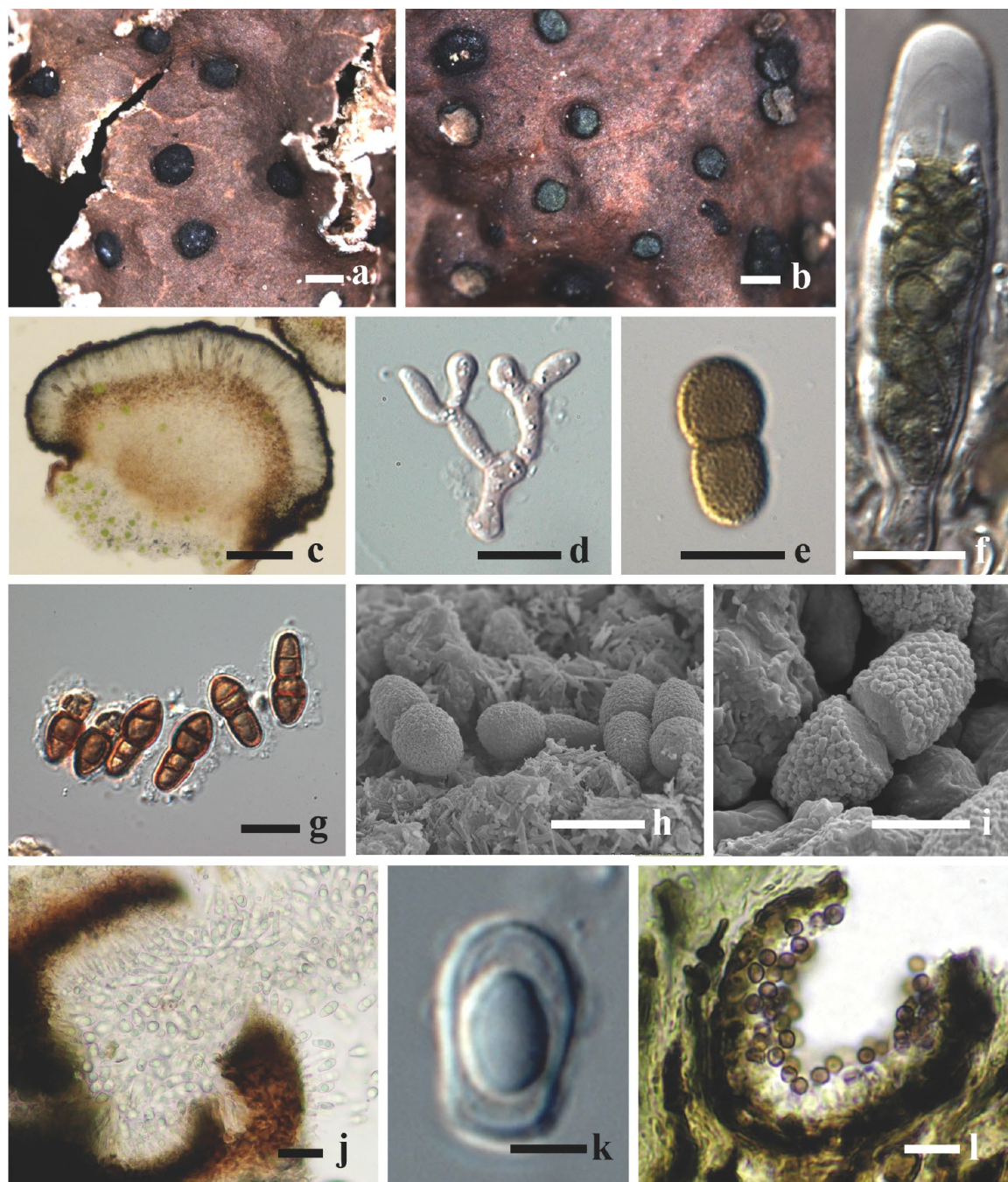
#### Economic and ecological significance

Species in *Abrothallaceae* are not harmful to plants or animals. However, their lichenicolous, parasymbiotic or parasitic lifestyles on macrolichens are interesting for biodiversity and ecological research.

**Acrospermales** Minter, Peredo & A.T. Watson.

*Index Fungorum number:* IF 90786; *Facesoffungi number:* FoF 06407.

Acrospermales was introduced by Minter (2007) to accommodate *Acrospermaceae*. The ordinal position of *Acrospermaceae* was previously unresolved and was referred to various orders by many authors. First, it was placed in Hysteriales or Dothideales in the 1st and 2nd editions of Ainsworth & Bisby’s Dictionary of the Fungi (Kirk et al. 2001). In the 3rd to 5th editions it was transferred to the Dothideales and in the 6<sup>th</sup> and 7<sup>th</sup> it was placed in the Ostropales and Clavicipitales, respectively. The family was also placed, rather hesitantly, in Pyrenulales by Eriksson (1982). Barr (1990) argued its ordinal position in more detail, and transferred it to Xylariales. Minter et al. (2007) introduced a new species in *Acrospermaceae* and discussed the ordinal position of *Acrospermaceae* with the introduction of Acrospermales. The divergence time for Acrospermales is estimated as 156 MYA (stem age, Hongsanan et al. 2020) (Fig. 3).



**Fig. 2** Morphological and anatomical features of *Abrothallaceae*. **a** Habitus *Abrothallus welwitschii*, mature apothecia. **b** Habitus *A. welwitschii*, young apothecia with greenish pruina. **c** Cross-section of *A. parmotremitis* on *Parmotrema* sp. **d** Interascal elements from *A. bertianus*. **e** One-septate ascospore of *A. welwitschii*, with surface showing ornamentation. **f** Ascus of *A. boomii*. **g** Three-septate ascospores

of *A. suecicus*. **h** Scanning electron micrograph of *A. welwitschii* ascospores. **i** Ascospore of *A. buellianus* showing occasional splitting at the septum. **j** *A. caerulescens* asexual stage (pycnidium, Vouauxiomyces-type). **k** Conidia from *A. boomii*. **l** *Lichenonidium* sp. on *A. santessonii* ascoma. Scale bars: **a–b** = 0.5 mm, **c** = 50  $\mu$ m, **d–h**, **k** = 10  $\mu$ m; **i** = 5  $\mu$ m, **j** = 30  $\mu$ m, **l** = 20  $\mu$ m

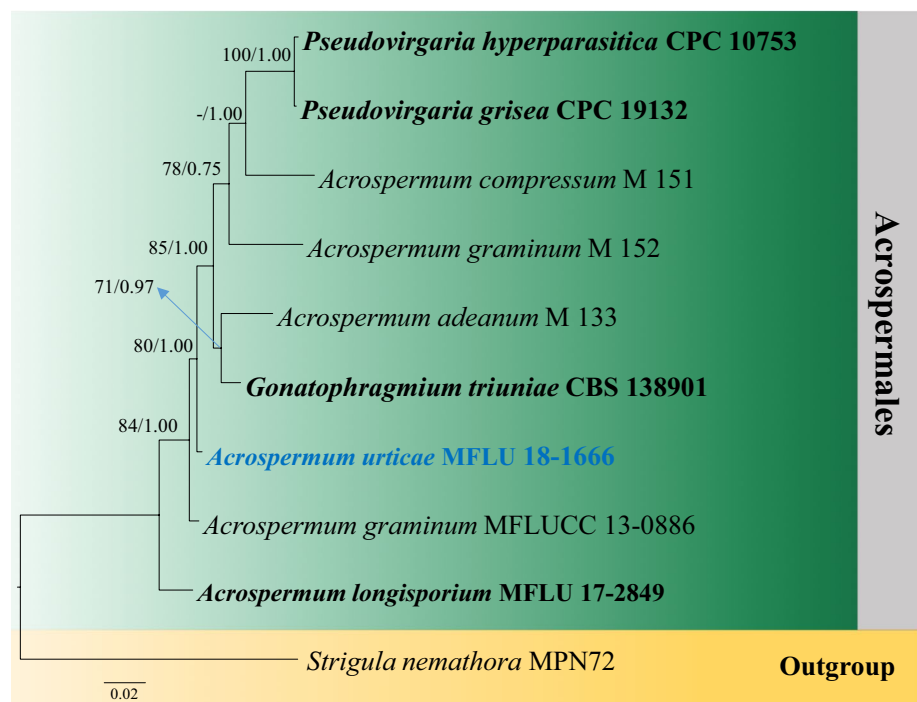
Accepted families: *Acrospermaceae*.

*Acrospermaceae* Fuckel, Jb. Nassau. Ver. Naturk. 23–24: 92 (1870) [1869–70].

*Index Fungorum* number: IF 80430; *Facesoffungi* number: FoF 06380, 52 species.

*Saprobic*, *epiphytic* or *symbiotic* on herbaceous plants. **Sexual morph:** *Ascomata* solitary or in groups, superficial or immersed in stromata, erect, elongate, with smooth or

**Fig. 3** Phylogram generated from maximum likelihood analysis based on combined LSU and SSU sequence data representing *Acrospermaceae*. *Strigula nemathora* (MPN72) (*Strigulaceae*, Pleosporales) is used as the outgroup taxon. Bootstrap values for maximum likelihood (ML) equal to or greater than 70% and clade credibility values greater than 0.90 (the rounding of values to 2 decimal proportions) from Bayesian-inference analysis are labeled on the nodes. Ex-type strains are in bold and black, the new isolate is indicated in bold and blue



sometimes rough surface, dark brown to black, flattened, club-shaped to conoid, with a short stipe, swelling when moist, ostiolate. *Peridium* comprising two or three layers, an outer layer composed of dark brown cells of *textura angularis*, a central layer, composed of hyaline, sometimes pale brown tissue of elongated cells intertwined, and an inner layer composed of dense tissue of small, light brown cells. *Hamathecium* comprising narrow, long, hyaline, filiform pseudoparaphyses. *Asci* typically 8-spored, bitunicate, long, narrowly cylindrical, pedicellate, apically rounded with an ocular chamber. *Ascospores* fasciculate, filiform, hyaline, multi-septate, almost as long as the asci, smooth-walled, not fragmenting, without sheath, typically intertwined in a fascicle within the ascus. **Asexual morph:** Hyphomycetous. *Conidiophores* micronematous, pale brown, septate, branched or unbranched. *Conidiogenous cells* holoblastic, sympodial with denticles, pale brown, smooth-walled. *Conidia* cylindrical, long ellipsoid, pale yellow, 1–3-septate, smooth-walled. **Type: *Acrospermum*** Tode.

**Notes:** *Acrospermaceae* was introduced with a single genus *Acrospermum* by Fuckel (1870) and since then its higher taxonomic placement has undergone various changes (Saccardo 1883; Rehm 1887; Ellis and Everhart 1892; Ainsworth et al. 1973; Barr 1990). The family was previously placed in the class Dothideomycetes family *incertae sedis*, due to its uncertain position (Hyde et al. 2013). Two genera, *Acrospermum* and *Oomyces* are currently accepted (Lumbsch and Huhndorf 2010; Wijayawardene et al. 2018). *Acrospermum* is characterised by erect, elongate, usually brown, superficial ascomata that are more or less club-shaped and are solitary or in small

groups, with long paraphyses which resemble ascospores. *Oomyces* is considered to be clavicipitalean (Diehl 1950) as it has conoid, yellowish white, multi-locular stromata, bitunicate asci and lacks pseudoparaphyses (Eriksson 1981). No monograph of the genus is available. Riddle (1920) reviewed *Acrospermum* and introduced *A. maxoni* and *A. graminum* var. *foliolum* based on asexual morphs. Presently, the asexual morphs of *Acrospermaceae* comprise members of *Dactylaria* and *Gonatophragmium* (Wijayawardene et al. 2018). *Dactylaria* was shown to be polyphyletic by Bussaban et al. (2005) and is heterogenous (Seifert et al. (2011)). *Gonatophragmium* was also found to be an asexual morph of *Acrospermum* by Kirk et al. (2008), but Seifert et al. (2011) did not assign it to any taxonomic rank. A Blast search of an LSU sequence of *Gonatophragmium triuniaie* showed closed hits to *Acrospermum adeanum* (Crous et al. 2014). We therefore, agree with Wijayawardene et al. (2018) and include *Gonatophragmium* in *Acrospermaceae* until further data becomes available. The hyphomycetous genus *Pseudovirgaria* was introduced by Shin et al. in Arzanlou et al. (2007), with *P. hyperparasitica* as type species. *Pseudovirgaria* is assigned to Capnodiales, genera *incertae sedis* in Index Fungorum (2020), while it was mentioned as Dothideomycetes genera *incertae sedis* in Wijayawardene et al. (2018). In our phylogenetic analysis, two species of *Pseudovirgaria* clustered in Acrospermales. *Pseudovirgaria* is a hyphomycetous genus and morphologically resembles *Gonatophragmium* in having cylindrical-clavate, thin-walled conidia. Therefore, we include *Pseudovirgaria* in *Acrospermaceae* based on phylogenetic evidence, and morphological resemblance to asexual genera of *Acrospermaceae*.

Descriptions and illustrations of the asexual morphs of *Acrospermaceae* can be seen in previous studies (i.e. Crous et al. 2014; Berger et al. 2015; Shamsi et al. 2017)

***Acrospermum*** Tode, Fung. mecklenb. sel. (Lüneburg) 1: 8 (1790).

*Index Fungorum number*: IF 54; *Facesoffungi number*: FoF 06381; 28 morphological species (Species Fungorum 2020), 8 species with molecular data.

*Type species*: ***Acrospermum compressum*** Tode, Fung. mecklenb. sel. (Lüneburg) 1: 8 (1790).

*Notes*: Tode (1790) introduced *Acrospermum* with *A. compressum* as the type species based on fruiting body and ostiole type. *Acrospermum* is characterised by superficial, club-like ascomata, bitunicate asci and fasciculate, filiform, hyaline, multi-septate ascospores (Riddle 1920). Species of *Acrospermum* are mostly saprobic and are distributed worldwide. The specimens of *A. compressum* were found on dry stems of *Heracleum sphondylium* in Germany. *Acrospermum compressum* can also be observed on dead stems of *Urtica dioica*, and *A. graminum* on grass culms. *Acrospermum aceanum* is a necrotrophic parasite and has been observed on 32 different moss species from 22 different genera, most of which belong to the pleurocarpous superorder Hypnanae (Döbbeler 1979; Bell and Newton 2004). The asexual morph of *Acrospermum* is phycomycetous (Wijayawardene et al. 2018).

***Acrospermum urticae*** D. Pem, Camporesi & K.D. Hyde, **sp. nov.**

*Index Fungorum number*: IF 556687; *Facesoffungi number*: FoF 06382; Fig. 4

*Etymology*: Name reflects the host from which the fungus is isolated.

*Holotype*: MFLU 18-1666.

*Saprobic* on dead stem of *Urtica dioica*. **Sexual morph**: *Ascomata* 940–1057 high  $\times$  301–345  $\mu\text{m}$  diam. ( $\bar{x}$  = 1021  $\times$  318  $\mu\text{m}$ ), solitary or in groups, superficial, club-shaped to conoid, erect, uni-locular, brown to blackish when dry, with a short stipe or sessile, flattened when dry, swelling when moist, ostiole large, apex rounded. *Peridium* 11–12  $\mu\text{m}$  in vertical section comprising three layers, an outer layer comprising dark brown cells of *textura angularis*, a central thick layer, comprising pale brown to hyaline tissue of gelatinized hyphae with elongated cells, and an inner layer comprising dense tissue of small, hyaline cells. *Hamathecium* comprising narrow, long, pseudoparaphyses. *Asci* 195–319  $\times$  6.2–6.7  $\mu\text{m}$  ( $\bar{x}$  = 252.5  $\times$  6.4  $\mu\text{m}$ ), 8-spored, bitunicate, narrowly cylindrical, pedicellate, with an ocular chamber. *Ascospores* 122–170  $\times$  1.1–1.2  $\mu\text{m}$  ( $\bar{x}$  = 146.2  $\times$  1.2  $\mu\text{m}$ ), fasciculate, filiform, hyaline, multi-septate, nearly as long as the asci, smooth-walled. **Asexual morph**: undetermined

*Material examined*: Italy, Ravenna [RA], San Cassiano di Brisighella, on dead aerial stem of *Urtica dioica*

(*Urticaceae*), 13 August 2018, Erio Camporesi (IT 3999, **holotype**; MFLU 18-1666, **isotype**).

*GenBank numbers*: LSU: MN597994, SSU: MN597996.

*Notes*: *Acrospermum urticae* differs from *Acrospermum longisporium* by its smaller ascomata (940–1057 high  $\times$  301–345  $\mu\text{m}$  diam. v.s. 1500–2000 high  $\times$  400–500  $\mu\text{m}$  diam.) and wider ascospores (122.1–175.3  $\times$  1.1–1.2  $\mu\text{m}$  v.s. 150–170  $\times$  0.5–1  $\mu\text{m}$ ). Phylogenetic analyses of a combined LSU, SSU sequence dataset show that *A. urticae* forms a distinct lineage in *Acrospermaceae* with strong ML and BYPP support (80% ML, 1.0 BYPP; Fig. 3). Therefore, we introduce *Acrospermum urticae* as a new species.

### Other genera included

***Gonatophragmium*** Deighton, in Cejp & Deighton, Mycol. Pap. 117: 13 (1969).

*Index Fungorum number*: IF 8376; *Facesoffungi number*: FoF 06486; – 17 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Gonatophragmium mori*** (Sawada) Deighton 1969, in Cejp & Deighton, Mycol. Pap. 117: 13 (1969).

$\equiv$  *Spondylocladium mori* Sawada, Spec. Bull. Agric. Exp. Station Formosa 19: 665 (1919).

*Notes*: *Gonatophragmium* was described in Cejp and Deighton (1969) with *G. mori* as the type species, a combination based on *Spondylocladium mori*. *Gonatophragmium mori* is a tropical-subtropical leaf-spotting species and is found on a wide range of hosts. Takahashi and Teramine (1986) considered *Acrospermum viticola* to be the sexual morph of this species, however this association was not proven by molecular data. *Gonatophragmium* is distinct in having pigmented, branched conidiophores formed as erect to decumbent threads with terminal and intercalary conidiogenous cells, which are regularly swollen around fertile portions with mostly numerous noticeable conidiogenous loci. The sexual morph of this genus is undetermined.

***Oomyces*** Berk. & Broome, Ann. Mag. nat. Hist., Ser. 2 7: 185 (1851).

*Index Fungorum number*: IF 8376; *Facesoffungi number*: FoF 06488; – 7 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Oomyces carneoalbus*** (Lib.) Berk. & Broome, Ann. Mag. Nat. Hist., Ser. 2 7: 185 (1851).

$\equiv$  *Sphaeria carneoalba* Lib., Pl. crypt. Arduenna, fasc. (Liège) 3(nos 201–300): no. 241 (1834).

*Notes*: *Oomyces* (= *Coscinaria* Ellis & Everh. 1886 *vide* Species Fungorum 2017) was introduced by Berk and Broome (1851), with *O. carneoalbus* as the type species. The genus is characterized by conoid, yellowish white, multi-locular stromata and lacks pseudoparaphyses (Eriksson 1981). *Oomyces* was described as similar to the egg of some insects,





**Fig. 4** *Acrospermum urticae* (IT 3999, holotype). **a–d** Ascomata on host surface. **e** Ascoma in vertical section **f** Peridium. **g–i** Narrowly cylindrical asci. **j–k** Filiform ascospores Scale bars: **a** = 2000  $\mu$ m, **b**,

**e** = 500  $\mu$ m, **c**, **d** = 300  $\mu$ m, **f**, **g** = 100  $\mu$ m, **h** = 25  $\mu$ m, **i** = 30  $\mu$ m, **j** = 50  $\mu$ m, **k** = 40  $\mu$ m

such as *Crioceris*, because its perithecia are visible as little dimples in the truncate apex of the fruiting body.

***Pseudovirgaria*** H.D. Shin, U. Braun, Arzanlou & Crous, in Arzanlou et al., Shin & Crous, Stud. Mycol. 58: 87 (2007)

*Index Fungorum number*: IF504564; *Facesoffungi number*: FoF 06487; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Pseudovirgaria hyperparasitica* H.D. Shin, U. Braun, Arzanlou & Crous, in Arzanlou et al., Stud. Mycol. 58: 87 (2007)

*Notes*: Phylogenetic analyses indicated that two species of *Pseudovirgaria* clustered within *Acrospermaceae* (Hudson

et al. 2019, this study). Morphologically, it resembles *Gonatophragmium* in having cylindrical-clavate, thin-walled conidia. Therefore, we agree with Hudson et al. (2019) to accept this genus in *Acrospermaceae*.

#### Economic and ecological significance

Species of *Acrospermaceae* are parasitic or endophytic and may play a negative role by infecting ferns. In Mexico, several species of *Terpsichore* (*T. subtilis* and *T. taxifolia*) are infected by *Acrospermum*, typically as black clavate stromata on the hosts.

**Asterinales** M.E. Barr ex D. Hawksw. & O.E. Erikss.

*Index Fungorum number*: IF 90461; *Facesoffungi number*: FoF 07605.

Asterinales contains epifoliar fungi which have superficial mycelium forming a network on host plants, 1-celled appressoria, with a star-like opening to the thyriothecium. The order was revised by Hongsanan et al. (2014b), however, its classification is unclear due to insufficient sequence data. Sequence data of Asterinales clustered in two unrelated clades in phylogenetic trees (Ertz et al. 2016; Hyde et al. 2016b; Liu et al. 2017). The clade containing the type species *Asterotexis cucurbitacearum* was treated as Astero-texales (Ertz et al. 2016). However, Hyde et al. (2016b) synonymized it under Asterinales *sensu stricto* because most Asterinales strains cluster in this clade. The other clade, including species of *Parmulariaceae* were treated as Asterinales *sensu lato* (Liu et al. 2017). *Parmulariaceae* was transferred to its own order Parmulariales by Dai et al. (2018).

Although the type species *Asterina melastomatis* and a few other Asterinales-like taxa fell within the clade Asterinales *sensu lato* (Ertz et al. 2016; Hyde et al. 2016b), we did not include these sequence data in our analysis. This is because Asterinales-like taxa forming in the Asterinales *sensu lato* need to be rechecked since other hyphomycetous strains were added into this clade, thus, there is possibility that these sequence data are not Asterinales. *Thyrinulaceae* is introduced to accommodate a clade sister to Parmulariales (= Asterinales *sensu lato*) with *Thyrinula* as generic type based on the rules of nomenclatural priority. Hongsanan et al. (2014b) synonymised *Lembosiaceae* under *Asterinaceae*, however, adding more sequence data for *Lembosia* (Fig. 5) indicates that *Lembosia* should be raised to a family in Asterinales.

By considering phylogenetic trees (Fig. 5), we retain *Lembosiaceae* in Asterinales and introduce *Morenoinaceae* and *Neobuelliellaceae* to accommodate the clades of *Morenoina* and *Neobuelliella*, respectively. Based on morphology and phylogeny, the current Asterinales comprises eight families. The classification of Asterinales is questionable and needs more morphological and molecular data to clarify its phylogenetic relationship. The divergence time for Asterinales is estimated as 221 MYA (stem age, Hongsanan et al. 2020).

*Accepted families*: *Asterinaceae*, *Asterotexaceae*, *Hemigraphaceae*, *Lembosiaceae*, *Melaspileellaceae*, *Morenoinaceae*, *Neobuelliellaceae* and *Stictographaceae*.

***Asterinaceae*** Hansf., Mycol. Pap. 15: 188 (1946).

*Index Fungorum*: IF 80492; *Facesoffungi number*: FoF 06726, >1000 species.

*Colonies* epiphyllous or hypophyllous. *Hyphae* superficial, straight to substraight, dark brown, reticulate, with appressoria. *Appressoria* 1-celled, mostly lateral, alternate to unilateral. **Sexual morph**: *Thyriothecia* superficial, flattened, with stellate or longitudinal dehiscence. *Upper walls* brown, comprising radial, septate cells of *textura prismatica*. *Asci* 8-spored, bitunicate,

ellipsoid, usually thickened at the apex. *Hamathecium* cellular pseudoparaphyses present or absent. *Ascospores* 2–5-seriate or fasciculate or conglobate, fusoid to ellipsoid, hyaline to dark brown, mostly 1-septate, smooth-walled or toughened. **Asexual morph**: Coelomycetous states with pycnidia or pycnothyria, and hyphomycetous states without conidiomata or sporodochia then gelatinous, pale. *Hyphae* brown, superficial, with appressoria. *Conidiomata* pycnothyria, flattened, dimidiate, radiate, orbicular, stellately dehiscent at the centre. *Conidiophores* branched or unbranched, hyaline or brown. *Conidiogenous* cells monoblastic or percurrent, hyaline or brown. *Conidia* ovate, pyriform, angular, or wall straight to sinuate, brown.

*Type*: ***Asterina*** Lév.

*Notes*: *Asterinaceae* was established as a member of Microthyriales by Hansford (1946). Members of the family typically have upper walls comprising radiating cells with star-like or longitudinal splits and dark brown hyphae with appressoria. There are 18 genera in this family based on morphology (Hongsanan et al. 2014b; Guatimosim et al. 2015; Wijayawardene et al. 2017a; Dai et al. 2018). Although Wijayawardene et al. (2017a) included *Echidnodes* in *Asterinaceae*, we exclude it from *Asterinaceae* as Hongsanan et al. (2014b) transferred this genus to *Aulographaceae*. Phylogenetic studies have several different interpretations of this family. In this study, we reappraise the phylogenetic relationship of *Asterinaceae* and related families based on all available sequence data and previous studies.

***Asterina*** Lév., Anns Sci. Nat., Bot., sér. 3 3: 59 (1845).

*Index Fungorum number*: IF 409; *Facesoffungi number*: FoF 06727; >1000 morphological species (Species Fungorum 2020), 9 species with molecular data.

*Type species*: ***Asterina melastomatis*** Lév., Anns Sci. Nat., Bot., sér. 3 3: 59 (1845).

*Notes*: *Asterina* was introduced as a member of *Sphaeriaceae* with *A. azarae*, *A. compacta*, *A. pulla* and the type *A. melastomatis*. It is the largest genus in *Asterinaceae*, but only nine species have sequence data available in GenBank due to its unculturable character. Members of the genus have circular thyriothecia with stellate dehiscence, lateral appressoria, globose asci, and dark brown, 1-septate ascospores.

***Asterina magnoliae*** X.Y. Zeng, T.C. Wen & K.D. Hyde, in Hyde et al., Mycosphere 9(2): 349 (2018).

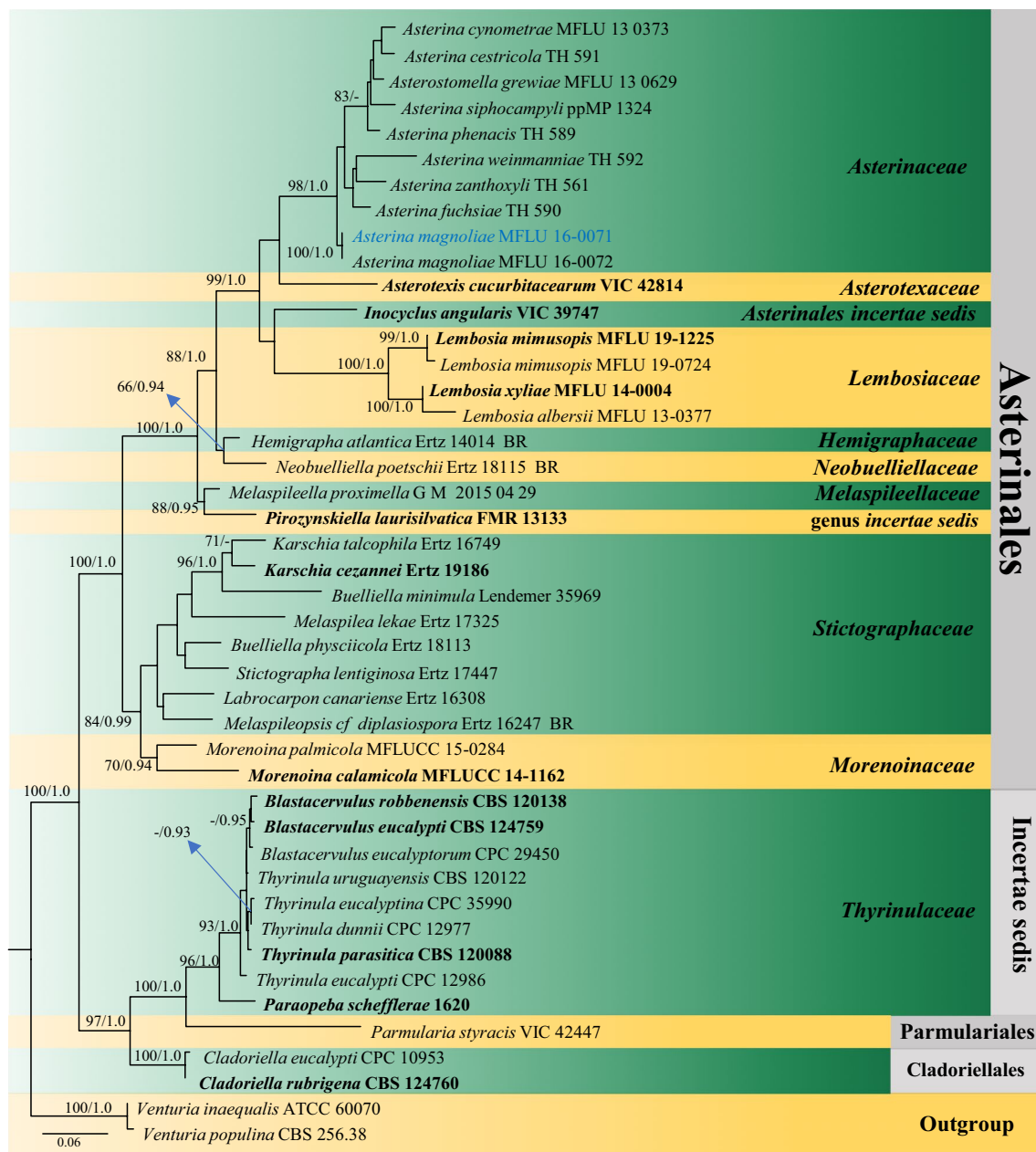
*Index Fungorum number*: IF 554238; *Facesoffungi number*: FoF 04089; Fig. 6

*Description*: see Hyde et al. (2018).

*Material examined*: Thailand, Chiang Mai, Mae Taeng, Pa Pae, Bahn Pa Deng, Mushroom Research Centre, 128 Moo 3, on living leaves of *Magnolia odora* (*Magnoliaceae*), 8 July 2015, Xiang-Yu Zeng (MFLU 16-0071).

*GenBank number*: LSU: MN629745.

*Notes*: Our new collection of *Asterina magnoliae* is identified by morphological characters (Fig. 6) and phylogenetic



**Fig. 5** Phylogram generated from maximum likelihood analysis (RAxML) of Asterinales based on LSU sequence data. Maximum likelihood bootstrap values equal to or greater than 70%, Bayesian posterior probabilities equal to or greater than 0.90 (MLBS/PP) are given at the nodes. Isolate numbers are noted after each species name.

The tree is rooted to *Venturia inaequalis* (ATCC 60070) and *Venturia populina* (CBS 256.38). Newly sequence data generated in this study are in blue. Ex-types are indicated in bold. Hyphen (-) represents support values less than 70% MLBS and 0.90 PP

evidence (Fig. 5). Hyde et al. (2018) provided a full description of this species.

#### Other genera included

*Asterinella* Theiss., Annl. mycol. 10(2): 160 (1912).

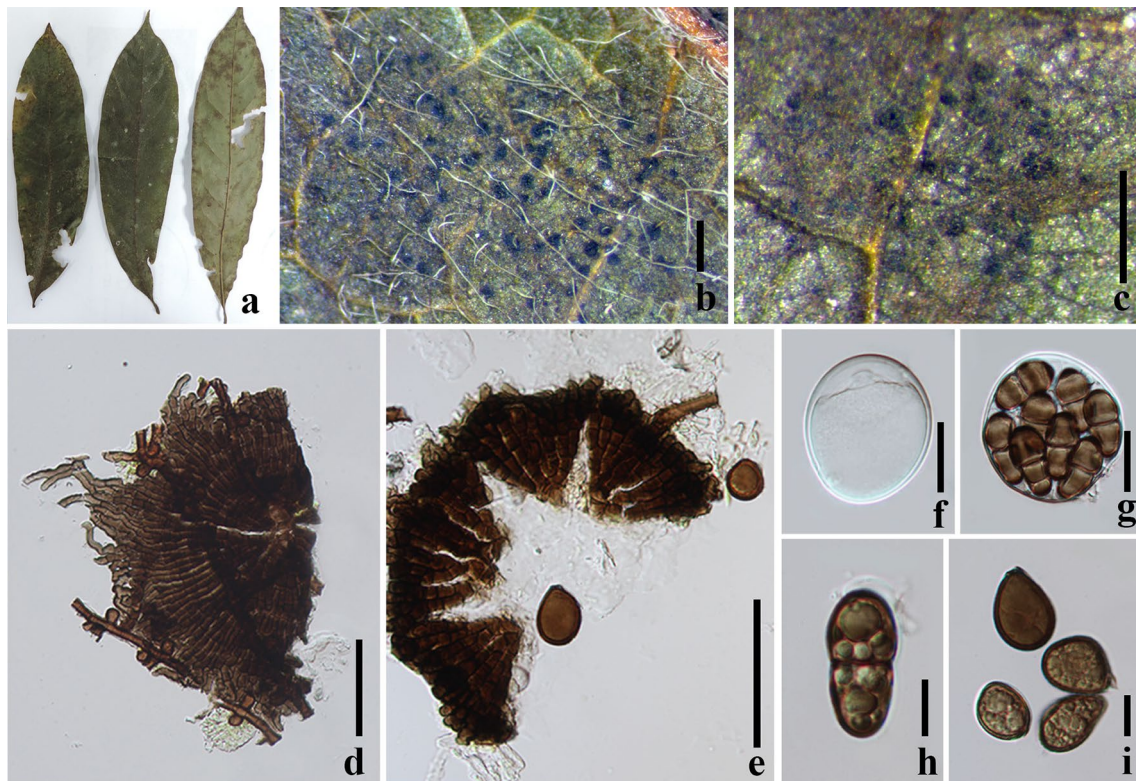
*Index Fungorum* number: IF 411; *Facesoffungi* number: FoF 06729; – 35 morphological species (Species Fungorum

2020), molecular data available for an unnamed species in the genus.

*Type species: Asterinella puiggarii* (Speg.) Theiss., Broteria, sér. bot. 10(2): 116 (1912).

≡ *Asterina puiggarii* Speg., Anal. Soc. cient. argent. 12(3): 99 (1881).

*Notes:* *Asterinella* was introduced as a member of *Microthyriaceae*. It is characterised by superficial hyphae with



**Fig. 6** *Asterina magnoliae* (MFLU 16-0071). **a** Host leaves. **b, c** Colonies on leaf surface. **d** Thyriothecium. **e** Pycnidium. **f** Young asci. **g** Mature asci. **h** Ascospores. **i** Pycnidia. Scales bars: **b–c** = 500  $\mu$ m, **d–e** = 50  $\mu$ m, **f–g** = 20  $\mu$ m, **h–i** = 10  $\mu$ m

intercalary appressoria and thyriothecia with a stellate ostiole. Wu et al. (2014) transferred it to *Asterinaceae* based on morphology.

*Asterolibertia* G. Arnaud 1918, Annals d'École National d'Agric. de Montpellier, Série 2 16(1–4): 165 (1918) [1917].

*Index Fungorum* number: IF 421; *Facesoffungi* number: FoF 06731; – 35 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Asterolibertia couepiae* (Henn.) G. Arnaud, Annals d'École National d'Agric. de Montpellier, Série 2 16(1–4): 165 (1918) [1917].

≡ *Asterina couepiae* Henn., Hedwigia 34: 104 (1895).

*Notes: Asterolibertia* is characterised by intercalary appressoria. Hongsanan et al. (2014b) synonymised *Asterolibertia* under *Asterina*, while Firmino et al. (2016) questioned the intercalary appressoria in *Asterolibertia* as not homologous to the lateral appressoria in *Asterina*. However, both justifications are based on morphology.

*Asterostomella* Speng., Anal. Soc. cient. argent. 22(4): 198 (1886).

*Index Fungorum* number: IF 7271; *Facesoffungi* number: FoF 06730; – 87 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Asterostomella paraguayensis* Speng., Anal. Soc. cient. argent. 22(4): 198 (1886).

*Notes: Asterostomella* is a coelomycetous genus characterised by brown, ovoid, aseptate pycnidia, sometimes with a non-pigmented band in the middle. The genus is considered as a member of *Asterinaceae* based on its scutellate conidiomata with stellate dehiscence, which is similar to *Asterina*.

*Batistinula* Arx, Publicações Inst. Micol. Recife 287: 4 (1960).

*Index Fungorum* number: IF 523; *Facesoffungi* number: FoF 06732; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Batistinula galleisae* Arx, Publicações Inst. Micol. Recife 287: 6 (1960).

*Notes: Batistinula* typically has 3-septate ascospores. A specimen that shares the same morphological and biometric characteristics of the type was collected and sequenced by Guatimosim et al. (2015). However, that fresh collection was found on a different host family, which may contradict the host-specificity of *Asterinaceae*.

*Cirsosia* G. Arnaud, Annals d'École National d'Agric. de Montpellier, Série 2 16(1–4): 127 (1918) [1917].

*Index Fungorum number*: IF 1065; *Facesoffungi number*: FoF 06734; – 15 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Cirsosia manaoensis* (Henn.) G. Arnaud [as ‘manaoensis’], *Annals d’École National d’Agric. de Montpellier*, Série 2 16(1–4): 127 (1918) [1917].

≡ *Lembosia manaoensis* Henn. [as ‘manaoensis’], *Hedwigia* 43(4): 265 (1904).

*Notes*: *Cirsosia* is mostly similar to *Lembosia* in having a linear fissure, but has intercalary appressoria.

***Dothidasteromella*** Höhn., *Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1* 119: 421 (1910).

*Index Fungorum number*: IF 1692; *Facesoffungi number*: FoF 06236; – 11 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Dothidasteromella sepulta* (Berk. & M.A. Curtis) Höhn., *Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1* 119: 421 (1910).

≡ *Asterina sepulta* Berk. & M.A. Curtis, *Proc. Amer. Acad. Arts & Sci.* 4: 129 (1860).

*Notes*: *Dothidasteromella* is mostly similar to *Echidnodella*, *Halbania* and *Uleothyrium* in lacking appressoria, but has Y-shaped dehiscence, 1-septate ascospores, and lack pseudoparaphyses.

***Echidnodella*** Theiss. & Syd., *Annls mycol.* 15(6): 422 (1918) [1917].

*Index Fungorum number*: IF 1731; *Facesoffungi number*: FoF 06761; – 33 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Echidnodella linearis* (Syd. & P. Syd.) Syd., *Annls mycol.* 15(6): 422 (1918) [1917].

≡ *Morenoella linearis* Syd. & P. Syd., *Annls mycol.* 15(3/4): 250 (1917).

*Notes*: *Echidnodella* is similar to *Lembosia* and *Cirsosia* in having linear fissures, but lacks appressoria and has cellular pseudoparaphyses.

***Halbania*** Racib., *Crypt. Par. Java*: no. 89 (1889).

*Index Fungorum number*: IF 2201; *Facesoffungi number*: FoF 06735; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Halbania cyathearum* Racib., *Crypt. Par. Java*: no. 89 (1889).

*Notes*: *Halbania* is mostly similar to *Batistinula* in having 3-septate ascospores, but lacks appressoria on the hyphae. Sequence data is needed to confirm its phylogenetic placement.

***Meliolaster*** Höhn., *Ber. dt. bot. Ges.* 35(10): 701 (1918).

*Index Fungorum number*: IF 3102; *Facesoffungi number*: FoF 06738; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Meliolaster clavisporus* (Pat.) Höhn., *Ber. dt. bot. Ges.* 35(10): 701 (1918).

≡ *Meliola clavisporea* Pat., *J. Bot., Paris* 4: 61 (1890).

*Notes*: Thyriothecia in *Meliolaster* are composed of radially arranged of cells, which open by star-like fissures when mature. *Meliolaster* is similar to *Batistinula* and *Halbania* in having 3-septate ascospores, but differs in the presence and shape of appressoria on the hyphae.

***Parasterinopsis*** Bat., *Atas Inst. Micol. Univ. Recife* 1: 327 (1960).

*Index Fungorum number*: IF 3722; *Facesoffungi number*: FoF 06739; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Parasterinopsis sersalisiae* (Hansf.) Bat., *Atas Inst. Micol. Univ. Recife* 1: 327 (1960).

≡ *Patouillardina sersalisiae* Hansf., *Proc. Linn. Soc. London* 156: 117 (1944) [1943–44].

*Notes*: *Parasterinopsis* is retained in *Asterinaceae* based on its thyriothecia with irregular fissures and the superficial hyphae with appressoria. However, it typically has cylindrical, 1–4-septate ascospores.

***Platypeltella*** Petr., in Sydow & Petrak, *Annls mycol.* 27(1/2): 62 (1929).

*Index Fungorum number*: IF 4178; *Facesoffungi number*: FoF 06741; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Platypeltella smilacis* Petr., *Annls mycol.* 27(1/2): 62 (1929).

*Notes*: *Platypeltella* was introduced as a member of *Microthyriaceae*. Wu et al. (2014) included it in *Asterinaceae* based on the superficial hyphae with intercalary capitate appressoria. *Platypeltella* is similar to *Asterinella*, but differs in having paraphyses and a round ostiole.

***Prillieuxina*** G. Arnaud, *Annals d’École National d’Agric. de Montpellier*, Série 2 16(1–4).

*Index Fungorum number*: IF 4365; *Facesoffungi number*: FoF 06742; – 62 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: *Prillieuxina winteriana* (Pazschke) G. Arnaud, *Annals d’École National d’Agric. de Montpellier*, Série 2 16(1–4): 162 (1918) [1917].

≡ *Asterina winteriana* Pazschke, *Hedwigia* 31(3): 104 (1892).

*Notes*: *Prillieuxina* is typical of *Asterinaceae* in having stellate fissures and brown, 1-septate ascospores. However, appressoria are very rare in *Prillieuxina*, and the cells of the upper walls are radially arranged as in *Microthyrium*.

Guatimosim et al. (2015) provided the only sequence for this genus.

***Pycnocarpon*** Theiss., Abh. K.K. Zool.-Bot. Ges. Wien 7(3): 31 (1913).

*Index Fungorum number*: IF 4564; *Facesoffungi number*: FoF 07606; – 4 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Pycnocarpon magnificum*** (Syd., P. Syd. & E.J. Butler) Theiss., Abh. K.K. Zool.-Bot. Ges. Wien 7(3): 31 (1913).

≡ *Asterina magnifica* Syd., P. Syd. & E.J. Butler, *Annls mycol.* 9(4): 391 (1911).

*Notes*: Wijayawardene et al. (2018) accepted this genus in Dothideomycetes *genera incertae sedis*. However, Doilom et al. (2018) included *Pycnocarpon* in *Asterinaceae* based on its superficial, web-like hypha, flattened thyriothecia, opening by radiating star-like or longitudinal splits, saccate asci, and conglobose, hyaline to brown, 1-septate ascospores strongly constricted at the septum (Doilom et al. 2018). We accept *Pycnocarpon* in *Asterinaceae* but note that the upper wall of ascomata of *Pycnocarpon* differs from members of *Asterinaceae* in having radially arranged, subglobose cells instead of cells of *textura prismatica*. Thus, sequence data is needed to confirm its placement.

***Schenckiella*** Henn., Bot. Jb. 17: 523 (1893).

*Index Fungorum number*: IF 4885; *Facesoffungi number*: FoF 06743; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Schenckiella marcgraviae*** Henn., Bot. Jb. 17: 523 (1893).

*Notes*: This is a very unusual genus with a unique combination of characters, with surface hyphae lacking appressoria, *Asterina*-like thyriothecia, elongated clavate asci, brown, cellular pseudoparaphyses, which are rarely observed in the Dothideomycetes, and 4–5-septate brown ascospores.

***Trichasterina*** G. Arnaud, *Annals d'École National d'Agric. de Montpellier*, Série 2 16(1–4): 172 (1918) [1917].

*Index Fungorum number*: IF 5544; *Facesoffungi number*: FoF 06744; – 11 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Trichasterina styracis*** (Theiss.) G. Arnaud, *Annals d'École National d'Agric. de Montpellier*, Série 2 16(1–4): 172 (1918) [1917].

≡ *Asterina styracis* Theiss., Abh. K.K. Zool.-Bot. Ges. Wien 7(3): 41 (1913).

*Notes*: *Thyriothecia* shares almost the same morphology as *Asterina*, but with setae on the hyphae. Whether such a character difference justifies separate genera should be tested using molecular data.

***Trichopeltospora*** Bat. & Cif., in Batista, Costa & Ciferri, *Publicações Inst. Micol. Recife* 90: 17 (1958) [1957].

*Index Fungorum number*: IF 5569; *Facesoffungi number*: FoF 06745; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Trichopeltospora pipericola*** Bat., Cif. & C.A.A. Costa, in Batista, Costa & Ciferri, *Publicações Inst. Micol. Recife* 90: 17 (1958) [1957].

*Notes*: *Trichopeltospora* was introduced as a member of *Microthyriaceae*. Wu et al. (2011b) transferred *Trichopeltospora* to *Asterinaceae* based on its irregular ostiole and appressoria on the hyphae. This transfer needs to be confirmed by phylogenetic analyses.

***Uleothyrium*** Petr., *Annls mycol.* 27(5/6): 388 (1929).

*Index Fungorum number*: IF 5661; *Facesoffungi number*: FoF 06762; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Uleothyrium amazonicum*** Petr., *Annls mycol.* 27(5/6): 388 (1929).

*Notes*: *Uleothyrium* is similar to *Platypeltella* in having rounded ostioles, which are distinct from any other genera in *Asterinaceae*. However, *Uleothyrium* lacks appressoria, while *Platypeltella* has intercalary appressoria.

***Vizellopsis*** Bat., J.L. Bezerra & T.T. Barros, *Publicações Inst. Micol. Recife* 637: 5 (1969).

*Index Fungorum number*: IF 5748; *Facesoffungi number*: FoF 06746; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Vizellopsis grevilleae*** Bat., J.L. Bezerra & T.T. Barros, *Publicações Inst. Micol. Recife* 637: 5 (1969).

*Notes*: *Vizellopsis* was introduced as a member of *Microthyriaceae*, and Lumbsch and Huhndorf (2010) included this genus in Dothideomycetes *incertae sedis*. Dai et al. (2014a) transferred *Vizellopsis* to *Asterinaceae* based on the small, black thyriothecia, forming below the dark brown mycelium, comprising radiating cells and a concentrically ridged surface, but strongly thickened and septate hyphae which is different from other genera of *Asterinaceae*.

### Economic and ecological significance

*Asterinaceae* species produce haustoria to gain nutrients from host plants without causing pathogenic damage. They may reduce photosynthesis by covering the host surface, and increase the temperature and respiration in those areas as do other black mildews.

***Asterotexaceae*** Firmino, O.L. Pereira & Crous [as '*Asterotexiaceae*'], in Guatimosim et al., *Persoonia* 35: 238 (2015).

*Index Fungorum number*: IF 548079; *Facesoffungi number*: FoF 07607, 2 species.

*Epiphytes, phytopathogens*, forming dark colonies irregular to star-shaped, solitary to confluent. *External mycelium* growing through ascomatal cavity or fusing with the host epidermis cells, septate, hyaline, smooth. *Appressoria* formed underneath the ascomata, solitary or forming in small clusters, globose, cone-shaped or ovoid to elongate, brown, with a central hyaline penetration peg. **Sexual morph:** *Ascomata* superficial to erumpent, scutellate, dimidiate, brown to black. *Scutellum* of radially arranged rows of cells, poorly developed base, opening by numerous irregular fissures. *Hamathecium* comprising septate, anastomosing, cellular pseudoparaphyses, embedded in a gelatinous matrix. *Asci* 8-spored, bitunicate, fissitunicate, oblong to cylindrical, with short and rounded pedicel or pedicel sometimes absent. *Ascospores* overlapping 2–3-seriate, ellipsoidal, hyaline to slightly yellowish, 1-septate, slightly constricted at the septum, upper cell broader than lower cell (adapted from Hongsanan et al. 2014b; Guatimosim et al. 2015). **Asexual morph:** Undetermined.

*Type:* *Asterotexis* Arx.

*Notes:* *Asterotexaceae* was established by Guatimosim et al. (2015), with the generic type *Asterotexis*. A phylogenetic tree provided by Guatimosim et al. (2015) showed that species of *Asterotexis* formed a distinct clade sister to the *Inocyclus angularis* (*Incertae sedis* clade). They introduced *Asterotexiales* to accommodate *Asterotexaceae* (Guatimosim et al. 2015). Ertz et al. (2016) indicated that the *Asterotexiales* clade contains *Asterotexis* species, *Inocyclus angularia* (*Parmulariaceae*) and some *Asterinales* species. However, the *Asterotexiales* clade in Ertz et al. (2016) was treated as *Asterinaceae sensu stricto* (Hyde et al. 2016b). *Asterotexales* was synonymized under *Asterinales* by Liu et al. (2017). In our phylogenetic analyses (Fig. 5), *Asterotexis* species cluster with the clade of *Asterina* species as an unstable clade. In another analysis, which did not include *Lembosia mimusopsis* (data not shown), *Asterotexis* clustered with *Inocyclus angularis* (*Incertae sedis* clade). Thus, we retain *Asterotexaceae* within *Asterinales* and note that more sequence data are needed to clarify its phylogenetic placement.

*Asterotexis* Arx, Fungus, Wageningen 28: 6 (1958).

*Index Fungorum number:* IF 430; *Facesoffungi number:* FoF 06766; 2 morphological species (Index Fungorum 2020), 1 species with molecular data.

*Type species:* *Asterotexis cucurbitacearum* (Rehm) Arx.

*Notes:* *Asterotexis* is a plant-pathogen found on leaves, and was identified as a member of *Asterinaceae* (Inácio and Cannon 2008; Guerrero et al. 2011; Hongsanan et al. 2014b). Morphologically and phylogenetically, the genus could not be placed in any family of *Asterinales* (this study). Thus, *Asterotexis* is placed in its own family, *Asterotexaceae*.

*Asterotexis cucurbitacearum* (Rehm) Arx [as ‘*cucurbitarum*’], Fungus, Wageningen 28: 6 (1958).

≡ *Dothidella cucurbitacearum* Rehm, Hedwigia 36(6): 376 (1897).

*Index Fungorum number:* IF 118911; *Facesoffungi number:* FoF 07608; Fig. 7

*Description:* see Hongsanan et al. (2014b).

*Material examined:* Brazil, Brazilia, Rio de Janeiro, on *Cucurbitaceae*, May 1887, E. Ule 676, Ex Herb. Sydow (SF7565, **holotype**); COSTA RICA, San José, Finca La Caja, on surface of leaves of *Sechium edule* (*Cucurbitaceae*), 25 March 1927, Det. J.A. Stevensen (S-F220847).

### Economic and ecological significance

Species in this family are phytopathogens. The appearance of colonies on leaves can mainly reduce the photosynthesis, respiration, disrupt other plants mechanism and can make host tissues become pale.

*Hemigraphaceae* D.Q. Dai & K.D. Hyde, in Dai et al., MycoKeys 369(2): 67 (2018).

*Index Fungorum number:* IF 554062; *Facesoffungi number:* FoF 03910, 9 species.

*Biotrophic* on lichens. **Sexual morph:** *Ascostromata* solitary to gregarious, superficial, stellate, irregularly opening from the centre to margin, conical in section, coriaceous, black to dark brown. *Peridium* comprises two layers, black and thick-walled cells of *textura angularis* in outer part, thin and light brown cells of *textura angularis* at inner layers. *Hamathecium* comprising few, brown, unbranched, filamentous, septate, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, clavate to cylindrical-clavate, subglobose, with an ocular chamber and a short pedicel. *Ascospores* 3-seriate to irregularly arranged, ellipsoid, brown, 1-septate, with larger upper cell and narrower lower cell, smooth-walled. **Asexual morph:** Undetermined.

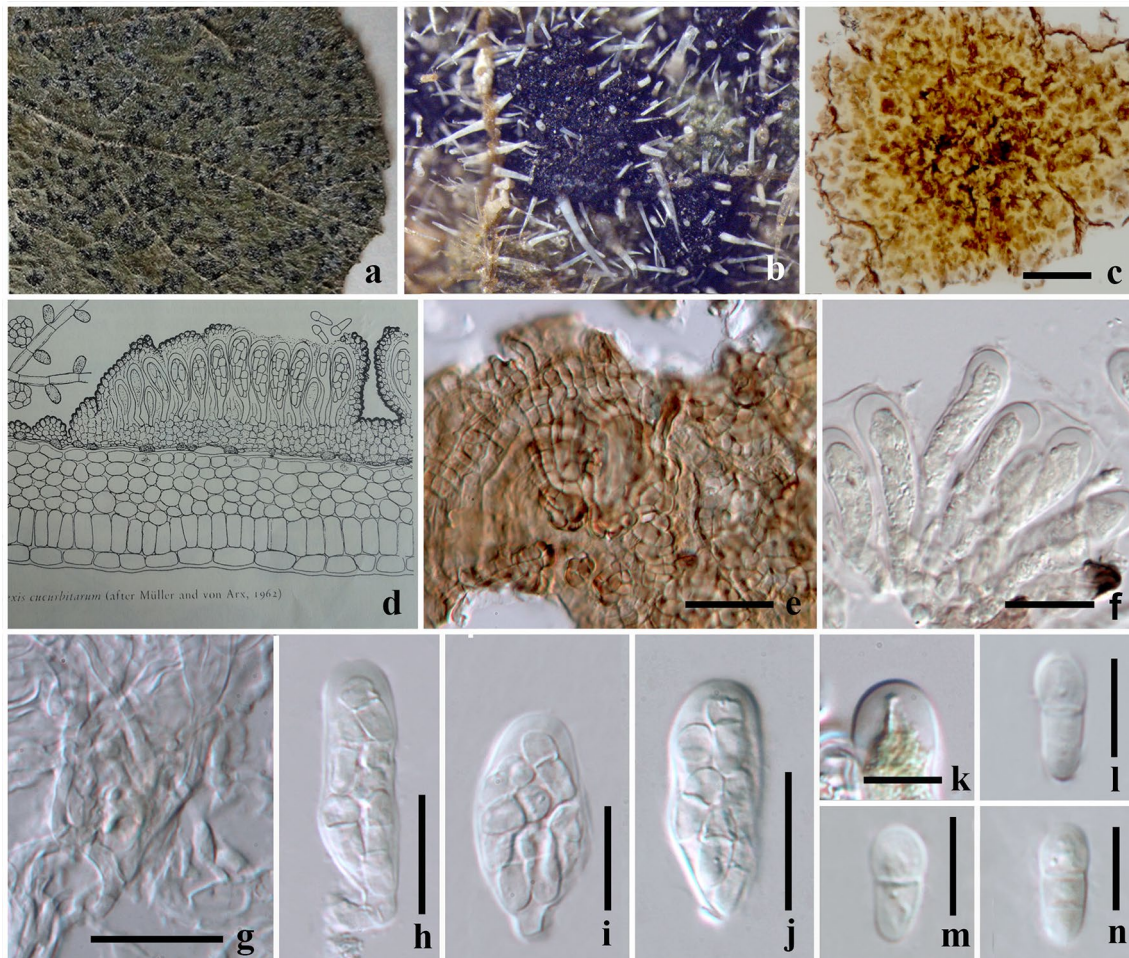
*Type:* *Hemigrapha* (Müll. Arg.) R. Sant. ex D. Hawksw.

*Notes:* Dai et al. (2018) studied the syntype of *Hemigrapha asteriscus* (≡ *Melanographa asteriscus*), and concluded that it is different from the family type of *Parmulariaceae*. Phylogenetically (LSU), *H. atlantica* forms a distinct lineage within *Asterinales* (Ertz and Diederich 2015; Dai et al. 2018; this study). Thus, *Hemigraphaceae* was established in *Asterinales* to accommodate a single genus *Hemigrapha* (Dai et al. 2018).

*Hemigrapha* (Müll. Arg.) R. Sant. ex D. Hawksw., Kew Bull. 30(1): 9 (1975).

≡ *Melanographa* sect. *Hemigrapha* Müll. Arg., Flora, Regensburg 65(33): 519 (1882).

*Index Fungorum number:* IF 2282; *Facesoffungi number:* FoF 02311; 8 morphological species (Index Fungorum 2020), 1 species with molecular data.



**Fig. 7** *Asterotexis cucurbitacearum* (a, b, d, f from S-F7565, **holo-**type and c, e, g–n from from S-F22084). **a** Herbarium specimen. **b** Ascomata on substrate. **c** Ascoma when viewed in squash mount. **d** Drawing from von Arx and Müller (1975). **e** Upper wall of ascoma. **f**

Asci. **g** Hamathecium. **h–j** Asci. **k** Ocular chamber strained in Melzer's reagent. **l, m** 1-septate ascospores. **n** 2-septate ascospore. Scale bars: **c** = 100  $\mu$ m, **e–j** = 20  $\mu$ m, **k–n** = 10  $\mu$ m

*Type species: Hemigrapha asteriscus* (Müll. Arg.) R. Sant. ex D. Hawksw., Kew Bull. 30(1): 191 (1975).

*Notes:* *Hemigrapha* was included in *Parmulariaceae* by Lumbsch and Huhndorf (2010), Hyde et al. (2013) and Wijayawardene et al. (2014a). However, it is dissimilar with the family type of *Parmulariaceae* having dark, superficial, star-shaped ascomata forming on a thallus of lichens (Diederich and Wedin 2000; Dai et al. 2018). Ertz and Diederich (2015) included *H. atlantica* in their phylogenetic analysis and indicated that this genus belongs to Asterinales based on LSU sequence data, without assigning the family placement. The same result was shown in Dai et al. (2018) and in this study (Fig. 5).

*Hemigrapha asteriscus* (Müll. Arg.) R. Sant. ex D. Hawksw., Kew Bull. 30(1): 191 (1975).

≡ *Melanographa asteriscus* Müll. Arg., Flora, Regensburg 65(33): 519 (1882).

*Index Fungorum number:* IF 530383; *Facesoffungi number:* FoF 02312; Fig. 8

*Description:* see Dai et al. (2018).

*Material examined:* Australia, New South Wales, Mount Kosciuszko, on thallus of *Peltigera dolichorrhiza* (Lichen). Müller J. 1882 (G 00292584, **syntype**).

#### Economic and ecological significance

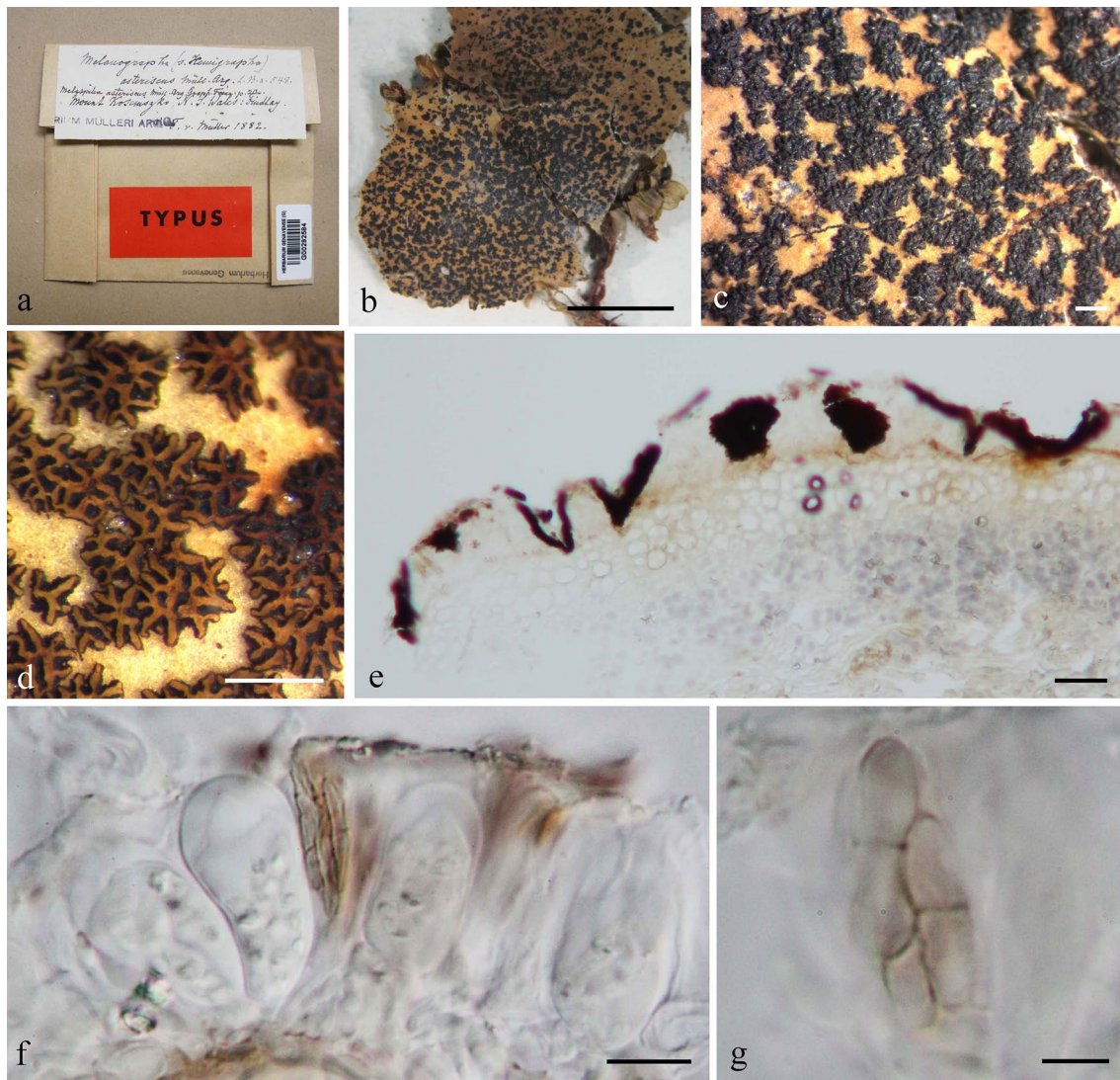
Members of this family are biotrophic on lichens and appear as black colonies on the host surface.

*Lembosiaceae* Hosag, in Hosagoudar et al., J. Mycopathol. Res. 39(1): 61 (2001).

*Index Fungorum number:* IF 80503; *Facesoffungi numbers:* FoF 07609, 160 species.

*Epiphytic* on living leaves. Superficial hyphae with lateral appressoria. **Sexual morph:** *Thyriothecia* solitary, scattered, superficial, oval, ellipsoidal, X- or Y-shaped, easily removed





**Fig. 8** *Hemigrapha asteriscus* (G 00292584, syntype). **a, b** Herbarium material. **c, d** Appearance of ascostromata on host surface. **d** Ascostromata in the water. **e** Section of ascostroma. **f** Asci with

hamathecial tissues. **g** Ascospores. Scale bars: **b** = 10 mm, **c, d** = 500  $\mu$ m, **e** = 50  $\mu$ m, **f, g** = 5  $\mu$ m

from the host surface, black, opening by a linear fissure, with basal peridium poorly developed. *Upper wall* comprising linear, dark cells, which are branched at the margin. *Hamathecium* comprising vertical asci inclined upwards, pseudoparaphyses not observed. *Asci* bitunicate, fissitunicate dehiscence not observed, subglobose to ovoid, apedicellate, apical region of asci usually with a thick opaque region, ocular chamber not observed, not staining blue in IKI. *Ascospores* overlapping, oblong to obvoid, hyaline to brown, 1-septate. **Asexual morph:** Undetermined.

**Type:** *Lembosia* Lév.

**Notes:** Hosagoudar et al. (2001) introduced *Lembosiaceae* using the morphological character of elongate thyriothechia with longitudinal or X- or Y-shaped slits (Hongsanan et al. 2014b). However, Hongsanan et al. (2014b) treated

*Lembosiaceae* as a synonym of *Asterinaceae* based on the first phylogenetic evidence of LSU sequence data of *Lembosia albersii*. Here, we re-introduced *Lembosiaceae* using sequence data currently available in GenBank.

***Lembosia*** Lév., *Annls Sci. Nat., Bot., sér. 3* 3: 58 (1845).

**Index Fungorum number:** IF 2724; **Facesoffungi number:** FoF 06736, – 160 morphological species (Species Fungorum 2020), 6 species with molecular data

**Type species:** *Lembosia tenella* Lév., *Annls Sci. Nat., Bot., sér. 3* 3: 58 (1845).

**Notes:** Species of *Lembosia* and *Asterina* are obligately biotrophic, having appressoria and similar thyriothechia (Hosagoudar et al. 2001). However, *Lembosia* differs from *Asterina* in having elongate thyriothechia which dehiscence to

open by a longitudinal or X- or Y-shaped slit (Hosagoudar 1991).

***Lembosia xyliæ*** X.Y. Zeng, T.C. Wen & K.D. Hyde, in Ariyawansa et al., *Fungal Diversity*: 75: 50 (2015).

*Index Fungorum number*: IF 551345; *Facesoffungi number*: FoF 00933, Fig. 9

*Description*: see Ariyawansa et al. (2015a).

*Material examined*: Thailand, Chiang Rai, Mae Fah Luang University, on leaves of *Xylia* sp. (*Fabaceae*), 18 January 2014, XY Zeng (MFLU 14-0004, **holotype**).

### Economic and ecological significance

Species in *Lembosiaceae* are considered as obligatory biotrophs, however, there are no records available to show its economic significance.

***Melaspileellaceae*** D.Q. Dai & K.D. Hyde, in Dai et al., *Phytotaxa* 369(2): 70 (2018).

*Index Fungorum number*: IF 554063; *Facesoffungi number*: FoF 03911, 1 species.

*Saprobic* on trees and shrubs. **Sexual morph**: *Ascostromata* solitary, superficial, dark to black, coriaceous, small rounded. *Peridium* comprises 2 layers, black and thick-walled cells at outer layers, light brown to hyaline cells of *textura angularis* of inner layers. *Hamathecium* comprising

dense, hyaline, mainly unbranched, filamentous, septate, cellular pseudoparaphyses around asci, with brownish tips. *Asci* 8-spored, bitunicate, broadly clavate to subglobose, with a rounded apex and a short pedicel. *Ascospores* 2-seriate to irregularly arranged, ellipsoid, hyaline, 1-septate, with slightly larger upper cell, with slightly narrower lower cell, smooth-walled, bearing 2–3 appendages which disappear when dry. **Asexual morph**: Undetermined (adapted from Dai et al. 2018).

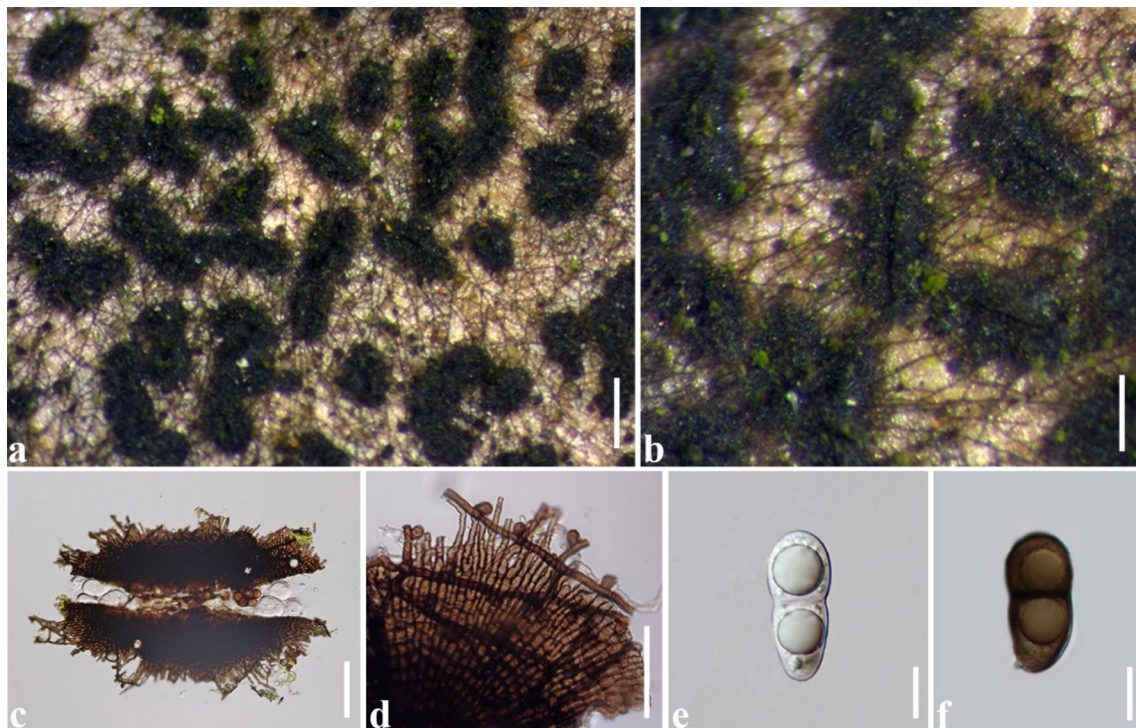
*Type*: ***Melaspileella*** (P. Karst.) Vain.

*Notes*: This family was established by Dai et al. (2018) to accommodate a single genus *Melaspileella* based on phylogenetic placement generated from LSU and SSU of *M. proximella*. The family formed a clade sister to *Hemigraphaceae* within Asterinales with high bootstrap support in Dai et al. (2018), while sister to *Pirozynskiella laurisilvatica* (FMR 13133) genus *incertae sedis* in Asterinales in our analyses (Fig. 5). Thus, we retain *Melaspileellaceae* in Asterinales.

***Melaspileella*** (P. Karst.) Vain., *Ann. Acad. Sci. fenn.*, Ser. A 15(no. 6): 317 (1921).

= *Mycomelaspilea* Reinke, in Pringsheim, *Jb. wiss. Bot.* 28: 136 (1895).

*Index Fungorum number*: IF 3095; *Facesoffungi number*: FoF 07733; 1 morphological species (Species Fungorum 2020), 1 species with molecular data.



**Fig. 9** *Lembosia xyliæ* (MFLU 14-0004, **holotype**). **a, b** Colonies on leaf surface. **c** Squash mount of ascomata with asci. **d** Upper walls and hyphae with hyphopodia. **e** Immature ascospores. **f** Mature

ascospores. Scale bars: **a** = 400  $\mu$ m, **b** = 200  $\mu$ m, **c** = 100  $\mu$ m, **d** = 50  $\mu$ m, **e–f** = 10  $\mu$ m

*Type species: Melaspileella proximella* (Nyl.) Ertz & Diederich.

*Notes:* *Melaspileella* was introduced by Vainio (1921b). Ertz and Diederich (2015) lectotypified the genus with *M. proximella*. They also transferred the genus to Asterinales without assigning it to any family. A phylogenetic tree based on LSU and SSU sequence data in Dai et al. (2018) indicated that *M. proximella* should be assigned in a new family, *Melaspileellaceae*.

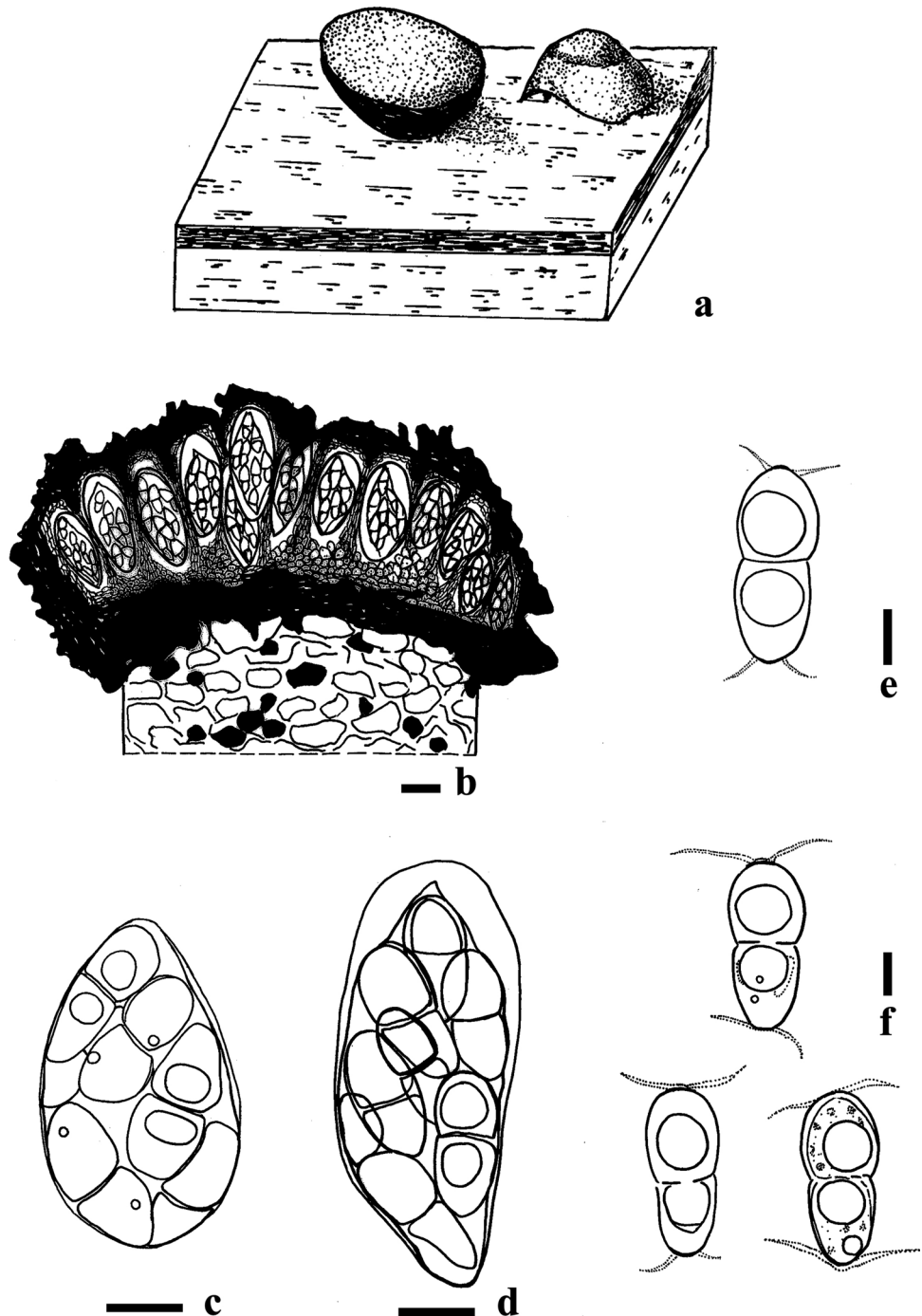
*Melaspileella proximella* (Nyl.) Ertz & Diederich, Fungal Diversity 71: 161 (2015).

≡ *Arthonia proximella* Nyl., Lich. Scand. (Helsinki): 262 (1861).

*Index Fungorum number:* IF 811374; *Facesoffungi number:* FoF 07610; Fig. 10

*Description:* see Zeller and Tóth (1960).

**Fig. 10** *Melaspileella proximella*. **a** Fruiting body on host (redrawn from ERD-7986. Photo: Enrique Rubio). **b** Section through ascoma, in water (redrawn from Finland, H-NYL 4827, **lectotype**). **c** Ascus with ascospores, in water (redrawn from Finland, H-NYL 4827, **lectotype**). **d** Ascus with ascospores (Hungary, on *Juniperus*, Zeller & Tóth 2835, BP – paratype of *Banhegyia setispora*). **e** Ascospore with polar setulae, in water (redrawn from Belgium, Ertz 19187). **f** Ascospore with polar setulae (redrawn from Finland, Nylander, H – **lectotype**). Scale bars: **b** = 20  $\mu\text{m}$ , **c**, **d** = 10  $\mu\text{m}$ , **e**, **f** = 5  $\mu\text{m}$



### Economic and ecological significance

Members of this family are saprobic on plants and involved in recycling organic matter. *Melaspilella proximella* grows on trees and shrubs including trunks of *Pinus* and *Tilia*, and twigs of *Juniperus* (Ertz and Diederich 2015).

### *Morenoinaceae* Hongsanan & K.D. Hyde, **fam. nov.**

*Index Fungorum number*: IF 557813; *Facesoffungi number*: FoF 07611, 26 species.

*Saprobic* on stem or leaves, forming blackened areas.

**Sexual morph**: *Thyriothecia* solitary, aggregated, or gregarious, superficial, easily removed from the host surface, black, ellipsoid, oblong, curved, opening by X- or Y-shaped or linear fissures, branched at the margin, from the center to the outer rim, lacking free hyphae and appressoria at the margin. *Upper wall* comprising linear, dark cells, which are branched at the margin, radiating from the center to the outer rim. *Hamathecium* pseudoparaphyses not observed. *Asci* 8-spored, bitunicate, fissitunicate dehiscence not observed, subglobose to oblong or saccate to globose, apedicellate, ocular chamber not observed, or with a distinct, thickened apical region. *Ascospores* overlapping 2–3-seriate, oblong to obovoid, or fusiform, hyaline, 1-septate, constricted at the septum, with or without guttules, smooth-walled (Hongsanan et al. 2014b; Tibpromma et al. 2017). **Asexual morph**: Coelomycetous. “*Sirothyriella*”, *Pycnothyria* circular, radially scutellate. *Conidiogenous cells* holoblastic, simple, hyaline. *Conidia* cylindrical, hyaline, 1-celled (asexual morph from Sivanesan 1984; drawing of asexual characters can be seen in Ellis 1980).

*Type*: *Morenoina* Theiss.

*Notes*: *Morenoinaceae* resembles *Aulographaceae* (Hongsanan et al. 2014b). In our phylogenetic analyses (Fig. 5), *Morenoina calamicola* is closely related to *Morenoina palmicola* (MFLUCC 15-0284) with 67% ML and 0.93 BYPP support as a distinct clade within Asterinales. Therefore, we introduce *Morenoinaceae* to accommodate the *Morenoina* clade.

*Morenoina* Theiss., *Annl. mycol.* 11(5): 434 (1913).

= *Aulographella* Höhn., *Ber. dt. bot. Ges.* 35: 359 (1917).

*Index Fungorum number*: IF 3270; *Facesoffungi number*: FoF 07612, 26 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: *Morenoina antarctica* (Speg.) Theiss.

*Notes*: *Morenoina* was placed in *Leptopeltidaceae* and *Asterinaceae* (von Arx and Müller 1975; Lumbsch and Huhndorf 2010). Hongsanan et al. (2014b) designated an epitype and placed this genus in *Aulographaceae* as *Morenoina* did not have free hyphae with appressoria as other members of *Asterinaeae* and it has different ascus form from members of *Leptopeltidaceae*. *Morenoina* resembles *Aulographum* and differs only in the morphology of the

scutellum which comprises inordinately arranged cells and a hypostroma of subcuticular hyphae beneath the thyriothecium, which is lacking in *Morenoina* (Ellis 1980). Phylogenetic placement of *Aulographaceae* is uncertain due to lack of sequence data. Sequence data of *Aulographum hederiae* (type species) formed an unstable clade, while two species of *Morenoina* form a distinct clade within Asterinales (Fig. 5). Therefore, we place *Morenoina* in the new family *Morenoinaceae*.

*Morenoina antarctica* (Speg.) Theiss., *Annl. mycol.* 11(5): 434 (1913).

≡ *Morenoella antarctica* Speg., *Boln Acad. nac. Cienc. Córdoba* 11(2): 240 (1887) [1888].

*Index Fungorum number*: IF 174884; *Facesoffungi number*: FoF 07613; Fig. 11

*Material examined*: Argentina, Tierra del Fuego, Ushuaia, south of Paso e Garibaldi, on the stem of Gramineae, 29 October 1989, collected by P.F. Cannon and D.W. Minter, identified by P.F. Cannon (IMI 349680, **epitype**).

### Economic and ecological significance

Species of this family are saprobic and play a role in recycling organic matter.

### *Neobuelliellaceae* Hongsanan & K.D. Hyde, **fam. nov.**

*Index Fungorum number*: IF 558103;

*Facesoffungi number*: FoF 07614, 1 species.

*Lichenicolous*. *Vegetative hyphae* intercellular. **Sexual morph**: *Ascomata* apothecioid, dispersed over the host thallus as black dots, grouped, rarely single, rounded, globose when young, pressed at the edges, oval when mature, often bleaching the host thallus, occasionally sunken. *Excipulum* dark brown, K+ greenish-brown. *Hymenium* hyaline to brownish. *Disc* olive-brown, I-, KI-. *Hamathecium* comprising branched, anastomosing, cellular pseudoparaphyses, capitate at apical and intercalary cells with pigment, thick at tips, with dark-brown pigment. *Asci* 4–6-spored, bitunicate, fissitunicate, cylindrical. *Ascospores* long, cells rounded, the upper cell sometimes tapered, hyaline, later ± brown, 1-septate, clearly constricted at the septa, thin-walled (adapted from Hafellner et al. 2008; Etayo 2010; Yazici and Etayo 2013). **Asexual morph**: Undetermined.

*Type*: *Neobuelliella* Hongsanan & K.D. Hyde

*Notes*: *Neobuelliellaceae* is similar to species of *Buelliella* which are placed in genus *incertae sedis* in Dothideomycetes. *Buelliella minimula* (type species) together with *B. physciicola* cluster within *Stictographaceae* (Asterinales) in the phylogenetic analyses of Dai et al. (2018) and this study. Two strains of *Neobuelliella poetschii* (≡ *Buelliella poetschii*) form a distinct clade separately from *Stictographaceae*, and are sister to *Hemigraphaceae* (Ertz et al.



**Fig. 11** *Morenoina antarctica* (IMI 349680, **epitype**). **a, b** Herbarium and specimen. **c, d** Appearance of thyriothecia on surface of plant. **e** Squash mount of thyriothecium. **f** Upper wall of thyriothecium. **g–h** Asci when immature. **i** Asci at maturity. **j–l** Ascospores. Scale bars: **e** = 100  $\mu$ m, **f** = 50  $\mu$ m, **g–l** = 20  $\mu$ m

2015; Dai et al. 2018; this study). Therefore, we introduce a new family *Neobuelliellaceae* to accommodate this clade.

***Neobuelliella*** Hongsanan & K.D. Hyde, **gen. nov.**

*Index Fungorum number*: IF 557815; *Facesoffungi number*: FoF 07615; 1 morphological species (this study), 1 species with molecular data.

*Lichenicolous*. *Vegetative hyphae* intercellular. **Sexual morph**: *Ascomata* apothecioid, dispersed over the host thallus as black dots, grouped, rarely single, rounded, globose when young, pressed at the edges, oval when mature, often bleaching the host thallus, occasionally sunken. *Hymenium* hyaline to brownish. *Disc* olive-brown, I-, KI-. *Excipulum* dark brown, K+ greenish-brown. *Hamathecium* comprising branched, anastomosing, cellular pseudoparaphyses, capitate at apical and intercalary cells with pigment, thick at tips, with dark-brown pigment. *Asci* 4–6-spored, bitunicate, fissitunicate cylindrical. *Ascospores* long, cells rounded, the upper cell sometimes tapered, hyaline, later  $\pm$  brown, 1-septate, clearly constricted at the septa, thin-walled (Hafellner

et al. 2008; Etayo 2010; Yazici and Etayo 2013). **Asexual morph**: Undetermined.

*Type species*: ***Neobuelliella poetschii*** (Hafellner) Hongsanan & K.D. Hyde.

*Notes*: The genus is introduced to accommodate *Neobuelliella poetschii* which was known as *Buelliella poetschii*.

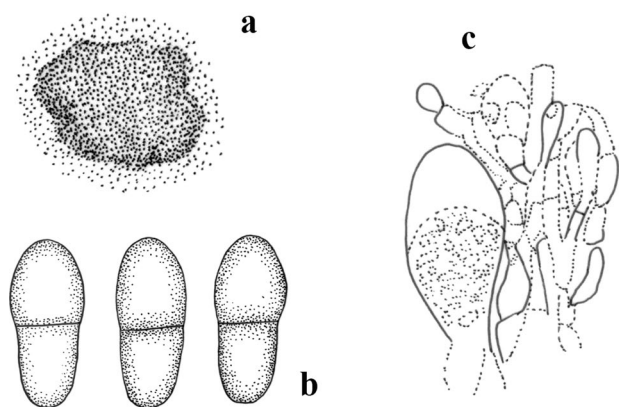
Phylogenetic analyses from Dai et al. (2018) and this study (Fig. 5) indicate that it does not cluster with the type species of *Buelliella*. Thus, we introduce the new genus *Neobuelliella* to accommodate a single species *Buelliella poetschii* (current name is *Neobuelliella poetschii*).

***Neobuelliella poetschii*** (Hafellner) Hongsanan & K.D. Hyde, **comb. nov.**

$\equiv$  *Buelliella poetschii* Hafellner, in Hafellner, Herzog & Mayrhofer, Mitt. naturw. Ver. Steierm. 137: 187 (2008).

*Index Fungorum*: IF 557814, *Facesoffungi number*: FoF 07616; Fig. 12

*Description*: see Yazici and Etayo (2013).



**Fig. 12** *Neobuelliella poetschii*. **a** Apothecioid ascomata (redrawn from Yazici and Etayo 2013). **b** Ascospores (redrawn from **holotype** in Hafellner et al. 2008). **c** Young ascus among hamathecium (redrawn from Ertz and Diederich 2015)

**Notes:** Phylogenetically, *Buelliella poetschii* formed a distinct lineage within Asterinales, and did not cluster with *B. minimula* (type species of *Buelliella*). Thus, *B. poetschii* is synonymized in *Neobuelliella*.

#### Economic and ecological significance

*Neobuelliellaceae* comprises lichenicolous taxa which play insignificant roles in ecosystems. There is only a single species in this family. Fresh collections are needed to understand the ecological significance of *Neobuelliellaceae*.

**Stictographaceae** D.Q. Dai & K.D. Hyde, in Dai et al., MycoKeys 369(2): 70 (2018).

**Index Fungorum number:** IF 554064; **Facesoffungi number:** FoF 03912, 39 species.

**Lichenicolous. Sexual morph:** Ascomata solitary, scattered to clustered, superficial, cymbiform to lirelliform, with slit-like disc, with a slit or star-shaped fissure, black to dark brown. *Peridium* thick, outer layers of black to dark brown, thick-walled cells of *textura angularis*, inner layers of light brown to hyaline cells of *textura angularis*. *Hamathecium* comprising dense, filamentous, septate, unbranched or occasionally branched at upper part around the asci, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, clavate to subglobose, with an ocular chamber, apically rounded, short pedicellate. *Ascospores* 2-seriate to irregularly arranged, ellipsoid, hyaline, becoming light brown to dark brown, 1-septate, with slightly larger upper cell, and narrower lower cell, smooth-walled. **Asexual morph:** Undetermined (Dai et al. 2018).

**Type:** *Stictographa* Mudd.

**Notes:** *Stictographaceae* was introduced to accommodate four lichenicolous or saprobic genera which have cymbiform to lirelliform, or a slit-like discs, black to dark brown ascomata, wide clavate to subglobose asci, and ellipsoid, brown,

1-septate ascospores (viz. *Karschia*, *Labrocarpon*, *Melaspileopsis* and *Stictographa*; Dai et al. 2018). In the phylogenetic tree, these four genera clustered as a distinct clade within Asterinales (Dai et al. 2018). As the type species of *Buelliella* clustered within the clade of *Stictographaceae*, we therefore include *Buelliella* in *Stictographaceae*.

**Stictographa** Mudd, Man. Brit. Lich.: 226 (1861).

**Index Fungorum number:** IF 5238; **Facesoffungi number:** FoF 07617; 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

**Type species:** *Stictographa lentiginosa* (Lyell ex Leight.) Mudd.

**Notes:** *Stictographa* can be compared with *Labrocarpon* in having lichenicolous, black, simple to occasionally short, branched, lirelliform ascomata with a slit-like opening (Ertz and Diederich 2015; Diederich et al. 2017). Ertz and Diederich (2015) inferred that *Stictographa* and *Labrocarpon* might be synonyms, however, they do not phylogenetically cluster together (Ertz and Diederich 2015; Dai et al. 2018). Thus, *Labrocarpon* is accepted as a distinct genus. More collections and species of these genera are needed to clarify their relationship.

**Stictographa lentiginosa** (Lyell ex Leight.) Mudd, Man. Brit. Lich.: 226 (1861).

≡ *Opegrapha lentiginosa* Lyell ex Leight., Ann. Mag. nat. Hist., Ser. 2 13: 211 (1854).

**Index Fungorum number:** IF 406525; **Facesoffungi number:** FoF 07618; Fig. 13

**Description:** see Redinger (1938), Sanderson et al. (2009), Ertz and Diederich (2015).

#### Other genera included

**Buelliella** Fink, Lich. Fl. U.S.: 372 (1935).

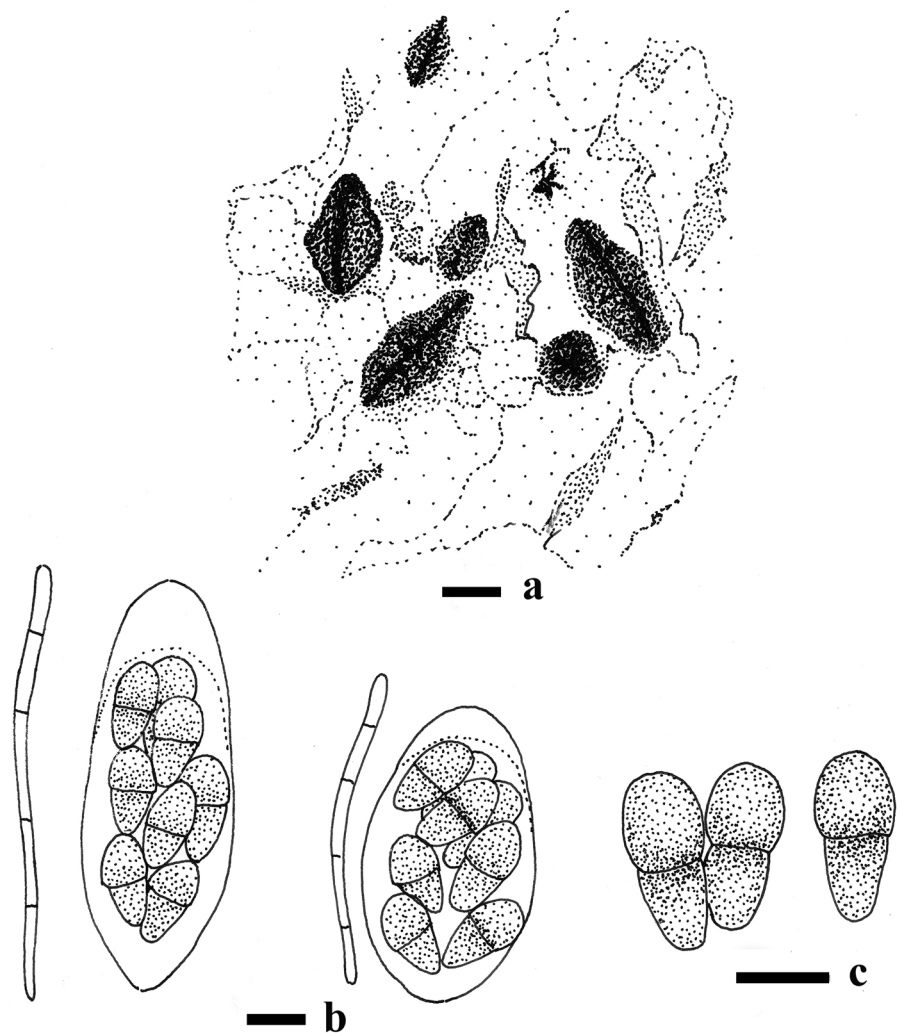
**Index Fungorum number:** IF 676; **Facesoffungi number:** FoF 03625; 12 morphological species (Species Fungorum 2020, this study), 2 species with molecular data.

**Type species:** *Buelliella minimula* (Tuck.) Fink, Lich. Fl. U.S.: 372 (1935).

≡ *Buelliella minimula* Tuck., Syn. N. Amer. Lich. (Boston) 2: 106 (1888).

**Notes:** The original diagnosis of this genus was provided by Fink (1935), and validated by Hafellner (1979). *Buelliella* is characterised by a non-lichenized, lichenicolous habit, initially subsphaerical and closed ascomata, with the upper ascomatal breaking gradually away to expose the hymenium when mature, becoming apothecioid, with bitunicate, broadly clavate to subcylindrical asci, and a distinct ocular chamber, and ellipsoid, 1-septate, pale to medium brown ascospores. Ertz and Diederich (2015) noted that the genus is not monophyletic due to *B. physciicola* and *B. poetschii* being distantly related, and sequence data of the type species

**Fig. 13** *Stictographa lentiginos* (redrawn Ertz and Diederich 2015). **a** Ascomata growing on lichen. **b** Clavate to subglobose asci and pseudoparaphyses. **c** Ascospores. Scale bars: **a** = 200  $\mu\text{m}$ , **b**, **c** = 10  $\mu\text{m}$



(*B. minimula*) was unavailable. Thus, it was placed as *incertae sedis* in Dothideomycetes (Kirk et al. 2008; Ertz and Diederich 2015; Wijayawardene et al. 2017a). We included sequence data of *B. minimula* in our analyses and found that it forms a lineage within *Stictographaceae*. *Buelliella poetschii* is transferred to a new genus, *Neobuelliella* in this paper.

***Karschia*** Körb., *Parerga lichenol.* (Breslau) 5: 459 (1865).

*Index Fungorum number*: IF 2545; *Facesoffungi number*: FoF 07619; – 24 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Karschia talcophila*** (Ach.) Körb., *Parerga lichenol.* (Breslau) 5: 460 (1865).

≡ *Lecidea talcophila* Ach., *Lich. univ.*: 183 (1810).

*Notes*: More than 100 species of *Karschia* are listed in *Index Fungorum* (2020), however, most taxa have been transferred to other genera, such as *Buelliella*, *Cycloschizon*, *Dothidea* and others by Hafellner (1979). Two species were accepted by Hawksworth et al. (1995), and later four

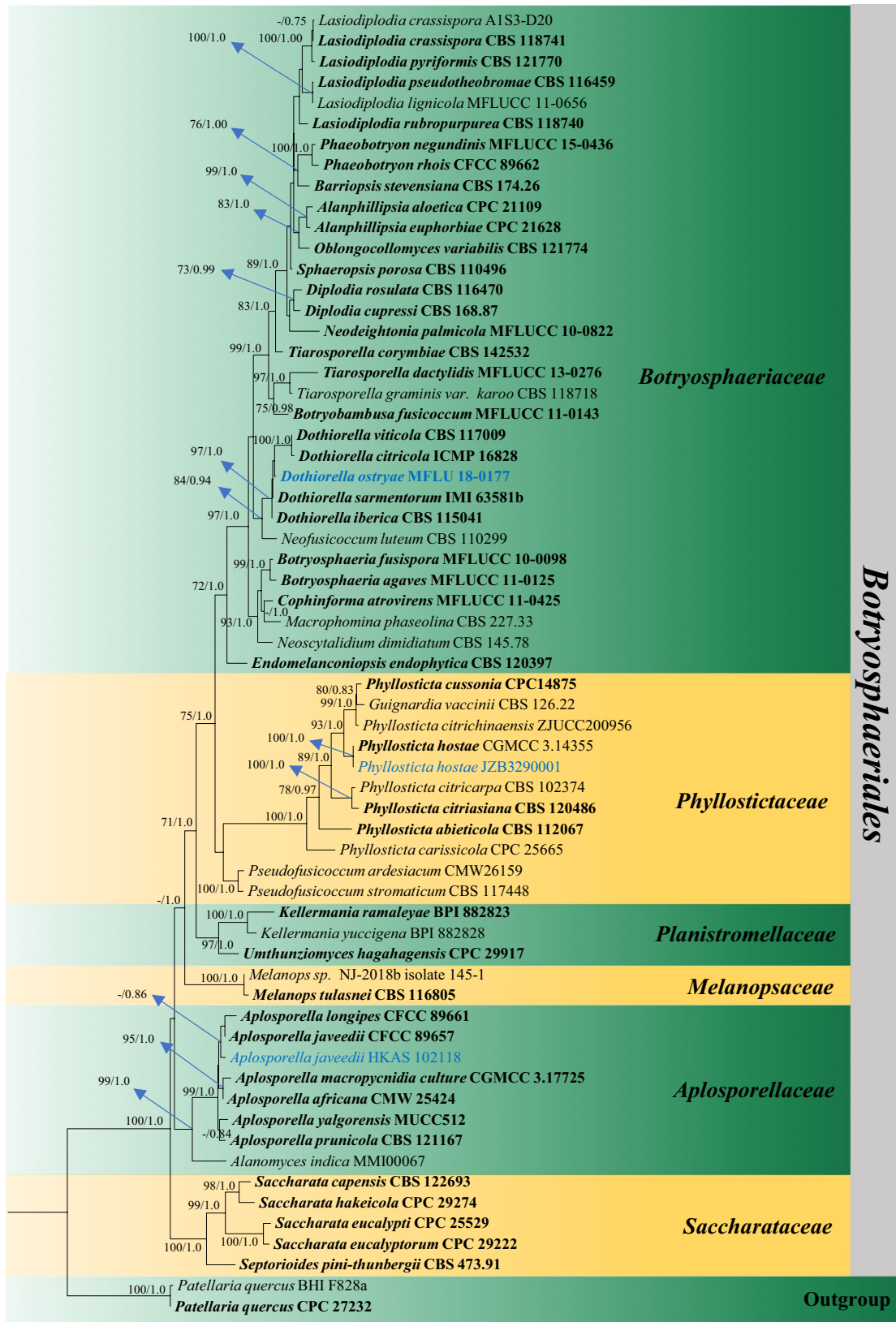
species were included (Kirk et al. 2008). *Karschia* is characterized by a lichenicolous life-style, immersed to erumpent, rounded, black ascomata with a large, irregular opening, producing pseudoparaphyses with a slightly enlarged and brown apex, bitunicate, clavate to subcylindrical asci, ellipsoid, brown, smooth ascospores with one septum (Ertz and Diederich 2015).

***Labrocarpon*** Etayo & Pérez-Ort., in Pérez-Ortega & Etayo, *Lichenologist* 42(3): 271 (2010).

*Index Fungorum number*: IF 515228; *Facesoffungi number*: FoF 07620; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Labrocarpon canariense*** (D. Hawksw.) Etayo & Pérez-Ort. [as ‘canariensis’], in Pérez-Ortega & Etayo, *Lichenologist* 42(3): 272 (2010).

≡ *Melaspilea canariensis* D. Hawksw., *Lichenologist* 14(1): 84 (1982).



Botryosphaeriales

*Botryosphaeriaceae*

*Phyllostictaceae*

*Planistromellaceae*

*Melanopsaceae*

*Aplosporellaceae*

*Saccharataceae*

Outgroup

0.05



**Fig. 14** Phylogram generated from maximum likelihood analysis (RAxML) of Botryosphaeriales based on ITS and LSU sequence data. Maximum likelihood bootstrap values equal to or greater than 70%, Bayesian posterior probabilities equal to or greater than 0.90 (MLBS/PP) are given at the nodes. Isolate numbers are noted after each species name. The tree is rooted to *Patellaria quercus* (CPC 27232 and BHI F828a). Newly sequence data generated in this study are in blue. Ex-type and references strains are indicated in bold. Hyphen (-) represents support values less than 70% MLBS and 0.90 PP

*Notes:* *Labrocarpon* is a monotypic genus which was introduced by Pérez-Ortega and Etayo (2010) based on morphology of ascomata with periphyses (Ertz and Diederich 2015). *Labrocarpon* is more or less similar to *Stictographa* (Pérez-Ortega and Etayo 2010; Ertz and Diederich 2015). However, it formed a separate clade from *Stictographa* (Ertz and Diederich 2015; Dai et al. 2018). *Labrocarpon* is characterized by a lichenicolous life-style, superficial, rounded to slightly elliptic, black, disk-like ascomata with a slit-like opening and a well-developed exciple, producing pseudoparaphyses with a swollen and brown apex, bitunicate, clavate, thick-walled asci with an ocular chamber, and two-celled ascospores (Ertz and Diederich 2015).

***Melaspileopsis*** (Müll. Arg.) Ertz & Diederich, Fungal Diversity 71: 161 (2015).

*Index Fungorum number:* IF 811387; *Facesoffungi number:* FoF 07621; – 1 morphological species (Dai et al. 2018), 1 species with molecular data.

*Type species:* ***Melaspileopsis diplasiospora*** (Nyl.) Ertz & Diederich, Fungal Diversity 71: 161 (2015).

≡ *Opegrapha diplasiospora* Nyl., Acta Soc. Sci. fenn. 7(2): 476 (1863).

*Notes:* The genus was established by Ertz and Diederich (2015), with the type species *M. diplasiospora* (≡ *Melaspilea diplasiospora* in Index Fungorum 2020). Phylogenetically, it does not belong to *Melaspileaceae* but is sister to *Stictographa* within *Stictographaceae* (Dai et al. 2018). This genus was placed in *Melaspileaceae*, order Eremithallales (Wijayawardene et al. 2018). However, we agree with Dai et al. (2018) to retain *Melaspileopsis* within *Stictographaceae*.

### Economic and ecological significance

*Stictographaceae* accommodates several lichenicolous and one saprobic genus. Members of this family usually occur on the thallus of lichens. They are distributed in tropical to temperate areas. *Stictographa lentiginosa* is much rarer than the host (*Phaeographis dendritica*) and thus can act as a useful indicator of the quality of ancient woodlands in western Europe (Ertz and Diederich 2015).

**Botryosphaeriales** C.L. Schoch, Crous & Shoemaker.

*Index Fungorum number:* IF 501513; *Facesoffungi number:* FoF 07659.

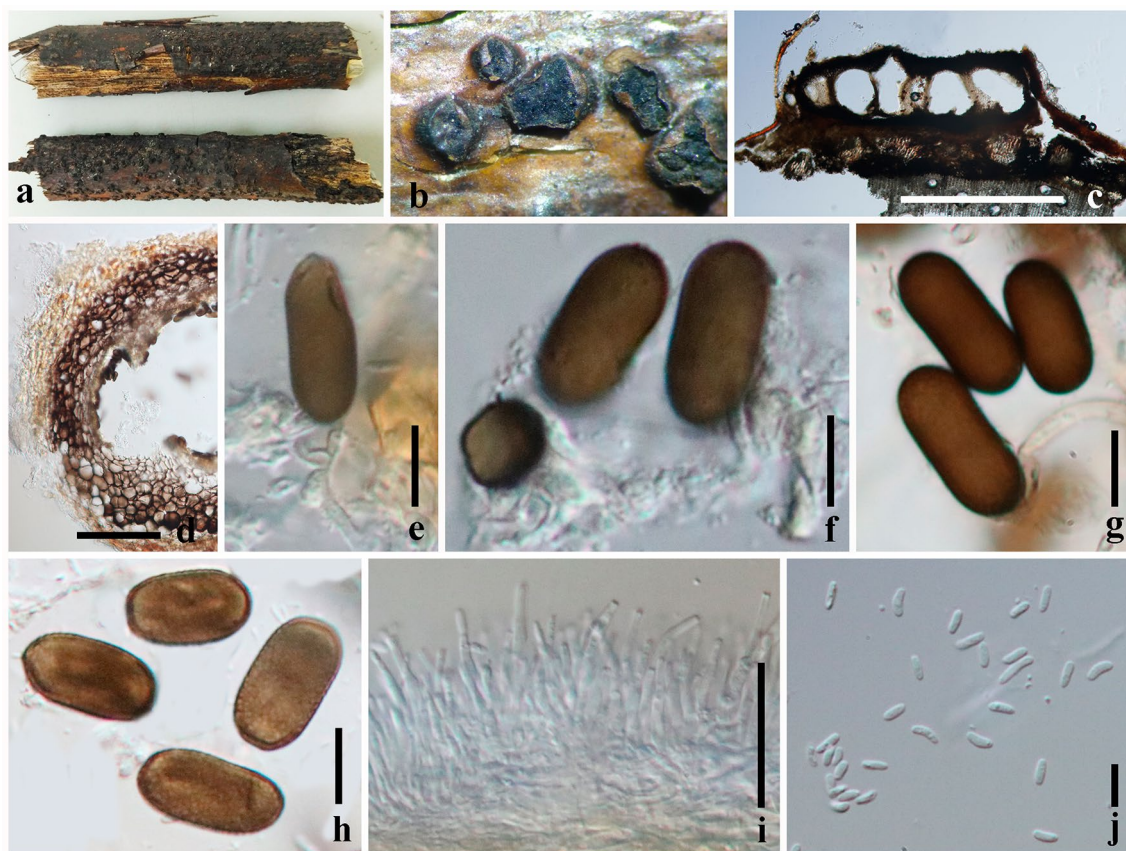
Botryosphaeriales was introduced to accommodate a single family *Botryosphaeriaceae* (Schoch et al. 2006). Previously, nine families (*Aplosporellaceae*, *Botryosphaeriaceae*, *Melanopsaceae*, *Phyllostictaceae*, *Planistromellaceae*, *Saccharataceae*, *Septorioideaceae*, *Endomelanconiopsidaceae*, *Pseudofusicoccaceae*) were accepted in Botryosphaeriales in the Outline of Ascomycetes (Wijayawardene et al. 2018). However, currently only six families (*Aplosporellaceae*, *Botryosphaeriaceae*, *Melanopsaceae*, *Phyllostictaceae*, *Planistromellaceae*, *Saccharataceae*) are accepted in this order (Phillips et al. 2019), the remaining three families were synonymized with existing families. Thus, *Endomelanconiopsidaceae* is considered a synonym of *Botryosphaeriaceae*, *Pseudofusicoccaceae* a synonym of *Phyllostictaceae* and *Septorioideaceae* a synonym of *Saccharataceae* (Phillips et al. 2019). Species in the order are characterized by uni- or multilocular ascostromata with multi-layered dark brown walls, occurring individually or in clusters, frequently embedded in stromatic tissue. Asci are bitunicate, with a thick endotunica, pedicellate or sessile, clavate, with a well-developed ocular chamber, intermixed with hyaline, septate pseudoparaphyses, branched or not. Ascospores are hyaline or pigmented, septate or not, ellipsoid to ovoid, with or without mucoid appendages or mucilaginous sheath. Conidiomata are pycnidial, uni- to multilocular, frequently embedded in stromatic tissue. Conidiogenous cells are hyaline, phialidic or annelidic. Conidia are hyaline or pigmented, septate or not, thin- or thick-walled, with or without mucoid appendages or sheaths (Phillips et al. 2019). The divergence time for Botryosphaeriales is estimated as 150 MYA (stem age, Hongsanan et al. 2020) (Fig. 14).

*Accepted families:* *Aplosporellaceae*, *Botryosphaeriaceae*, *Melanopsaceae*, *Phyllostictaceae*, *Planistromellaceae*, *Saccharataceae*.

***Aplosporellaceae*** Slippers, Boissin & Crous, Stud. Mycol. 76(1): 41 (2013).

*Index Fungorum:* IF 805795; *Facesoffungi number:* FoF 00113, 13 species.

**Sexual morph:** *Stromata* pseudothecial, multiloculate ascomata with multi-layered, dark brown walls, embedded in stromatic tissue. *Hamathecium* comprising hyphoid, hyaline pseudoparaphyses. *Asci* bitunicate, mostly with a thick endotunica, clavate, with a well-developed ocular chamber and intermixed with pseudoparaphyses. *Ascospores* 1–2-seriate, ellipsoid to ovoid, mostly aseptate, or septate, hyaline to pigmented, lacking mucoid appendages or sheaths (Slippers et al. 2013; Liu et al. 2012; Thambugala et al. 2014a; photoplates of sexual characters can be seen in Ekanayaka et al. 2016). **Asexual morph:** Coelomycetous. *Conidiomata* pycnidial, multilocular, embedded in stromatic tissues.



**Fig. 15** Asexual morph of *Aplosporella javeedii* (HKAS 102118). **a** Substrate. **b** Conidiomata on substrate. **c** Cross section of multiloculate conidioma. **d** Conidioma wall. **e, f** Different stages of con-

idiogenesis. **g, h** Conidia. **i** Spermatogenous cells. **j** Spermatia. Scale bars: **c** = 1.5 mm, **d** = 100  $\mu$ m, **e–h, j** = 10  $\mu$ m, **i** = 25  $\mu$ m

*Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, phialidic. *Conidia* ellipsoid to subcylindrical, initially hyaline, thin-walled and smooth, becoming pigmented, thick-walled and spinulose, aseptate (Sutton 1980).

*Type: Aplosporella* Speg.

*Notes: Aplosporellaceae* was introduced by Slippers et al. (2013) to accommodate *Aplosporella* and *Bagnisiella*. Currently two genera (*Aplosporella* and *Alanomyces*) are accepted in this family. This family is phylogenetically close to *Botryosphaeriaceae*. Liu et al. (2017), using evolutionary evidence, questioned whether this family was introduced unnecessarily and should be regarded as a genus. However, based on morphology, phylogeny and evolutionary divergence times, Phillips et al. (2019) regarded *Aplosporellaceae* as a distinct family.

*Aplosporella* Speg., Anal. Soc. cient. argent. 10(4): 157 (1880).

= *Bagnisiella* Speg., Anal. Soc. cient. argent. 10(4): 146 (1880).

*Index Fungorum number:* IF 7191; *Facesoffungi number:* FoF 01427; 12 morphological species (botryosphaerales.org 2020), 10 species with molecular data.

*Type species: Aplosporella chlorostroma* Speg.

*Notes: Aplosporella* was introduced by Spegazzini (1880). This genus has frequently been incorrectly referred to as “*Haplosporella*” (Tilak and Rao 1964; Petrak and Sydow 1927; Tai 1979; Wei 1979). About 340 epithets for *Aplosporella* are listed in Index Fungorum (July 2019). This genus is characterised by multiloculate pycnidia, brown, aseptate, spinulose conidia, hyaline, aseptate spermatia and fusiform paraphyses (Du et al. 2017). Its sexual morph is not common (Ekanayaka et al. 2016). Slippers et al. (2013) indicated that *Aplosporella* should be separate from *Botryosphaeriaceae* as a distinct family, which they named *Aplosporellaceae*, and confirmed that *Aplosporella* is well-resolved with species described from living culture. They also found a close genetic relationship between the genera *Aplosporella* and *Bagnisiella* and considered that *Bagnisiella* represents the sexual morph and should be reduced to synonymy with *Aplosporella* (Schoch et al. 2009a; Slippers et al. 2013). Ekanayaka et al. (2016) introduced a new

species *Aplosporella thailandica* from Thailand with morphology corresponding to *Bagnisiella*. Phillips et al. (2019) formally placed *Bagnisiella* as a synonym of *Aplosporella*. The most recent phylogenetic tree of species in *Aplosporella* is provided by Hyde et al. (2020a).

***Aplosporella javeedii*** Jami, Gryzenh., Slippers & M.J. Wingf., *Fungal Biology* 118(2): 174 (2013).

*Index Fungorum number*: IF 803637; *Facesoffungi number*: FoF 07383; Fig. 15

*Description*: see Phillips and Alves (2009).

*Saprobic* on dead stems. **Sexual morph**: Undetermined. **Asexual morph**: *Conidiomata* 1–2 mm diam., erumpent from bark surface, separate, discoid, dark-brown to black, multi-locular. *Peridium* composed cells of *textura angularis*, 4–10 layers, thick-celled, dark-brown to black cells at outer layers, thin-walled and hyaline cells at inner layers. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, holoblastic, smooth, cylindrical. *Conidia* 18–25 × 9–13 μm ( $\bar{x}$  = 20 × 11 μm, n = 20) ellipsoidal to subcylindrical, with rounded ends, initially light brown, slightly granulated walls, becoming dark brown (black in mass), aseptate. *Spermatophores* reduced to *Spermatogenous cells*, occurring intermingled among conidiogenous cells in same conidioma, subcylindrical, hyaline, smooth. *Spermatia* 4–7 × 1–3 μm ( $\bar{x}$  = 6 × 2 μm, n = 20) subcylindrical, straight or slightly curved, hyaline, smooth-walled, granular.

*Material examined*: China, Yunnan Province, Kunming, Kunming Institute of Botany, Botanical Garden, on dead stems, 24 May 2018, A.H. Ekanayaka (HKAS 102118).

*GenBank number*: ITS: MW136694, LSU: MW142386, SSU: MW127178

*Notes*: This collection is morphologically and phylogenetically similar to the type specimen of *Aplosporella javeedii* from South Africa (Jami et al. 2014). Comparison of ITS and LSU sequence data of this collection with sequence data of *A. javeedii* (CMW38165) has 99% similarity. However, spermatia were found in HKAS 102118.

#### Other genus included

***Alanomyces*** Roh. Sharma, *Phytotaxa* 297(2): 170 (2017).

*Index Fungorum number*: IF 804153; *Facesoffungi number*: FoF 07623; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: *Alanomyces indica* Roh. Sharma, *Phytotaxa* 297(2): 172 (2017).

*Notes*: *Alanomyces*, introduced by Sharma et al. (2017), is characterised by rapidly spreading dark greenish black colonies. Pycnidia are multilocular with a long neck and cylindrical, hyaline, guttulate, single celled spermatia (Sharma et al. 2017).

#### Economic and ecological significance

Some taxa in *Aplosporellaceae* are recorded as plant pathogens. *Aplosporella prunicola* was recorded as a probable tree pathogen on gymnosperms (Aylward et al. 2017). *Aplosporella beaumontiana* was recorded as a major pathogen associated with a disease of okra (Yan et al. 2018).

***Botryosphaeriaceae*** Theiss. & Syd. [as ‘*Botryosphaeriae*’], *Annls mycol.* 16(1/2): 16 (1918).

*Index Fungorum number*: IF 80530; *Facesoffungi number*: FoF 00116, 279 species.

*Endophytic, pathogenic* and *saprobic* on a wide range of hosts worldwide. **Sexual morph**: *Ascomata* uniloculate, solitary or clustered, becoming fully or partially erumpent with maturity, wall multi-layered, dark brown, infrequently embedded in stromatic tissues. *Asci* 8-spored, bitunicate, fissitunicate, with well-developed ocular chamber, thick endotunica, short pedicellate, clavate. *Pseudoparaphyses* cellular, intermixed with asci, hyaline, septate, frequently constricted at septa, hyphae-like, branched or not, deliquescent with maturity. *Ascospores* 2–3-seriate, fusoid to ellipsoid or ovoid, hyaline or pigmented, smooth to verruculose, septate or not, mucoid sheath mostly absent (photoplates of sexual characters can be seen in Phillips et al. 2013, 2019). **Asexual morph**: Coelomycetous. *Conidiomata* uni or rarely multiloculate, pycnidial, infrequently embedded in stromatic tissue. *Conidiophores* mostly reduced to conidiogenous cells. *Conidiogenous cells* hyaline, phialidic, proliferating percurrently or internally giving rise to periclinal thickenings, or proliferating percurrently forming annulations, without collarettes. *Conidia* hyaline or pigmented, aseptate or one or multi-septate, sometimes muriform, smooth or striate, thin- or thick-walled, without mucoid sheaths or appendages. *Spermatogonia* similar to conidiomata in anatomy. *Spermatogenous cells* ampulliform to lageniform or subcylindrical, hyaline smooth, phialidic. *Spermatia* developing in conidiomata or spermatogonia, hyaline, smooth, granular, subcylindrical or dumbbell-shaped, with rounded ends. (Liu et al. 2012; Slippers et al. 2013; Phillips et al. 2013).

*Type*: *Botryosphaeria* Ces. & De Not.

*Notes*: *Botryosphaeriaceae* was introduced by Theissen and Sydow (1918) for three genera, *Botryosphaeria*, *Phaeobotryon* and *Dibotryon*. Over decades of taxonomic revisions and updates based on morphology, the family became increasingly complex. However, based on LSU sequence data Crous et al. (2006a) revealed ten lineages within *Botryosphaeriaceae*, which they considered to represent individual genera. Phillips et al. (2008) defined, introduced and reinstated a further five genera in *Botryosphaeriaceae*. *Aplosporella* was shown to reside in *Botryosphaeriaceae* by Damm et al. (2007). *Endomelanconiopsis* was assigned to this family by Rojas et al. (2008) while Phillips and Alves (2009) considered that *Melanopsis* is another genus in *Botryosphaeriaceae*. Two new genera (*Botryobambusa* and

*Cophinforma*) were introduced by Liu et al. (2012). Phillips et al. (2013) resolved *Botryosphaeriaceae* into 17 genera and 110 species known from culture. Thereafter six new genera and 85 new species/species combinations have been introduced (Dissanayake et al. 2016). According to a recent study by Phillips et al. (2019) currently 22 genera are accepted in *Botryosphaeriaceae*. In earlier studies *Dothiorella* and *Spencermartinsia* were regarded as two separate genera in the family (Phillips et al. 2008, 2013). However, Yang et al. (2017) synonymized *Spencermartinsia* under *Dothiorella*. These two genera are morphologically distinguishable only in sexual morphs by the hyaline apiculi in *Spencermartinsia*. So far, these characters are reported only in *S. viticola* but no other species in this genus have been observed with asexual morphs. Furthermore, phylogenetic distance is also small between these two genera. Therefore, in this paper we accept that *Spencermartinsia* is a synonym of *Dothiorella*. *Phyllostictaceae* was re-instated for *Phyllosticta* (Wikee et al. 2013a). Another three families were introduced in *Botryosphaeriales* by Slippers et al. (2013), namely *Saccharataceae* for *Saccharata*, *Aplosporellaceae* for *Aplosporella* and *Melanopsaceae* for *Melanops*. Wyka and Broders (2016) introduced *Septorioideaceae* for *Septorioides* while Yang et al. (2017) raised *Endomelanconiopsis* and *Pseudofusicoccum* to familial status as *Endomelanconiopsidaceae* and *Pseudofusicoccaceae* respectively. Taking into account morphology, phylogeny and evolutionary divergence times, Phillips et al. (2019) synonymised *Endomelanconiopsidaceae* with *Botryosphaeriaceae*, *Pseudofusicoccaceae* with *Phyllostictaceae*, and *Septorioideaceae* with *Saccharataceae*. In addition to that, *Pilgeriella* which fit within *Botryosphaeriaceae*, but do not have cultures or DNA (Wijayawardene et al. 2017a). Therefore, we place this genus *incertae sedis* in *Botryosphaeriales*.

***Botryosphaeria*** Ces. & De Not., *Comm. Soc. crittog. Ital.* 1(fasc. 4): 211 (1863).

*Index Fungorum number:* IF 635; *Facesoffungi number:* FoF 00141; 283 morphological species (Index Fungorum January, 2020), 13 species with molecular data.

*Type species: Botryosphaeria dothidea* (Moug.) Ces. & De Not.

*Notes:* *Botryosphaeria* was introduced by Cesati and De Notaris (1863). Species in *Botryosphaeria*, based on the type species *B. dothidea*, are characterised by ascospores that are hyaline and aseptate, although they can become pale brown and septate with age (Shoemaker 1964; Sivanesan 1984; Denman et al. 2000; Alves et al. 2004; Phillips et al. 2005; Jayawardena et al. 2018).

#### Other genera included

***Alanphillipsia*** Crous & M.J. Wingf., in Crous et al., *Persoonia* 31: 197 (2013).

*Index Fungorum number:* IF 805816; *Facesoffungi number:* FoF 01417; – 5 morphological species (Species Fungorum 2020), 5 species with molecular data.

*Type species: Alanphillipsia aloes* Crous & M.J. Wingf., in Crous et al. *Persoonia* 31: 197 (2013).

*Notes:* *Alanphillipsia* was introduced by Crous et al. (2013) to accommodate species that are aplosporella-like in morphology, but have conidia with a hyaline outer layer.

***Barriopsis*** A.J.L. Phillips, A. Alves & Crous (2008).

*Index Fungorum number:* IF 511712; *Facesoffungi number:* FoF 01679; – 6 morphological species (Species Fungorum 2020), 6 species with molecular data.

*Type species: Barriopsis stevensiana* A.J.L. Phillips & Pennycook, in Wijayawardene et al., *Fungal Diversity* 86: 56 (2017).

Based on *Barriopsis fusca* A.J.L. Phillips, A. Alves & Crous, in Phillips, Alves, Pennycook, Johnston, Ramaley, Akulov & Crous, *Persoonia* 21: 39 (2008).

*Notes:* *Barriopsis* is characterised by aseptate, brown ascospores without apiculi (Phillips et al. 2008). Absence of apiculi on the ascospores differentiates this genus from *Sphaeropsis*.

***Botryobambusa*** Phook., Jian K. Liu & K.D. Hyde, in Liu et al., *Fungal Diversity* 57(1): 166 (2012).

*Index Fungorum number:* IF 801313; *Facesoffungi number:* FoF 02408; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Botryobambusa fusicoccum* Phook., Jian K. Liu & K.D. Hyde, in Liu et al., *Fungal Diversity* 57(1): 166 (2012).

*Notes:* *Botryobambusa* was introduced by Liu et al. (2012) with a single species with both sexual and asexual morphs. Phylogenetically this genus is clearly distinguished from *Botryosphaeria*. However, it is similar to *Botryosphaeria* except for smaller asci and ascospores that are surrounded by a mucilagenous sheath.

***Cophinforma*** Doilom, Jian K. Liu & K.D. Hyde, in Liu et al., *Fungal Diversity* 57(1): 174 (2012).

*Index Fungorum number:* IF 801315; *Facesoffungi number:* FoF 07624; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Cophinforma eucalypti* Doilom, Jian K. Liu & K.D. Hyde, in Liu et al., *Fungal Diversity* 57(1): 174 (2012).

*Notes:* *Cophinforma* was introduced by Liu et al. (2012) as a monotypic genus for *C. eucalypti*. Phillips et al. (2013), based on a multi-gene analysis, introduced two species to this genus that were previously included in *Botryosphaeria*. *Cophinforma* is phylogenetically distinguished from

*Botryosphaeria* despite being similar, except for conidia that are longer than any known species in *Botryosphaeria*.

**Diplodia** Fr., in Montagne, *Annls Sci. Nat., Bot., sér. 2* 1: 302 (1834).

*Index Fungorum number*: IF 8047; *Facesoffungi number*: FoF 00147; – 397 morphological species (Species Fungorum 2020), 30 species with molecular data (Jayawardena et al. 2019b, c).

*Type species*: **Diplodia mutila** (Fr. : Fr.) Fr., *Summa Veg. Scand.* 2: 417. 1849.

≡ *Sphaeria mutila* Fr. : Fr., *Syst. Mycol.* 2: 424. 1823.

≡ *Phyalospora mutila* (Fr. : Fr.) N.E. Stevens, *Mycologia* 28: 333. 1936.

≡ *Botryosphaeria stevensii* Shoemaker, *Can. J. Bot.* 42: 1299. 1964.

*Notes*: *Diplodia* comprises two morphological groups that are supported by two distinct phylogenetic lineages. In one type the conidia are initially hyaline and aseptate, later becoming brown and 1-septate. Pigmentation is often delayed and in some species dark conidia are never seen. In the second type the conidia become pigmented at an early stage, even while they are enclosed within the pycnidia, they only rarely become septate.

**Dothiorella** Sacc., *Michelia* 2(no. 6): 5 (1880).

*Index Fungorum number*: IF 8098; *Facesoffungi number*: FoF 00148; – 257 morphological species (Species Fungorum 2020), 44 species with molecular data.

*Type species*: **Dothiorella pyrenophora** Berk. ex Sacc., *Michelia* 2(no. 6): 5 (1880)

*Notes*: *Dothiorella* has often been confused with *Diplodia* in morphological characterisations. The type species, *Dothiorella pyrenophora* differs from *Diplodia* by conidia that are brown and 1-septate early in their development, while they are still attached to the conidiogenous cells. Sexual morphs of *Dothiorella* have pigmented, septate ascospores. However, the sexual stage of the species is rarely found in nature and has never been reported in culture.

**Dothiorella ostryae** Manawasinghe, Camporesi & K.D. Hyde, **sp. nov.**

*Index Fungorum number* IF556874, *Facesoffungi number*: FoF 06578; Fig. 16

*Etymology*: Name reflects the host genus of *Ostrya carpinifolia*.

*Holotype*: MFLU 18-0177.

*Saprobic* on dead aerial branch of *Ostrya carpinifolia*. **Sexual morph** Undetermined. **Asexual morph** *Conidiomata* pycnidial, stromatic, solitary, dark brown, semi-immersed, unilocular, globose papillate with a short neck, wall 5–7 cell layers, outer layers composed of light-brown cells of *textura angularis*, inner layer hyaline and thin-walled

*Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* holoblastic, hyaline, cylindrical, proliferating percurrently. *Conidia* 15–21 × 7–10 ( $\bar{x}$  = 19 × 9 μm, n = 30) μm, ellipsoidal initially hyaline and aseptate, becoming pale brown while attached to the conidiogenous cells, finally dark brown or sepia, 1-septate, with 2 cells of equal length, thick-walled.

*Culture characteristics*: Colonies on PDA reach 70 mm after 5 d in the dark at 25 °C.

*Material examined*: Italy, Passo delle Forche - Galeata (province of Forli-Cesena), dead aerial branch of *Ostrya carpinifolia* L. (*Betulaceae*), 9 April 2018, Erio IT Camporesi (MFLU 18-0177, **holotype**), ex-type living culture, JZB3150026.

*GenBank number*: ITS: MN533805, tef1 MN537429.

*Notes*: The species identified in this study is similar to other species in *Dothiorella* (Phillips et al. 2013). In phylogenetic analysis (Fig. 14), *Dothiorella ostryae* is closely related to the clade that contains *Dothiorella citricola* (ICMP 16828) and *D. viticola* (CBS 117009). There are four *Dothiorella* species associated with the host genus *Ostrya*, namely *D. iberica*, *D. omnivora*, *D. parva* (Farr and Rossman) and *D. ostryae* (this study).

**Endomelanconiopsis** Rojas & Samuels, *Mycologia* 100: 770. (2008).

*Index Fungorum number*: IF 555482; *Facesoffungi number*: FoF 07625; – 3 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: **Endomelanconiopsis endophytica** Rojas & Samuels, *Mycologia* 100: 770 (2008).

*Notes*: This genus was introduced by Rojas et al. (2008) with two species. Tibpromma et al. (2018a) introduced a third species, *Endomelanconiopsis freycinetiae*, bringing the total to three species. *Endomelanconiopsis* is characterized by eustromatic conidiomata and holoblastically produced, brown, non-apiculate, unicellular conidia, each with a longitudinal germ slit (Rojas et al. 2008).

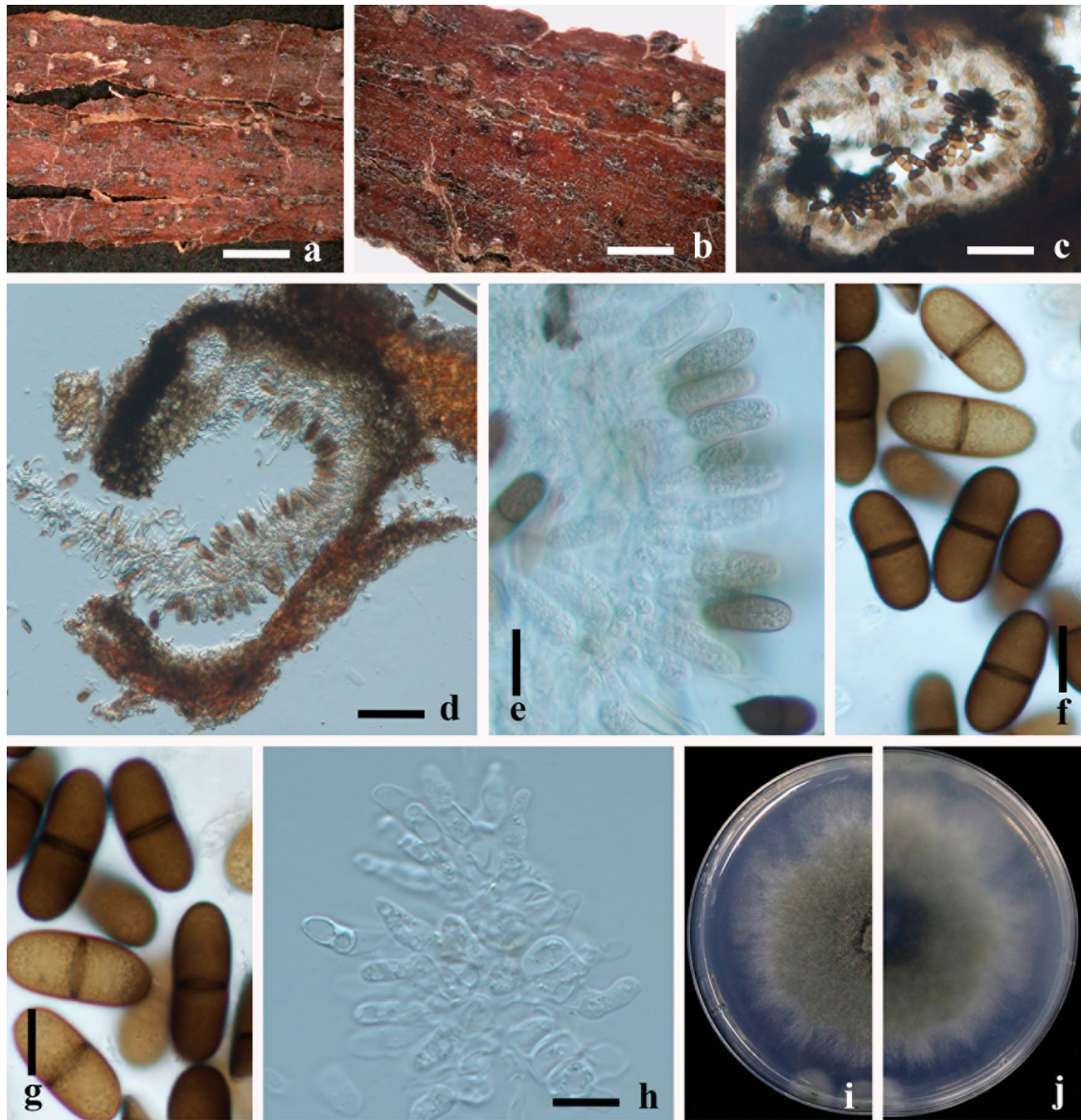
**Eutiarosporella** Crous, in Crous et al., *Phytotaxa* 202(2): 85 (2015).

*Index Fungorum number*: 811248; *Facesoffungi number*: FoF 07365; – 7 morphological species (Species Fungorum 2020), 7 species with molecular data.

*Type species*: **Eutiarosporella tritici** (B. Sutton & Marasas) Crous, in Crous et al., *Phytotaxa* 202(2): 85 (2015).

≡ *Tiarosporella tritici* B. Sutton & Marasas, *Trans. Br. mycol. Soc.* 67(1): 74 (1976)

*Notes*: This genus was introduced by Crous et al. (2015a) to accommodate tiarosporella-like taxa with long conidial necks and holoblastic conidiogenesis. *Eutiarosporella* differs from *Marasasiomyces* by developing clustered conidiomata.



**Fig. 16** *Dothiorella ostryae* (MFLU 18-0177, **holotype**). **a** Material examined. **b** Submerged conidiomata on host. **c**, **d** Cross section of conidiomata on host. **e** Developing conidia while attached to the pyc-

nidial wall on host. **f**, **g** Conidia on host. **h** Conidiogenous cells in culture. **i** Upper view of colony on PDA. **j** reverse view of 7 days old culture on PDA. Scale bars: **a**, **b** = 2 mm, **c–h** = 10  $\mu$ m

***Lasiodiplodia*** Ellis & Everh., Bot. Gaz. 21: 92 (1896).

*Index Fungorum number*: IF 8708; *Facesoffungi number*: FoF 00151; – 64 morphological species (Species Fungorum 2020), 35 species with molecular data.

*Type species*: *Lasiodiplodia theobromae* (Pat.) Griff. & Maubl. Bull. trimest. Soc. Mycol. Fr. 25: 57 (1909).

≡ *Botryodiplodia theobromae* Pat., in Patouillard & Lagerheim, Bull. Soc. mycol. Fr. 8(3): 136 (1892).

*Notes*: *Lasiodiplodia* was introduced by Ellis in 1894 with *L. tuberculata* as the type species. Ellis did not provide a description of the genus and species, but this was provided by Clendenin (1896) who attributed both the genus

and species to Ellis and Everhart. Griffon and Maublanc (1909) considered that *Botryodiplodia theobromae* was more suitably accommodated in *Lasiodiplodia*. Since the epithet *theobromae* (1892) is older than *tuberculata* (1896), *L. theobromae* should be regarded as the type species of *Lasiodiplodia*. In earlier works on *Lasiodiplodia* and *Diplodia* it was considered that *Lasiodiplodia* could represent a possible synonym of *Diplodia* (Denman et al. 2000). However, in phylogenetic analyses these two genera were clearly separated in two distinct clades (Zhou and Stanosz 2001; Slippers et al. 2004a, b; Phillips et al. 2008). *Lasiodiplodia* is distinguished from *Diplodia* by striations on the conidia.

Conidiomatal paraphyses distinguishes *Lasiodiplodia* from *Neodeightonia*. Although *Barriopsis* has striate conidia, they are unique in *Botryosphaeriaceae* because they are also present on immature, hyaline conidia.

**Macrophomina** Petr., *Annls mycol.* 21(3/4): 314 (1923).

*Index Fungorum number*: IF 8814; *Facesoffungi number*: FoF 07626; – 4 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: **Macrophomina philippinensis** Petr., *Annls mycol.* 21(3/4): 314 (1923).

Other synonyms can be seen in Index Fungorum.

*Notes*: *Macrophomina* comprises two species with cultures and molecular data. This genus is similar to *Tiarospora* in having apical mucoid appendages (Sutton and Marasas 1976). Apart from the phylogeny, these two species can be distinguished, since *Macrophomina* has percurrently proliferating conidiogenous cells (Nag-Raj 1993; Crous et al. 2006a) and conidia that become dark brown at maturity, and microsclerotia (Phillips et al. 2013).

**Marasasiomyces** Crous, in Crous et al., *Phytotaxa* 202(2): 86 (2015).

*Index Fungorum number*: IF 811252; *Facesoffungi number*: FoF 07440; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: **Marasasiomyces karoo** (B. Sutton & Marasas) Crous, Crous et al., *Phytotaxa* 202(2): 85 (2015).

≡ *Tiarospora graminis* var. *karoo* B. Sutton & Marasas, *Trans. Br. mycol. Soc.* 67(1): 73 (1976).

*Notes*: This monotypic genus was introduced by Crous et al. (2015a) for *M. karoo* to accommodate tiarosporella-like taxa. *Marasasiomyces* is distinguished from *Tiarospora* by conidiomata with long necks covered in brown setae, and holoblastic conidiogenesis. These characters are similar to *Eutiarospora*, but differ on account of the non-clustered conidiomata.

**Mucoharknessia** Crous, R.M. Sánchez & Bianchin., in Crous et al., *Phytotaxa* 202(2): 86 (2015).

*Index Fungorum number*: IF 811254; *Facesoffungi number*: FoF 01651; – 2 morphological species (Species Fungorum 2020), 2 species with with molecular data.

*Type species*: **Mucoharknessia cortaderiae** Crous, R.M. Sánchez & Bianchin Crous, in Crous et al., *Phytotaxa* 202(2): 85 (2015).

*Notes*: This genus was introduced by Crous et al. (2015a) for species resembling *Harknessia*. The genus is characterised by conidia bearing mucoid appendages. *Mucoharknessia* comprises two species.

**Neodeightonia** C. Booth, in Punithalingam, *Mycol. Pap.* 119: 17 (1970) [1969].

*Index Fungorum number*: IF 3450; *Facesoffungi number*: FoF 07627; – 8 morphological species (Species Fungorum 2020), 8 species with with molecular data.

*Type species*: **Neodeightonia subglobosa** C. Booth, *Mycol. Pap.* (1970).

*Notes*: *Neodeightonia* was regarded as a synonym of *Botryosphaeria* (von Arx and Müller 1975). However, it was reinstated by Phillips et al. (2008) based on morphological characters including the dark, 1-septate ascospores, and its phylogenetic placement. Longitudinal striations on the conidial wall are an additional characteristic feature of this genus (Crous et al. 2006a; Phillips et al. 2008). *Neodeightonia* can be differentiated from *Lasiodiplodia* by the absence of conidiomatal paraphyses, and conidial striations distinguish it from *Diplodia*.

**Neofusicoccum** Crous, Slippers & A.J.L. Phillips, in Crous et al., *Stud. Mycol.* 55: 247 (2006).

*Index Fungorum number*: IF 500870; *Facesoffungi number*: FoF 00153; – 45 morphological species (Species Fungorum 2020), 43 species with molecular data (Jayawardena et al. 2019a, c).

*Type species*: **Neofusicoccum parvum** (Pennycook & Samuels) Crous, Slippers & A.J.L. Phillips., in Crous et al., *Stud. Mycol.* 55: 247 (2006).

≡ *Fusicoccum parvum* Pennycook & Samuels, *Mycotaxon* 24: 455 (1985).

*Notes*: *Neofusicoccum* was introduced by Crous et al. (2006a) to accommodate species that are similar to *Botryosphaeria*, but phylogenetically distinct. *Dichomera* synasexual morph in *Neofusicoccum* has been used to differentiate it from *Botryosphaeria*, even though not all *Neofusicoccum* species form such a synasexual morph (Phillips et al. 2005; Barber et al. 2005). Development of paraphyses can be observed in all accepted *Botryosphaeria* species, but have not been reported in conidiomata of any *Neofusicoccum* species. However, this character is difficult to use as developing conidiogenous cells can resemble paraphyses. Accepted species in this genus have been separated on the basis of conidial dimensions and pigmentation, pigment production in culture media and ITS sequence data (Phillips et al. 2013). However, morphological characterisation of these species remains controversial (Abdollahzadeh et al. 2013). To resolve the species, multi-gene sequence data are essential. Species in *Neofusicoccum* have been reported as endophytes, pathogens and saprobes on a wide range of hosts.

**Neoscytalidium** Crous & Slippers, *Stud. Mycol.* (2006).

*Index Fungorum number*: IF 500868; *Facesoffungi number*: FoF 07628; – 3 morphological species (Species Fungorum 2020), 7 species with molecular data.

*Type species*: **Neoscytalidium dimidiatum** (Penz.) Crous & Slippers, in Crous et al., *Stud. Mycol.* 55: 244 (2006).

≡ *Torula dimidiata* Penz., in Saccardo, *Michelia* 2(no. 8): 466 (1887).

**Notes:** In earlier studies, species belonging to this genus was introduced as *Hendersonula toruloidea*, which have conidia that become septate with a darker central cell and formed a Scytalidium-like synanamorph (Crous et al. 2006a). Since the description, the production of both arthroconidial and pycnidial synasexual morphs has been shown and led to several controversies in the nomenclature. However, the current genus name was introduced by Crous et al. (2006a) and other relevant epitypifications and synonymies by Madrida et al. (2009). Species in this genus have been reported as pathogens on human skin and nails (Campbell and Mulder 1977) and plants. Diseases reported associated with this genus tend to be more common in tropical regions (Polizzi et al. 2009, 2011; Phillips et al. 2013).

**Oblongocollomyces** Tao Yang & Crous., in Yang et al., *Fungal Biology* 121: 339 (2016).

**Index Fungorum number:** IF 817640; **Facesoffungi number:** FoF 08049; 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

**Type species:** *Oblongocollomyces variabilis* (F.J.J. Van der Walt, Slippers & G.J. Marais) Tao Yang & Crous., in Yang et al., *Fungal Biology* 121: 339 (2016).

≡ *Sphaeropsis variabilis* F.J.J. Van der Walt, Slippers & G.J. Marais, in Slippers et al., *Persoonia* 33: 164 (2014).

**Notes:** *Oblongocollomyces* was introduced by Yang et al. (2017) as a monotypic genus in *Botryosphaeriaceae*. In earlier studies, this species was identified as *Sphaeropsis variabilis* and it was different from *Sphaeropsis* in having long conidiomatal necks on PNA, aggregated in dense clusters of conidiomata on OA (Yang et al. 2017). This species has conidia with up to 3 septa. Phylogenetically *Oblongocollomyces* close to *Alanphillipsia* (Fig. 14).

**Phaeobotryon** Theiss. & Syd., *Annls mycol.* 13(5/6): 664 (1915).

**Index Fungorum number:** IF 3892; **Facesoffungi number:** FoF 07629; – 8 morphological species (Species Fungorum 2020), 6 species with molecular data.

**Type species:** *Phaeobotryon cercidis* (Cooke) Theiss. & Syd., *Annls mycol.* (1915).

≡ *Dothidea cercidis* Cooke, *Grevillea* 13(no. 67): 66 (1885).

**Notes:** *Phaeobotryon* has 2-septate, brown ascospores with an apiculus at each end.

**Sakireeta** Subram. & K. Ramakr., *J. Indian bot. Soc.* 36: 83 (1957).

**Index Fungorum number:** IF 9775; **Facesoffungi number:** FoF 07583; – 1 morphological species (Wijayawardene et al. 2017a), 1 species with molecular data.

**Type species:** *Sakireeta madreeya* Subram. & K. Ramakr., *J. Indian bot. Soc.* 36: 84 (1957).

**Notes:** *Sakireeta* comprises a single species, *S. madreeya*, which was previously known as *Tiarosporella madreeya*. This genus is distinguished from the closely related *Tiarosporella* by conidiomata that are aggregated in a stroma, and being plurilocular whereas, *Tiarosporella* has solitary unilocular conidiomata. In addition, *Sakireeta* has holoblastic conidiogenous cells (Crous et al. 2015a).

**Sardiniella** Linald., A. Alves & A.J.L. Phillips, *Mycosphere* (2016).

**Index Fungorum number:** IF 817511; **Facesoffungi number:** FoF 02405; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

**Type species:** *Sardiniella urbana* Linald., A. Alves & A.J.L. Phillips, *Mycosphere* (2016).

**Notes:** *Sardiniella* was introduced as a monotypic genus for *Sardiniella urbana*. This genus is characterised by thick-walled, oblong conidia that become pigmented and 1-septate, which distinguishes it from *Neofusicoccum*. This genus is similar to *Diplodia* and *Dothiorella*. However, in *Dothiorella*, and in some species of *Diplodia* the conidia become pigmented while still attached to the conidiogenous cell and this character is not seen in *Sardiniella*. The conidial wall in species of *Diplodia* is thicker than in *Sardiniella*. Phylogenetically these two genera are clearly separated.

**Sphaeropsis** Sacc., *Michelia* 2(no. 6): 105 (1880).

**Index Fungorum number:** IF 562041; **Facesoffungi number:** FoF 01704; – 142 morphological species (Species Fungorum 2020), 5 species with molecular data.

**Type species:** *Sphaeropsis visci* (Alb. & Schwein.) Sacc., *Michelia* 2(no. 6): 105 (1880).

≡ *Dothidea visci* Kalchbr., *Hedwigia* 8: 117 (1869).

**Notes:** *Sphaeropsis* was introduced by Saccardo (1880) to accommodate species of *Diplodia* with brown, aseptate conidia. Since then species were described based on host association, resulting in more than 600 species names. Pycnidial paraphyses distinguish *Sphaeropsis* from *Diplodia*. The striate conidia of *Lasiodiplodia* differentiate it from *Sphaeropsis*, which has smooth-walled conidia.

**Tiarosporella** Höhn., in Weese, *Ber. dt. bot. Ges.* (1919).

**Index Fungorum number:** IF 10233; **Facesoffungi number:** FoF 00333; – 8 morphological species (Species Fungorum 2020), 5 species with molecular data.

**Type species:** *Tiarosporella paludosa* (Sacc. & Fiori) Höhn., in Weese, *Ber. dt. bot. Ges.* 37: 159 (1919).

≡ *Neottiospora paludosa* Sacc. & Fiori, in Sydow, *Hedwigia* 38(Beibl.): (137) (1899).

**Notes:** This genus is characterised by conidia formed from smooth, hyaline conidiogenous cells that lack periclinal



thickenings and percurrent proliferations. The conidia are hyaline, subcylindrical to fusiform with irregular mucoid appendages. There are 22 species names for this genus in Index Fungorum.

### Economic and ecological significance

*Botryosphaeriaceae* comprises a diverse range of taxa that are pathogens, endophytes or saprobes on a wide range of hosts including dicotyledonous monocotyledonous, and gymnosperms (Schoeneweiss 1981; Manawasinghe et al. 2016). Their distribution is vast, covering all geographic and climatic regions, except Polar Regions (Crous et al. 2007a; Rodas et al. 2009; Wunderlich et al. 2011; Manawasinghe et al. 2016). At present, their ecological role as phytopathogens has gained a great attention (Manawasinghe et al. 2016). The pathogenic taxa in *Botryosphaeriaceae* cause several important diseases such as leaf spots, cankers, dieback, fruit rot, gummosis and even plant death on many economically important crops (Rodas et al. 2009, Hyde et al. 2014). Some species are pathogenic on many hosts (*Diplodia seriata*, *Lasioidiplodia* spp., and *Neofusicoccum parvum*) in the same geographic area. Pathogenicity of some taxa (e.g. *B. dothidea*) varies with the country for the same host species (Chen et al. 2014; Netto et al. 2014; Linaldeddu et al. 2015). The pathogenic fungal taxa of this family are recognized as “opportunistic plant fungal pathogens” (Chethana et al. 2016). It is not clear whether changes in the environment triggers pathogenicity or if disease development is due to weakening of the host defenses (Chethana et al. 2016; Manawasinghe et al. 2016). Since phytopathogenic botryosphaeriaceous taxa also have an endophytic lifestyle they may act as latent pathogens. Some species in this family have been reported as human pathogens (Polizzi et al. 2009, 2011; Phillips et al. 2013).

***Melanopsaceae*** A.J.L. Phillips, Slippers, Boissin & Crous, Stud. Mycol. 76(1): 43 (2013).

*Index Fungorum number*: IF 805796; *Facesoffungi numbers*: FoF 07630, 111 species.

On woody hosts. **Sexual morph**: *Ascostromata* pseudothecial, multiloculate, locules at various levels in ascoma, immersed, partially erumpent at maturity, black, subglobose, thick-walled. *Ascomatal wall* thick-walled, comprised of cells of *textura angularis*. *Asci* 8-spored, bitunicate, fissionate, pedicellate, clavate. *Hamathecium* comprising hyaline, thin-walled, hypha-like, septate, not constricted at septa, cellular pseudoparaphyses. *Ascospores* overlapping, ellipsoid to rhomboid, hyaline, aseptate, thin-walled, with a persistent mucus sheath. **Asexual morph**: Coelomycetous. *Conidiomata* often formed in the same stroma as *ascostromata*. *Paraphyses* septate, branched or not, filiform, hyaline, arising from between the conidiogenous cells. *Conidiophores* 1–2-septate, branched or not, hyaline, smooth, or

reduced to conidiogenous cells. *Conidiogenous cells* subcylindrical, branched or unbranched, discrete, hyaline, formed from the inner wall of the conidioma, proliferating percurrently at apex, or with periclinal thickening. *Conidia* fusoid, hyaline, aseptate, with a persistent mucus sheath, rarely with minute marginal frill (adapted from Slippers et al. 2013; Phillips et al. 2019)

*Type*: ***Melanops*** Nitschke ex Fuckel.

*Notes*: Slippers et al. (2013) established *Melanopsaceae* in Botryosphaeriales to accommodate *Melanops*. *Melanops* has a mucilage sheath around the ascospores and in that respect is identical to *Phyllostictaceae*. However, *Phyllostictaceae* has uniloculate *ascostromata*, while those of *Melanops* are multiloculate (Slippers et al. 2013). Phylogenetic analyses supported the placement of *Melanops* as a distinct family in Botryosphaeriales (Wikee et al. 2013b; Slippers et al. 2013; Phillips et al. 2019). Divergence time estimates for this family also support its familial status (Slippers et al. 2013; Phillips et al. 2019). However, Jiang et al. (2018b) suggested that the divergence time estimation in the previous studies might not be accurate estimates due to the fact that sequence data from only two taxa were used in the phylogenetic placement, an opinion also voiced by Phillips et al. (2019).

***Melanops*** Nitschke ex Fuckel, Jb. nassau. Ver. Naturk. 23–24: 225 (1870) [1869–70].

*Index Fungorum number*: IF 3078; *Facesoffungi number*: FoF 07442; 111 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: ***Melanops tulasnei*** Fuckel.

*Notes*: Over 100 species names are listed under *Melanops* in Index Fungorum (2020), but, only three species have sequence data (Jiang et al. 2018b). We were unable to obtain fresh collections to represent this genus. Thus, a drawing is provided. A description of the type species can be seen in Phillips and Alves (2009).

***Melanops tulasnei*** Fuckel, Jb. nassau. Ver. Naturk. 23–24: 225 (1870) [1869–70].

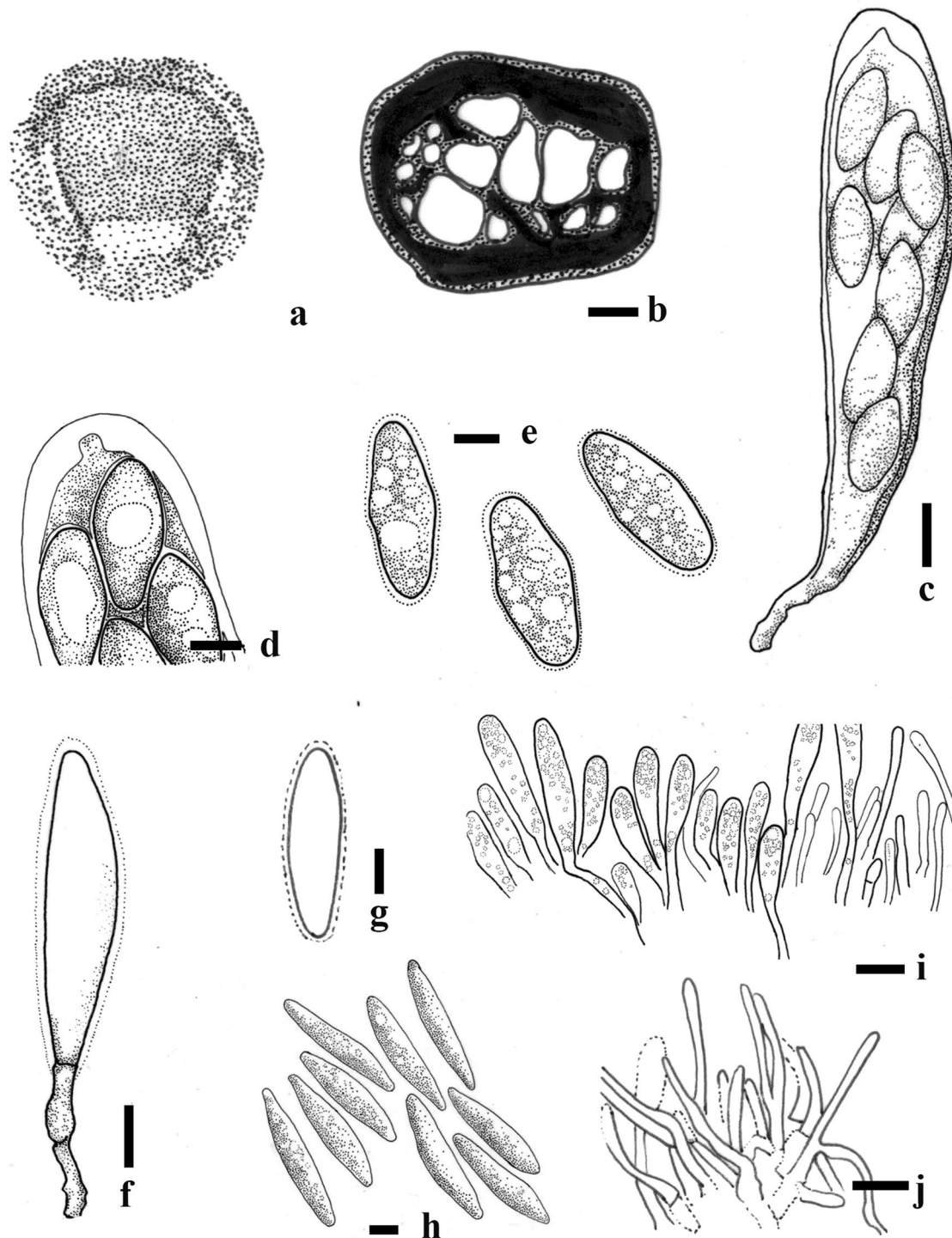
*Index Fungorum number*: IF 150956; *Facesoffungi number*: FoF 07444; Fig. 17

*Description*: see Phillips and Alves (2009).

### Economic and ecological significance

The ecology and distribution of *Melanops* is poorly known. Although its appearance is similar to other Botryosphaeriales, it is not clear whether it is pathogenic or endophytic (Slippers et al. 2013).

***Phyllostictaceae*** Fr. (as “Phyllostictei”), Summa vegetabilium Scandinaviae 2: 420 (1849).



**Fig. 17** *Melanops tulasnei* (redrawn from **neotype** and **epitype** specimens in Phillips and Alves 2009). **a** Stroma erumpent through the bark. **b** Stroma cut through horizontally revealing ascomata and conidiomata. **c** Ascus. **d** Ascus tip. **e** Ascospores. **f** Conidium and conid-

iogenous cell with mucus sheath around the conidium. **g** Conidium with mucous sheath. **h** Conidia. **i** Conidiogenous with conidia developing on conidiogenous cells. **j** Paraphyses. Scale bars: **b** = 250  $\mu$ m, **c** = 20  $\mu$ m, **d, e, g–j** = 10  $\mu$ m, **f** = 5  $\mu$ m

*Index Fungorum* number: IF 81162; *Facesoffungi* numbers: FoF 02296, >2000 species.

*Foliicolous, pathogenic, endophytic or saprobic* on plants. **Sexual morph:** *Ascostromata* pseudothecial, uniloculate, separate to gregarious, globose, brown to black,

with a central ostiole. *Asci* 8-spored, bitunicate, fissitunicate, clavate to subcylindrical, fasciculate, pedicellate, with an ocular chamber. *Pseudoparaphyses* mostly absent at maturity, when present broad-cylindric, septate, cellular. *Ascospores* 2–3-seriate, ellipsoid-fusoid to limoniform, hyaline, aseptate, smooth-walled, usually with mucilaginous caps, or surrounded by a mucilaginous sheath. **Asexual morph:** Coelomycetous. *Conidiomata* pycnidial globose, dark brown, separate to aggregated, with a central ostiole; wall of 3–6 layers of brown cells of *textura angularis*. *Conidiogenous cells* lining the inner wall, hyaline, smooth, subcylindrical to ampulliform or doliiform, proliferating percurrently near apex, frequently covered in mucilaginous sheath. *Conidia* ellipsoid-fusoid to obovoid or ovoid, hyaline, aseptate, smooth-walled, guttulate or granular, frequently surrounded by a mucilaginous sheath, often bearing a single mucilaginous apical appendage.

**Type:** *Phyllosticta* Pers.

**Notes:** *Phyllostictaceae* (as Phyllostictici) was proposed by Fries (1849). Seaver (1922) used Phyllostictales and *Phyllostictaceae* for *Phyllosticta*. *Phyllostictaceae* was accepted by Hawksworth and David (1989). Schoch et al. (2006) suggested that *Phyllosticta* belongs to *Botryosphaeriaceae* and this was accepted by Crous et al. (2006a) and Liu et al. (2012) who noted that *Phyllosticta* is distinct from other genera in *Botryosphaeriaceae*. Wikee et al. (2013b) suggested *Phyllostictaceae* as a distinct family in Botryosphaeriales and Slippers et al. (2013) formally re-instated the family.

Ascospores in *Melanopsaceae* and *Phyllostictaceae* have a mucilage sheath. *Phyllostictaceae* differs from *Melanopsaceae* by uniloculate ascostromata. Though mucoid apical appendages on the conidia have been regarded as characteristic of *Phyllosticta*, this feature is not necessarily a characteristic of the family since they are absent in some species such as *P. leucothoicola* or *P. neopyrolae* (Wikee et al. 2013b).

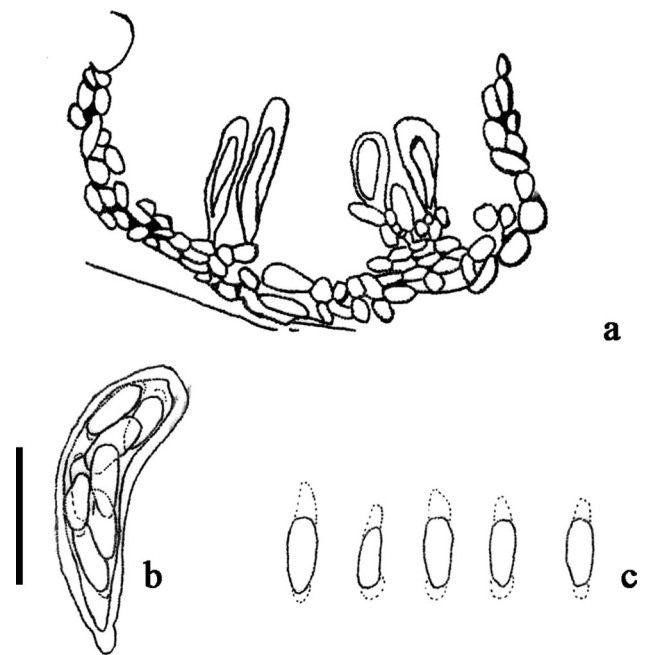
***Phyllosticta* Pers.**, Traité sur les Champignons Comestibles (Paris): 147 (1818).

***Index Fungorum number:*** IF 9384; ***Facesoffungi number:*** FoF 00155; >2000 records (Species Fungorum 2020), several species with molecular data.

***Type species:*** *Phyllosticta cruenta* (Kunze: Fr.) J. Kickx f.

≡ *Sphaeria cruenta* Fr., Syst. mycol. (Lundae) 2(2): 581 (1823).

**Notes:** *Phyllosticta* is a geographically widespread genus of plant pathogenic fungi with a diverse host range and a *Guignardia* sexual morph (Fig. 18). Seaver (1922) used Phyllostictales and *Phyllostictaceae* for *Phyllosticta*. *Phyllosticta* was placed in Botryosphaeriales by Schoch et al. (2006), who proposed that *Botryosphaeriaceae* contained



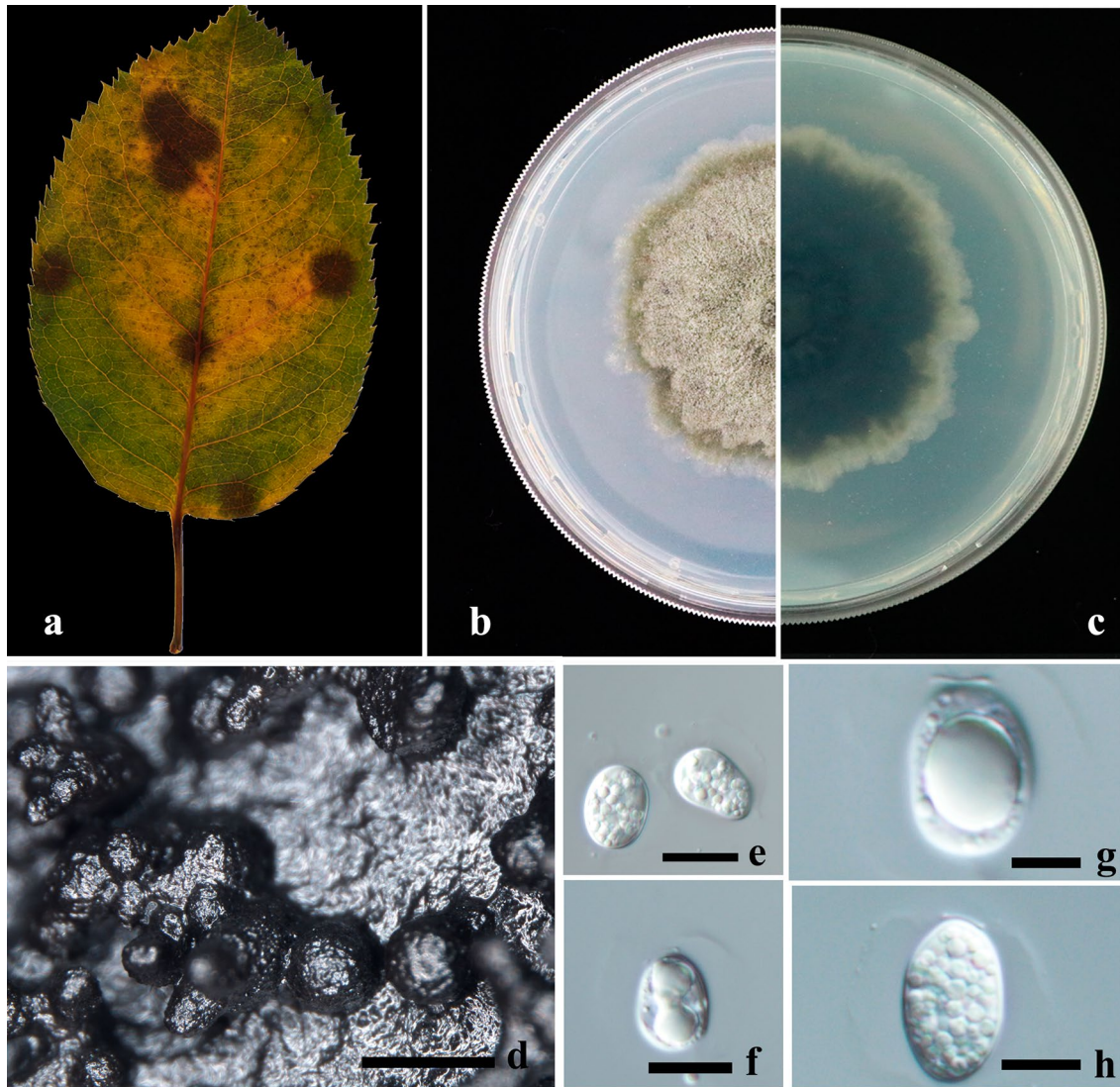
**Fig. 18** Sexual morph of *Phyllosticta ellipsoidea* (redrawn from Wulandari et al. 2011, MFLU 10-0475). **a** Section of ascoma. **b** Ascus. **c** Ascospores with polar mucilaginous appendage at each end. Scale bars: 25  $\mu$ m

both *Botryosphaeria* and *Phyllosticta*, although no support was obtained for this relationship. Crous et al. (2006a) and Liu et al. (2012) also classified *Phyllosticta* in *Botryosphaeriaceae*. In both studies it was noted that *Phyllosticta* was distinct from other genera in *Botryosphaeriaceae*, and that these authors eventually expected it to be placed elsewhere. Wikee et al. (2013b) redefined *Phyllosticta*, and showed that it clusters sister to *Botryosphaeriaceae*, for which the older family name *Phyllostictaceae* was resurrected. In moving away from a dual nomenclature for fungi, the generic name *Phyllosticta* was chosen over *Guignardia* in previous studies. There are 3214 *Phyllosticta* epithets listed in Index Fungorum. In this entry we illustrate *Phyllosticta hostae* (Fig. 19).

***Phyllosticta hostae* Y.Y. Su & L. Cai**, Persoonia 28: 79 (2012).

***Index Fungorum number:*** IF 564904; ***Facesoffungi number:*** FoF 07380; Fig. 19

Leaf spots circular to somewhat irregularly rotundate, pale brown to brown. **Sexual morph:** Undetermined. **Asexual morph:** Colonies on PDA, *Pycnidia* black, sub epidermal, globose, 40–150  $\mu$ m in diam. dark brown to black, darker around ostiole. *Conidiogenous cells* holoblastic, phialidic, cylindrical, subcylindrical to ampulliform, hyaline, thin-walled, smooth. *Conidia* 8–15  $\times$  5–9  $\mu$ m ( $\bar{x}$  = 10  $\times$  7, n = 20), unicellular, thin- and smooth-walled, ellipsoid, subglobose to obovoid, with large central guttule, truncate at



**Fig. 19** *Phyllosticta hostae* (JZB 3290001). **a** Leaf spot on rose leaf. **b** Front view of the colony on PDA. **c** Rear view of the colony on PDA. **d** Conidiomata in culture. **e–h** Conidia. Scale bars: **d** = 100  $\mu\text{m}$ , **e–h** = 10  $\mu\text{m}$

the base when young, later rounded at both ends, enclosed in a 1–3  $\mu\text{m}$  thick mucilaginous sheath, and bearing a hyaline, mucoid apical appendage, 4–8  $\times$  1–3  $\mu\text{m}$ , straight to flexuous, unbranched, tapering towards an acute tip.

**Material examined:** China, Beijing Tongzhou-Yongle Eco Park, leaf spot on rose (*Rosaceae*) leaves, 18 August 2018, Jia Jing Yi, 28-10-1, living culture: JZB 3290001.

**GenBank number:** ITS: MW130255.

**Notes:** *Phyllosticta* is an important genus of plant pathogens and contains quarantinable pathogenic species in some countries, especially in Europe (Wulandari et al. 2013). *Phyllosticta hostae* was introduced by Su and Cai (2012) from *Hosta plantaginina* (*Liliaceae*). This is the first record of *P. hostae* causing leaf spots in rose in China.

#### Other genera included

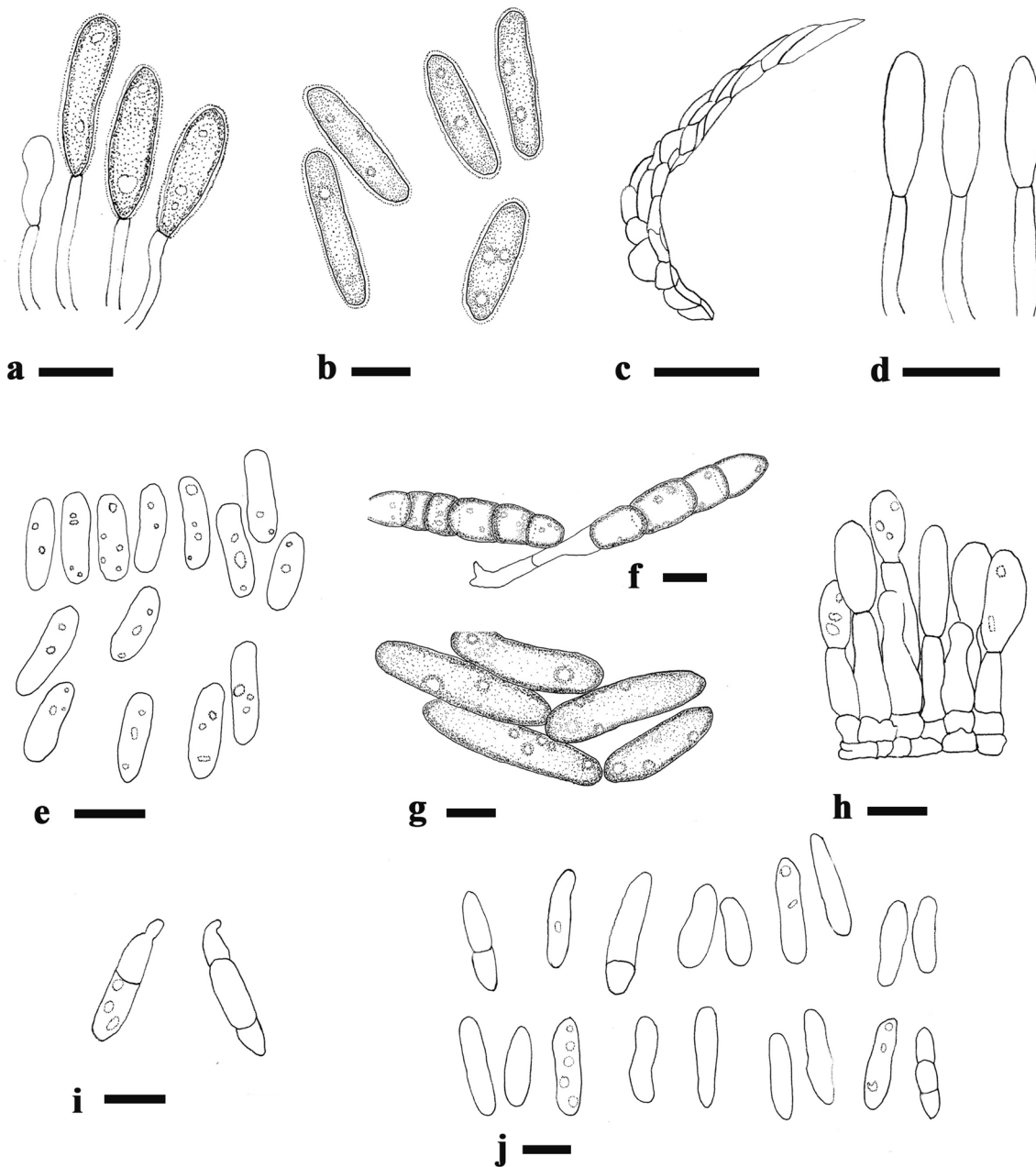
***Pseudofusicoccum*** Mohali, Slippers & M.J. Wingf., Stud. Mycol. 55: 249 (2006).

**Index Fungorum number:** IF 555584; **Facesoffungi number:** FoF 05299; – 8 morphological species (Species Fungorum 2020), 7 species with molecular data.

**Type species:** *Pseudofusicoccum stromaticum* (Mohali, Slippers & M.J. Wingf.) Mohali, Slippers & M.J. Wingf., in Crous et al., Stud. Mycol. 55: 249 (2006).

$\equiv$  *Fusicoccum stromaticum* Mohali, Slippers & M.J. Wingf., Mycol. Res. 110(4): 408 (2006).

**Notes:** The type species of *Pseudofusicoccum*, *P. stromaticum* was introduced as *Fusicoccum stromaticum* and was distinguished from other species by its large conidiomata, the ability to grow at 35°C, and thick-walled conidia. Crous



**Fig. 20** Morphology of *Pseudofusicoccum*. **a, b** Conidiophores and conidia of *P. stromaticum*. **c–e** Conidiomatal wall, conidiophore and conidia of *P. africanum*. **f, g** Conidia becoming brown and septate

when mature and young conidia of *P. artocarpi*. **h–j** Conidiogenous cells, germinating conidia and conidia of *P. adansoniae* Scale bars: **a** = 5  $\mu$ m, **b, c, e, f–j** = 10  $\mu$ m, **d** = 25  $\mu$ m

et al. (2006a) recognized that its conidia were covered by a mucous sheath, which is lacking in all species of *Fusicoccium*. Therefore, they introduced *Pseudofusicoccum* as a new genus to accommodate this taxon. *Pseudofusicoccum adansoniae*, *P. ardesiacum* and *P. kimberleyense* were proposed and distinguished from others by production of a pigment in culture and the size of conidia (Pavlic et al. 2008). Later, *P. olivaceum* was identified as a new species because of the discrepancy between ITS and *tef1* BLAST results

(Mehl et al. 2011). *Pseudofusicoccum artocarpi* was introduced as its conidia were clearly longer than others (Trakunyingcharoen et al. 2015). *Pseudofusicoccum violaceum* is distinctive because of the violet/purple pigment formed in culture and this has not been observed in any other *Pseudofusicoccum* species (Mehl et al. 2011). *Pseudofusicoccum africanum* was introduced as it is different from its neighbor *P. violaceum* by unique fixed alleles in ITS and *tef1* (Jami et al. 2018). Yang et al. (2017) raised the genus to familial

status as *Pseudofusicoccaceae*. The phylogenies reported in Phillips et al. (2019), as well as those of Minnis et al. (2012) and Liu et al. (2017), place *Pseudofusicoccum* in the same clade as *Phyllosticta* species. In view of this consistent relationship, together with the evolutionary divergence evidence as well as morphological data presented in Phillips et al. (2019), *Pseudofusicoccum* is considered to be an additional genus within *Phyllostictaceae* (Fig. 20).

### Economic and ecological significance

*Phyllosticta* species have globally been recorded as endophytes, plant pathogens and saprobes from economically and ecologically important plant hosts. Some cause important diseases such as Citrus black spot and tan spot, subjected to phyto-sanitary legislation in the European Union and the USA. Further leaf- and fruit-spotting disease of *Musa* spp. (freckle disease), leaf spots in turmeric, cashew, ginger, orchids and black rot of grapes diseases are also caused by *Phyllosticta* species.

***Planistromellaceae*** M.E. Barr, Mycotaxon 60: 437 (1996).

*Index Fungorum*: IF 81919; *Facesoffungi* number: 06689, 33 species.

*Biotrophic, hemibiotrophic* or *saprobic* on leaves and stems of various plants in terrestrial habitats. **Sexual morph**: *Ascostromata* multi- or uni-loculate, immersed to erumpent through cracking or splitting of the host tissue, solitary to gregarious, with periphysate ostioles, with or without papilla. *Cells of ascostromata* thick-walled, composed of several layers of dark brown cells, arranged in a *textura angularis*. *Locules* ovoid to globose, developing in the same stroma of the conidiogenous and/or spermatogenous locules, collapsed with the empty locule, which previously produced conidia or spermatia or both, ostiole periphysate. *Peridium* of locules composed of a few layers of hyaline to light brown flattened cells. *Hamathecium* lacking pseudoparaphyses, interascal cells abundant even at maturity. *Asci* 8-spored, bitunicate, fissitunicate, oblong, clavate to nearly cylindrical, with a pedicel and with an ocular chamber, forming in a basal layer, often interspersed with and covered by cellular remnants of interthecial tissues. *Ascospores* overlapping 1–3-seriate, ellipsoid to broadly obovoid, hyaline or lightly pigmented, yellowish to brownish, aseptate or 1–2-trans-septate, thin-walled, with or without gelatinous sheath, guttulate. **Asexual morph**: Coelomycetous. *Conidiomata* subepidermal, dark, immersed to erumpent, solitary to gregarious, pycnidia, locules or acervuli in a stroma or bearing conidia over stroma surface prior to locule formation, ostiolate. *Conidiomata walls* comprising several layers with cells of *textura angularis*, the outer layers composed of dark thick-walled cells, lighter towards the inner layers of hyaline cells. *Conidiogenous cells* short cylindrical, conidiogenesis holoblastic, hyaline, smooth. *Conidia* oblong,

ellipsoid-cylindric, hyaline to brown, aseptate or 1-multi-trans-septate, smooth-walled or verruculose, with or without one or more apical appendages. *Spermatial state* developing in the same or separate locules. *Spermatogenous cells* discrete or integrated, phialidic, cylindrical to elongate-conical, determinate, hyaline, smooth. *Spermatia* bacillary, hyaline, aseptate, smooth-walled.

*Type: Kellermania* Ellis & Everh.

*Notes: Planistromellaceae* was introduced by Barr (1996) and belongs to Botryosphaerales (Minnis et al. 2012; Monkai et al. 2013). Lumbsch and Huhndorf (2010) included the genera *Comminutispora*, *Eruptio*, *Loratospora*, *Microcylus*, *Mycosphaerellopsis*, *Planistroma* and *Planistromella* in *Planistromellaceae* based on morphology. Phylogenetic analysis based on SSU, ITS and LSU sequence data by Minnis et al. (2012) showed that *Kellermania*, *Piptarthron*, *Planistroma* and *Planistromella* should be treated as a single genus, thus, they synonymized them under *Kellermania* (oldest name). However, Monkai et al. (2013) indicated that the type species of *Kellermania*, which is also the type of *Planistromella*, clustered separately from *Planistroma* based on LSU and ITS sequence data. *Planistroma* was accepted as a distinct genus. The family was revised to accommodate *Kellermania*, *Planistroma* *Mycosphaerellopsis* and *Umthunziomyces* based on morphology and molecular data (Monkai et al. 2013; Phillips et al. 2019).

***Kellermania*** Ellis & Everh., J. Mycol. 1(12):153 (1885).

*Index Fungorum* number: IF 8668; *Facesoffungi* number: FoF 06690; 23 morphological species (Species Fungorum 2020), 18 species with molecular data.

*Type species: Kellermania yuccifoliorum* A.W. Ramaley.

*Notes:* Species in this genus are known from the host genera *Agave* and *Nolina* (*Asparagaceae*). Five species have been reported with both sexual and asexual morphs in Ramaley (1993, 1995, 1998) and Barr (1996). Many species of *Kellermania* were illustrated by Minnis et al. (2012) and conidia range from 0 to several trans-septa, and with or without appendages.

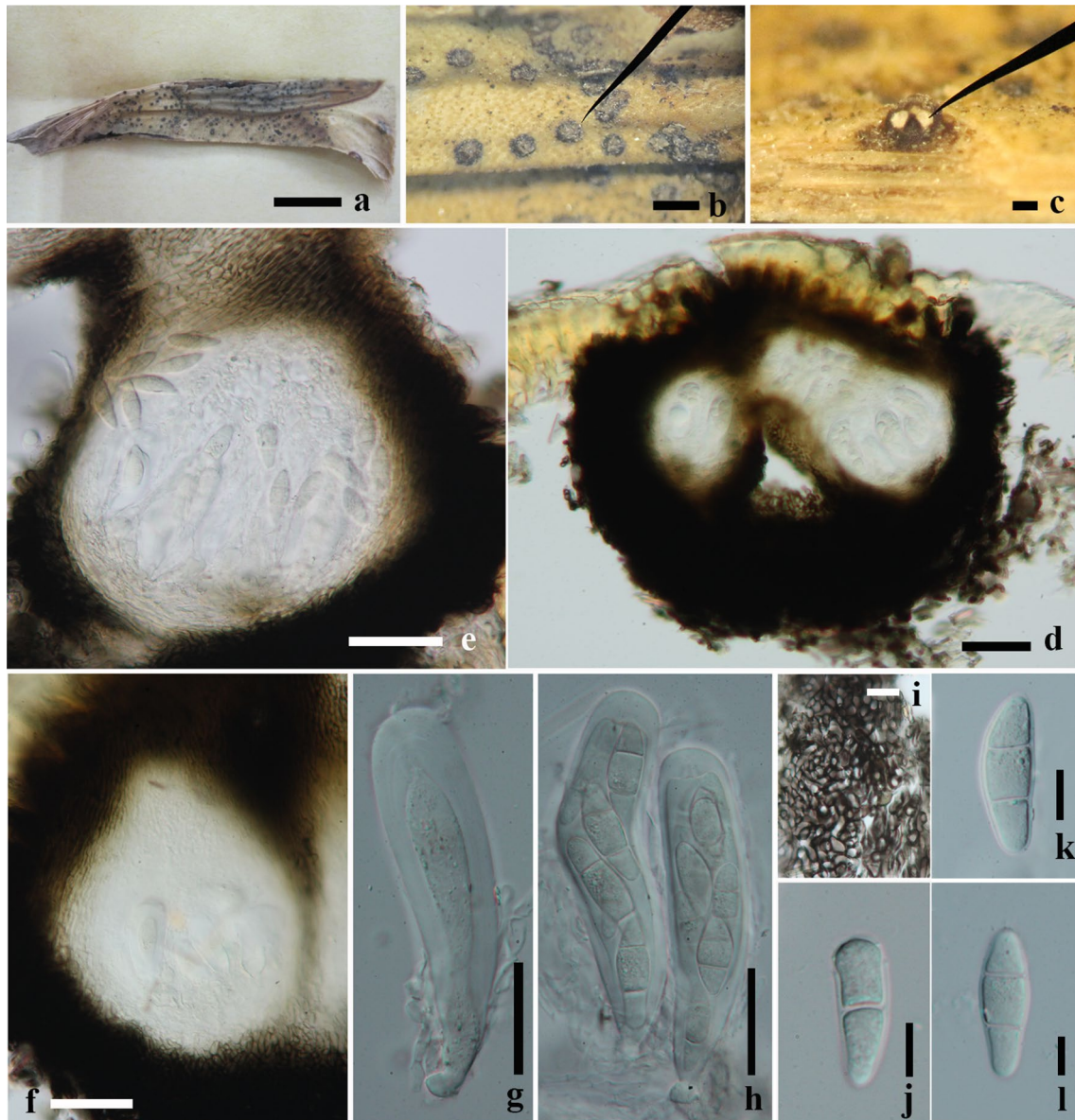
***Kellermania yuccifoliorum*** A.W. Ramaley, Mycotaxon 47: 262 (1993).

*Index Fungorum*: IF 360150; *Facesoffungi* number: FoF 06691; Figs. 21 and 22

*Description*: see Monkai et al. (2013).

*Material examined*: USA, California, San Bernardino County, Roadside 20 miles east of Baker (Hwy. 91/466), on leaves of *Yucca brevifolia* Engelm., 14 April 1960, Isabelle Tavares No. 466 (UC 1202973, holotype of *Planistromella yuccifoliorum*).

*Notes:* The type species of *Kellermania* (*K. yuccifoliorum* ≡ *Planistromella yuccifoliorum*) differs from other genera in *Planistromellaceae* in having 1–2-septate ascospores



**Fig. 21** *Kellermania yuccifoliorum* (UC 1202973, holotype of *P. yuccifoliorum*). **a, b** Ascostromata on the host surface. **c, d** Section of ascostroma. **e, f** Ascoma. **g** Immature ascus. **h** Mature asci. **i** Cells

of ascostroma. **j** Immature ascospore. **k, l** Mature ascospores. Scale bars: **a** = 1 cm, **b** = 1000  $\mu$ m, **c** = 200  $\mu$ m, **d** = 100  $\mu$ m, **e, f** = 50  $\mu$ m, **g, h** = 30  $\mu$ m, **i** = 20  $\mu$ m, **j–l** = 10  $\mu$ m

(Ramaley 1993; Barr 1996). The asexual morph of *K. yuccifoliorum* is characterized by uniloculate conidiomata, which develops in the same stroma as the ascogenous locules and 2-septate conidia with a unique apical appendage (Ramaley 1993).

#### Other genera included

*Mycosphaerellopsis* Höhn., Annal. Mycol. 16(1/2): 157 (1918).

*Index Fungorum* number: IF 3345; *Facesoffungi* number: FoF 06263; – 2 morphological species (Monkai et al. 2013), molecular data unavailable.

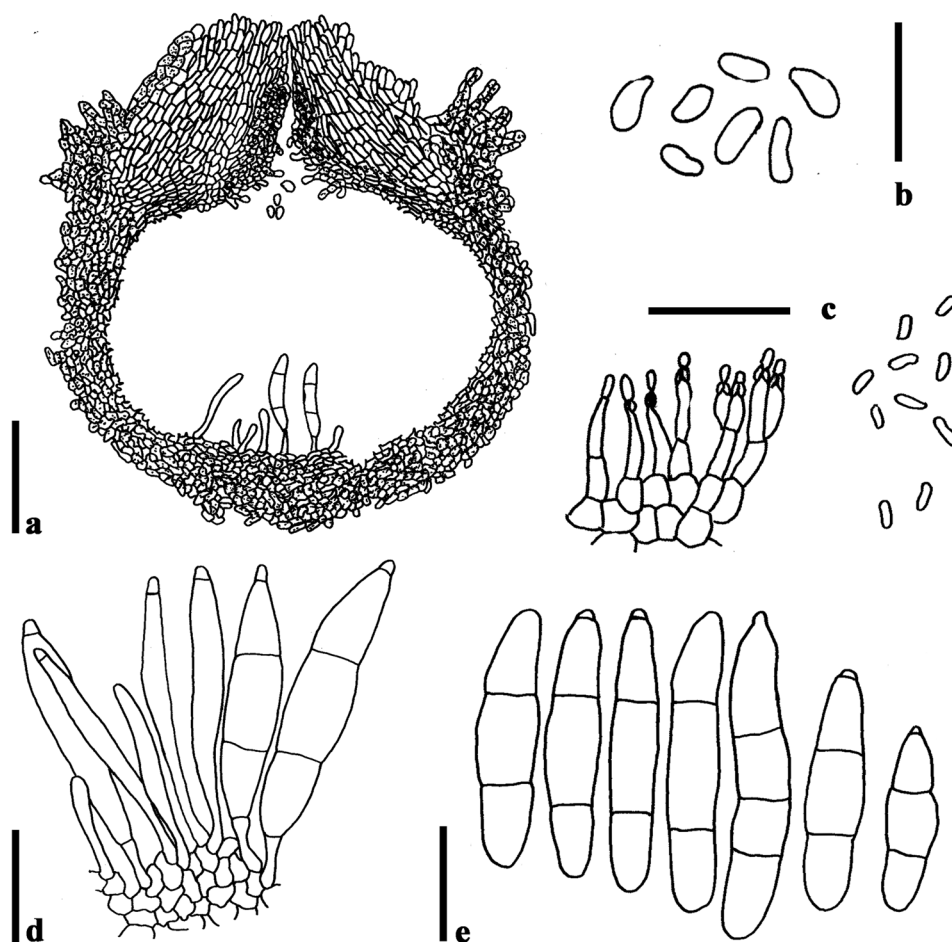
*Type species: Mycosphaerellopsis myricariae* (Fuckel) Höhn., Annal. Mycol. 16(1/2):157 (1918).

≡ *Sphaeria myricariae* Fuckel, Jb. Nassau. Ver. Naturk. 27–28: 22 (1874) [1873–74].

*Notes: Mycosphaerellopsis* differs from other genera in *Planistromellaceae* in having uniloculate ascomata and 1-septate, broadly obovoid ascospores. We accept *Mycosphaerellopsis* in this family based on its morphology (Monkai et al. 2013).

*Planistroma* A.W. Ramaley, Mycotaxon 42: 69 (1991).

**Fig. 22** *Kellermania yuccifoliorum* (redrawn from Ramaley 1993). **a** Conidioma. **b** Microconidia. **c** Spermata and spermatogenesis. **d** Conidiogenesis and origin appearance of apical appendage. **e** Conidia. Scale bars: **a** = 80  $\mu$ m, **b**, **d** = 27  $\mu$ m, **e** = 40  $\mu$ m



*Index Fungorum number*: IF 25358; *Facesoffungi number*: FoF 06264; – 7 morphological species (Monkai et al. 2013), 6 species with molecular data.

*Type species*: ***Planistroma yuccigenum*** A.W. Ramaley, Mycotaxon 42: 69 (1991), MycoBank: MB 358836.

*Notes*: *Planistroma* was established by Ramaley (1991), and is similar to *Kellermania* in ascostromata characters, but *Planistroma* differs on account of its aseptate ascospores (Barr 1996). The asexual morphs of *Planistroma* resemble *Kellermania* except in having apically appendaged conidia in the latter genus (Ramaley 1995). Minnis et al. (2012) synonymized *Planistroma* under *Kellermania* based on molecular data support. However, we follow Monkai et al. (2013) who assigned *Planistroma* as a distinct genus based on both morphological and molecular data.

***Umthunziomyces*** Crous & M.J. Wingf., in Crous et al., Persoonia 37: 315 (2016).

*Index Fungorum number*: IF 819069; *Facesoffungi number*: FoF 06718; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Umthunziomyces haghagensis*** Crous & M.J. Wingf., Persoonia 37: 315 (2016).

*Notes*: The monotypic genus *Umthunziomyces* was introduced by Crous et al. (2016a) and is known only from its asexual morphs. *Umthunziomyces* is similar to *Kellermania* in having septate conidia, but they are longer and narrower than in the latter genus. Phillips et al. (2019) included *Umthunziomyces* in *Planistromellaceae* with evidence from the phylogenetic analyses of ITS and LSU sequence data.

#### Economic and ecological significance

Members in this family usually grow on living or dead leaves or on stems of various plants, and are mostly saprobes, but some species are pathogens such as *Kellermania agaves*, and *Mycosphaerellopsis moravica* (Barr 1996; Ramaley 1993, 1995, 1998; Minnis et al. 2012; Crous et al. 2013). Most species inhabit *Asparagaceae*.

***Saccharataceae*** Slippers, Boissin & Crous, Studies in Mycology 76: 41 (2013).

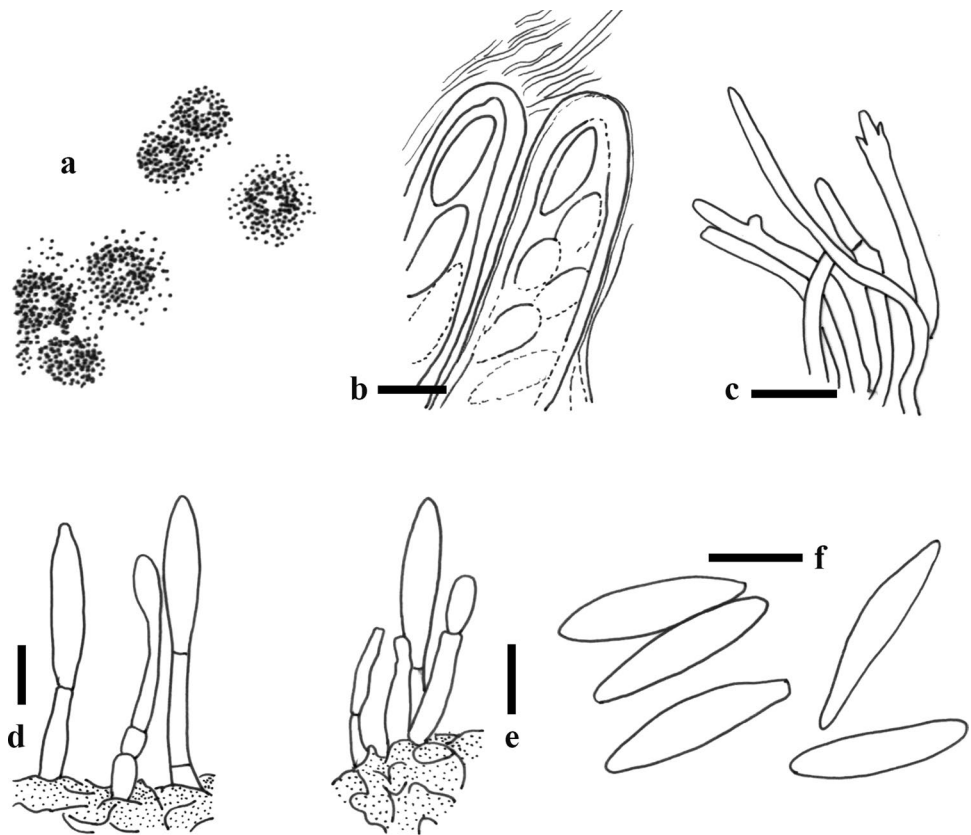
*Index Fungorum number*: IF 805794; *Facesoffungi numbers*: FoF 02296, 22 species.

*Saprobic, endophytic, or pathogenic* on plants. **Sexual morph**: *Ascostromata* pseudothecial, uniloculate, solitary or in clusters, with multi-layered, dark brown walls,



**Fig. 23** *Saccharata proteae* (redrawn from Slippers et al. 2013, CBS 121406).

**a** Immersed ascomata with clypeus-like structure. **b** Asci and ascospores. **c–e** Conidiogenous cells and paraphyses. **f** Conidia. Scale bars: **b–f** = 10  $\mu\text{m}$



infrequently embedded in stromatic tissue, with upper ascomatal layer darkened and thickened, developing under a very small epidermal clypeus, *ascomatal wall* continuous with clypeus. *Asci* 8-spored, bitunicate, fissitunicate, with a thick endotunica, pedicellate or sessile, cylindrical, with a well-developed ocular chamber. *Hamathecium* comprising 3–5  $\mu\text{m}$  wide, filiform, septate, hypha-like, branched or not, abundant, intermixed with asci, cellular pseudoparaphyses. *Ascospores* 2–3-seriate, ellipsoidal, hyaline to pigmented, pale golden brown, granular, septate or not, without mucoid appendages or sheath. **Asexual morph:** Coelomycetous. *Conidiomata* unilocular pycnidial, infrequently embedded in stromatic tissue with thickened, darkened upper layer. *Conidiophores* sparingly branched, hyaline, subcylindrical, or reduced to conidiogenous cells. *Conidiogenous cells* hyaline, smooth, phialidic, proliferating via periclinal thickening or percurrent proliferation, with or without collarettes. *Conidia* fusoid, hyaline, aseptate, thin-walled, granular. Synasexual morph formed in separate conidiomata, or in same conidiomata with asexual morph. **Synasexual morph:** *Conidia* ellipsoid or oval, pigmented, aseptate, thick-walled, finely verruculose. *Spermatogonia* similar to conidiomata in anatomy. *Spermatogenous cells* ampulliform to lageniform or subcylindrical, hyaline smooth, phialidic. *Spermatia* developing in conidiomata or spermatogonia, subcylindrical

or dumbbell-shaped, with rounded ends, hyaline, smooth, granular.

**Type:** *Saccharata* Denman & Crous.

**Notes:** The narrow, aseptate, filiform pseudoparaphyses in *Saccharataceae* are unique in Botryosphaerales and the pale golden brown ascospores are also distinctive. Slippers et al. (2013) accommodated this family in Botryosphaerales. *Saccharataceae* grouped separately from all other families that were basal in the phylogenetic tree, suggesting a long, separate evolutionary history. *Saccharataceae* has previously been known only from southern Africa, and is most diverse on the *Proteaceae*. Recent research has shown, however, that it has also been introduced as endophytes in other countries where South African *Proteaceae* are now being cultivated (Marincowitz et al. 2008).

***Saccharata*** Denman & Crous, in Crous et al., CBS Diversity Ser. (Utrecht) 2: 104 (2004).

**Index Fungorum number:** IF 28918; **Facesoffungi number:** FoF 02297; 19 morphological species (Species Fungorum 2020), 15 species with molecular data.

**Type species:** *Saccharata proteae* (Wakef.) Denman & Crous.

≡ *Phyllachora proteae* Wakef., Bull. Misc. Inf., Kew(5): 164 (1922).

*Notes:* Crous et al. (2004) described the first species of this genus from *Proteaceae* in the South Western Cape region of South Africa. Three other species were added to the genus, two from *Proteaceae* and one from *Encephalartos* (Marincowitz et al. 2008; Crous et al. 2008, 2009). Apart from its restricted distribution and host range, *Saccharata* is also unique in its asexual morphology, which includes a hyaline, fusicocum-like and a pigmented diplodia-like asexual morph. Based on phylogenetic analysis, evolutionary estimates and morphological data, Phillips et al. (2019) considered *Septorioideaceae* a synonym of *Saccharataceae*. We were unable to obtain fresh collections of *Saccharata* or other genera of *Saccharataceae*, therefore, a drawing of *Saccharata proteae* is provided (Fig. 23).

*Saccharata proteae* (Wakef.) Denman & Crous, in Crous et al., CBS Diversity Ser. (Utrecht) 2: 104 (2004).

≡ *Phyllachora proteae* Wakef., Bull. Misc. Inf., Kew(5): 164 (1922).

*Index Fungorum number:* IF 370531; *Facesoffungi number:* FoF 07631; Fig. 23

*Description:* see Slippers et al. (2013).

#### Other genera included

*Pileospora* J.B. Tanney & K.A. Seifert, Mycol. Prog. 18: 169 (2019).

*Index Fungorum number:* IF 824738; *Mycobank number:* MB82473; – 1 species with molecular data.

*Type species: Pileospora piceae* J.B. Tanney & K.A. Seifert, Mycol. Prog. 18: 169 (2019).

*Notes:* *Pileospora* is distinct from *Septorioides* by its aseptate, ellipsoidal-fusiform conidia with apical appendages versus subcylindrical to fusiform-ellipsoidal, 1–10-septate conidia lacking appendages. *Pileospora* is similar to *Neofusicoccum*, *Saccharata*, and other genera of Botryosphaerales having fusicocum-like asexual states with co-occurring irregularly-shaped conidia. An irregular, mucoid, apical appendage distinguishes conidia of *Pileospora* from above mentioned similar genera.

*Septorioides* Quaedvli., Verkley & Crous, Stud. Mycol. 75: 383 (2013).

*Index Fungorum number:* IF 804464; *Facesoffungi number:* FoF 06278; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Septorioides pini-thunbergii* (S. Kaneko) Quaedvlieg et al. Stud. Mycol. 75: 383 (2013).

≡ *Septoria pini-thunbergii* S. Kaneko, in Kaneko et al., Trans. Mycol. Soc. Japan 30(4): 463 (1989).

*Notes:* This genus is characterized by acervular conidiomata that open by means of an irregular rupture and paraphyses that are intermingled among conidiogenous cells (Quaedvlieg et al. 2013). *Septorioides pini-thunbergii* was

associated with needle blight and the cause of sooty mould of *Pinus thunbergii* in Japan (Suto 2000). Later, this species was isolated as an endophyte from *P. densiflora* in South Korea (Yoo and Eom 2012). The trend of raising established genera to familial status continued when Wyka and Broders (2016) introduced *Septorioideaceae* within the Botryosphaerales to accommodate *Septorioides* species. They introduced a novel species *Septorioides strobi* as the second species of this family. However, Phillips et al. (2019) placed *Septorioides* as a genus in *Saccharataceae* taking into consideration the results of phylogenetic analyses, evolutionary divergence and morphological data.

#### Economic and ecological significance

*Saccharataceae* has previously been known only from southern Africa, and is most diverse on *Proteaceae*. Research has shown, however, that it has also been introduced as an endophyte into other countries where South African *Proteaceae* are now cultivated (Marincowitz et al. 2008). This plant family, which has a high endemic richness in southern Africa, has evolved in the region for more than 100 million years (Barker et al. 2007). This date allows for the estimated 57 (28–100) MYA (based on rDNA SSU) separation of the *Saccharataceae* as a family and to have evolved with these endemic plant hosts in the region. The species are typically associated with leaf spots and stem cankers and they appear to be pathogens. Separate studies have also shown that they are endophytes (Swart et al. 2000, Taylor et al. 2001), similar to members of the *Botryosphaeriaceae*.

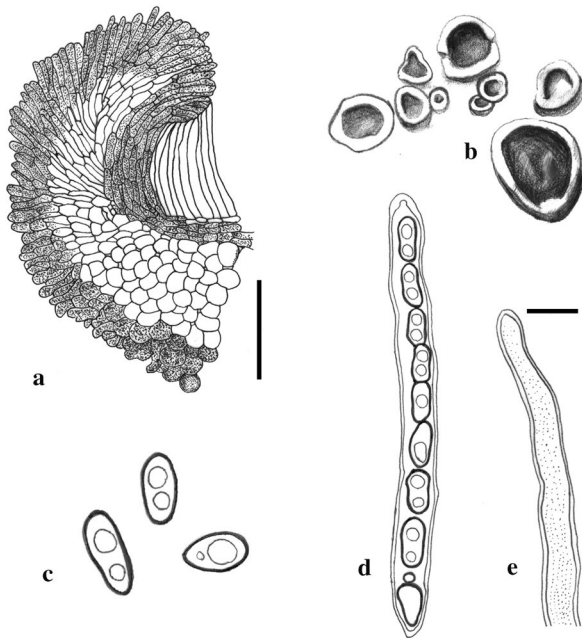
#### Catinellales Ekanayaka, K.D. Hyde & Ariyawansa, ord. nov.

*Index Fungorum number:* IF 557327; *Facesoffungi number:* FoF 07646

*Saprobic* on dead wood in terrestrial habitats. **Sexual morph:** *Ascomata* apothecial, discoid. *Excipulum* composed of *angularis* to globose cells. *Hamathecium* comprising cylindrical, septate, paraphyses. *Asci* cylindrical, clavate, inoperculate with an ocular chamber, J-. *Ascospores* ellipsoidal, uni-seriate. **Asexual morph:** Undetermined.

*Type: Catinellaceae* Ekanayaka, K.D. Hyde & Ariyawansa.

*Notes:* *Catinella* was established by Boudier (1907). Several authors have misidentified this fungus and placed it within Leotiomyces (Durand 1922). However phylogenetic study of Greif et al. (2007) strongly supported its placement within Dothideomycetes. *Catinella* formed a distinct lineage within Dothideomycetes in Hongsanan et al. (2020), thus we introduced this new order to accommodate *Catinella* and allied species in the class Dothideomycetes. The divergence time for Catinellales is estimated as 163 MYA (Hongsanan et al. 2020).



**Fig. 24** *Catinella olivacea* (a = redrawn from Gamundí 1981; b–e = redrawn from Akata et al. 2016). **a** Peridium. **b** Apothecial ascomata. **c** Ascospores. **d** Asci. **e** Anchor hyphae. Scale bars: **a** = 10  $\mu$ m, **b** = 20  $\mu$ m

Accepted families: *Catinellaceae*.

***Catinellaceae*** Ekanayaka, K.D. Hyde & Ariyawansa, **fam. nov.**

*Index Fungorum number*: IF 557328; *Facesoffungi number*: FoF 07647, 1 species.

*Saprobic* on dead wood in terrestrial habitats. **Sexual morph**: *Ascomata* apothecial, discoid, cupulate, flattened disc. *Excipulum* composed of *subangularis* to globose cells, ectal cells are pigmented. *Hamathecium* comprising cylindrical, septate, swollen apices agglutinate to form a pseudoepithecium, paraphyses. *Asci* 8-spored, cylindrical, clavate, inoperculate, unitunicate, J-, with well-developed ocular chamber. *Ascospores* ellipsoidal, uni-seriate, darkly pigmented, one-celled. **Asexual morph**: Undetermined.

*Type genus*: *Catinella* Boud.

*Notes*: The new family *Catinellaceae* bears some morphological characteristics similar to Leotiomyces, *i.e.* cupulate apothecia, unitunicate asci, aseptate ascospores. However, Dothideomycetes also show these characters, although they are not common within the class (Greif et al. 2007).

*Catinella* Boud., *Hist. Class. Discom. Eur.* (Paris): 150 (1907).

*Index Fungorum number*: IF 845; *Facesoffungi number*: FoF 07648; 3 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type*: *Catinella olivacea* (Batsch) Boud.

$\equiv$  *Peziza olivacea* Batsch, *Elench. fung.* (Halle): 127 (1783).

*Notes*: *Catinella* was established by Boudier (1907), with *C. olivacea* as the type species. The genus was recognised as a member in Leotiomyces based on its morphology. However, sequence data of *C. olivacea* indicated that this genus formed a distinct clade within Dothideomycetes (Fig. 24).

**Economic and ecological significance**

*Catinellaceae* is saprobic on dead wood and plays a role in recycling of organic matter.

**Cladoriellales** Crous.

*Index Fungorum number*: IF 823435; *Facesoffungi number*: FoF 07649.

Cladoriellales was established by Crous et al. (2017), with a single genus *Cladoriella*. Molecular data (LSU) confirmed its status as a distinct order within Dothideomycetes. This order contains asexual, cladospore-like species which are found as saprobes or pathogens on leaf surface. In Fig. 25, four species of *Cladoriella* (*Cladoriella eucalypti*, *C. kinglakensis*, *C. rubrigena*, and *C. xanthorrhoeae*) grouped with high support. The divergence time for Cladoriellales is estimated as 183 MYA (stem age, Hongsanan et al. 2020, Fig. 2).

Accepted families: *Cladoriellaceae*.

***Cladoriellaceae*** Crous, in Crous et al., *Persoonia* 39: 417 (2017).

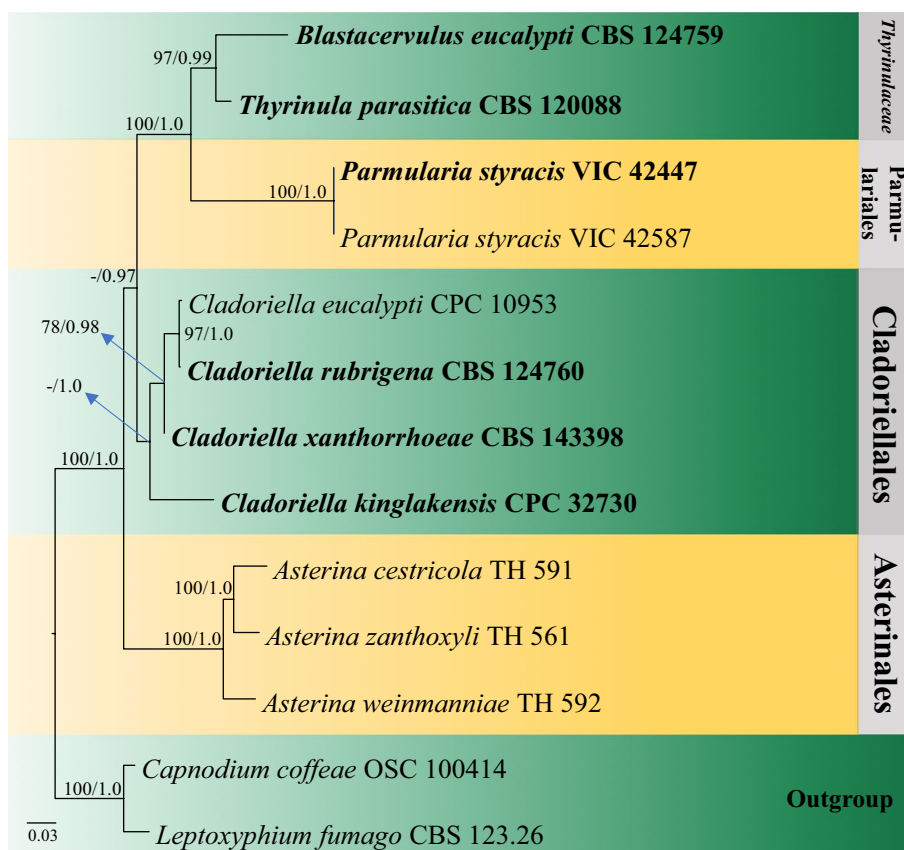
*Index Fungorum number*: IF 823436; *Facesoffungi number*: FoF 07650, 5 species.

*Saprobies* or *pathogens* on leaf surface. **Sexual morph**: Undetermined. **Asexual morph**: *Hyphae* coiling, branched, septate, with swollen cells giving rise to conidiophores, with hyphopodium-like structures at the base, simple, intercalary, brown to dark brown, thick-walled, smooth to finely verruculose. *Conidiophores* separate, erect, subcylindrical, straight, septate, thick-walled, brown to dark brown, smooth to finely verruculose. *Conidiogenous cells* terminal or intercalary, mono- or poly-tretic, sympodial, with 1–2 conspicuous loci, thickened, darkened, refractive, with a minute central pore. *Conidia* remains in long acropetal chains, narrowly ellipsoidal to cylindrical or fusoid, brown, non or 1-septate, thick-walled, finely verruculose, with apical conidium rounded at the apex; additional conidia with 1–2 truncate, conspicuous hila; thickened, darkened, refractive, with a minute central pore. *Chlamydospores* absent (Crous et al. 2006b, 2017).

*Type*: *Cladoriella* Crous.

*Notes*: *Cladoriellaceae* was established by Crous et al. (2017) to accommodate a single genus *Cladoriella*. Sequence data for this family are available in GenBank and it also supports *Cladoriellaceae* as a family of Cladoriellales in Dothideomycetes.

**Fig. 25** Phylogram generated from maximum likelihood analysis (RAxML) of Cladoriellales based on LSU sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Capnodium coffeae* (OSC 100414) and *Leptoxyhium fumago* (CBS 123.26). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



*Cladориella* Crous, Stud. Mycol. 55: 54 (2006).

*Index Fungorum number*: IF 500799; *Facesoffungi number*: FoF 07651; 5 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species*: *Cladориella eucalypti* Crous.

*Notes*: Crous et al. (2006b) introduced *Cladориella* to accommodate cladosporium-like species. This genus is similar to *Devriesia*, but lacks chlamyospores, and produces a distinct red pigment on media. Phylogenetic analyses also support this distinctness as *Cladориella* formed a clade apart from *Cladosporium* complex (*Mycosphaerellaceae*), *Cladophialophora* complex (*Herpotrichiellaceae*), or *Pseudocladosporium* complex (*Venturiaceae*) (Crous et al. 2006b) (Fig. 26).

### Economic and ecological significance

Species in this family are saprobic and probably are plant pathogenic (Wijayawardene et al. 2017a). They are found on leaf surfaces, however, the lifestyle of species in *Cladориellaceae* is not well-studied.

### Collemopsidiales Pérez-Ort.

*Index Fungorum number*: IF 815627; *Facesoffungi number*: FoF 07652.

This recently erected order includes a single family, *Xanthopyreniaceae*. It encompasses species of lichen-forming

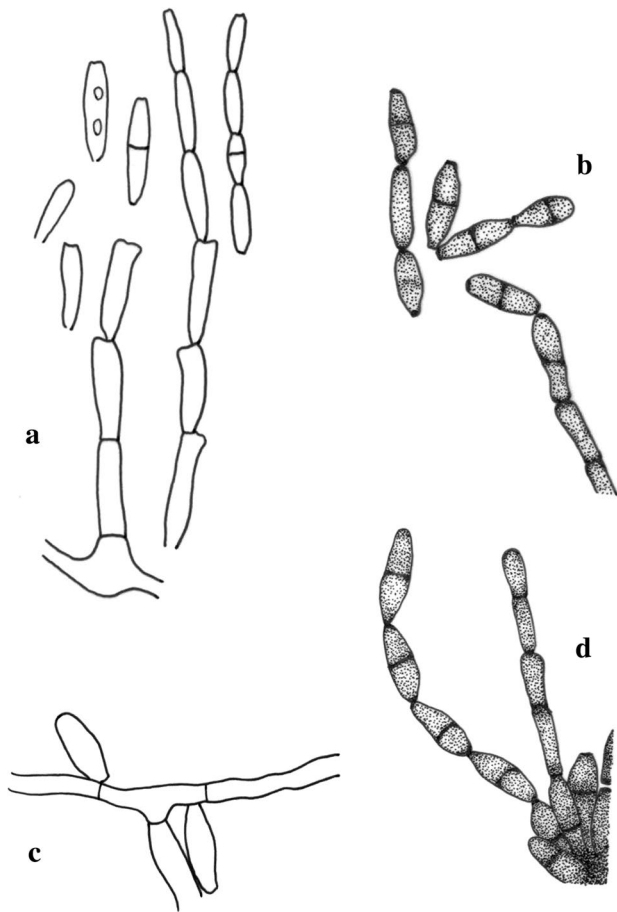
fungi, lichenicolous or forming loose associations with cyanobacteria. The diversity of the order has been largely underestimated and the actual number of species could exceed 200. The divergence time for Collemopsidiales is estimated as 230 MYA (stem age, Hongsanan et al. 2020) (Fig. 27).

*Accepted families*: *Xanthopyreniaceae*.

*Xanthopyreniaceae* Zahlbr., in Engler & Prantl, Nat. Pflanzenfam., Edn 2 (Leipzig) 8: 91 (1926).

*Index Fungorum number*: IF 81525; *Facesoffungi number*: FoF 07653, 53 species.

*Lichen-forming fungi*, lichenicolous or forming loose associations with cyanobacteria. *Vegetative hyphae* usually hyaline. **Sexual morph**: *Ascomata perithecioid*, solitary or in groups, superficial or immersed in the substratum, subglobose. *Peridium* thin to thick, composed by elongated to roundish, more or less compressed cells of *textura angularis*. *Involucrelum* present in some species, with *textura intricata*. *Hamathecium* comprising thin, septate, highly branched and anastomosed interascal filaments. *Asci* 4–8-spored, thick-walled, bitunicate, fissitunicate, ovate to clavate, apedicellate, with a distinct ocular chamber. *Ascospores* irregularly arranged within the ascus, ellipsoid to broadly ellipsoid, hyaline, 1-septate, wall cell smooth, usually with a gelatinous shell. **Asexual morph**: Coelomycetous. *Pycnidium*,



**Fig. 26** Conidiophore and conidia of *Cladoriella* spp. **a** *Cladoriella eucalypti* (redrawn from Crous et al. 2006, CBS H-18043). **b–d** *Cladoriella xanthorrhoeae* (redrawn from Crous et al. 2017, CBS H-23300)

superficial or immersed in the substratum, black, with a small ostiole. *Pycnidial wall* thick-walled cells of *textura angularis*, composed of  $\pm$  isodiametric or elongated cells. *Conidiogenous cells*  $\pm$  cylindrical, phialidic. *Conidiospores* bacilliform to ellipsoid.

*Type: Xanthopyrenia* Bachm.

*Notes: Xanthopyreniaceae* was introduced by Zahlbruckner to accommodate the single species *Xanthopyrenia tichothecioides* (= *Arthopyrenia tichothecioides*), a species growing on periodically inundated calcareous rocks. The species was later combined into *Pyrenocollema* (*P. tichothecioides*) and subsequently many species associated with cyanobacteria, and with perithecioid ascomata, highly branched and anastomosed interascal filaments and hyaline 1-septate ascospores were transferred or described in *Pyrenocollema* (e.g. Santesson 1992; Coppins et al. 1992; McCarthy and Kantvilas 1999; Nordin 2002). However, Grube and Ryan (2002) stated that the type species of the genus, *P. tremeloides* is in fact a parasite on *Nostoc* and is not congeneric

with *X. tichothecioides*, suggesting that the correct generic name for those species should be *Collemopsidium*, and many species of *Pyrenocollema* were subsequently combined into this genus (Grube and Ryan 2002; Mohr et al. 2004). Pérez-Ortega et al. (2016) studied the phylogenetic relationships of *Xanthopyreniaceae* using six molecular markers. Although they found *Xanthopyreniaceae* belongs to Dothiideomycetes, and described the new order Collemopsidiales, their exact position remained elusive despite of using different taxa sampling, very likely due to the use of Arthoniomycetes as outgroup. Subsequent work by Liu et al. (2017) found high support for the sister relationships of Collemopsidiales with Monoblastiales. Based on uncertainties by Pérez-Ortega et al. (2016), Tedersoo et al. (2018) described the new class Collemopsidiomycetes which should be considered as a synonym of Dothiideomycetes. Lumbsch and Huhndorf (2007) included the genera *Collemopsidium*, *Didymellopsis*, *Frigidopyrenia*, *Pyrenocollema*, and *Zwackhiomyces* as members of the *Xanthopyreniaceae*. Later, Wijayawardene et al. (2018) excluded *Frigidopyrenia* and *Pyrenocollema* from the family and placed them in *Pezizomycotina* genera *incertae sedis*. Unfortunately, no molecular data is available for *Didymellopsis*, *Frigidopyrenia* and *Pyrenocollema*. Pérez-Ortega et al. (2016) discussed that the number of species in the family may have been highly underestimated.

*Xanthopyrenia* Bachm., Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 105(1): 65 (1919).

*Index Fungorum number:* IF 5810; *Facesoffungi number:* FoF 07654; – 2 morphological species (Pérez-Ortega et al. 2016), molecular data unavailable.

*Type species: Xanthopyrenia tichothecioides* (Arnold) Bachm.

$\equiv$  *Arthopyrenia tichothecioides* Arnold, Flora, Regensburg 52: 268 (1869).

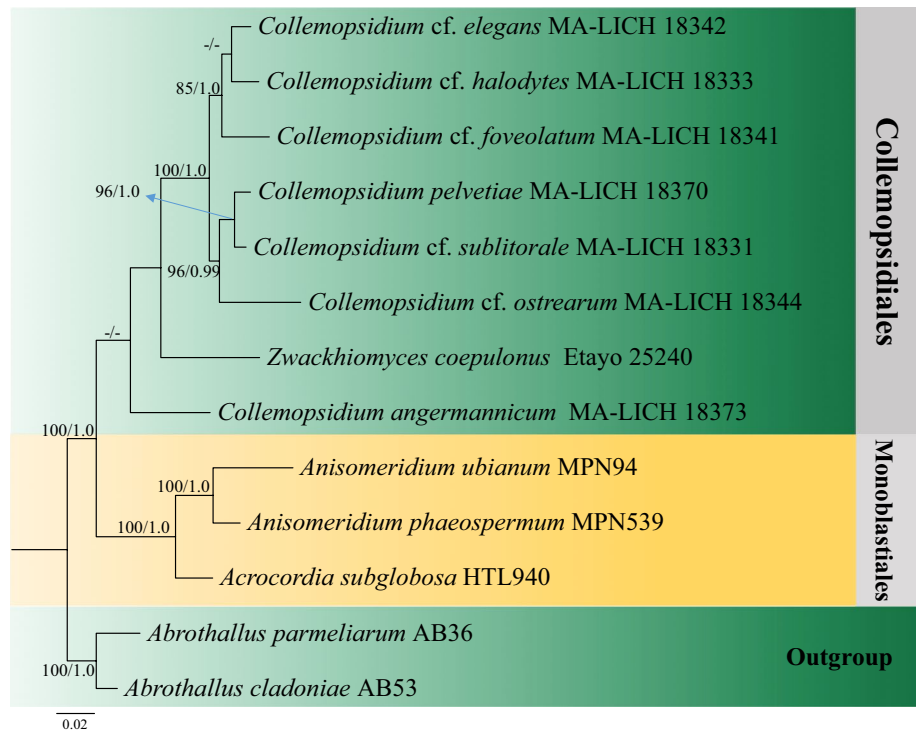
*Notes:* The genus was described to accommodate the single species *Arthopyrenia tichothecioides*, a species occurring with seawater or spray on calcareous rocks (Thüs and Schultz 2009). This species and *X. heardensis*, the only other species described in the genus, were subsequently transferred to *Pyrenocollema*. Pérez-Ortega et al. (2016) showed that *Collemopsidium* as currently circumscribed is paraphyletic, so *Xanthopyrenia* might be the correct generic name for non-marine *Collemopsidium* species (Fig. 28).

#### Other genera included

*Collemopsidium* Nyl., Flora, Regensburg 64: 6 (1881).

*Index Fungorum number:* IF 1182; *Facesoffungi number:* FoF 07655; – 16 morphological species (Species Fungorum 2020), 3 species with molecular data (Pérez-Ortega et al. 2016).

**Fig. 27** Phylogram generated from maximum likelihood analysis (RAxML) of Collempsidiales based on LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%. Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to and *Abrothallus cladoniae* (AB53) and *A. parmeliarum* (AB36). Hyphen (-) represents support values below 70% MLBS and 0.90 PP



*Type species: Collemopsidium iocarpum* (Nyl.) Nyl., Flora, Regensburg 64: 6 (1881).

≡ *Pyrenopsis iocarpa* Nyl., Not. Sällsk. Fauna et Fl. Fenn. Förh., Ny Ser. 5: 26 (1861).

*Notes:* Grube and Ryan (2002) studied the types of *Collemopsidium* and *Pyrenocollema* and stated that the former is the correct generic name for species previously included in *Pyrenocollema*. Pérez-Ortega et al. (2016) showed that the genus as currently understood is paraphyletic and species occurring in marine and terrestrial and freshwater habitats belong to different lineages. *Collemopsidium iocarpum* was described growing close to the seashore and it is likely the correct name for the marine clade. Species concepts and taxonomy have to be thoroughly studied. Pérez-Ortega et al. (2016) showed that each of the species commonly accepted in the literature likely encompass dozens of different taxa. Cyanobacteria associated with *Collemopsidium* are largely undetermined, marine species likely belong to *Hyella* (Swin-scow 1965b). *Xanthocapsa* may be involved in freshwater symbioses (Grube and Hafellner 1990).

*Didymellopsis* (Sacc.) Clem. & Shear, Gen. fung., Edn 2 (Minneapolis): 66 (1931).

= *Didymella* subgen. *Didymellopsis* Sacc. & D. Sacc., Syll. fung. (Abellini) 17: 657 (1905).

*Index Fungorum number:* IF 1550; *Facesoffungi number:* FoF 07656; – 8 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Didymellopsis latitans* (Nyl.) Sacc. ex Clem. & Shear, Gen. fung., Edn 2 (Minneapolis): 265 (1931).

≡ *Obryzum latitans* Nyl., Flora, Regensburg 68: 298 (1885).

*Notes:* All species in *Didymellopsis* are found on lichens with cyanobacterial photobionts, but *D. perigena* which grows on *Catapyrenium squamulosum* might be associated with cyanobacteria surrounding the host thallus. Differences between *Didymellopsis* and *Zwackhiomyces* are subtle (Zhurbenko et al. 2015) and a thorough revision of the group, including DNA sequence analyses should be carried out.

*Frigidopyrenia* Grube, Phytion, Horn 45(2): 307 (2005).

*Index Fungorum number:* IF 521258; *Facesoffungi number:* FoF 07657; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Frigidopyrenia bryospila* (Nyl.) Grube, Phytion, Horn 45(2): 308 (2005).

≡ *Verrucaria bryospila* Nyl., Flora, Regensburg 47: 357 (1864).

*Notes:* Grube (2005) described the monotypic genus *Frigidopyrenia* for *Verrucaria bryospila* occurring on mosses in arctic-alpine areas, forming distinct squamules and with cyanobacteria as photobiont. Grube (2005) discussed the morphological differences of the genus with similar genera such as *Collemopsidium*, *Magnopsis* and



**Fig. 28** Morphological and anatomical features of *Xanthopyreniaceae*. **a** Habitus *Collemopsidium foveolatum*-morphotype. **b** *C. halodytes*-morphotype. **c** *C. ostrearum*-morphotype. **d** *Zwackhiomyces coepulonus*. **e** Ascus from *C. angermannicum*. **f** Interascal fila-

ments from *C. cf. foveolatum*. **g** Ascospore from *C. cf. sublitorale*. **h** Ascospore from *C. angermannicum* with gelatinous sheath. Scale bars: **a–c** = 1 mm; **d** = 0.5 mm; **e–h** = 10  $\mu$ m

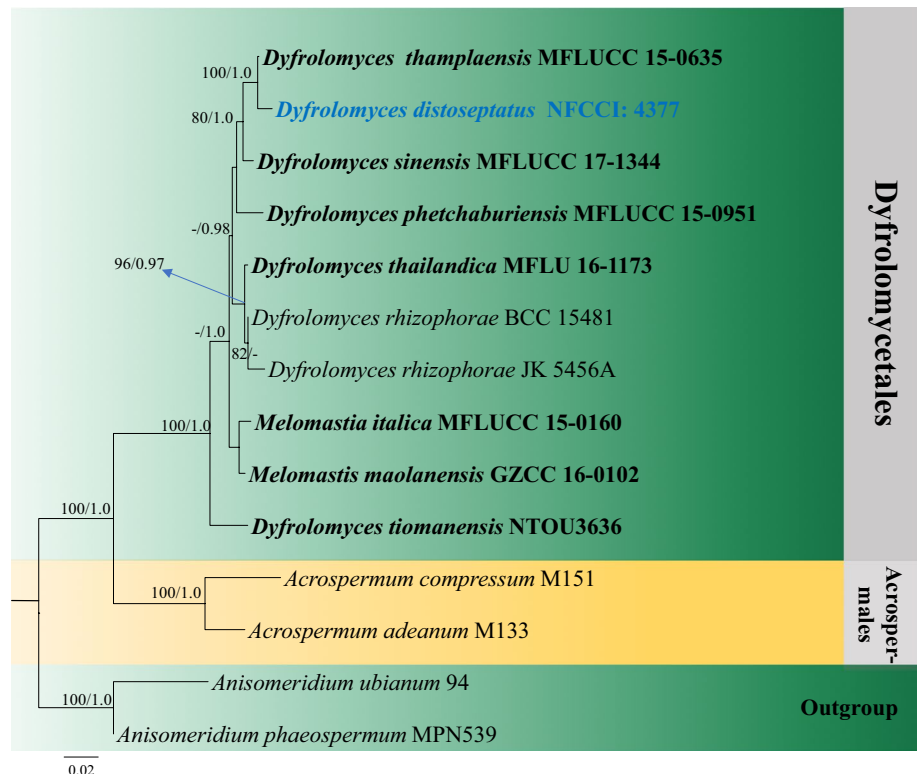
*Pyrenocollema*, which have different peridial structure. It is not clear that the genus belongs in *Xanthopyreniaceae*.

*Rhagadodidymellopsis* Fdez.-Brime, Gaya, Llimona & Nav.-Ros., Plant and Fungal Systematics 65(1): 177 (2020).

*Index Fungorum number*: IF 835454; *Facesoffungi number*: FoF 09130; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Rhagadodidymellopsis endocarpi* Fdez.-Brime, Gaya, Llimona & Nav.-Ros., Plant and Fungal Systematics 65(1): 177 (2020).

**Fig. 29** Phylogram generated from maximum likelihood analysis (RAxML) of Dyfrolomycetales based on LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%. Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Anisomeridium phaeospermum* (MPN539) and *A. ubianum* (94). The ex-type and reference strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



**Notes:** This recently erected genus, with the only species *R. endocarpi* growing on *Endocarpon pusillum*, was described based on the presence of ascomata occurring in stromata with uneven wall. It seems to be closely related to *Didymellopsis* and *Zwackhiomyces* (Fernández-Brime et al. 2020). It is here tentatively placed in Collemopsidiales and Xanthopyreniaceae until molecular data is available.

**Zwackhiomyces** Grube & Hafellner, Nova Hedwigia 51(3–4): 305 (1990).

**Index Fungorum number:** IF 25388; **Facesoffungi number:** FoF 07658; – 26 morphological species (Species Fungorum 2020), 1 species with molecular data.

**Type species:** *Zwackhiomyces coepulonus* (Norman) Grube & R. Sant., in Grube & Hafellner, Nova Hedwigia 51(3–4): 310 (1990).

≡ *Arthopyrenia coepulona* Norman, Bot. Notiser: 192 (1868) [1867].

**Notes:** *Zwackhiomyces* is one of the most diverse genera of lichenicolous fungi with 35 known species (Diederich et al. 2018). Species mostly grow on crustose lichens with green photobionts, although five species grow on hosts with cyanobacteria as photobiont. Pérez-Ortega et al. (2016) sequenced the type species and confirmed the genus is a member of Xanthopyreniaceae.

**Zwackhiomacromyces** Etayo & van den Boom, Opuscula Philolichenum 13: 70 (2014).

**Index Fungorum number:** IF 803963; **Facesoffungi number:** FoF 08929; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Zwackhiomacromyces constrictocarpus* Etayo & van den Boom, Opuscula Philolichenum 13: 72 (2014).

**Notes:** van den Boom and Etayo (2014) established the new genus based on material from the Iberian Peninsula growing on *Megaspora verrucosa*. The new genus differs from *Zwackhiomyces* in having lageniform ascomata, with large and granulose papillae, larger asci and ascospores, and normally 3-septate smooth-walled ascospores (van den Boom and Etayo 2014). Later, Etayo and Berger (in Berger and Zimmerman 2016) combined *Pyrenidium hyalosporum* growing in *Placopsis gelida* into *Zwackhiomacromyces* based on ascoma and ascospore characters. This genus tentatively placed in the order Collemopsidiales and Xanthopyreniaceae until molecular data is available.

### Economic and ecological significance

Members of the Xanthopyreniaceae are usually inconspicuous and have been often overlooked. Most of the lichenicolous species do not cause harm to the hosts, and many of the interactions may be considered commensalistic. Marine species of *Collemopsidium* with boring capacity may have relevant ecological significance since they actively produce bioweathering in littoral rocky substrates, boosting the deteriorative action of waves. Furthermore, those species are



able to colonize and modified mollusk and barnacle shells, mediating mimicry in some species (Espoz et al. 1995).

**Dyfronomycetales** K.L. Pang, K.D. Hyde and E.B.G. Jones.

*Index Fungorum number*: IF 805281; *Facesoffungi number*: FoF 07670.

Dyfronomycetales with the type genus *Dyfronomycetes* was introduced to accommodate marine fungi and now includes terrestrial, wood-inhabiting taxa which are characterized by immersed, ostiolate, clypeate, papillate ascomata, bitunicate, cylindrical, short pedicellate asci, with a distinct ocular chamber along with a ring-like subapical ring, and overlapping uni-seriate, broadly fusiform, symmetrical, hyaline, multi-septate ascospores. Only the single family *Pleurotremataceae* is accepted in this order. The divergence time for Dyfronomycetales is estimated as 171 MYA (stem age, Hongsanan et al. 2020) (Fig. 29).

*Accepted families*: *Pleurotremataceae*.

***Pleurotremataceae*** Walt. Watson, *New Phytol.* 28: 113 (1929).

*Index Fungorum*: IF 81192; *Facesoffungi number*: FoF 01911, 47 species.

= *Dyfronomycetaceae* K.D. Hyde, K.L. Pang, Alias, Suetrong & E.B.G. Jones, in Pang et al., *Cryptog. Mycol.* 34(3): 227 (2013).

*Saprobic* on wood in terrestrial and aquatic habitats. **Sexual morph**: *Ascomata* perithecial, gregarious or solitary, immersed or erumpent throughout the host, dark-brown to black, ovoid to subglobose, carbonaceous to membranaceous, clypeate, ostiolate, papillate. *Peridium* comprising of dark pigmented cells of *textura angularis* or *epidermoidea*. *Hamathecium* comprising numerous, filamentous, hyaline, septate, branched or unbranched, narrow cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, clavate to cylindrical, short pedicellate, apical ring present, J-. *Ascospores* uni-seriate, ellipsoidal to cylindrical or fusiform, hyaline, septate, smooth-walled, mostly with guttules. **Asexual morph**: Undetermined.

*Type*: *Pleurotrema* Müll.

*Notes*: *Pleurotremataceae* is typified by *Pleurotrema* with *Pleurotrema polysemum* as the type species. Subsequently, the nomenclature and placement of this family has been the subject of discussion until Maharachchikumbura et al. (2015) placed it under Chaetosphaeriales, Sordariomycetes. Maharachchikumbura et al. (2016) examined the isotype of *P. polysemum* and found that *Dyfronomycetaceae* (Dyfronomycetales) is a synonym of *Pleurotremataceae*, thus removed *Pleurotremataceae* from Sordariomycetes to be a single family of Dyfronomycetales. This family comprises three genera, and most members are characterized by perithecial, ostiolate, glabrous, ovoid to subglobose ascomata, clavate to cylindrical, unitunicate, short pedicellate asci with

a J- apical ring, and hyaline, ellipsoidal to cylindrical, septate, guttulate ascospores that are uni-seriately arranged in the asci.

***Pleurotrema*** Müll. Arg., *Bot. Jb.* 6: 388 (1885).

*Index Fungorum number*: IF 4251; *Facesoffungi number*: FoF 07671; 14 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Pleurotrema polysemum* (Nyl.) Müll. Arg. ≡ *Parathelium polysemum* Nyl., *Bot. Ztg.* 20: 279 (1872).

*Notes*: *Pleurotrema* was introduced as lichenized by Müller (1885). The placement of this genus has been the subject of controversy as it has been placed in different families viz., *Pyrenulaceae*, *Pleurotremataceae* and *Ascomycota* genera *incertae sedis*, based on its morphological characters (Barr 1994; Kirk et al. 2001; Lumbsch and Huhndorf 2010). Maharachchikumbura et al. (2016) re-examined the isotype of *Pleurotrema polysemum*, and synonymized *Dyfronomycetaceae* under *Pleurotremataceae*.

#### Other genera included

***Dyfronomycetes*** K.D. Hyde, K.L. Pang, Alias, Suetrong & E.B.G. Jones, in Pang et al., *Cryptog. Mycol.* 34(3): 227 (2013).

*Index Fungorum number*: IF 804660; *Facesoffungi number*: FoF 07672; – 9 morphological species (Species Fungorum 2020), 6 species with molecular data.

*Type species*: *Dyfronomycetes tiomanensis* K.L. Pang, Alias, K.D. Hyde, Suetrong & E.B.G. Jones, in Pang et al., *Cryptog. Mycol.* 34(3): 228 (2013).

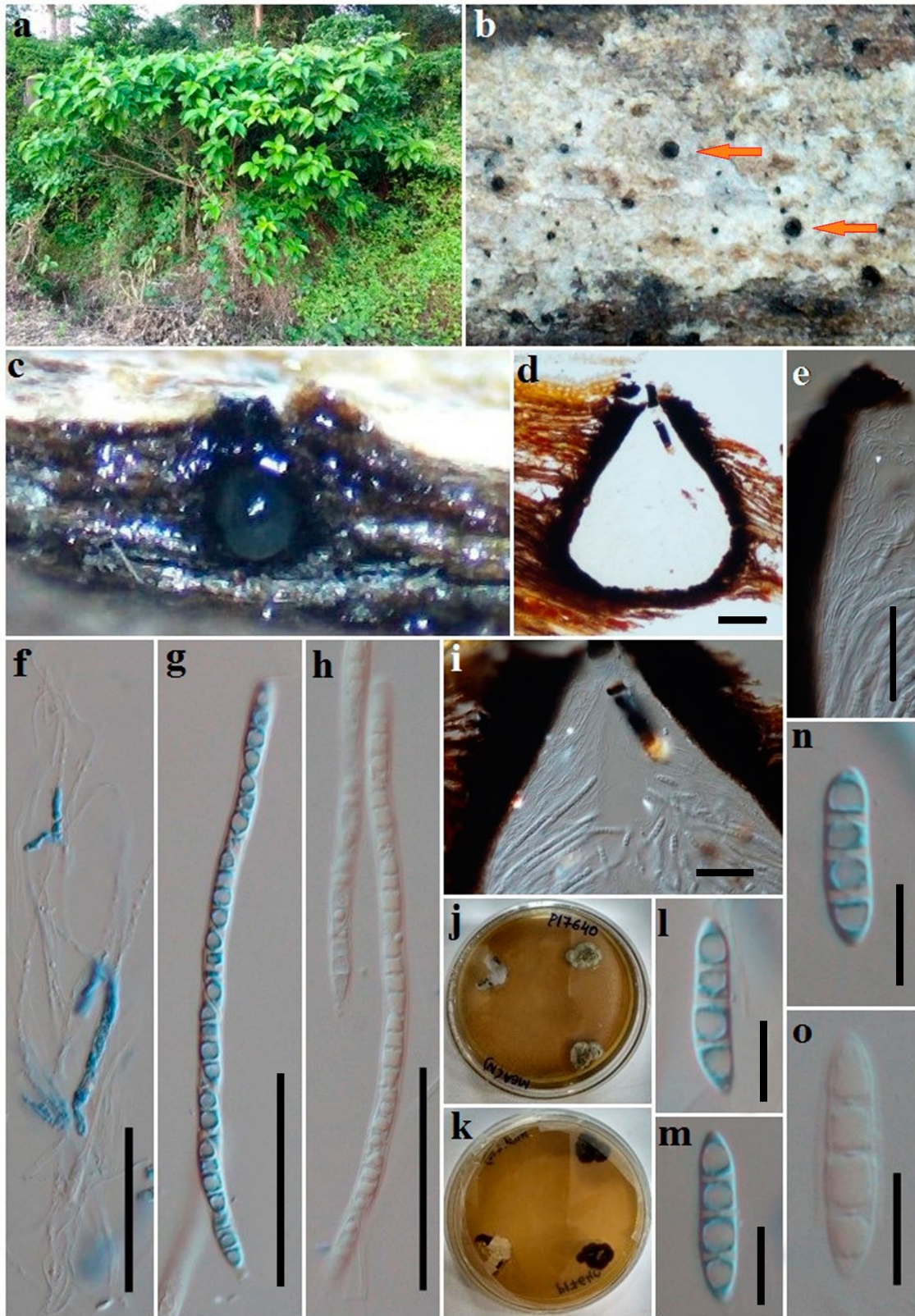
*Notes*: *Dyfronomycetes* was established based on morphological and molecular analyses. Members of this genus are characterized by relatively large, immersed, globose or subglobose, clypeate, ostiolate, papillate ascomata, bitunicate, fissitunicate, cylindrical asci and broadly fusiform, symmetrical, hyaline, septate ascospores, with or without a mucilaginous sheath.

***Dyfronomycetes distoseptatus*** M. Niranjan and V.V. Sarma, *sp. nov.*

*Index Fungorum number*: IF 556726; *Facesoffungi number*: FoF 06625; Fig. 30

*Etymology*: In reference to the distoseptate ascospores.

*Saprobic* on undetermined decaying twig. **Sexual morph**: *Ascomata* 550–630 high × 450–600 µm wide, perithecial, immersed in periderm, erumpent neck with pseudoparaphyses, clypeate, ostiolate, papillate. *Peridium* 40 µm, with two strata, outer thick, carbonaceous and inner brown and hyaline cells of *textura angularis* to *epidermoidea* cells. *Hamathecium* comprising 1.8–2.1 µm wide, filamentous, septate, unbranched, dense, narrow cellular pseudoparaphyses, longer than asci. *Asci* (123.1)126.7–146.2 (148.6) × (4.1)4.7–6.3 (6.5) µm ( $\bar{x}$  = 136.8 × 5.6, n = 25), 8-spored,



**Fig. 30** *Dyfrolomyces distoseptatus* (AMH 9984, holotype). **a** Host plant. **b** Papillate necks. **c, d, i** Vertical section of ascomata. **e** Peridium. **f** Pseudoparaphyses. **g, h** Asci **j, k** Cultures in Petri plates from

single spore isolations. **l–o** Ascospores. Scale bars: **d** = 100  $\mu$ m, **e–i** = 50  $\mu$ m, **l–o** = 10  $\mu$ m

bitunicate, cylindrical, apical ends obtuse, smooth-walled, short pedicellate, persistent. *Ascospores* (19.4)19.7–24.9 × (4.1) 4.3–5 μm ( $\bar{x}$  = 21.9 × 4.7, n = 25), uni-seriate, fusoid, obtuse ends, hyaline, 3-distoseptate, apical ends slightly bent. **Asexual morph:** Undetermined.

*Material examined:* India, Andaman and Nicobar Islands, South Andaman, Manjery, (11°52'25.7"N 92°64'89.9"E), on unidentified twig, 10 December 2017, M. Niranjana (AMH 9984, **holotype**), ex-type living culture NFCCI: 4377.

*GenBank numbers:* ITS: MK024391, LSU: MH971236.

*Notes:* *Dyfrlomyces distoseptatus* clustered with *D. thampilaensis* with strong bootstrap support (100%) in ML analysis. It also forms a sister relationship clade with *D. sinensis* (Fig. 29). However, *D. distoseptatus* has several distinguishable characters. It is closely related to *D. thampilaensis* in having distoseptate ascospores with acute ends, but the ascospores in the latter have prominent guttules. In addition, the asci of *D. distoseptatus* are smaller than *D. thampilaensis* (123.1–148.6 × 4.1–6.3 μm vs. 114–160 × 6–8.5 μm) (Zhang et al. 2017a). Furthermore, *D. distoseptatus* produces ascospores that are 3-septate when compared to 6–7 septate ascospores in *D. sinensis* (Hyde et al. 2018). Hence, based on the above-mentioned morphological differences (Fig. 30) and molecular sequence analyses (Fig. 29), a new species, *Dyfrlomyces distoseptatus*, is introduced.

**Melomastia** Nitschke ex Sacc., Atti Soc. Veneto-Trent. Sci. Nat., Padova, Sér. 4 4: 90 (1875).

*Index Fungorum number:* IF 3118; *Facesoffungi number:* FoF 07673; – 24 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species:* **Melomastia mastoidea** (Fr.) J. Schröt., in Chon, Krypt. -Fl. Schlesien (Breslau) 3.2(3): 320 (1894) [1908].

≡ *Sphaeria mastoidea* Fr., K. svenska Vetensk-Akad. Handl., ser. 3 38: 267 (1817).

*Notes:* *Melomastia* was introduced by Saccardo (1875) to accommodate the type species *M. friesii*. Schröter (1894) synonymized *M. friesii* under *M. mastoidea*. Species of *Melomastia* are characterized by immersed, black, ostiolate ascomata, cylindrical, thick-walled, pedicellate asci with a J- subapical ring, and ovoid, hyaline, 2-septate, guttulate ascospores (Norphanphoun et al. 2017).

### Economic significance

Only three genera are accepted in *Pleurotremaceae*, and most of the taxa in this family are saprobes in aquatic, mangrove and terrestrial habitats (Pang et al. 2013; Norphanphoun et al. 2017; Zhang et al. 2017a).

**Eremithallales** Lücking & Lumbsch.

*Index Fungorum number:* IF 540500; *Facesoffungi number:* FoF 07674.

*Eremithallales* was introduced for a single species *Eremithallus costaricensis* (Lücking et al. 2008). Previously *Eremithallales* was reported close to Lichinomycetes. However, both phylogenetic and morphological analysis confirmed the placement of this order in Dothideomycetes with strong support and later *Melaspileaceae* was included (Ertz and Diederich 2015). In Hongsanan et al. (2020), *Eremithallales* forms a distinct clade within Dothideomycetes. The divergence time for *Eremithallales* is estimated as 238 MYA (stem age Hongsanan et al. 2020).

*Accepted families:* *Melaspileaceae*.

**Melaspileaceae** Walt. Watson, New Phytol. 28: 94 (1929).

= *Eremithallaceae* Lücking & Lumbsch, in Lücking, Lumbsch, Di Stéfano, Lizano, Carranza, Bernecker, Chaves & Umaña, Symbiosis 46(3): 163 (2008).

*Index Fungorum number:* IF 80992; *Facesoffungi number:* FoF 07675, 40 species.

*Lichenized.* Thallus thin, white, corticolous, with *Trentepohlia* photobiont. **Sexual morph:** *Ascomata* apothecoid, immersed when young, erumpent to superficial when mature, with a flat to slightly convex disk and a slightly elevated margin, often surrounded by marginal lobes from the substrate, roundish. *Peridium* reddish brown, K+ olivaceous brown at exciple issue, with a I- hymenium, apically not enlarged, cellular pseudoparaphyses that are sometimes branched or anastomosed, anastomosed paraphyses arising from the inner excipular layer. *Asci* 6–8-spored, elongate or clavate to subcylindrical, wall apically thickened, with a distinct ocular chamber, I- and K/I-. *Ascospores* overlapping, 2-seriate, ellipsoid to oblong, hyaline to brown, 1-septate, constricted near the septum, smooth-walled, sometimes K/I+ blue gelatinous sheath. **Asexual morph:** Undetermined.

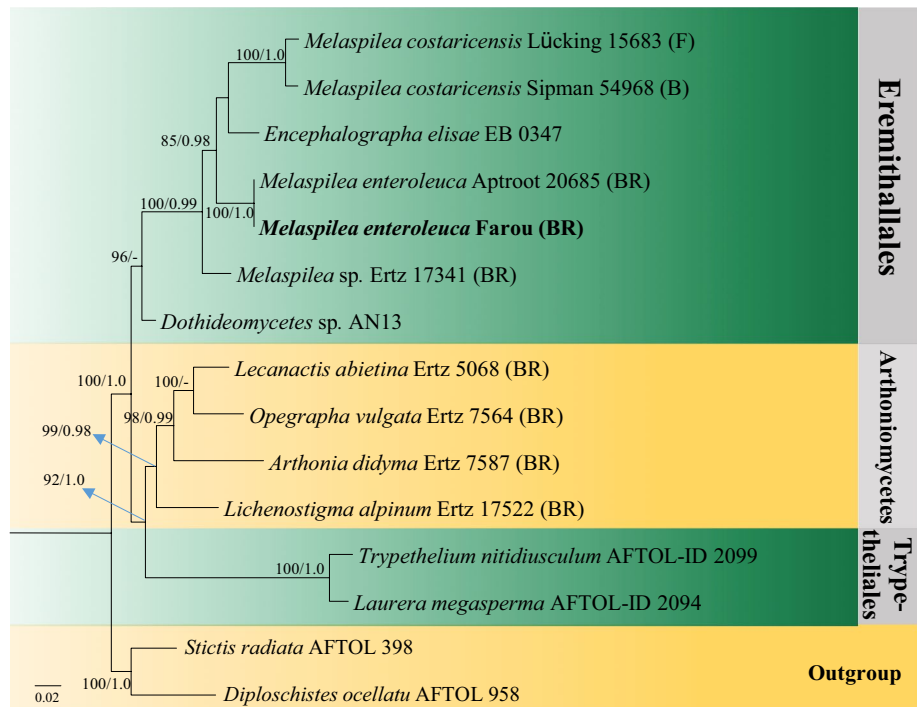
*Type:* **Melaspilea** Nyl.

*Notes:* The taxonomic placement of this group was uncertain due to the absence of molecular data. However, the first phylogenetic analysis confirmed the placement of *Melaspileaceae* under *Eremithallales*. The same result is shown in our phylogenetic tree (Fig. 31). Morphologically, *Melaspilea sensu stricto* is similar to *Eremithallus* in ascomata, exciple, hamathecium, ascus and ascospore types, and being lichenized with a trentepohlioid photobiont (Ertz and Diederich 2015). Thus, *Eremithallus* was reduced as a synonym of *Melaspilea* and *Eremithallaceae* was synonymized under *Melaspileaceae* (Ertz and Diederich 2015). This was followed by Wijayawardene et al. (2017a) and our study.

**Melaspilea** Nyl., Act. Soc. linn. Bordeaux 21(4): 416 (1857) [1856].

= *Eremithallus* Lücking, Lumbsch & L. Umaña, in Lücking et al., Symbiosis 46(3): 163 (2008).

**Fig. 31** Phylogram generated from maximum likelihood analysis (RAxML) of Eremithallales based on LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%. Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Diploschistes ocellatus* (AFTOL 958) and *Stictis radiata* (AFTOL 398). The ex-type and reference strains is indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



*Index Fungorum number*: IF 3094; *Facesoffungi number*: FoF 07676; 37 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: ***Melaspilea arthonioides*** (A. Massal.) Nyl. ≡ *Catillaria arthonioides* A. Massal., Geneac. lich. (Verona): 19 (1854).

*Notes*: *Melaspilea* was introduced for two species *M. deformis* and *M. arthonioides*. Taxa in this genus are distributed worldwide and occur primarily as epiphytes on bark or wood, rocks and parasites or commensals with lichens (Ertz and Diederich 2015). *Melaspilea* is a heterogeneous group and more collections are needed to resolve the genus (Ertz and Diederich 2015).

***Melaspilea enteroleuca*** (Ach.) Ertz & Diederich, Fungal Diversity 71: 151 (2015).

≡ *Lecidea enteroleuca* Ach., Lich. univ.: 177 (1810).

*Index Fungorum number*: IF 811372; *Facesoffungi number*: FoF 07677; Fig. 32

*Description and discussions*: see epitype in Ertz and Diederich (2015).

#### Other genus included

***Encephalographa*** A. Massal., Geneac. lich. (Verona): 13 (1854).

*Index Fungorum number*: IF 1776; *Facesoffungi number*: FoF 07678; – 3 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Encephalographa cerebrina*** (DC.) A. Massal., Miscell. Lichenol.: 49 (1856).

≡ *Opegrapha cerebrina* DC., in Lamarck & de Candolle, Fl. franç., Edn 3 (Paris) 2: 312 (1805).

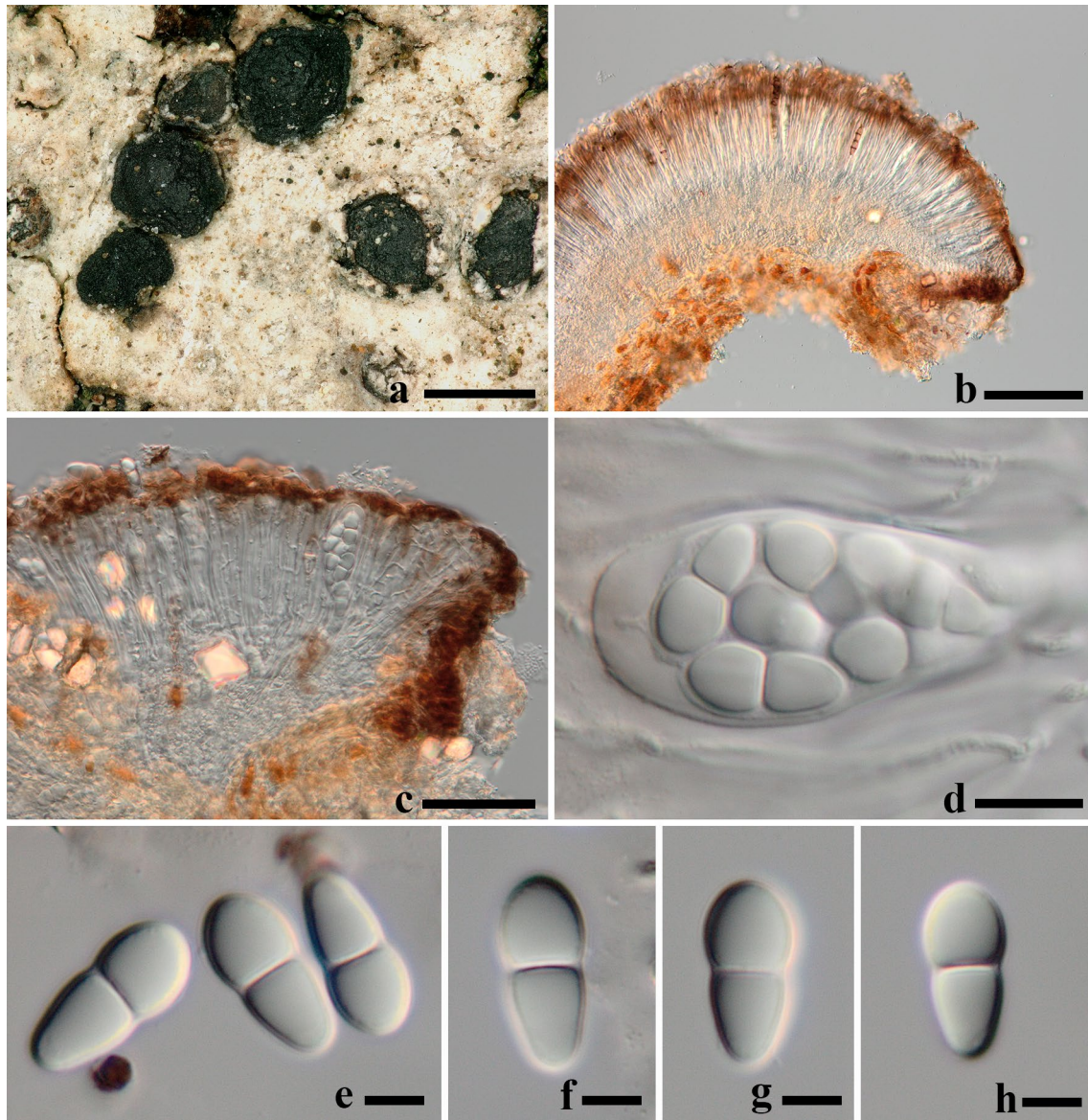
*Notes*: *Encephalographa* comprises only a single species (Wijayawardene et al. 2017a). This genus was placed in *Hysteriaceae* (Renobales and Aguirre 1990). Ertz and Diederich (2015) indicated that the type species *Encephalographa elisae*, belongs in Eremithallales. Presently, *Encephalographa* is included in *Melaspileaceae* (Ertz and Diederich 2015). The species is characterized by saxicolous, lirelliform, superficial and black ascomata, lichenized, dark brown to black exciple, I- hymenium, anastomosed paraphyses, clavate, 8-spored and thick-walled asci, apically thickened with distinct ocular chamber, I- and K/I-, and ellipsoid, 1-septate, smooth to finely ornamented, hyaline to brownish ascospores, constricted at the septum with thin perispore (Renobales and Aguirre 1990; Ertz and Diederich 2015).

#### Economic and ecological significance

*Melaspileaceae* comprises lichenized, lichenicolous and saprobic taxa (Ertz and Diederich 2015). Saprobic fungi play a vital role in decomposing plant and animal debris (Dix and Webster 1995) while lichens are frequently used as air pollution indicators, which is a simple and economically viable approach to detect and monitor air pollution (Lopes et al. 2019).

**Eremomycetales** Crous, Spatafora, Haridas & I.V. Grig., in Haridas et al., Stud. Mycol. 96: 151 (2020)

*Index Fungorum number*: IF 831891; *Facesoffungi number*: FoF 07679



**Fig. 32** *Melaspilea enteroleuca* (France, Ertz 19235 (BR)). **a** Thallus with apothecia. **b** Section of a single apothecium in water. **c** Hymenium and ascomatal margin in water. **d** Ascus in water. **e** Ascospores in water. Scale bars: **a** = 0.5 mm, **b** = 100  $\mu$ m, **c** = 50  $\mu$ m, **d** = 10  $\mu$ m, **e** = 5  $\mu$ m

*Notes:* This order was introduced by Haridas et al. (2020). Analyses of combined LSU and SSU sequence data (Fig. 33) reveals that the genera *Arthrographis*, *Eremomyces* and *Rhexothecium* grouped together, forming a distinct clade apart from other orders in Dothideomycetes. The divergence time for Eremomycetales is estimated as 262 MYA (stem age, Hongsanan et al. 2020).

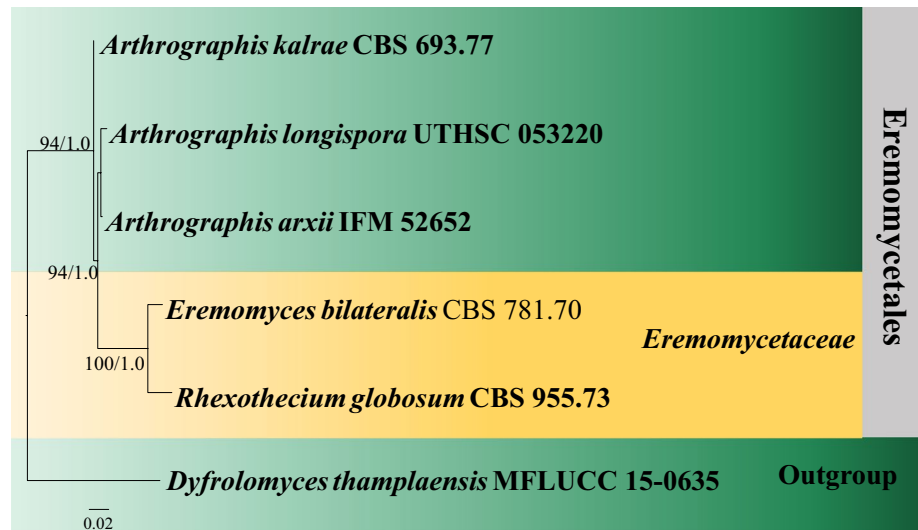
*Accepted families:* Eremomycetaceae.

*Eremomycetaceae* Malloch & Cain, Can. J. Bot. 49: 847 (1971).

*Index Fungorum number:* IF 80751; *Facesoffungi number:* FoF 05359, 3 species.

*Saprobic*, isolated primarily on animal dung or soil. *Colonies* flocculent, drift white, superficial, dense, and growing slowly on agar media. *Hyphae* septate, branch, hyaline to brown. **Sexual morph:** *Ascomata* sphaerical to ellipsoid, solitary, scattered, superficial on hyphae, or submerged in the agar, dark brown to black, lacking ostioles, but tending to split open before maturity. *Peridium* thin, pseudo-parenchymatous, composed of large brown cells of *textura angularis*. *Hamathecium* lacking pseudoparaphyses. *Asci* irregularly disposed within the ascoma, 8-spored, bitunicate, not fissitunicate, obovoid to clavate, thin-walled, pedicellate, and evanescent. *Ascospores* multi-seriate, small, often fabiform to broadly oblate, hyaline to pale brown, aseptate,

**Fig. 33** Phylogram generated from maximum likelihood analysis (RAxML) of genera in Eremomycetales based on LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Dyfratomyces thamplaensis* (MFLUCC 15-0635). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



smooth-walled to slightly verrucose. **Asexual morph:** Coelomycetous or hyphomycetous. *Pycnidia* globose to subglobose, thin-walled, papillate. *Conidiophores* filiform, septate, hyaline to brown. *Conidia* ellipsoidal, hyaline, aseptate, thin-walled, guttulate.

**Type:** *Eremomyces* Malloch & Cain.

**Notes:** Malloch and Cain (1971) introduced *Eremomycetaceae* for species having solitary ascomata and hyaline, aseptate ascospores. *Eremomycetaceae* consists of three species: *Eremomyces bilateralis*, *Rhexothecium globosum*, and *Pithoascus langeronii*, (= *Eremomyces langeronii*). *Eremomycetaceae* are most similar to *Pseudeurotiaceae* (Malloch and Sigler 1988), but differ in ascomatal initials (coiled in *Pseudeurotiaceae*, pseudoparenchymatous in *Eremomycetaceae*). *Eremomycetaceae* comprises two genera *Eremomyces*, the type genus and *Rhexothecium* (Lumbsch and Huhndorf 2010). *Eremomyces* has fabiform and hyaline ascospores, while *Rhexothecium* has broadly oblate and pale yellow to brown ascospores. *Eremomyces* is more similar to *Trichosporiella* (Helotiales) in having subglobose to globose, black conidiomata and scopulariopsis-like hyaline conidia. *Rhexothecium* resembles *Trichosporiella* (Helotiales) in having solitary to catenulate, lateral, and hyaline, basic truncate conidia. Species of *Eremomycetaceae* are distributed worldwide and can be commonly found in Egypt, Kenya, North America and the Netherlands. Wijayawardene et al. (2018) included *Arthrographis* in *Eremomycetaceae*, while Liu et al. (2017) included *Arthrographis* in a new family *Arthrographaceae*. However, whether *Arthrographaceae* is valid or not is unclear as there is no mention of this family in the literature or in Index Fungorum. Members of both *Arthrographis* and *Eremomyces* produce hyaline to subhyaline conidia, however *Arthrographis* is distinct in producing unicellular arthroconidia and chlamydospores which are absent in *Eremomyces*. We include *Arthrographis* in

*Eremomycetales*, genera *incertae sedis* until further studies are carried out.

***Eremomyces*** Malloch & Cain, Can. J. Bot. 49(6): 847 (1971).

= *Pithoascina* Valmaseda et al., Can. J. Bot. 65(9): 1905 (1987).

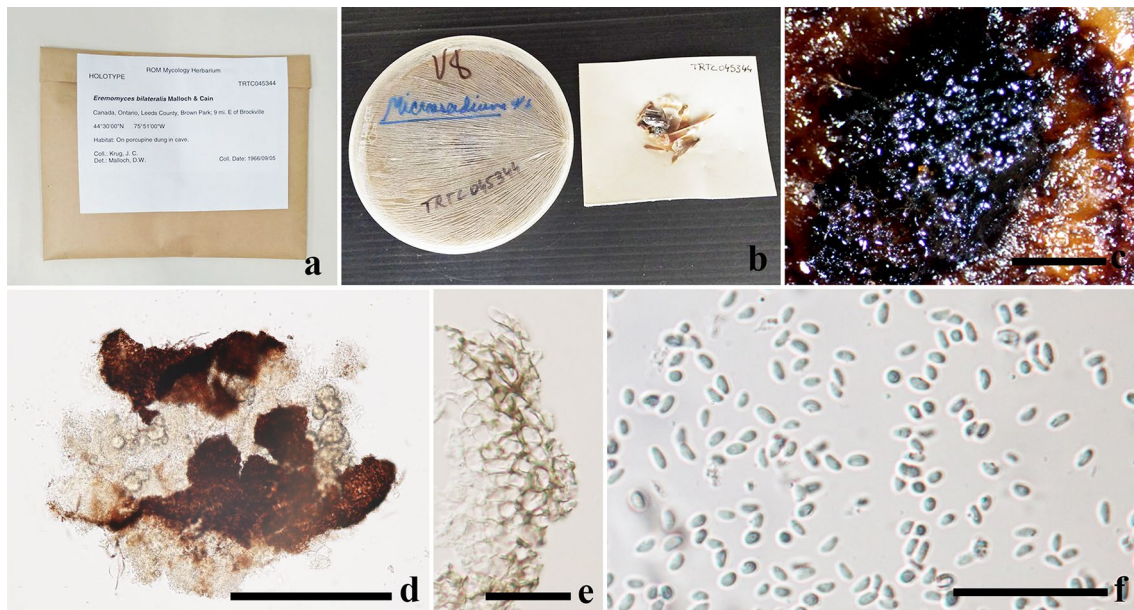
**Index Fungorum number:** IF 1880; **Facesoffungi number:** FoF 05360; 2 morphological species (Species Fungorum 2020), 1 species with molecular data.

**Type species:** *Eremomyces bilateralis* Malloch & Cain.

**Notes:** *Eremomyces bilateralis*, which was isolated on dung of the North American porcupine. The genus is characterised by pseudoparenchymatous ascomatal initials and cleistothecia, clavate to ovoid, evanescent short asci and one-celled hyaline to pale brown ascospores (Hyde et al. 2013). Superficially, *Eremomyces* resembles some tropical parasites such as *Cleistosphaera* and *Pilgeriella* (Malloch and Cain 1971). However, it differs from these genera in having irregularly disposed asci, a cephalothecoid peridium and in its coprophilous habitat. *Eremomyces* was compared to members of *Sporormiaceae* based on cleistothecial characters and members of *Venturiaceae* as it produces setose ascomata (Malloch and Cain 1971). Presently, it is clear that *Eremomyces* is distinct from all other genera and it is included in its own monotypic family *Eremomycetaceae* because of apparent lack of close association with any other group. Cultures and sequence data are available but lacking for the type.

***Eremomyces bilateralis*** Malloch & Cain, Can. J. Bot. 49(6): 849 (1971).

**Index Fungorum number:** IF 313945; **Facesoffungi number:** FoF 05361; Fig. 34



**Fig. 34** *Eremomyces bilateralis* (TRTC 045344, holotype). **a** Herbarium packet and label. **b** Herbarium culture **c** Pycnidium on the upper surface of agar media. **d** Squash mount of pycnidium. **e** Conidia. Scale bars: **c** = 2000  $\mu\text{m}$ , **d** = 300  $\mu\text{m}$ , **e** = 25  $\mu\text{m}$ , **f** = 50  $\mu\text{m}$

*Saprobic* on dung of the North American porcupine. Colonies flocculent, drift white to dark brown, superficial, compact, and growing slowly on agar media. Hyphae septate, branched, hyaline to brown. **Sexual morph:** Ascumata solitary, scattered, superficial on hyphae, globose to ellipsoid, dark brown to black, lacking ostioles. Peridium thin, composed of large brown cells of *textura angularis*. Hamathecium lacking pseudoparaphyses. Asci 8-spored, bitunicate, obovoid, thin-walled, pedicellate, evanescent. Ascospores multi-seriate, fabiform, hyaline, aseptate, smooth-walled (adapted from Hyde et al. 2013). **Asexual morph:** Coelomycetous. Pycnidia in culture brown to dark-brown, globose to subglobose, thin-walled, papillate. Conidiophores filiform, septate, hyaline to brown. Conidiogenous cells formed inside the swollen part. Conidia  $3.2\text{--}4.8 \times 1.7\text{--}2.8 \mu\text{m}$  ( $\bar{x} = 3.85 \times 2.3 \mu\text{m}$ ,  $n = 20$ ), ellipsoidal, hyaline, aseptate, thin-walled, guttulate.

**Material examined:** Canada, Ontario, Leeds Co., East of Brockville, on porcupine dung in cave, 5 September 1966, J.C. Krug (TRTC 45344, holotype).

**Notes:** *Eremomyces bilateralis* is found on dung of usually sedentary animals, particularly rodents in Canada (Ontario), Kenya, Tanzania and the USA (California). Colonies are relatively slow growing on most media. Ascumata tend to be fragmented when immature and lack characteristic cephalothecoid peridium when mature. On the natural substrate the ascumata are equally conspicuous and produce short setae compared to long hairs seen in culture.

#### Other genera included

*Rhexothecium* Samson & Mouch., Can. J. Bot. 53(16): 1637 (1975).

**Index Fungorum number:** IF 4699; **Facesoffungi number:** FoF 06699; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

**Type species:** *Rhexothecium globosum* Samson & Mouch., Can. J. Bot. 53(16): 1637 (1975).

**Notes:** *Rhexothecium globosum* was found from desert soil in Egypt. The genus is characterised by spherical ascumata with a pseudoparenchymatous peridium, clavate 8-spored asci and yellow to yellow-brown spherical ascospores. The asexual morph of *Rhexothecium* is hyphomycetous and described as *trichosporiella*-like. Hyde et al. (2013) accepted *Rhexothecium* as a genus in *Eremomycetaceae*. Cultures and sequence data are available but lacking for the type species.

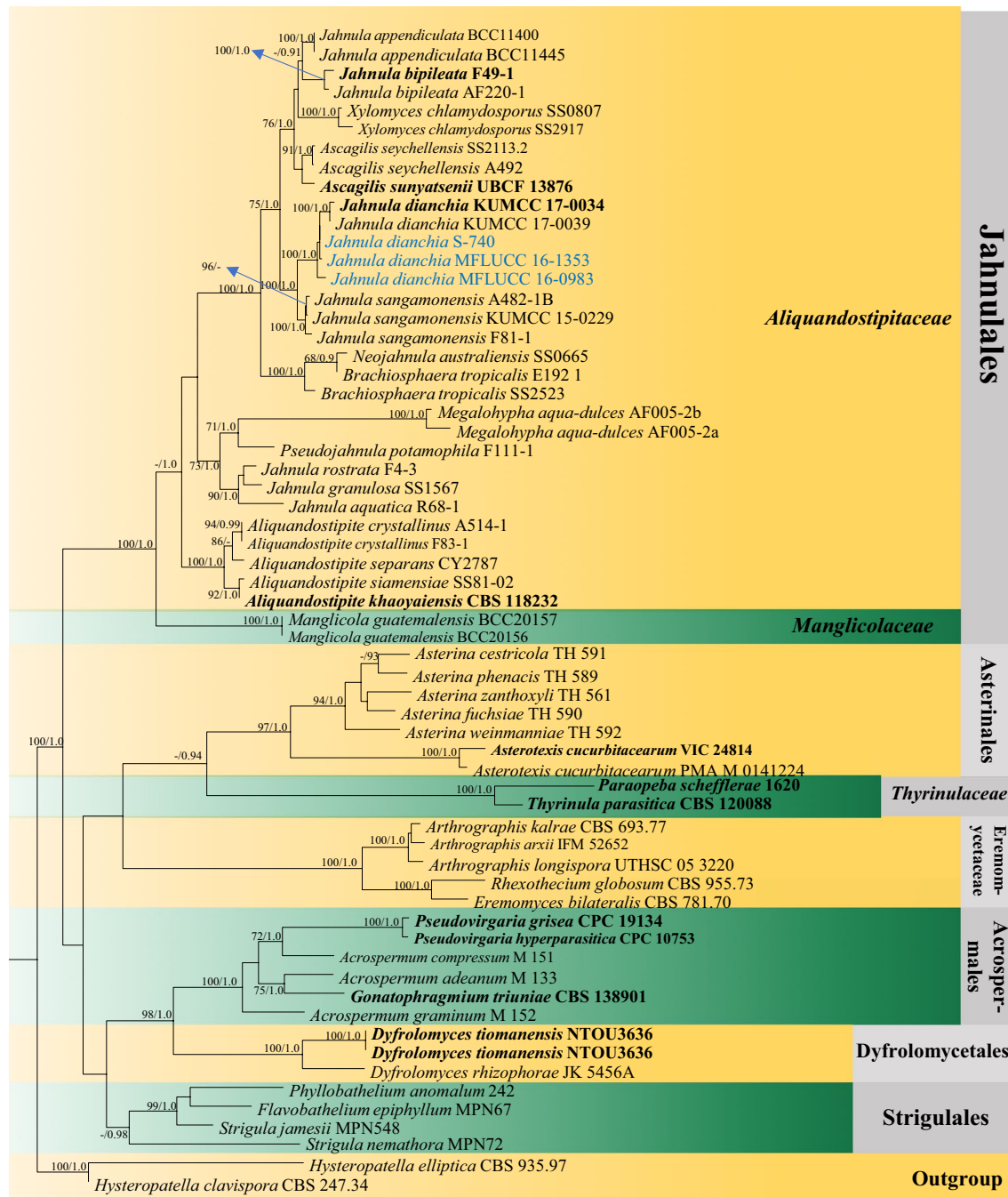
#### Economic and ecological significance

Species included in *Eremomyces* are implicated as opportunistic human pathogens.

**Jahnulales** K.L. Pang, Abdel-Wahab, El-Shar., E.B.G. Jones & Sivichai.

**Index Fungorum number:** IF 90550; **Facesoffungi number:** FoF 07682.

Jahnulales was introduced in Dothideomycetes based on phylogenetic analysis of SSU nrDNA sequence data from *Aliquandostipite*, *Jahnula* and *Patescospora* (Pang et al. 2002). This order is phylogenetically related to the



**Fig. 35** Phylogram generated from maximum likelihood analysis (RAxML) of Jahnulales based on ITS, LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 60%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at

the nodes. Isolate/specimen number is noted after the species name. The tree is rooted to *Hysteropatella clavispora* (CBS 247.34) and *H. elliptica* (CBS 935.97). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP

Dothideales, Patellariales and Pleosporales (Campbell et al. 2007). Most Jahnulales species occur on rotting or soft submerged corticated or decorticated wood (Huang et al. 2018). Phylogenetic analyses (Fig. 35) indicate that Jahnulales comprises two major lineages which are designated as

two different families (*Aliquandostipitaceae* and *Manglicolaceae*). *Jahnula* forms as paraphyletic within *Aliquandostipitaceae*. The divergence time for Jahnulales is estimated as 204 MYA (stem age, Hongsanan et al. 2020).

*Accepted families: Aliquandostipitaceae, Manglicolaceae.*



*Aliquandostipitaceae* Inderb., in Inderbitzin et al., Am. J. Bot. 88(1): 54 (2001).

*Index Fungorum* IF82130; *Facesoffungi* number: FoF 07683, 36 species.

*Saprobic* on submerged or trapped decorticated wood or leaves in freshwater streams, rivers, lakes, peat swamps and marine habitats. **Sexual morph:** *Ascomata* scattered or rarely in small groups, immersed to erumpent or superficial, if superficial often attached to substrate by hyphal stalks, with repent or pendant thick brown hyphal strands, globose to subglobose, hyaline, pale brown or black, coriaceous to subcarbonaceous, ostiolate, papillate. *Peridium* variable, 3–7 cell layers thick, comprising very large, light brown to brown, thin-walled, cells of *textura globulosa* to *angularis*. *Hamathecium* comprising 2–7 µm wide, hyaline, septate, sparsely branched, filamentous, cellular pseudoparaphyses, anastomosing above the asci. *Asci* 8-spored, bitunicate, fissitunicate, clavate to cylindrical, pedicel absent or very short, with or without an ocular chamber. *Ascospores* 2- to multi-seriate, ellipsoid to fusiform, hyaline to pale brown to dark brown, 1-septate, guttulate, with or without various types of appendages and/or sheaths. **Asexual morph:** Hyphomycetous. *Conidiophores* reduced or un-branched or sparingly branched, hyaline. *Conidiogenous cells* monoblastic, thallic or sympodial or percurrent, moniloid, hyaline or brown. *Conidia* phragmosporous or staurosporous, with globose central cell, with 4-several, radiating septate arms, hyaline or brown, single or branched or un-branched chains (Seifert et al. 2011) or tetra- to octo-radial with 4–8 appendages.

*Type: Aliquandostipite* Inderb.

*Notes:* *Aliquandostipitaceae* was introduced by Inderbitzin et al. (2001) for taxa characterized by mycelium five times wider than those of most ascomycetes. *Ascomata*, borne either on these thick hyphae or on hyphal stalks are membranous, have a hamathecium of persistent pseudoparaphyses, bitunicate asci and hyaline to pale brown, 1-septate ascospores with or without a sheath or with appendages.

*Manglicola* has also been referred to the *Jahnulales* and as the type for *Manglicolaceae* by Suetrong et al. (2011). *Patescospora* was synonymised under *Aliquandostipite* (Suetrong et al. 2011). The phylogenetic analysis based on ITS and LSU sequence data showed that the genera *Aliquandostipite*, *Ascagilis*, *Brachiosphaera*, *Jahnula*, *Megalohypha*, *Neojahnula*, *Pseudojahnula*, and *Xylomyces* cluster together with high support (100% ML, 1.00 PP). We follow the previous studies and accept these eight genera in *Aliquandostipitaceae* (Dong et al. 2020).

*Aliquandostipite* Inderb., Am. J. Bot. 88(1): 54 (2001).

*Index Fungorum* number: IF 28650; *Facesoffungi* number: FoF 07684; 6 morphological species (Index Fungorum 2020), 6 species with molecular data.

*Type species: Aliquandostipite khaoyaiensis* Inderb.

*Notes:* The genus was introduced for two freshwater lignicolous ascomycetes collected in Thailand and China and it is characterised by immersed-erumpent or superficial ascomata. Hamathecium consists of pseudoparaphyses. Asci are bitunicate, and fissitunicate. Hyphae are up to 50 µm wide (Suetrong et al. 2011; Liu et al. 2015).

#### Other genera included

*Ascagilis* K.D. Hyde, Aust. Syst. Bot. 5(1): 109 (1992).

*Index Fungorum* number: IF 21262; *Facesoffungi* number: FoF 09187; – 7 morphological species (Dong et al. 2020), 7 species with molecular data.

*Type species: Ascagilis bipolaris* K.D. Hyde, Aust. Syst. Bot. 5(1): 111 (1992).

*Notes:* The type species *Ascagilis bipolaris* was transferred to *Jahnula* by Hyde and Wong (1999). Dong et al. (2020) resurrected *Ascagilis* to accommodate 7 species based on its mucilaginous pad of ascospores which is considered as noticeable characteristic of *Ascagilis*. Phylogenetic analyses supported the placement of *Ascagilis* in *Aliquandostipitaceae* (Dong et al. 2020; this study).

*Brachiosphaera* Nawawi, in Descals et al., Trans. Br. mycol. Soc. 67: 213 (1976).

*Index Fungorum* number: IF 7438; *Facesoffungi* number: FoF 07685; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Brachiosphaera tropicalis* Nawawi, Transactions of the British Mycological Society 67 (2): 213 (1976).

*Notes:* The hyphomycetous genus *Brachiosphaera* is characterised by its effuse colonies, septate hyphae and conidia frequently formed in chains.

*Jahnula* Kirschst., Ann. mycol. 34(3): 196 (1936).

*Index Fungorum* number: IF 2526; *Facesoffungi* number: FoF 07686; – 17 morphological species (Huang et al. 2018, Species Fungorum 2020), 6 species with molecular data.

*Type species: Jahnula aquatica* (Plötner & Kirschst.) Kirschst., Ann. Mycol. 34: 196 (1936).

≡ *Amphisphaeria aquatica* Plöttn. & Kirschst., in Kirschstner, Verh. bot. Ver. Prov. Brandenb. 48: 52 (1906) [1907].

*Notes:* The largest genus within *Jahnulales*, *Jahnula*, is characterised by perithecial, solitary, superficial to sub-immersed ascomata, bitunicate, fissitunicate, cylindrical, pedicellate asci and light brown to dark brown ascospores. All 17 *Jahnula* species have been reported from wood or decorticated wood in freshwater habitats (Huang et al. 2018). The genus is currently polyphyletic, and *Jahnula sensu stricto* accommodates *J. aquatica*, *J. granulosa*, *J. potamophila* and *J. rostrata* (Suetrong et al. 2011; Huang et al. 2018).



**Fig. 36** *Jahnula dianchia* (HKAS 92632). **a** Appearance of ascomata on substrate. **b** Vertical section of ascoma. **c** Structure of peridium. **d** Pseudoparaphyses. **e–i** Asci. **j–o** Ascospores. **p** Germinating

ascospore. **q, r** Colony on MEA. Scale bars: **b** = 150  $\mu$ m, **c, e–i** = 50  $\mu$ m, **j–p** = 20  $\mu$ m, **d** = 15  $\mu$ m

***Jahnula dianchia*** S.K. Huang & K.D. Hyde, Mycol. Progr. 17: 549 (2018).

*Index Fungorum number*: IF 553200; *Facesoffungi number*: FoF 03149; Fig. 36

*Saprobic* on decaying wood submerged in freshwater habitats. **Sexual morph**: *Ascomata* 285–390 µm high, 250–350 µm diam, perithecial, solitary, superficial to semi-immersed, obpyriform to subglobose, black, papillate, ostiolate. *Peridium* around 40 µm thick, membranous, composed of brown to hyaline cells of *textura angularis*. *Hamathecium* comprising 2–3 µm wide, septate, branched, filiform, cellular pseudoparaphyses, embedded in a gelatinous matrix. *Asci* 150–170 µm ( $\bar{x}$  = 160 µm, SD = 10, n = 15) long, 15–17 µm ( $\bar{x}$  = 16 µm, SD = 1, n = 15) wide, 8-spored, bitunicate, fissitunicate, cylindrical, pedicellate, rounded at apex, with a distinct ocular chamber. *Ascospores* 27–29 µm ( $\bar{x}$  = 28 µm, SD = 1, n = 20) long, 11–13 µm ( $\bar{x}$  = 12 µm, SD = 1, n = 20) wide, uni-seriate, oval to broadly ellipsoid, slightly curved, initially pale brown, becoming dark brown at maturity, 1-septate, verruculose, multiguttulate. **Asexual morph**: Undetermined.

*Material examined*: China, Yunnan Province, saprobic on decaying wood submerged in Erhai Lake, December 2014, Z.L. Luo, S-364 (HKAS 92632), living culture MFLUCC 16-0983; saprobic on decaying wood submerged in Erhai Lake, December 2014, H.Y. Su, S-460, living culture MFLUCC 16-1353; saprobic on decaying wood submerged in a freshwater stream in Cangshan Mountain, June 2016, S.M. Tang, S-740.

*GenBank numbers*: ITS: MH793537, LSU: MH793543 (MFLUCC 16-0983); ITS: MH793538, LSU: MH793544 (MFLUCC 16-1353), LSU: MT797171 (S-740).

*Notes*: *Jahnula dianchia* was collected from a freshwater lake in Yunnan Province, China. During our study of lignicolous freshwater fungi from Northwestern Yunnan Province, three isolates were obtained from different collections. The morphology of those isolates fit well with *Jahnula dianchia*, and the phylogenetic analysis showed that our isolates cluster with this species with strong support. We therefore identify our isolates as *J. dianchia* based on morphology and phylogeny.

***Megalohypha*** A. Ferrer & Shearer, in Ferrer et al., Mycologia 99: 458 (2007).

*Index Fungorum number*: IF 505741; *Facesoffungi number*: FoF 07687; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Megalohypha aqua-dulces*** A. Ferrer & Shearer, in Ferrer et al., Mycologia 99(3): 456 (2007).

*Notes*: *Megalohypha* was introduced based on two collections obtained from submerged wood in tropical forest streams in Panama and Thailand. *Megalohypha* is characterized by hyaline, translucent ascomata, with subtending,

wide, brown, septate, stoloniferous hyphae, a peridium of large, thin-walled cells, a hamathecium of septate pseudo-paraphyses, clavate, fissitunicate, 8-spored asci and 1-septate, brown, rough-walled ascospores, with longitudinal sulcate striations (Ferrer et al. 2007).

***Neojahnula*** W. Dong, H. Zhang & K.D. Hyde, Fungal Divers (revising).

*Index Fungorum number*: IF 557823; *Facesoffungi number*: FoF 07688; – 1 morphological species (Dong et al. 2020), 1 species with molecular data.

*Type species*: ***Neojahnula australiensis*** (K.D. Hyde) W. Dong, H. Zhang & K.D. Hyde, Fungal Divers (revising).

≡ *Jahnula australiensis* K.D. Hyde, Aust. Syst. Bot. 6(2): 161 (1993).

*Notes*: The type species, *Neojahnula australiensis* was transferred from *Jahnula* collected from submerged wood in freshwater (Hyde 1993). Phylogenetically, the species clustered basal to *Brachiosphaera* within *Aliquandostipitaceae* (Prihatini et al. 2008; Hyde et al. 2017; Huang et al. 2018; Dong et al. 2020). Morphologically, *J. australiensis* could not be placed in *Jahnula* because of the few setae surrounding the ascomata, a thin peridium comprising single row of cells, asci with an ocular chamber and a faint apical ring (Dong et al. 2020). Therefore, Dong et al. (2020) introduced *Neojahnula* to accommodate this species.

***Pseudojahnula*** W. Dong, H. Zhang & K.D. Hyde, Fungal Divers (revising).

*Index Fungorum number*: IF 557824; *Facesoffungi number*: FoF 07689; – 1 morphological species (Dong et al. 2020), 1 species with molecular data.

*Type species*: ***Pseudojahnula potamophila*** (K.D. Hyde & S.W. Wong) W. Dong, H. Zhang & K.D. Hyde, Fungal Divers (revising).

≡ *Jahnula potamophila* K.D. Hyde & S.W. Wong, Nova Hedwigia 68(3–4): 499 (1999).

*Notes*: *Pseudojahnula* was introduced by Dong et al. (2020) to accommodate the unstable lineage of *Jahnula potamophila*. This genus differs from *Jahnula* by hyaline to metallic grey ascomata, a several-layered peridium, comprising hyaline cells and covered with sparse hyaline hairs, obclavate asci, with an ocular chamber, and ascospores surrounded by a wavy mucilaginous sheath (Hyde and Wong 1999; Dong et al. 2020).

***Xylomyces*** Goos et al., Mycologia 69(2): 282 (1977).

*Index Fungorum number*: IF 10460; *Facesoffungi number*: FoF 07690; – 8 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Xylomyces chlamydosporus*** Goos et al. [as ‘chlamydosporis’], Mycologia 69(2): 282 (1977).

*Notes:* *Xylomyces* is characterised by large, dematiaceous, thick-walled, multi-septate, more or less fusiform chlamydospores that superficially resemble phragmoconidia, however, it has been shown to be polyphyletic and not all species belong in the Jahnulales.

### Ecological significance

Members of *Aliquandostipitaceae* are saprobes with the ability to decompose lignocellulose in woody litter, and thus contribute to the recycling of material in aquatic habitats (Yuen et al. 1998; Bucher et al. 2004).

***Manglicolaceae*** Suetrong & E.B.G. Jones, in Suetrong et al., *Fungal Divers* 51(1): 183 (2011).

*Index Fungorum number:* IF 563225; *Facesoffungi number:* FoF 07691, 2 species.

*Saprobic* on intertidal mangrove wood and the brackish water palm *Nypa fruticans*. **Sexual morph:** *Ascomata* superficial, solitary, or in groups, immersed in the substrate with a hypostroma, obtuse clavate to fusiform, coriaceous, olive-brown, pedicellate, ostiolate, epapillate, periphysate. *Peridium* thick, 3–5-layered, inner layers hyaline, outer layers pale brown to olive-brown of cells of *textura angularis*. *Hamathecium* comprising numerous, simple, septate, trabeculate pseudoparaphyses. *Asci* 8-spored, bitunicate, cylindrical, thick-walled, with an ocular chamber and a short pedicel, developed at the base of the ascocarp venter between the pseudoparaphyses. *Ascospores* uni-seriate, fusiform, apiculate, 1-septate, with larger and dark brown upper cell, with smaller and light brown lower cell, gelatinous appendages covering both ends. **Asexual morph:** Undetermined.

*Type:* ***Manglicola*** Kohlm. & E. Kohlm.

*Notes:* The family was introduced to accommodate a marine ascomycete with large, club-shaped, coriaceous ascomata, lacking a papilla, and with trabeculate pseudoparaphyses, cylindrical asci and ascospores, with a large apical cell, and a basal turbinate cell with gelatinous appendages at each end. Phylogenetic analyses using LSU and SSU indicated that *Manglicolaceae* is related to *Aliquandostipitaceae* within Jahnulales (100 ML/1.0 PP). This result was confirmed by many studies, such as Suetrong et al. (2011) and Hyde et al. (2013). *Manglicolaceae* is similar to *Aliquandostipitaceae* in that it has wide hyphae, ascomata with short stalks, cylindrical asci, and large ascospores with appendages, and all are saprobic species in aquatic habitats (Hyde et al. 2013). However, it differs from *Aliquandostipitaceae* by its marine mangrove habitat, larger ascomata, with a wide ostiole, surrounded by hyaline, clavate hyphae and periphysate ostioles, large, unequally, 1-septate, pale brown ascospores, with a turbinate basal cell and with few asci per ascoma. *Manglicolaceae* comprises a monotypic genus, *Manglicola*.

***Manglicola*** Kohlm. & E. Kohlm., *Mycologia* 63(4): 840 (1971).

*Index Fungorum number:* IF 2995; *Facesoffungi number:* FoF 07692; 2 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species:* ***Manglicola guatemalensis*** Kohlm. & E. Kohlm.

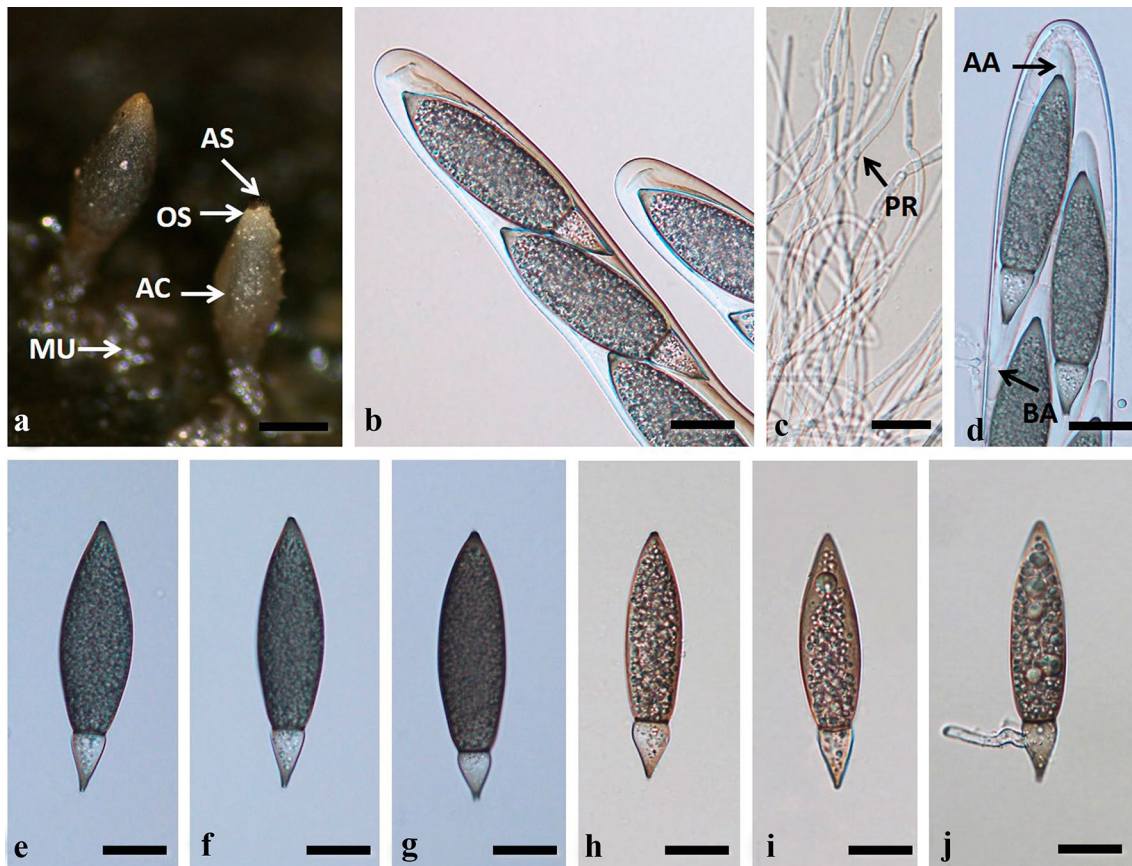
*Notes:* Huhndorf (1994) referred *Manglicola* to the *Hypsostromataceae* order *incertae sedis* based on its superficial, large, elongate ascomata (stalked) with a soft texture, trabeculate pseudoparaphyses, long pedicellate asci attached in a basal arrangement in the centrum and fusiform, septate ascospores. However, phylogenetic analyses indicated that *Manglicola* formed a clade as a family in Jahnulales (Suetrong et al. 2010, 2011; Hyde et al. 2013), while *Hypsostroma saxicola* and *H. caimitalense* (*Hypsostromataceae*) are placed in Pleosporales with high bootstrap support (Hyde et al. 2013). *Manglicola* contains two species, *M. guatemalensis* (type species) and *M. samuelsii* Huhndorf. *Manglicola guatemalensis* differs from *M. samuelsii* by its marine habitat, few asci per ascomata, 1-septate ascospores which are constricted at the septum, deliquescing appendages covering both ascospore apices, with an apical cylindrical appendage and subglobose basal appendage, while *M. samuelsii* is terrestrial, found on bamboo in lowland rainforest, has numerous asci per ascomata and 3-septate ascospores without a sheath or appendages (Jones et al. 2019). Further studies are required to determine if *M. samuelsii* is correctly placed in *Manglicolaceae*.

***Manglicola guatemalensis*** Kohlm. & E. Kohlm., *Mycologia* 63(4): 841 (1971).

*Index Fungorum number:* IF 317136, *Facesoffungi number:* FoF 06123; Fig. 37

*Saprobic* on frond bases of *Nypa fruticans*. **Sexual morph:** *Ascomata* 425–866 µm height, 115–310 µm in diam around the center, obtusely clavate to fusiform, pedicellate, solitary or aggregated, superficial, ostiolate, coriaceous, olive-brown. Ascoma attached by a hypostroma immersed in the host tissue of *N. fruticans*. *Hamathecium* comprising 1.25–2.5 µm in diam., simple, numerous, septate trabeculate, hyaline, pseudoparaphyses. *Asci* 300–605 × 30–42.5 µm, 8-spored, cylindrical, bitunicate, thick-walled, with an apical apparatus. *Ascospores* 95–112.5 × 20–30 µm, uni-seriate, fusiform, apiculate, light brown to dark brown, unequally 1-septate, constricted at the septum, apical cell larger, basal cell, turbinate, light brown, with a gelatinous appendage at the spore apex. **Asexual morph:** Undetermined.

*Material examined:* Thailand, Suratthani Province, Ban Hui Sap Mangrove Forest, superficial on frond bases of *Nypa fruticans*, 8 Jan 2019, S. Preedanon & S. Suetrong (BBH 45364).



**Fig. 37** *Manglicola guatemalensis* (BBH 45364). **a** Superficial ascomata on *N. fruticans*, partially immersed in mud (MU), composed of dark ascospores (AS) in mature asci (AC), visible through the thin wall peridium, spores exuded at the ostiole (OS). **b** Ascus apex with an apical apparatus. **c** Trabeculate pseudoparaphyses (PR) numerous, septate,

simple. **d** Ascospore in ascus with apical (AA) and basal (BA) appendages. **e–i** Ascospores. **j** Germinating ascospore, with germ tube developing laterally from the basal cell. Scale bars: **a** = 250  $\mu$ m, **b, e–j** = 25  $\mu$ m, **c** = 15  $\mu$ m, **d** = 20  $\mu$ m

*Notes:* The genus has been reported as a saprobe from bark of dead roots, and from a seedling of *Rhizophora mangle* in Guatemala (see morphology Suetrong et al. 2010).

#### Economic and ecological significance

*Manglicolaceae* contains two species saprobic on woody material involved in decay of dead woody structures and likely to be involved in nutrient recycling.

**Kirschsteiniotheliales** Hernandez-Restrepo, R.F. Castañeda, Gen. & Crous.

*Index Fungorum number:* IF 821220; *Facesoffungi number:* FoF 07693.

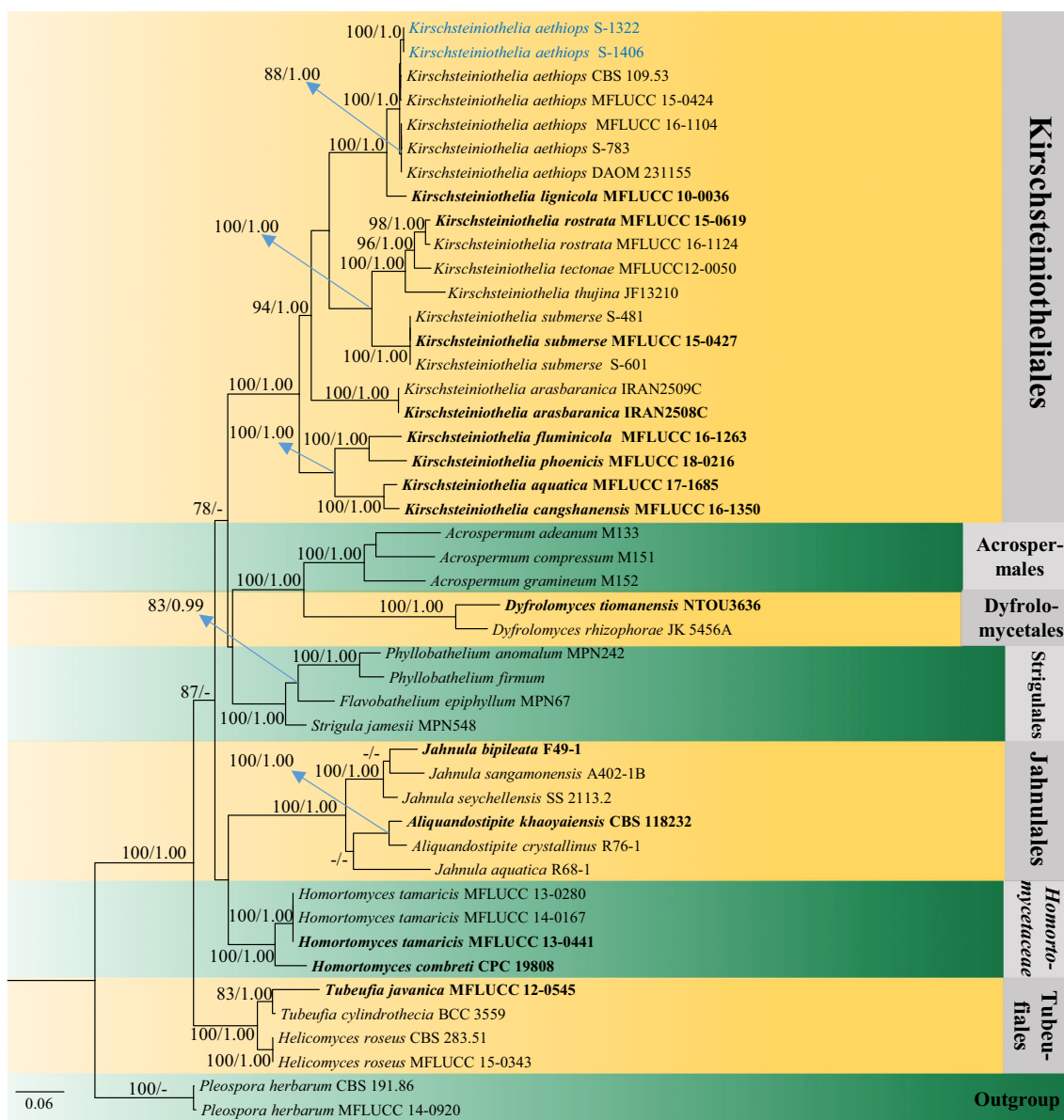
Kirschsteiniotheliales was introduced based on phylogenetic analysis. Only a single family *Kirschsteiniotheliaceae* is accepted in this order. Phylogenetic analyses indicate that *Kirschsteiniotheliales* formed a distinct clade within Dothideomycetes with high support (Fig. 38). The divergence time for Kirschsteiniotheliales is estimated as 221 MYA (stem age, Hongsanan et al. 2020).

*Accepted families:* *Kirschsteiniotheliaceae*.

***Kirschsteiniotheliaceae*** Boonmee & K.D. Hyde, Mycologia 104(3): 705 (2012).

*Index Fungorum number:* IF 561021; *Facesoffungi number:* FoF 01737, 24 species.

*Saprobic* on decaying wood. **Sexual morph:** *Ascomata* superficial, subglobose to globose, dark brown to black, membranaceous, solitary, with a central papilla. *Peridium* composed of cells of *textura angularis*. *Hamathecium* comprising numerous, filiform, hyaline, mostly cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, cylindrical to clavate, with a long pedicel, apical rounded, with an ocular chamber. *Ascospores* 2-seriate, ellipsoidal, septate, slightly curved, dull green, brown to dark brown at maturity, with median septum or in lower part, some ascospores with secondary septa, thick-walled, lacking a mucilaginous sheath. **Asexual morph:** Hyphomycetous. *Conidiophores* macronematous, mononematous, erect, apically branched, arising straight or slightly curved, solitary, elongate and thick-walled, septate, brown to



**Fig. 38** Phylogram generated from maximum likelihood analysis (RAxML) of Kirschsteinotheliales based on ITS, LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/

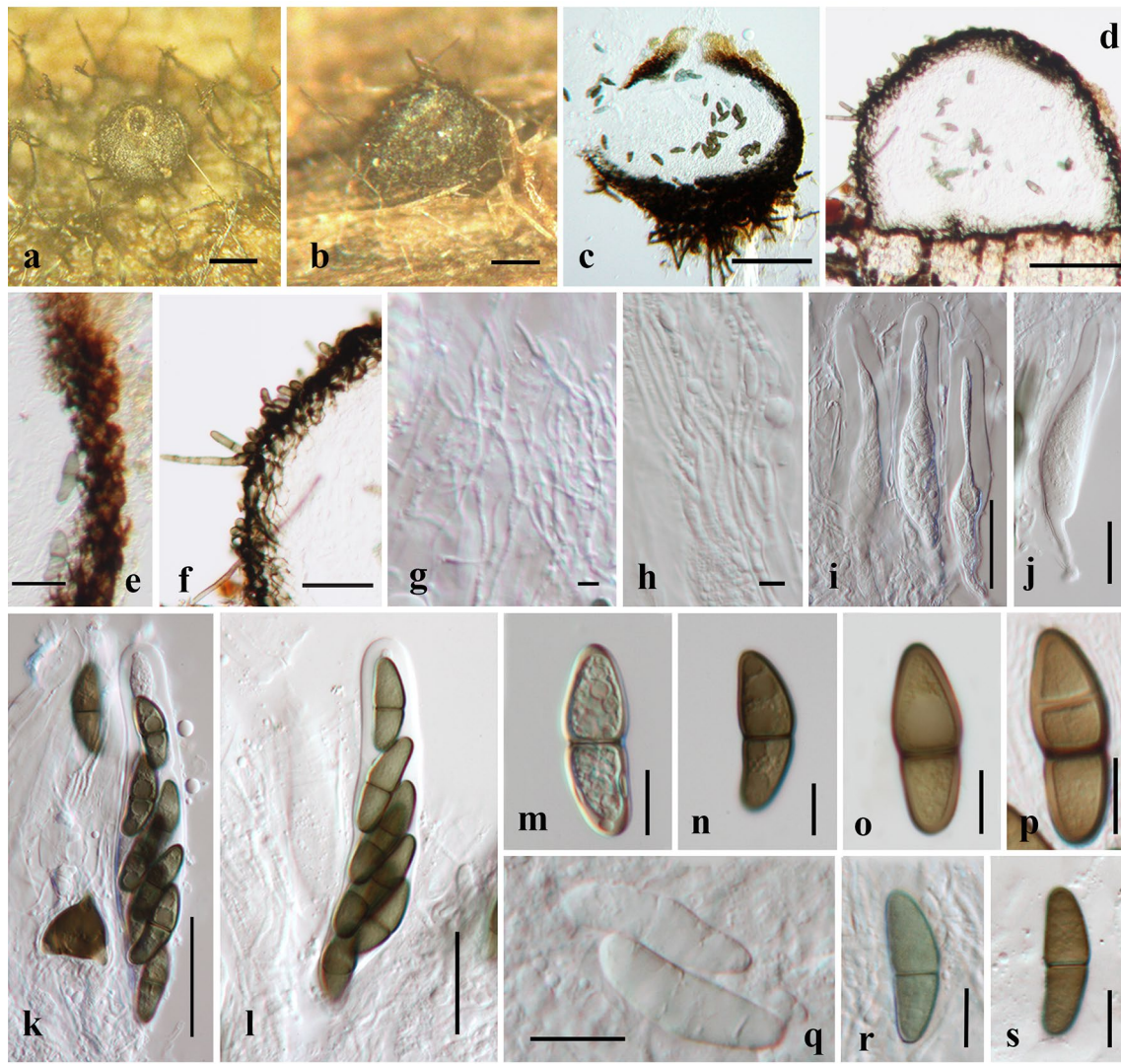
PP) are given at the nodes. Isolate/specimen number is noted after the species name. The tree is rooted to *Pleospora herbarum* (CBS 191.86, MFLUCC 14–0920). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP

dark brown, smooth-walled. *Conidiogenous cell* tretric, terminal, constricted at delimiting septa. *Conidia* broadly ellipsoid-obovoid, brown to dark brown, constricted and darkly pigmented at the septa, rounded at both ends, smooth-walled.

**Type:** *Kirschsteinothelia* D. Hawksw., J. Linn. Soc., Bot. 91: 182 (1985).

**Notes:** *Kirschsteinotheliaceae* species are mostly saprobes on dead wood from terrestrial and aquatic habitats (Boonmee et al. 2012; Hyde et al. 2013; Su et al. 2016).

*Taeniolella* is an asexual genus with saprobic, endophytic and lichenicolous life styles. It was found to be a polyphyletic genus distributed between the Dothideomycetes and the Sordariomycetes (Ertz et al. 2016). The type species *Taeniolella exilis* formed a lineage within *Kirschsteinotheliaceae* (Ertz et al. 2016), therefore, the genus was placed in *Kirschsteinotheliaceae* by Ertz et al. (2016) and Wijayawardene et al. (2017a). However, Heuchert et al. (2018) and Dong et al. (2020) suggested that four freshwater species of *Taeniolella* are undoubtedly not congeneric with *Taeniolella*



**Fig. 39** The sexual morph characters of *Kirschsteinothelia* spp. **a, b** Appearance of ascomata on host surface. **c, d** Section through ascoma. **e, f** Peridium. **g, h** Immature asci. **i, j** Asci. **k, l** Asci. **m–s** Ascospores.

Note: **a, c, e, g, i, k, m–p** = *Kirschsteinothelia lignicola* (holotype); **b, d, f, h, j, l, q–s** = *Kirschsteinothelia emarceis* (holotype)

*sensu lato*. Thus, we suggest to exclude this genus from *Kirschsteinotheliaceae* and further studies are needed to resolve placement of this group.

***Kirschsteinothelia*** D. Hawksw., J. Linn. Soc., Bot. 91: 182 (1985).

*Index Fungorum number*: IF 25723; *Facesoffungi number*: FoF 08040; 24 morphological species (Bao et al. 2018; Species Fungorum 2020), 11 species with molecular data.

*Type species*: ***Kirschsteinothelia aethiops*** (Sacc.) D. Hawksw., Bot. J. Linn. Soc. 91(1–2): 185 (1985).

*Notes*: *Kirschsteinothelia* has little DNA sequence data for *Kirschsteinothelia* species available in GenBank, thus, more collections and sequence data are needed (Fig. 39).

***Kirschsteinothelia aethiops*** (Sacc.) D. Hawksw., J. Linn. Soc., Bot. 91(1–2): 185 (1985).

≡ *Amphisphaeria aethiops* Sacc., Syll. fung. (Abellini) 1: 722 (1882).

*Index Fungorum number*: IF 104401; *Facesoffungi number*: FoF 01738; Fig. 40

*Saprobic* on decaying wood submerged in freshwater habitats. **Sexual morph**: Undetermined. **Asexual morph**: *Colonies* on the natural substrate superficial, effuse, gregarious, hairy, dark brown to black. *Mycelium* immersed, composed of septate, branched, thin-walled, smooth, pale brown hyphae. *Coinidiophores* 148–228 μm ( $\bar{x}$  = 188 μm, SD = 40, n = 20) long, 6–8 μm ( $\bar{x}$  = 7 μm, SD = 1, n = 20) wide, mononematous, macronematous, septate, usually with one or a number of short branches near apex, erect, straight

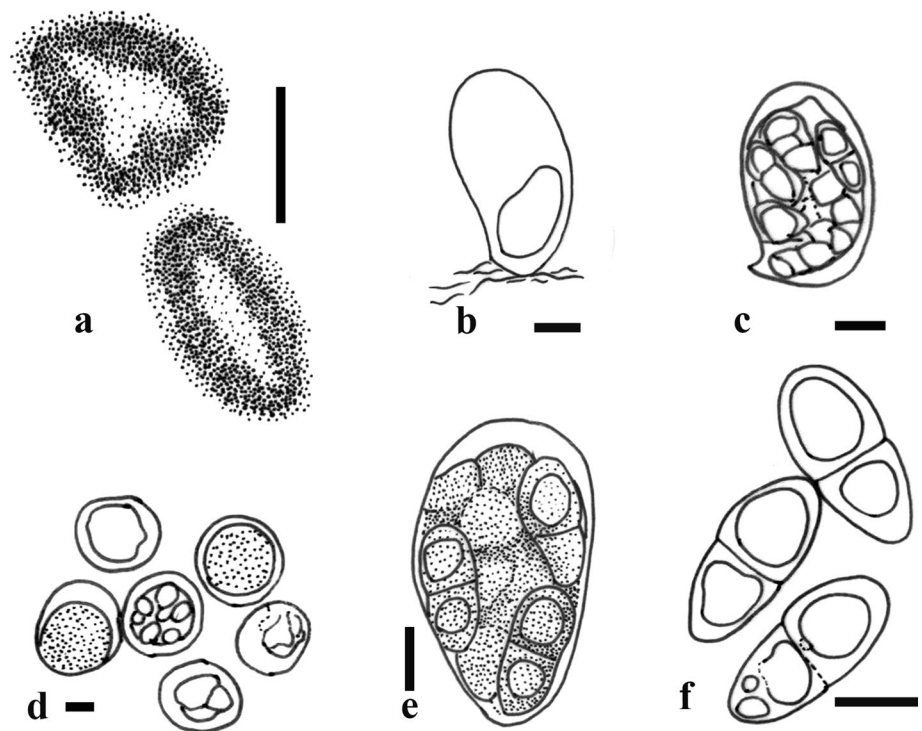


**Fig. 40** *Kirschsteinothelia aethiops* (S-1322) **a** Colonies on natural substrate. **b, c** Conidiophores with conidia. **d, e** Conidiogenous cells. **f–i** Conidia. **j** Germinating conidium. **k, l** Culture on PDA from sur-

face and reverse. Scale bars: **b** = 90  $\mu\text{m}$ , **c** = 70  $\mu\text{m}$ , **d, e** = 40  $\mu\text{m}$ , **f–i** = 15  $\mu\text{m}$ , **j** = 30  $\mu\text{m}$



**Fig. 41** *Lembosina aulographoides* (redrawn from Crous et al. 2019b, CPC 33049, holotype). **a** Hysterothecoid ascomata on host surface. **b, c** Young asci. **d** Asci viewed from above. **e** Asci when mature. **f** Ascospores. Scale bars: **a** = 250  $\mu\text{m}$ , **b–f** = 10  $\mu\text{m}$



or flexuous, smooth, brown to dark brown, gradually paler towards the apex, cylindrical, septate. *Conidiogenous cells* 25–33  $\mu\text{m}$  ( $\bar{x}$  = 29  $\mu\text{m}$ , SD = 4, n = 20) long, 5–7  $\mu\text{m}$  ( $\bar{x}$  = 6  $\mu\text{m}$ , SD = 1, n = 20) wide, tetric, integrated, sometimes percurrent, terminal, subhyaline to pale brown, doliiform or lageniform, new cell developing from apical or subapical part of subtending cell. *Conidia* 41–53  $\mu\text{m}$  ( $\bar{x}$  = 47  $\mu\text{m}$ , SD = 6, n = 40) long, 12–16  $\mu\text{m}$  ( $\bar{x}$  = 14  $\mu\text{m}$ , SD = 2, n = 40) wide, acrogenous, solitary, dry, cylindrical, sometimes clavate, rounded at the apex, 3–4-septate, constricted and darkly pigmented at the septa, smooth, brown.

*Material examined*: China, Yunnan Province, saprobic on submerged decaying wood in a freshwater stream in Laojunshan Mountain, H.W. Shen, June 2017, S-1322.

*Sequence data*: ITS MH793539, LSU MH793545, SSU MH793556.

*Notes*: *Kirschsteiniothelia aethiops* is the generic type of *Kirschsteiniothelia*. Phylogenetic analysis based on ITS, LSU and SSU sequence data showed that our strains (S-1322 and S-1406) are identical to the strains of *K. aethiops* (Fig. 38). The morphology of our isolates also fit well with *K. aethiops* (Su et al. 2016).

#### Economic and ecological significance

Poch et al. (1992) reported the first chemical examination of a *Kirschsteiniothelia* species and extracted five major compounds from cultures of this species. Species of *Kirschsteiniotheliales* have the potential as important sources of novel

biologically active secondary metabolites. Most *Kirschsteiniothelia* species are saprobes involved in nutrient cycling.

#### Lembosinales Crous.

*Index Fungorum number*: IF 832086; *Facesoffungi number*: FoF 07694.

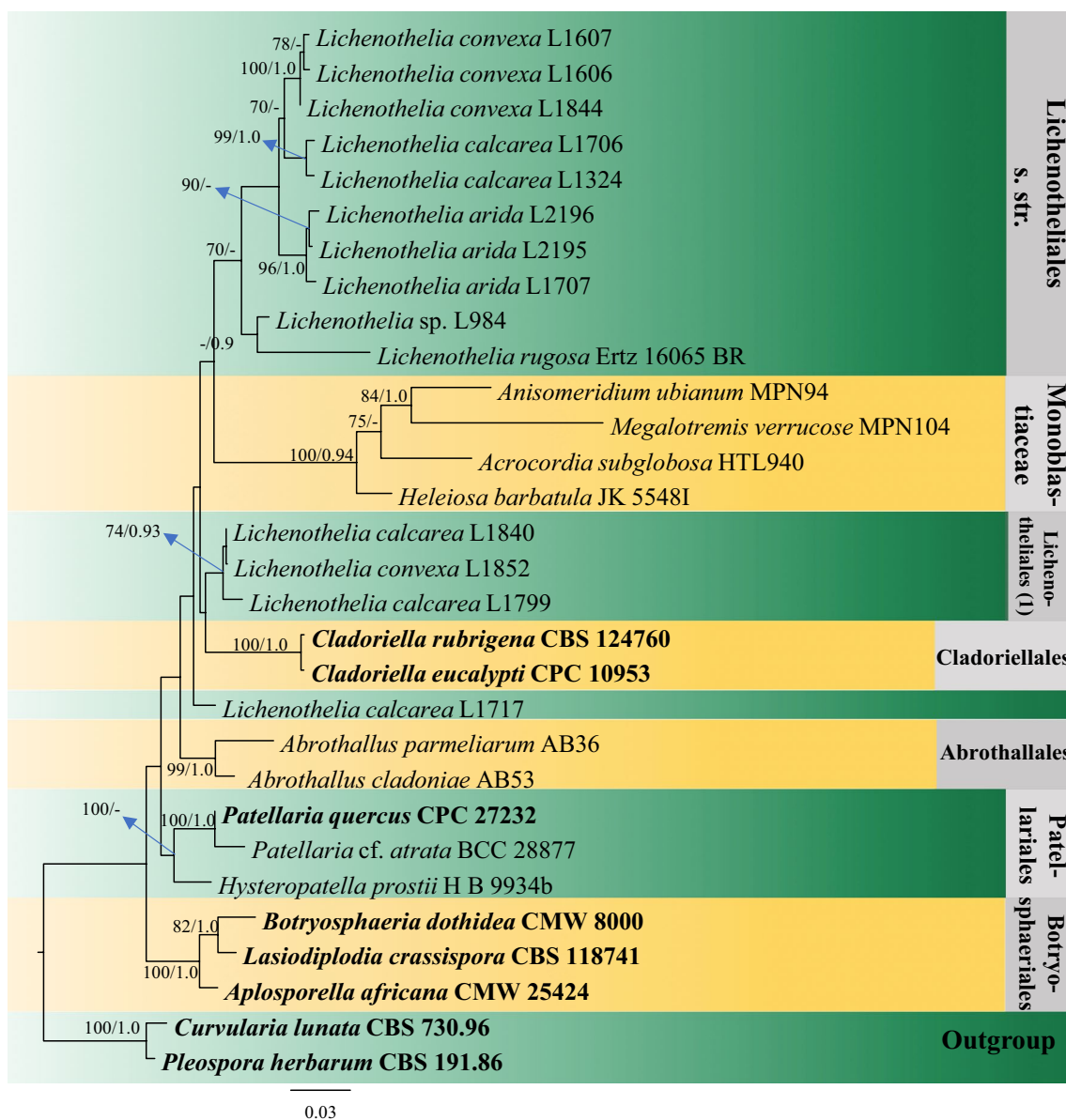
Crous et al. (2019b) provided the first molecular data for *Lembosina* and found that it formed a distinct lineage next to Lichenconiales. Therefore, they introduced Lembosinales to accommodate this lineage. The divergence time for Lembosinales is estimated as 253 MYA (Hongsanan et al. 2020).

*Accepted families*: *Lembosinaceae*.

**Lembosinaceae** Crous, in Crous et al., *Fungal Systematics and Evolution* 5: 91 (2019) [2020].

*Index Fungorum number*: IF 832087; *Facesoffungi number*: FoF 07695, 26 species.

**Sexual morph**: *Ascomata* thyriothecial or hysterothecial, linear, rarely y-shaped, solitary, gregarious, superficial, loose on host surface, black, opening with linear fissures. *Upper wall* comprises thin layer of mostly neatly arranged dark cells, branched at the outer rim, poorly developed at the base. *Hamathecium* comprising sparse, filiform, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, subglobose to oblong. *Ascospores* 2–4-seriate, hyaline to brown, 1-septate, upper cell slightly wider and shorter than the lower cell,



**Fig. 42** Phylogram generated from maximum likelihood analysis (RAxML) of Lichenotheliales based on LSU, SSU and mtSSU sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after

the species name. The tree is rooted to *Curvularia lunata* (CBS 730.96) and *Stemphylium versicarium* (CBS 191.86). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP

with basal protrusion (Crous et al. 2019b). **Asexual morph:** Undetermined.

**Type:** *Lembosina* Theiss.

**Notes:** This family was established based on phylogenetic placement of *Lembosina aulographoides*. More fresh collections and sequence data are needed to confirm its placement.

*Lembosina* Theiss., Annl. mycol. 11(5): 437 (1913).

**Index Fungorum number:** IF 2728; **Facesoffungi number:** FoF 07696; 26 morphological species (Species Fungorum 2020), 1 species with molecular data.

**Type species:** *Lembosina aulographoides* (E. Bommer et al.) Theiss.

**Notes:** *Lembosina* was placed in *Leptopeltidaceae* and *Asterinaceae* by von Arx and Müller (1975) and Hawksworth et al. (1995), respectively. Hyde et al. (2013) placed this genus in *Aulographaceae*. However, Crous et al. (2019b) indicated that *Lembosina* based on *L. aulographoides*, does

not belong to any of these families and should be placed in its own family and order.

***Lembosina aulographoides*** (E. Bommer, M. Rousseau & Sacc.) Theiss., *Annl. mycol.* 11(5): 437 (1913).

≡ *Lembosia aulographoides* E. Bommer et al., *Bull. Soc. R. Bot. Belg.* 29(1): 238 (1890).

*Index Fungorum number*: IF 148168; *Facesoffungi number*: FoF 07697; Fig. 41

*Description*: see Crous et al. (2019b).

### Economic and ecological significance

The life style of *Lembosiaceae* is unclear, however, they tend to be saprobes and involved in nutrient recycling.

### Lichenotheliales K. Knudsen, Muggia & K.D. Hyde.

*Index Fungorum number*: IF 805298; *Facesoffungi number*: FoF 07698.

The order *Lichenotheliales* comprises non-lichenized taxa, including saprobic, lichenicolous, epiphytic or endolithic species growing on or within rocks where they are associated with algae (Hyde et al. 2013). These fungi are found in hot and cold arid regions worldwide (Muggia et al. 2015). *Lichenotheliales* comprises only *Lichenotheliaceae* which comprises one genus *Lichenothelia* and *Endococcus*. Ametrano et al. (2019) indicated that *Lichenotheliales* formed two clades within Dothideomycetes named *Lichenotheliales sensu stricto* and *Lichenotheliales* (1). The same result is shown in our analyses (Fig. 42). *Lichenotheliales sensu stricto* is monophyletic (Ametrano et al. 2019). The divergence time for *Lichenotheliales* is estimated as 265 MYA (stem age, Hongsanan et al. 2020).

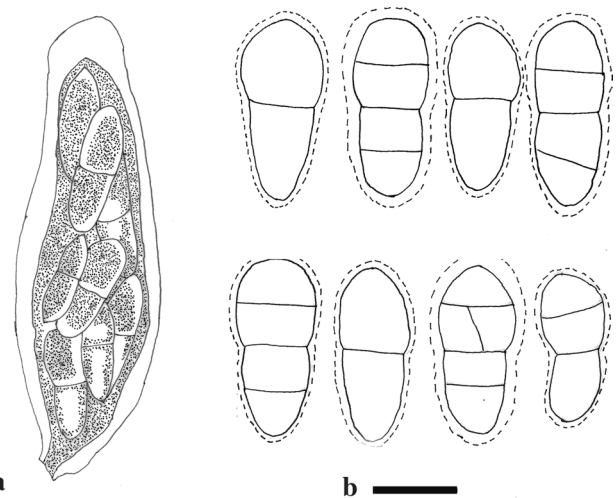
*Accepted families*: *Lichenotheliaceae*.

### *Lichenotheliaceae* Henssen, *Syst. Ascom.* 5: 137 (1986).

*Index Fungorum number*: IF 81652; *Facesoffungi number*: FoF 07699, 51 species.

*Saprobic* or *lichenicolous*. *Endolithic* or *epilithic* thallus in saxicolous lifestyle. Lichenicolous shows episubstratic or endokapyllic thallus black, dispersed or continuous, areolate or not, frequently producing black superficial or rarely effigurate, hyphae, branching or not, sometimes connecting scattered stromata; meristematic growth frequent. **Sexual morph**: *Ascomata* perithecioid and with interascal filaments or fertile stromata without an ostiole and with asci forming in pseudoparenchymatous locules. *Asci* 8-spored, globose to broadly clavate, bitunicate, sometimes K/I+bluish around the outer layers or apex of the ascus. Interascal gel amyloid or not. *Ascospores* uni- to 2-seriate, partially overlapping, hyaline or brown, 1-septate to muriform (sometimes variable). **Asexual morph**: Undetermined.

*Type*: *Lichenothelia* D. Hawksw.



**Fig. 43** Morphology of *Lichenothelia* spp. (redrawn from Hawksworth 1981a). **a** Asci of *Lichenothelia scopularia*. **b** Ascospores of *Lichenothelia metzleri*

*Notes*: The family *Lichenotheliaceae* was introduced to encompass *Lichenothelia* and *Lichenostigma* in Dothideales (Henssen and Jahns 1973; Hyde et al. 2013; Valadbeigi et al. 2016). *Lichenostigma* was placed with *Lichenothelia* in *Lichenotheliaceae* based on morphology (Henssen 1987; Muggia et al. 2015). However, based on phylogenetic analysis *Lichenostigma* was excluded from *Lichenotheliaceae* and placed to *Lichenostigmatales* in Arthoniomycetes (Ertz et al. 2014; Hyde et al. 2013; Muggia et al. 2013, 2015). Presently, *Lichenotheliaceae* comprises two genera namely *Lichenothelia* and *Endococcus*. *Endococcus* was formally referred to Dothideales (Hawksworth 1979). Lumbsch and Huhndorf (2010) and Hyde et al. (2013) placed *Endococcus* in Dothideomycetes genera *incertae sedis*. However, Jaysiri et al. (2016) included this genus in *Lichenotheliaceae* based on morphological similarities to the type species of *Lichenothelia*. *Lichenotheliaceae* is placed in *Lichenotheliales* based on morphological, habitat and molecular evidence (Hyde et al. 2013). Both sexual and asexual morphs have been recorded as saprobic, lichenicolous or lichenized taxa (Hyde et al. 2013; Valadbeigi et al. 2016; Wijayawardene et al. 2017a).

### *Lichenothelia* D. Hawksw., *Lichenologist* 13(2): 142 (1981).

*Index Fungorum number*: IF 2855; *Facesoffungi number*: FoF07700; 11 morphological species (Species Fungorum 2020), 9 species with molecular data.

*Type species*: *Lichenothelia scopularia* (Nyl.) D. Hawksw.

≡ *Verrucaria scopularia* Nyl., *Not. Sällsk. Fauna et Fl. Fenn. Förh., Ny Ser.* 3: 85 (1861).

*Notes*: The cosmopolitan genus *Lichenothelia* is characterized by fertile ascomata and many species are described

based on morphological identification (Ametrano et al. 2019). Both sexual and asexual morphs have been recorded (Valadbeigi et al. 2016; Wijayawardene et al. 2017a) and the taxa show a wide range of life strategies including rock inhabiting, lichenized, lichenicolous and saprobic taxa (Ametrano et al. 2019). Based on modern phylogeny, this genus is incorporated in the order Lichenotheliales (Hyde et al. 2013). Broader sampling with informative loci at the species level is required for species delimitation within this genus (Ametrano et al. 2019) (Fig. 43).

**Endococcus** Nyl., Mém. Soc. Sci. Nat. Cherbourg 3: 193 (1855).

*Index Fungorum number*: IF 1791; *Facesoffungi number* FoF 00560; 40 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: **Endococcus rugulosus** Nyl., Mém. Soc. Imp. Sci. Nat. Cherbourg 3: 193 (1855).

=*Verrucaria rugulosa* Borrer ex Leight., Brit. Sp. Ang. Lich.: 47 (1851).

*Notes*: *Endococcus* species occur on crustose, foliose, and fruticose lichens and some are lichenicolous, while others colonize diverse rock types (Halıcı et al. 2007; Knudsen 2008; Jayasiri et al. Hong). Species are commonly host-specific, while some species have wide host ranges (Halıcı et al. 2007; Jayasiri et al. 2016). *Endococcus* was affiliated in Dothideales (Hawksworth 1979). However, the taxonomic placement of this genus has changed over time (Hafellner 2019). Jayasiri et al (2016a) transferred this genus to *Lichenotheliaceae* based on the morphological characteristics, such as perithecioid ascomata with widely porate ostioles, globose to broadly clavate asci and hyaline or brown with 1-septate ascospores. However, Diederich et al (2018) accepted this genus under *Verrucariaceae* while Wijayawardene et al (2018) accepted in uncertain placement in Dothideomycetes. Molecular data are lacking for this genus and needs critical revision (Hafellner 2019).

### Economic and ecological significance

Species such as *Lichenothelia scopularia*, *Lichenothelia arida*, *L. calcarea* and *L. convexa* are lichenicolous (Hawksworth 1981a), while other species are reported as lichenized and non-lichenized (Hyde et al. 2013). Ametrano et al. (2019) stated that *Lichenothelia* consists of rock-inhabiting taxa which colonize natural and anthropogenic lithic substrates.

### Microthyriales G. Arnaud.

*Index Fungorum number*: IF 90485; *Facesoffungi number*: FoF 07701.

Arnaud (1918) introduced this order, with type family *Microthyriaceae*. Microthyriales contained two families viz. *Microthyriaceae* and *Micropeltidaceae* based on their

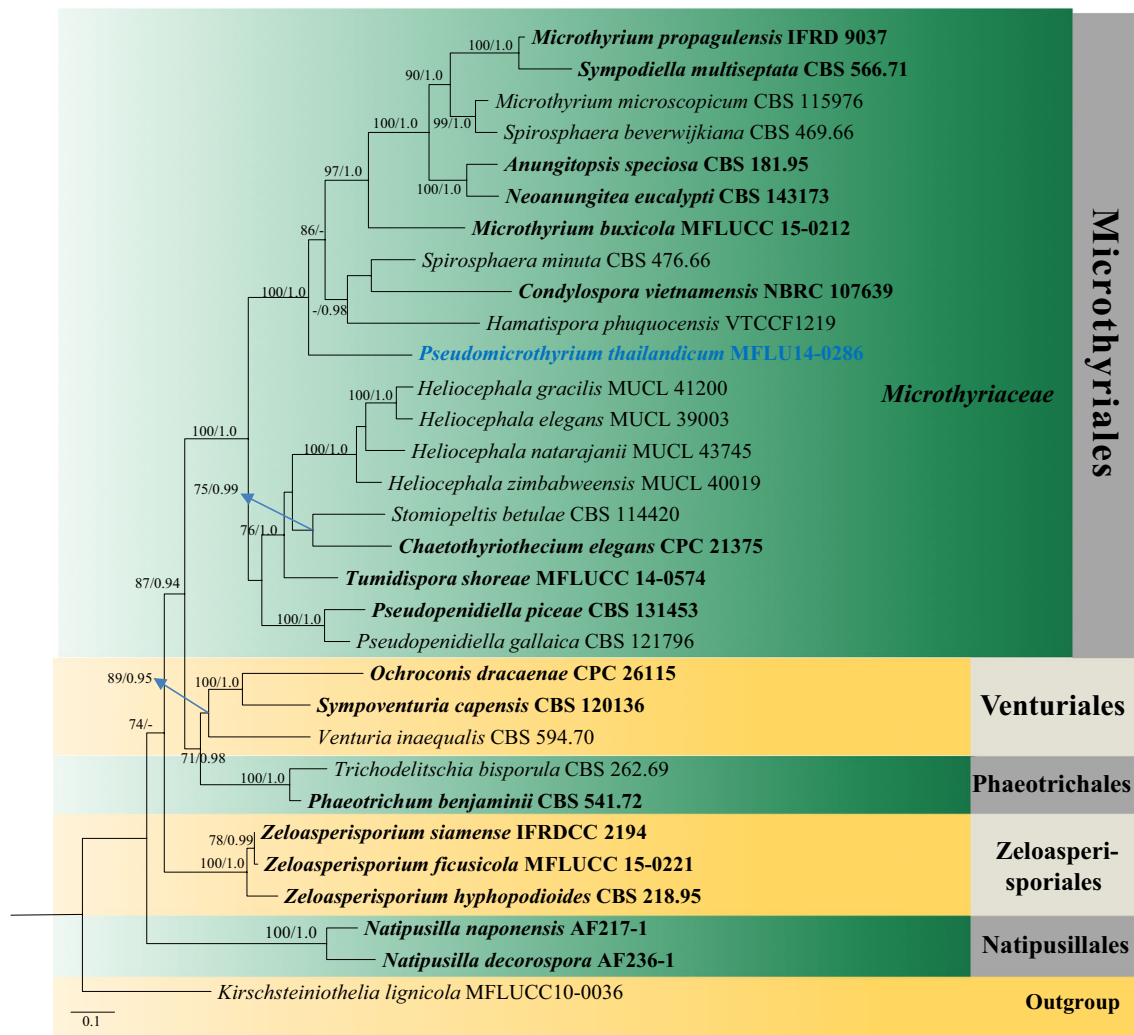
flattened ascomata with poorly developed base. However, members of *Microthyriaceae* have brown to black thyriothecia, comprising cuboid or angular cells arranged in parallel rows, with prominent central ostioles, and usually uniseptate ascospores (Doidge 1942; Müller and von Arx 1962; Luttrell 1973; Barr 1987b; Hofmann and Piepenbring 2006; Wu et al. 2011b; Hyde et al. 2013; Hongsanan et al. 2015b; Hongsanan and Hyde 2017), while *Micropeltidaceae* has black-blue or greenish thyriothecia, comprising interwoven hyphae, with a central ostiole, and multiple trans-septate ascospores (Clements and Shear 1931; Batista 1959; von Arx and Müller 1975; Barr 1987b; Wu et al. 2011b; Hyde et al. 2013; Hongsanan and Hyde 2017; Hongsanan et al. 2015a; Zeng et al. 2019). Hongsanan and Hyde (2017) excluded *Micropeltidaceae* from Microthyriales based on their phylogenetic analyses. This was supported by new collections of *Micropeltidaceae* in Zeng et al. (2019). Therefore, Microthyriales contains a single family, *Microthyriaceae* based on morphology and phylogeny. Species of Microthyriales cluster together as a distinct clade within Dothideomycetes with high support (Fig. 44). The divergence time for Microthyriales is estimated as 184 MYA (stem age, Hongsanan et al. 2020).

*Accepted families*: *Microthyriaceae*.

**Microthyriaceae** Sacc., Syll. fung. (Abellini) 2: 658 (1883).

*Index Fungorum number*: IF 81008; *Facesoffungi number*: FoF 06747, 120 species.

*Saprobic* on leaves. *Hyphae* mostly absent, superficial, brown, septate, branched, reticulate. **Sexual morph**: *Thyriothecia* superficial, circular, flattened, dark brown, solitary or gregarious, with a round, central ostiole, with poorly developed basal plate. *Upper wall* brown, comprising radially arranged cells of *textura prismatica*, often darkened at the ostiole and tapering at the margin. *Hamathecium* comprising asci inclined from the base and rim towards the central ostiole. *Pseudoparaphyses* present or absent. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical to obpyriform, with or without a pedicel, with or without an ocular chamber at the tip. *Ascospores* overlapping uni- to 3-seriate, fusiform to ellipsoidal, hyaline or brown, usually 1-septate, with cilia or appendages, smooth-walled. **Asexual morph**: *Mycelium* consisting of hyaline to pale brown, smooth to verruculose, branched, septate hyphae. *Conidiophores* micronematous or macronematous, mononematous, arising from a brown stroma or from superficial hyphae, erect, solitary, unbranched or branched, straight or flexuous, smooth or roughened, septate, subcylindrical, pale brown to brown; microconidiophores when present, reduced to conidiogenous cells on hyphae, visible as slight thickenings on hyphal cells, somewhat erumpent, pale brown, truncate apex. *Conidiogenous cells* mono- to polyblastic, integrated, terminal, smooth or verruculose, determinate or sympodial, clavate,



**Fig. 44** Phylogram generated from maximum likelihood analysis (RAxML) of Microthyriales and related orders based on ITS and LSU sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is

noted after the species name. The tree is rooted to *Kirschsteiniothelia lignicola* (MFLUCC10-0036). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP

subcylindrical, ampulliform or ovoid. *Ramoconidia* when present, pale brown, verruculose, subcylindrical to fusoid-ellipsoid, aseptate, giving rise to branched chains of conidia. *Conidia* solitary or in branched chains, sometimes radial on compact heads, acrogenous or acropleurogenous, verruculose, subcylindrical to ellipsoid, obclavate, pale brown, aseptate to multi-septate, sometimes rostrate; hilum inconspicuous, truncate, sometimes unthickened, sometimes thickened; conidia in *Hamatispora* consisting of a main axis and lateral branches; main axis hook-shaped with a long tail bearing lateral branches; lateral branches straight, developing from different cells of the helicoid part of the main axis.

**Type:** *Microthyrium* Desm.

**Notes:** The phylogenetic placement of this family was first provided by Wu et al. (2011b), represented by *Microthyrium*

*microscopicum*. New genera and new species in *Microthyriaceae* with molecular data were provided to support the placement of *Microthyriaceae*. Eleven genera are accepted in this family based on morphology and phylogeny.

The genera *Condylospora*, *Spirosphaera* and *Stomiopeltis* are not included in the family due to their polyphyletic characters or lack of evidence. *Caribaeomyces* is excluded from the family as it is typical of Asterinales by its hyphopodia and structure of upper walls. *Hansfordiella* and *Isthmospora* are also excluded from the family, as they are asexual morphs of *Trichothyrium* (*Trichothyriaceae*) (Wijayawardene et al. 2017a). *Monorhizina* was referred as a member of *Microthyriaceae* in some studies. This genus was synonymised under *Lauterbachella* and *Rhagadolobium* by Dingley (1972) and Müller and von Arx (1962), respectively.

Hofmann (2009) accepted *Monorhizina* in *Microthyriaceae*, while Hyde et al. (2013) did not accept this genus. Kirk et al. (2013) retained *Monorhizina* as a distinct genus but did not assign it to any family. Wijayawardene et al. (2017a) listed *Monorhizina* as a genus in *Microthyriaceae*. We do not accept *Monorhizina* in *Microthyriaceae* and note that the placement of this genus in *Microthyriaceae* needs future study.

***Microthyrium*** Desm., *Annls Sci. Nat., Bot., sér. 2* 15: 137 (1841).

*Index Fungorum number*: IF 3206; *Facesoffungi number*: FoF 06748; 91 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: ***Microthyrium microscopicum*** Desm., *Annls Sci. Nat., Bot., sér. 2* 15: 138 (1841).

*Notes*: *Microthyrium* is characterized by flattened thyriothecia with cells of radial arrangement and hyaline ascospores with cilia.

#### Other genera included

***Arnaudiella*** Petr., *Annls mycol.* 25(3/4): 339 (1927).

*Index Fungorum number*: IF 311; *Facesoffungi number*: FoF 06749; – 10 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Arnaudiella caronae*** (Pass.) Petr., *Annls mycol.* 25(3/4): 339 (1927).

≡ *Seynesia caronae* Pass., *Atti Reale Accad. Lincei, Rendic., Sér. 4* 4(2): 63 (1888).

*Notes*: *Arnaudiella* is similar to *Microthyrium* in having flattened thyriothecia and the radial arrangement of upper wall with a darkened ostiole, but is distinct in brown ascospores.

***Calothyriopsis*** Höhn., *Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1* 128(7–8): 552 (1919).

*Index Fungorum number*: IF 761; *Facesoffungi number*: FoF 06750; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Calothyriopsis conferta*** (Theiss.) Höhn., *Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1* 128(7–8): 552 (1919).

≡ *Microthyrium confertum* Theiss., *Annls mycol.* 7(4): 352 (1909).

*Notes*: *Calothyriopsis* is typical of *Microthyriaceae* in having flattened thyriothecia and 1-septate ascospores. However, the arrangement of upper wall is different from the type genus. Therefore, its placement needs to be confirmed by phylogeny.

***Chaetothyriotheceum*** Hongsanan & K.D. Hyde, *Phytotaxa* 161(2): 161 (2014).

*Index Fungorum number*: IF 804964; *Facesoffungi number*: FoF 06751; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Chaetothyriotheceum elegans*** Hongsanan & K.D. Hyde, *Phytotaxa* 161(2): 161 (2014).

*Notes*: *Chaetothyriotheceum* was introduced with a single species *C. elegans*, which typically has radial setae growing around a central ostiole. Based on the flattened thyriothecia with cells in a radial arrangement and phylogenetic analyses, *Chaetothyriotheceum* is accommodated in *Microthyriaceae*. Sequence data of LSU is available for the genus

***Hamatispora*** L.T.H. Yen, K. Yamag. & K. Ando, in Yen et al., *Mycoscience* 59(6): 468 (2018).

*Index Fungorum number*: IF 822829; *Facesoffungi number*: FoF 06752; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Hamatispora phuquocensis*** L.T.H. Yen, K. Yamag. & K. Ando, in Yen et al., *Mycoscience* 59(6): 468 (2018).

*Notes*: *Hamatispora* is a hyphomycetous genus with staurospores that are question mark-shaped or hook-shaped with 3 arms developing from each cell on the helicoid part (Yamaguchi et al. 2018). It is considered as a member of *Microthyriaceae* based on the phylogeny.

***Neoanungitea*** Crous, in Crous et al., *Persoonia* 39: 359 (2017).

*Index Fungorum number*: IF 823489; *Facesoffungi number*: FoF 07702; – 2 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Neoanungitea eucalypti*** Crous, in Crous et al., *Persoonia* 39: 359 (2017)

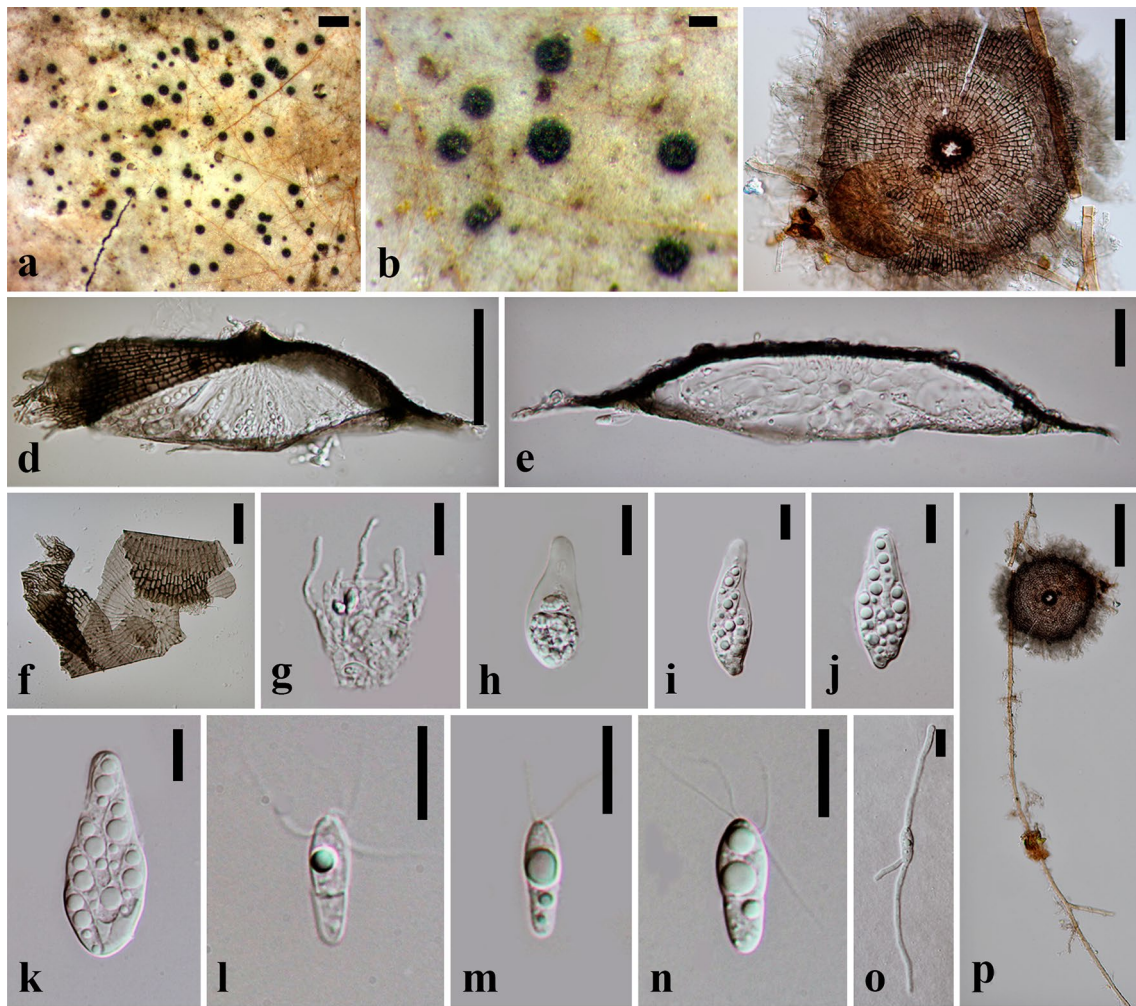
*Notes*: *Neoanungitea* was introduced with a single species that shares features of both *Anungitea* and *Anungitopsis*. It is characterized by conidiogenous cells forming a terminal rachis with flat-tipped sympodial loci. Crous et al. (2017) classified *Neoanungitea* as a member of *Microthyriaceae* based on phylogenetic analysis. Sequence data of ITS and LSU is available for the genus.

***Paramicrothyrium*** H.X. Wu & K.D. Hyde, in Wu, Schoch, Boonmee, Bahkali, Chomnunti & Hyde, *Fungal Diversity* 51(1): 204 (2011).

*Index Fungorum number*: IF 563363; *Facesoffungi number*: FoF 06754; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Paramicrothyrium chinensis*** H.X. Wu & K.D. Hyde [as ‘chinensis’], in Wu et al., *Fungal Diversity* 51(1): 204 (2011).

*Notes*: *Paramicrothyrium* was introduced with a single species *Paramicrothyrium chinensis*, which is characterized by irregular ostioles without a darkened ring. However, the



**Fig. 45** *Pseudomicrothyrium thailandicum* (MFLU 14-0286, **holotype**). **a, b** Colony on the surface of host leaf. **c** Ascoma. **d, e** Ascoma in cross section. **f** Basal layer. **g** Pseudoparaphyses. **h–k** Asci from young state to mature state. **l–n** Ascospores from young state to

mature state. **o** Germinating ascospore. **p** Ascoma with hyphae. Scale bars: **a** = 400  $\mu\text{m}$ , **b, p** = 100  $\mu\text{m}$ , **c, d** = 50  $\mu\text{m}$ , **e, f** = 20  $\mu\text{m}$ , **g–o** = 10  $\mu\text{m}$

sequence data of the type species is questionable, as it does not cluster with the main clade of Microthyriales.

***Pseudomicrothyrium*** X.Y. Zeng, S. Hongsanan & K.D. Hyde, **gen. nov.**

*Index Fungorum number*: IF 556881; *Facesoffungi number*: FoF 06755; – 1 morphological species (this study), 1 species with molecular data.

*Saprobic* on dead leaves. *Hyphae* superficial, pale brown, septate, branched, loosely reticulate. **Sexual morph**: *Thyriothecia* superficial, circular, light brown, solitary or gregarious, slightly carbonaceous, with a colorless basal layer, connected with hyphae, easily separated from the host surface. *Upper wall* light brown, comprising cells of radial arrangement of *textura prismatica*, darken at the central ostiole, tapering at margin. *Hamathecium* comprising asci inclined from the base and rim towards the central ostiole, with thin,

filiform, narrow cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, ovoid to obpyriform. *Ascospores* 2–3-seriate, fusiform to ellipsoidal, hyaline, 1-septate, upper cell slightly wider than lower cell, not constricted at the septum, with 2–4 apical appendages, usually with 2 large guttules in the upper cell, 2 small guttules in the lower cell, smooth-walled. **Asexual morph**: Undetermined.

*Type species*: ***Pseudomicrothyrium thailandicum*** X.Y. Zeng, S. Hongsanan & K.D. Hyde.

*Notes*: *Pseudomicrothyrium* is similar to *Microthyrium* in having hyaline ascospores with cilia around the ostiole, but differs in superficial, brown, reticulate hyphae. Phylogenetically, the new species described below forms a distinct clade within *Microthyriaceae*.

***Pseudomicrothyrium thailandicum*** X.Y. Zeng, S. Hongsanan & K.D. Hyde, **sp. nov.**

**Etymology:** Referring to its occurrence in Thailand.

**Index Fungorum:** IF 556882; **Facesoffungi number:** FoF 06756; Fig. 45

**Saprobic** on dead leaves. **Hyphae** superficial, pale brown, septate, branched, loosely reticulate. **Sexual morph:** *Thyriothecia* 32–42 high  $\times$  140–160  $\mu\text{m}$  diam. ( $\bar{x}$  = 37  $\times$  148  $\mu\text{m}$ ,  $n$  = 10), superficial, circular, light brown, solitary or gregarious, slightly carbonaceous, with a colorless basal layer, connected with hyphae, easily separated from the host surface. **Upper wall** light brown, comprising cells of radial arrangement of *textura prismatica*, darken at the central ostiole, tapering at margin. **Hamathecium** comprising asci inclined from the base and rim towards the central ostiole, with thin, filiform, narrow cellular pseudoparaphyses. **Asci** 35–40  $\times$  10–15  $\mu\text{m}$  ( $\bar{x}$  = 37  $\times$  13  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate, ovoid to obpyriform. **Ascospores** 13–15  $\times$  4–5  $\mu\text{m}$  ( $\bar{x}$  = 14  $\times$  5  $\mu\text{m}$ ,  $n$  = 20), 2–3-seriate, fusiform to ellipsoidal, 1-septate, upper cell slightly wider than lower cell, not constricted at the septum, hyaline, with 2–4 apical appendages, usually with 2 large guttules in the upper cell and 2 small guttules in the lower cell, smooth-walled. **Asexual morph:** Undetermined.

**Material examined:** Thailand, Chaing Rai, Mae Fah Luang University, on dead leaves of unidentified host, 3 March 2014, Xiang-Yu Zeng (MFLU 14-0286, **holotype**).

**GenBank numbers:** LSU: MT741680, SSU: MT741682.

**Notes:** *Pseudomicrothyrium* is introduced in this paper. Sequence data of *P. thailandicum* indicate that it forms a distinct lineage within *Microthyriaceae* with high support (100% ML, 1.0 PP).

***Pseudopenidiella*** Crous & Koukol, in Crous et al., *Persoonia* 28: 167 (2012).

**Index Fungorum number:** IF 800382; **Facesoffungi number:** FoF 06757; – 3 morphological species (Species Fungorum 2020), 2 species with molecular data.

**Type species:** *Pseudopenidiella pini* (P.M. Kirk & Minter) P.M. Kirk, *Index Fungorum* 120: 1 (2014).

$\equiv$  *Polyscytalum pini* P.M. Kirk & Minter, in Kirk, *Trans. Br. mycol. Soc.* 80(3): 462 (1983).

**Notes:** *Pseudopenidiella* was introduced as a hyphomycetous genus characterised by the formation of dimorphic conidiophores with terminal, aseptate ramoconidia producing branched conidial chains and lack of coronate-type scars on conidia or conidiogenous cells (Crous et al. 2012b). It is similar to *Cladosporium* (*Capnodiaceae*), *Digitopodium* and *Penidiella* (*Teratosphaeriaceae*), but phylogenetically related to *Microthyriaceae*.

***Seynesiella*** G. Arnaud, *Annals d'École National d'Agric. de Montpellier*, Série 2 16(1–4): 202 (1918) [1917].

**Index Fungorum number:** IF 5018; **Facesoffungi number:** FoF 06758; – 5 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Seynesiella juniperi* (Desm.) G. Arnaud, *Annals d'École National d'Agric. de Montpellier*, Série 2 16(1–4): 203 (1918) [1917].

$\equiv$  *Dothidea juniperi* Desm., *Annls Sci. Nat., Bot., sér.* 2 15: 141 (1841)

**Notes:** *Seynesiella* was transferred from *Venturiaceae* to *Microthyriaceae* by Barr (1987b) based on the upper walls with cells of radial arrangement. However, the light brown ascospores are different from the type genus. Sequence data are needed to confirm its taxonomic placement.

***Tumidispora*** Hongsanan & K.D. Hyde, in Ariyawansa et al., *Fungal Diversity* 75: 95 (2015)

**Index Fungorum number:** IF 551375; **Facesoffungi number:** FoF 00944; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

**Type species:** *Tumidispora shoreae* Hongsanan & K.D. Hyde, in Ariyawansa et al., *Fungal Diversity* 75: 95 (2015).

**Notes:** *Tumidispora* is similar to *Microthyrium* in having flattened thyriothecia with radial arrangement of upper wall and hyaline, 1-septate ascospores, but differs in the shape of ostiole, lack superficial hyphae, and lacking appendages around the ascospores.

### Economic and ecological significance

Species of this group are saprobes and poorly studied but play a role in recycling organic matter.

**Minutisphaerales** Raja, Oberlies, Shearer & A.N. Mill.

**Index Fungorum number:** IF 811951; **Facesoffungi number:** FoF 08064.

Minutisphaerales was established by Raja et al. (2015) to accommodate *Minutisphaeraceae*, members of which are found on submerged wood in freshwater streams. Jayasiri et al. (2018) included *Acrogenosporaceae* in this order based on the morphological similarities and phylogenetic analyses. The same result is shown in Fig. 46. The divergence time for Minutisphaerales is estimated as 224 MYA (stem age, Hongsanan et al. 2020).

**Accepted families:** *Acrogenosporaceae*, *Minutisphaeraceae*.

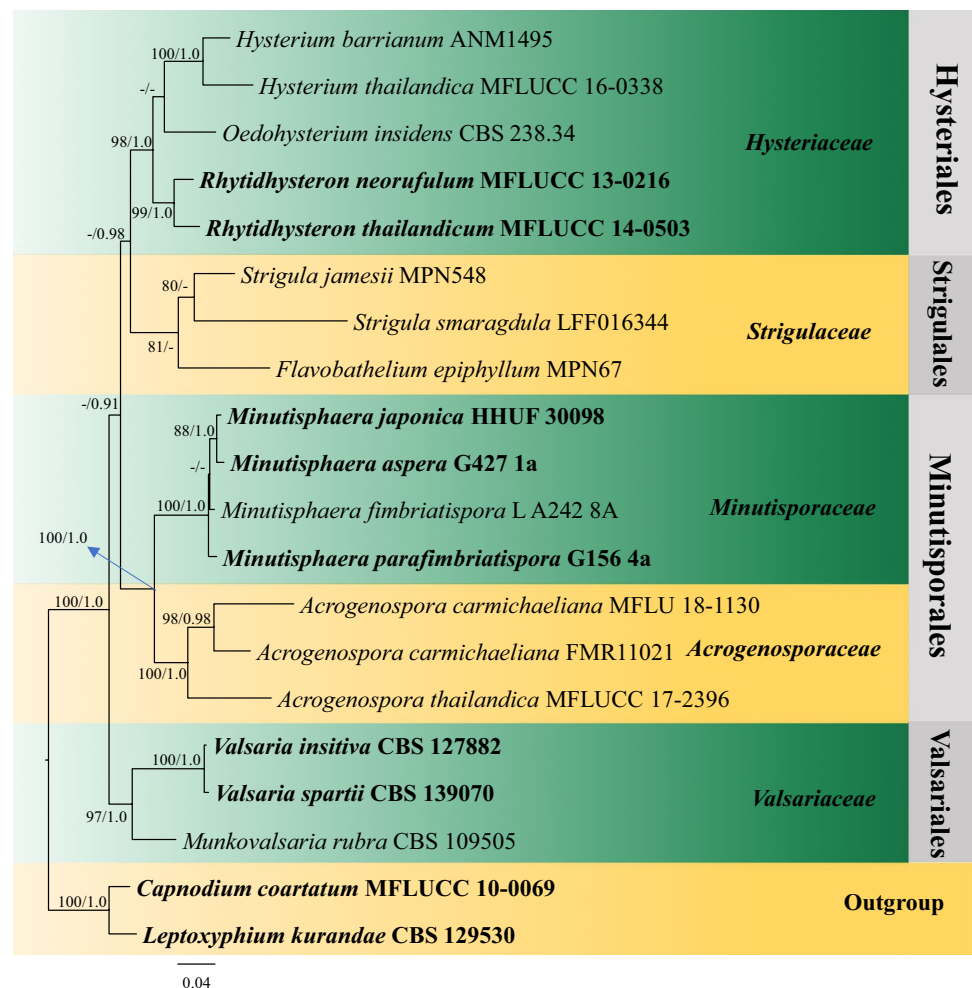
***Acrogenosporaceae*** Jayasiri & K.D. Hyde, *Mycosphere* 9(4): 809 (2018).

**Index Fungorum number:** IF 554451; **Facesoffungi number:** FoF 04575; 13 species.

**Saprobic** on bark and wood. **Sexual morph:** *Hysteriothecia* superficial, laterally compressed, thick-walled, with a prominent sunken slit, solitary to gregarious, erect and elevated, presenting an almost pedicellate appearance.



**Fig. 46** Phylogram generated from maximum likelihood analysis (RAxML) of Minutisphaerales based on ITS, LSU, SSU and tef1 sequence data. Maximum likelihood bootstrap values equal or above 70%. Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Capnodium coartatum* (MFLUCC 10-0069) and *Leptoxyphium kurandae* (CBS 129530). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



*Hamathecium* comprising persistent cellular, hypha-like, hyaline, septate, paraphyses. *Asci* 8-spored, cylindrical to clavate. *Ascospores* 1–2-seriate, ellipsoidal to fusiform, hyaline or moderately pigmented, 1- or 2-celled, with the septum near the lower end, hyaline or moderately pigmented. **Asexual morph:** Hyphomycetous. *Colonies* effuse, scattered, black, glistening, hairy. *Mycelium* mostly immersed, consisting of septate, subhyaline to pale brown hyphae. *Conidiophores* macronematous, mononematous, pale to mid brown, often slightly paler at the apex, smooth, septate, unbranched, long cylindrical or slightly tapering towards the apex, straight or slightly flexuous, erect, solitary or in small groups. *Conidiogenous cells* monoblastic, integrated, terminal or intercalary, light brown or hyaline, cylindrical, often elongated percurrently. *Conidia* holoblastic, solitary, globose, obovoid to ellipsoidal, aseptate, dark brown to black, smooth or verrucose, truncate at base.

*Type genus:* *Acrogenospora* M.B. Ellis.

*Notes:* *Acrogenosporaceae* was introduced by Jayasiri et al. (2018) for a single genus *Acrogenospora*. Based on morphological characters and phylogenetic analyses,

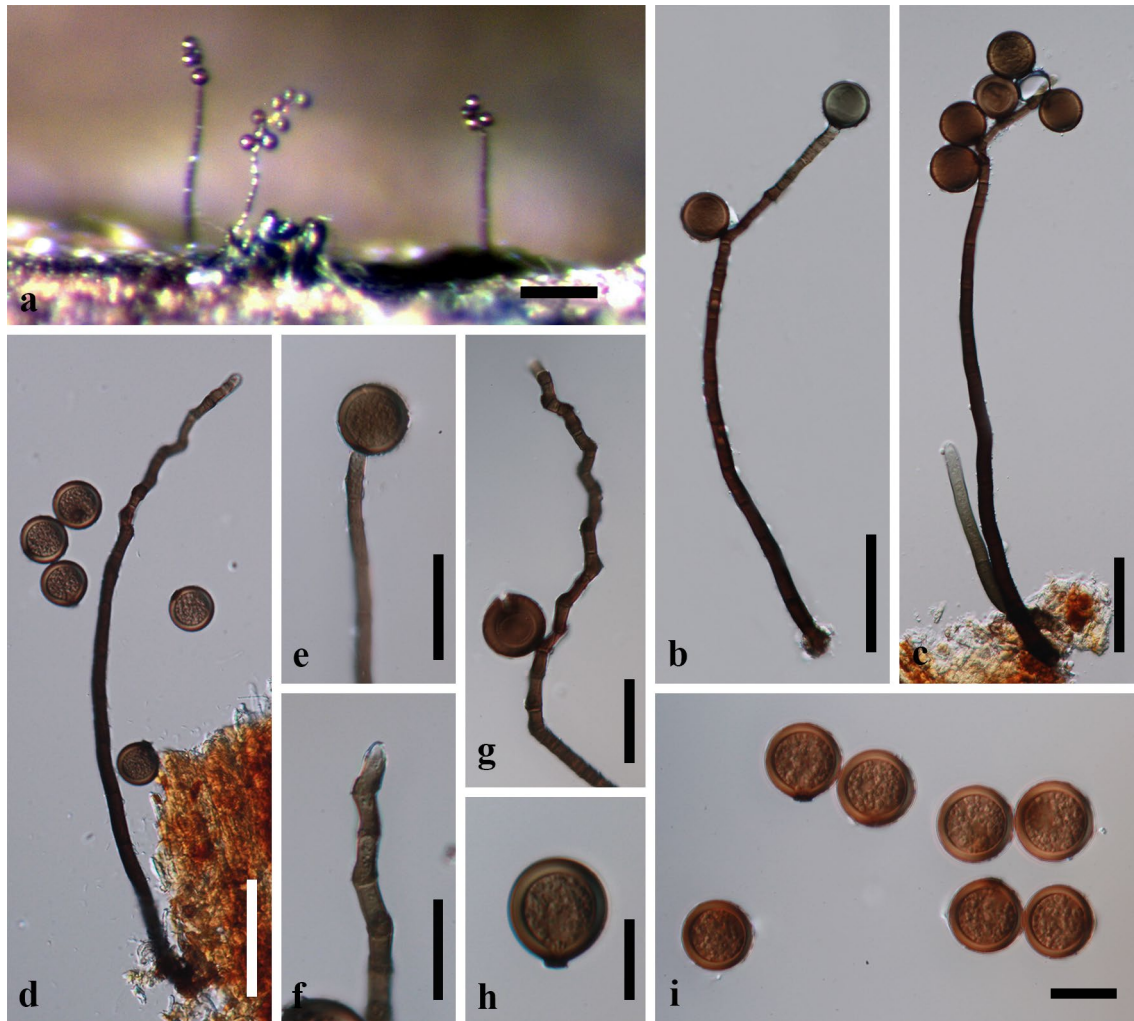
*Acrogenosporaceae* was placed within Minutisphaerales as a sister clade to the type family *Minutisphaeraceae* (Jayasiri et al. 2018). This study further supports the earlier result (Fig. 46). Descriptions and illustrations of the sexual morphs of *Acrogenosporaceae* can be seen in previous studies (i.e. Greville 1825; Duby 1862; von Arx and Müller 1975).

***Acrogenospora*** M.B. Ellis, Dematiaceous Hyphomycetes (Kew): 114 (1971).

*Index Fungorum number:* IF 7036; *Facesoffungi number:* FoF 08065; 13 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species:* ***Acrogenospora sphaerocephala*** (Berk. & Broome) M.B. Ellis.

*Notes:* *Acrogenospora altissima* was presumed to be the asexual morph of *Farlowiella australis* Dennis on host surfaces (Ellis 1972) while *A. megalospora* and *F. carmichaeliana* were linked by cultural studies (Mason 1941). Molecular data support the synonymy of *Acrogenospora* and *Farlowiella* (Jayasiri et al. 2018; Hyde et al. 2019). Nomenclaturally, *Acrogenospora* was protected over *Farlowiella*



**Fig. 47** *Acrogenospora sphaerocephala* (MFLU 18-1130). **a** Colony on substrate. **b, c** Conidiophores with conidia. **d** Conidiophore. **e** Conidiogenous cell with conidium. **f, g** Conidiogenous cells. **h, i**

Conidia. Scale bars: **a** = 100  $\mu$ m, **b–d** = 50  $\mu$ m, **e, g** = 30  $\mu$ m, **f, i** = 20  $\mu$ m, **h** = 15  $\mu$ m

(Rossman et al. 2015). *Acrogenospora* was monographed by Goh et al. (1998b). The genus is similar to *Monotosporella* in having macronematous, mononematous conidiophores, monoblastic conidiogenous cells and brown, sphaerical, obovoid to ellipsoidal conidia. However, *Acrogenospora* has unicellular conidia, while *Monotosporella* has septate conidia. With little available sequence data, two strains of *Monotosporella* clustered in *Melanommataceae* (Dothideomycetes) and Pleurotheciales (Sordariomycetes), respectively (Schoch et al. 2009a; Yang et al. 2019), which are phylogenetically distinct from *Acrogenospora*.

*Acrogenospora* cf. *sphaerocephala* (Berk. & Broome) M.B. Ellis, Dematiaceae Hyphomycetes (Kew): 114 (1971).

*Index Fungorum* number: IF 308236; *Facesoffungi* number: FoF 04687; Fig. 47

*Description*: see Hyde et al. (2019).

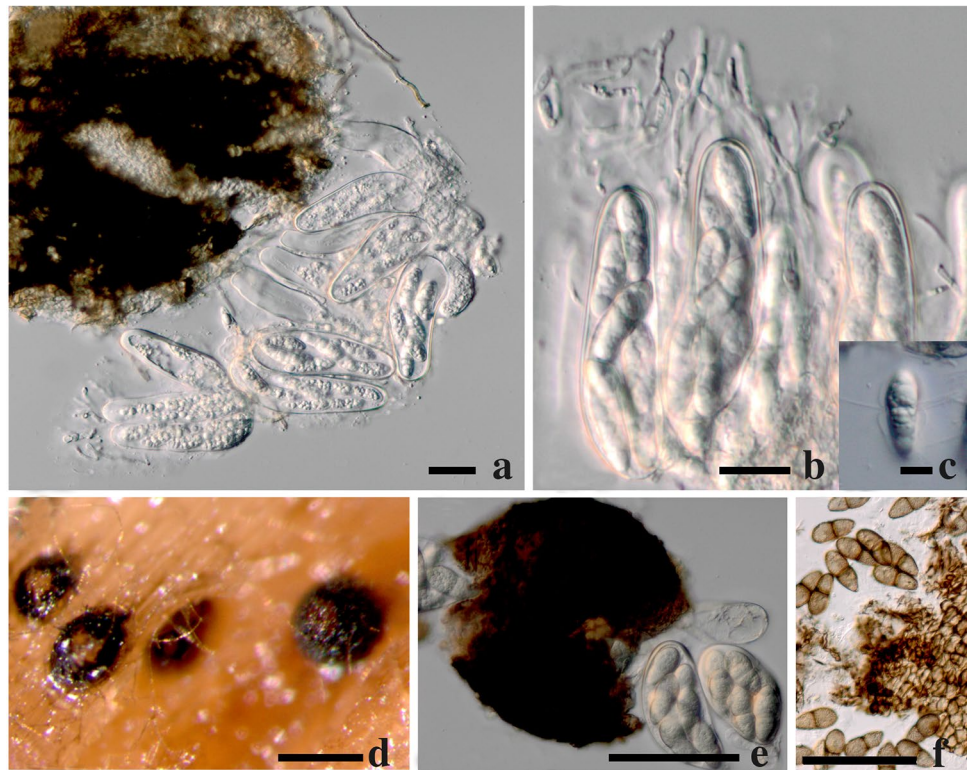
*Material examined*: Thailand, Prachuap Khiri Khan Province, near 1230.1950 N, 9931.3500 E, on decaying wood submerged in a freshwater stream, 25 December 2014, Jaap van Strien, Site 5-14-2 (MFLU 18-1130).

#### Ecological and economic significance

*Acrogenosporaceae* contains saprobic, lignicolous taxa found in terrestrial, but mostly in freshwater habitats. They play an important role in wood decay by the decomposition of lignocelluloses (Wong et al. 1998; Krauss et al. 2011; Hyde et al. 2016b). Generally, it is assumed that aquatic fungi transfer organic matter directly to the higher trophic levels of aquatic food webs (Christian et al. 2011).

*Minutisphaeraceae* Raja, Oberlies, Shearer & A.N. Mill., *Mycologia* 107 (4): 854 (2015).

**Fig. 48** *Minutisphaera parafimbriatispora* (ILLS 72341, holotype). **a, e** Squash mount of ascoma. **b** Asci. **d** Ascomata on host surface. **f** Ascospores. Scale bars: **a, b** = 20  $\mu$ m, **c** = 10  $\mu$ m, **d, e** = 100  $\mu$ m. **f** = 50  $\mu$ m



*Index Fungorum number*: IF 811062; *Facesoffungi numbers*: FoF 08066, 4 species.

*Saprobic* on submerged wood in freshwater habitats. **Sexual morph**: *Ascomata* pseudothecioid or apothecioid, erumpent to superficial, brown, with an ostiole and irregularly curved, dark brown to black hypha-like structures around the ostiole. *Peridium* thin-walled, composed of cells of *textura angularis* to *textura globosum*. *Hamathecium* comprising septate, cellular pseudoparaphyses with or without enlarged pigmented tips. *Asci* 8-spored, fissionate, ovoid to obclavate, sessile to short-pedicellate, apically rounded with or without an ocular chamber. *Ascospores* 2–4-seriate, clavate, fusiform to ellipsoidal, hyaline or pale brown septate, multiguttulate, smooth or rough-walled, with gelatinous sheath, with or without filamentous appendages radiating around the mid-septum. **Asexual morph**: Undetermined.

*Type*: *Minutisphaera* Shearer, A.N. Mill. & A. Ferrer, Ferrer et al.

*Notes*: This monotypic family was established by Raja et al. (2015) to accommodate *Minutisphaera*. Raja et al. (2015) placed *Minutisphaeraceae* in a newly introduced order *Minutisphaerales*, Dothideomycetes based on its distinct morphological characters and multi-gene phylogenies. The morphological characters such as small, globose to subglobose, ostiolate ascomata, septate, cellular pseudoparaphyses, fissionate, ovoid to obclavate asci and hyaline to brown, 1-septate, ascospores with or without a gelatinous

sheath, suggest that *Minutisphaeraceae* could be placed in Pleosporales (Zhang et al. 2012). Nevertheless, the molecular phylogenetic analysis shows that the family has no relationship with the members of Pleosporales (Raja et al. 2015; Liu et al. 2017). Bao et al. (2019) provided a new species of *Minutisphaera*. All the taxa of *Minutisphaeraceae* are freshwater fungi occurring on submerged woody substrates.

*Minutisphaera* Shearer, A.N. Mill. & A. Ferrer, Mycologia 103(2): 415 (2011).

*Index Fungorum number*: IF 518355; *Facesoffungi number*: FoF 08067; 5 morphological species (Species Fungorum 2020), 5 species with molecular data.

*Type species*: *Minutisphaera fimbriatispora* Shearer, A.N. Mill. & A. Ferrer.

*Notes*: *Minutisphaera*, typified by *M. fimbriatispora* was described from submerged wood in freshwater habitats in the USA (Ferrer et al. 2011). Subsequently, *M. japonica* was described in Japan (Raja et al. 2013), and *M. aspera* and *M. parafimbriatispora* in the USA (Raja et al. 2015). The members of this genus are only known by their sexual morphs and no asexual morph has been reported.

*Minutisphaera parafimbriatispora* Raja, Oberlies, Shearer & A.N. Mill., in Raja et al., Mycologia 107(4): 855 (2015).

*Index Fungorum number*: IF 5811064; *Facesoffungi number*: FoF 08068; Fig. 48

*Description*: see Raja et al. (2015).

**Material examined:** USA, North Carolina, Guilford County, Piedmont Plateau, Bur-Mil Park, Greensboro, swampy area behind Lake Brandt, on submerged decorated wood, 20 October 2011, H.A. Raja G156-1 (ILLS 72341, **holotype**).

### Economic and ecological significance

Members of this family usually inhabit woody substrates in freshwater habitats as saprobes (Ferrer et al. 2011; Raja et al. 2013, 2015). Some species produce dipeptides and aromatic polyketides secondary metabolites belonging to two structural classes (Raja et al. 2015).

### Monoblastiales Lücking, M.P. Nelsen & K.D. Hyde.

**Mycobank number:** MB 805299; **Index Fungorum number:** IF 805299; **Facesoffungi number:** FoF 08069.

This order comprises lichenized and non-lichenized fungi. It was introduced by Hyde et al. (2013) to accommodate the single family, *Monoblastiaceae*. Among the mostly lichenized orders in Dothideomycetes, Monoblastiales differs from Strigulales in the net-like physes and from most *Trypetheliales* in having euseptate ascospores with few septa and the poor secondary chemistry; from both orders it also deviates in the macroconidia often arranged in a gelatinous matrix (Hyde et al. 2013). The divergence time for *Monoblastiales* is estimated as 230 MYA (stem age, Hongsanan et al. 2020).

**Accepted families:** *Monoblastiaceae*.

**Monoblastiaceae** Walt. Watson, *New Phytologist* 28: 106 (1929).

= *Eriomycetaceae* Huanraluek & Hyde, in Hyde et al., *Fungal Diversity* 100: 146 (2020).

**Mycobank number:** MB 81020; **Index Fungorum number:** IF 81020; **Facesoffungi number:** FoF 08851; approximately 120 species (this paper).

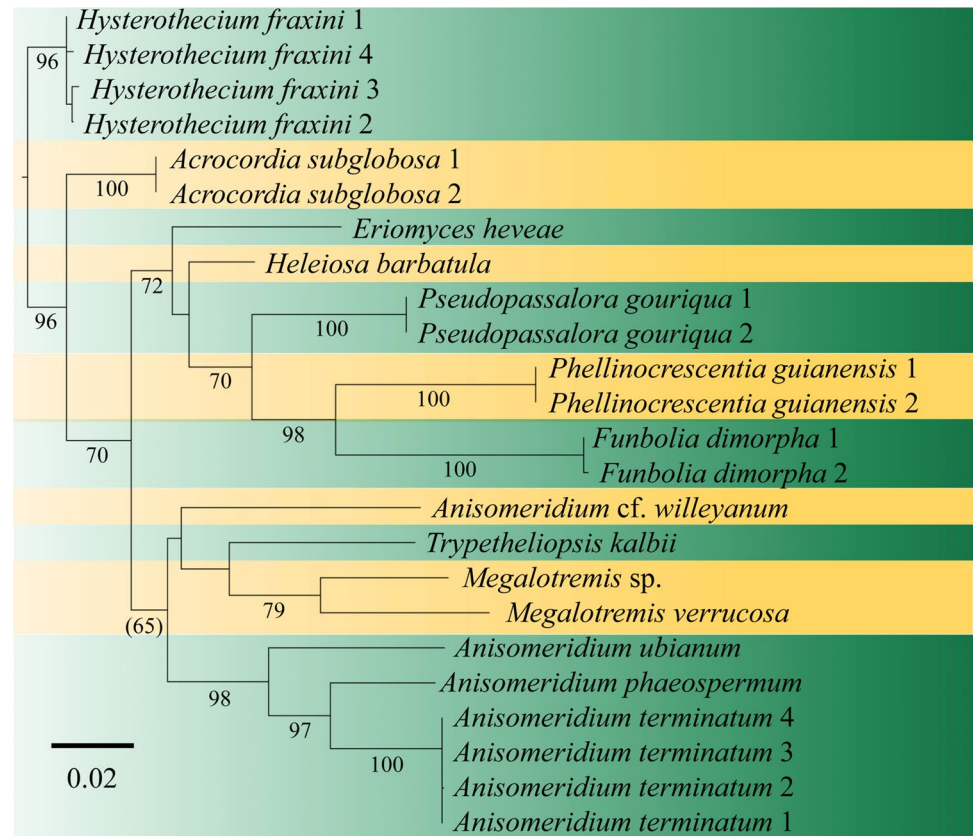
**Lichenized** on bark, more rarely on rocks or leaves (supra- or rarely subcuticular), more rarely non-lichenized and saprobic on leaves or bark (*Eriomyces*, *Funbolia*, *Heleiosa*, *Pseudopassalora*) or hyperparasitic on bracket fungi (*Phellinocrescentia*); usually in terrestrial, chiefly lowland to montane tropical to subtropical habitats, with few species extending into temperate regions and in one case (*Heleiosa*) growing on leaves of *Juncus* in salt marshes. **Thallus** in lichenized species mostly reduced and ecorticate, white, to distinctly corticate, grey-green to olive brown, sometimes shiny (*Megalotremis*, *Trypetheliopsis*), in non-lichenized species absent. **Photobiont** in lichenized species trentepohlioid. **Ascomata** when present scattered, clustered, or aggregated, immersed to sessile, mostly black but sometimes covered by thallus, rarely non-carbonaceous, globose to pear-shaped or conical, ostiolate, ostiole apical or eccentric, with periphyses. **Involucrellum** present, sometimes

only apically, or reduced, usually dark brown to carbonized, paraplectenchymatous in thin sections. *Excipulum* dense, consisting of compressed hyphae, appearing prosoplectenchymatous in thin sections but structure sometimes difficult to observe when carbonaceous, hyaline to brown or brown-black. *Hamathecium* usually comprising 0.5–0.7 µm wide paraphyses (trabeculate pseudoparaphyses according to Harris (1990, 1995), hyaline, straight, branched and anastomosing, rarely (*Eriomyces*) formed by 1–3 µm wide, branched cellular pseudoparaphyses. **Asci** (1–)2–8-spored, rarely poly-spored (*Eriomyces*), bitunicate, fissitunicate, mostly cylindrical to sometimes cylindrical-clavate, shortly pedicellate, with narrow to broad, non-amyloid ocular chamber and in part fluorescent ring- or cap-structures. **Ascospores** uni- to biseriolate or irregularly arranged, ellipsoid-oval to oblong or sometimes fusiform, hyaline to rarely brown, aseptate or 1–3-septate, with thin to rather thick (*Megalotremis*, *Trypetheliopsis*) eusepta and more or less rectangular lumina, smooth-walled or ornamented or rarely with appendages (*Heleiosa*), sometimes slightly constricted at the septa, in 1-septate ascospores the upper cell often distinctly larger than the lower cell (particularly in *Anisomeridium*). **Conidiomata** common, usually pycnidia, very rarely hyphomycetous (*Funbolia*, *Pseudopassalora*); pycnidia immersed to sessile and usually visible as black dots, but sometimes conspicuous and flask-shaped with a short to long a beak or hair-like (*Anisomeridium*, *Caprettia*) or asymmetrically cup- or ear-shaped (campylidiiform: *Trypetheliopsis*). **Conidia** acrogenous or rarely pleurogenous (*Funbolia*), either macro- or microconidia; macroconidia usually aseptate (septate in *Funbolia*, *Pseudopassalora*), (globose to) broadly ellipsoid to oblong-bacillar or guttuliform, (2.5–)5–15(–45) × (2–)3–7(–16) µm large, hyaline (brown in *Funbolia*, *Pseudopassalora*), often forming clusters embedded in a gelatinous matrix, these clusters in some species in the form of sacci or cirri (*Anisomeridium*, *Caprettia*); microconidia aseptate, globose to broadly ellipsoid or fusiform, small, 2–4(–5) × 1–2(–4) µm large, hyaline. **Chemistry:** Most species do not contain secondary substances; lichexanthone and anthraquinone pigments are known from a few taxa.

**Type:** *Monoblastia* Riddle.

**Notes:** For a detailed discussion of the lichenized core group of the family (*Acrocordia*, *Anisomeridium*, *Caprettia*, *Megalotremis*, *Monoblastia*, *Trypetheliopsis*), including a critical review of the currently applied genus concept, see Lücking et al. in Hyde et al. (2013). The scarce molecular data available support monophyly of *Megalotremis* and a close relationship of the latter with *Trypetheliopsis*, while *Anisomeridium* is likely polyphyletic (Fig. 49), a notion anticipated by Harris (1995). Representatives of all genera except *Caprettia* and the type genus, *Monoblastia*, have been sequenced, so the position of *Caprettia* within the family, based on hamathecium and ascus structure, ascospore type,

**Fig. 49** Best-scoring maximum likelihood tree of currently available data in Monoblastiales and its only family, *Monoblastiaceae* (including *Eriomycetaceae*), based on a combined alignment of five markers (nuSSU, nuLSU, ITS, mtSSU, TEF1 $\alpha$ ), with a length of 3612 bases (single autapomorphic base calls in gappy sites removed). The tree was reconstructed using the universal GTR-Gamma model without site partitioning, and the final likelihood was  $-10218.109712$



and the peculiar conidiomata and conidia, remains tentative. The accurate circumscription of the family hinges on the presumed close relationship of *Monoblastia* with e.g. *Acrocordia*, and so far only a single species of the latter has been sequenced. The taxonomic delimitation between *Anisomeridium*, *Megalotremis*, and *Trypetheliopsis* is discussed in detail below.

In this updated treatment, we also include several non-lichenized, monospecific genera in the family. None of them were originally established with a connection to *Monoblastiaceae* (Kohlmeyer et al. 1996; Crous et al. 2011a, b, 2014; Hyde et al. 2020b), but two genera (*Funbolia*, *Heleiosa*) were associated with the latter in a subsequent study (Nelsen et al. 2011a). Recently, Hyde et al. (2020b) established the new family *Eriomycetaceae* for the five non-lichenized lineages; however, these authors did not include lichenized representatives of *Monoblastiaceae* in their analysis and therefore overlooked the close relationship that had previously been established by Nelsen et al. (2011a). The expanded phylogeny presented here does not resolve *Monoblastiaceae* and *Eriomycetaceae* as reciprocally monophyletic, but renders the non-lichenized lineages as a moderately supported clade nested within a paraphyletic backbone comprising the lichenized lineages (Fig. 49).

Given this topology, one could theoretically retain *Eriomycetaceae* by splitting a *Acrocordiaceae* from

*Monoblastiaceae*, the latter then corresponding to the clade containing *Anisomeridium sensu lato*, *Megalotremis*, and *Trypetheliopsis* (Fig. 49). However, this solution is not appropriate, for various reasons. First, the type of *Monoblastiaceae*, *Monoblastia*, has not yet been sequenced. While its relationship with the other lichenized genera is supported by morphological and anatomical characters (Lücking et al. in Hyde et al. 2013), it is unclear whether it is more closely related to *Acrocordia* or to the *Anisomeridium-Megalotremis-Trypetheliopsis* clade, thus creating potentially unstable nomenclature regarding the application of the name *Monoblastiaceae*. Second, while the non-lichenized lineages partly deviate from the lichenized taxa anatomically, the genus *Heleiosa* is very similar to the latter: its ascoma anatomy, including the thin, anastomosing paraphyses and the cylindrical asci with broad ocular chamber (Kohlmeyer et al. 1996), is in line with that of *Acrocordia* and *Monoblastia*. Also the pycnidial genus *Phellinocrescentia* agrees with lichenized taxa, in particular species of *Anisomeridium*, in the guttuliform conidia (Crous et al. 2014). Thus, even if *Eriomyces* differs in its peculiar asci and the rather thick pseudoparaphyses (Hyde et al. 2020b), and *Funbolia* and *Pseudopassalora* deviate from the other genera by their hyphomycetous asexual morphs (Crous et al. 2011a, b), there are at least two genera in the former *Eriomycetaceae* that agree phenotypically with lichenized *Monoblastiaceae*.

The inclusion of lichenized and non-lichenized lineages in a single family, even with such disparate morphological and anatomical features, is not entirely surprising. The situation is analogous to *Graphidaceae* and *Trypetheliaceae*, which feature some non-lichenized or borderline lichenized lineages as early diverging clades (Nelsen et al. 2009, 2011a, 2014; Lücking et al. 2016; Cáceres et al. 2020; Miranda-González et al. 2020). Several lineages of lichenized fungi produce hyphomycetous asexual morphs, particularly in the order *Arthoniales* (*Arthoniomycetes*), e.g. in the genera *Reichlingia* and *Tylophoron* (Frisch et al. 2014; Van den Broeck et al. 2018), so the relationship of *Funbolia* and *Pseudopassalora* with the other lineages in *Monoblastiaceae* is also not entirely unexpected, although without molecular evidence such relationships would not have been predicted.

***Monoblastia*** Riddle, Mycologia 15: 70 (1923).

*Mycobank number*: MB 3251; *Index Fungorum number*: IF 3251; *Facesoffungi number*: FoF 08070; 12 morphologically defined species (Lücking et al. 2017; Harada 2018), molecular data thus far unavailable.

*Lichenized* on bark or rarely on limestone, in terrestrial, chiefly lowland to montane tropical to subtropical habitats, with few species extending into temperate regions. *Thallus* usually ecorticate, white. *Photobiont Trentepohlia*. *Ascomata* scattered or rarely clustered, erumpent to sessile, mostly black, carbonaceous, ostiolate, ostiole round. *Involucrum* present or reduced, carbonized. *Excipulum* dense, consisting of compressed hyphae, appearing prosoplectenchymatous in thin, bleached sections, hyaline to brown or brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, straight, branched and anastomosing. *Asci* (2–)8-spored, bitunicate, fissitunicate, cylindrical, short pedicellate, with broad, non-amyloid ocular chamber and fluorescent cap-structures. *Ascospores* mostly uni-seriate, ellipsoid-oval, hyaline, aseptate, ornamented with warts, short ridges or spines. *Pycnidia* rare. *Conidia* acrogenous, microconidia, aseptate, oblong to ellipsoid to fusiform, small, hyaline. *Chemistry*: Secondary substances absent.

*Type species: Monoblastia palmicola* Riddle, Mycologia 15: 70 (1923).

*Notes*: See Lücking et al. in Hyde et al. (2013) for discussion and illustrations.

#### Other genera:

***Acrocordia*** A. Massal., Geneac. Lich. (Verona): 17 (1854).

*Mycobank number*: MB 46; *Index Fungorum number*: IF 46; *Facesoffungi number*: FoF 08071; ten morphologically defined species (Lücking et al. 2017), molecular data available for one species.

*Lichenized* on bark or rarely on bryophytes or on limestone, in temperate to tropical montane regions. *Thallus* ecorticate, white. *Photobiont Trentepohlia*. *Ascomata*

scattered or rarely clustered, erumpent to sessile, black, carbonaceous, ostiolate, ostiole apical or lateral. *Involucrum* present or reduced, carbonized. *Excipulum* dense, consisting of compressed hyphae, appearing prosoplectenchymatous in thin, bleached sections, hyaline to brown or brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, straight, branched and anastomosing. *Asci* (2–)8-spored, bitunicate, fissitunicate, cylindrical, short pedicellate, with broad, non-amyloid ocular chamber and fluorescent cap-structures. *Ascospores* mostly uni-seriate, rarely biseriate, ellipsoid-oval to rarely oblong, hyaline, 1-septate, usually granular ornamented. *Pycnidia* rare. *Conidia* acrogenous, microconidia, aseptate, oblong to ellipsoid to fusiform, small, hyaline. *Chemistry*: Secondary substances absent.

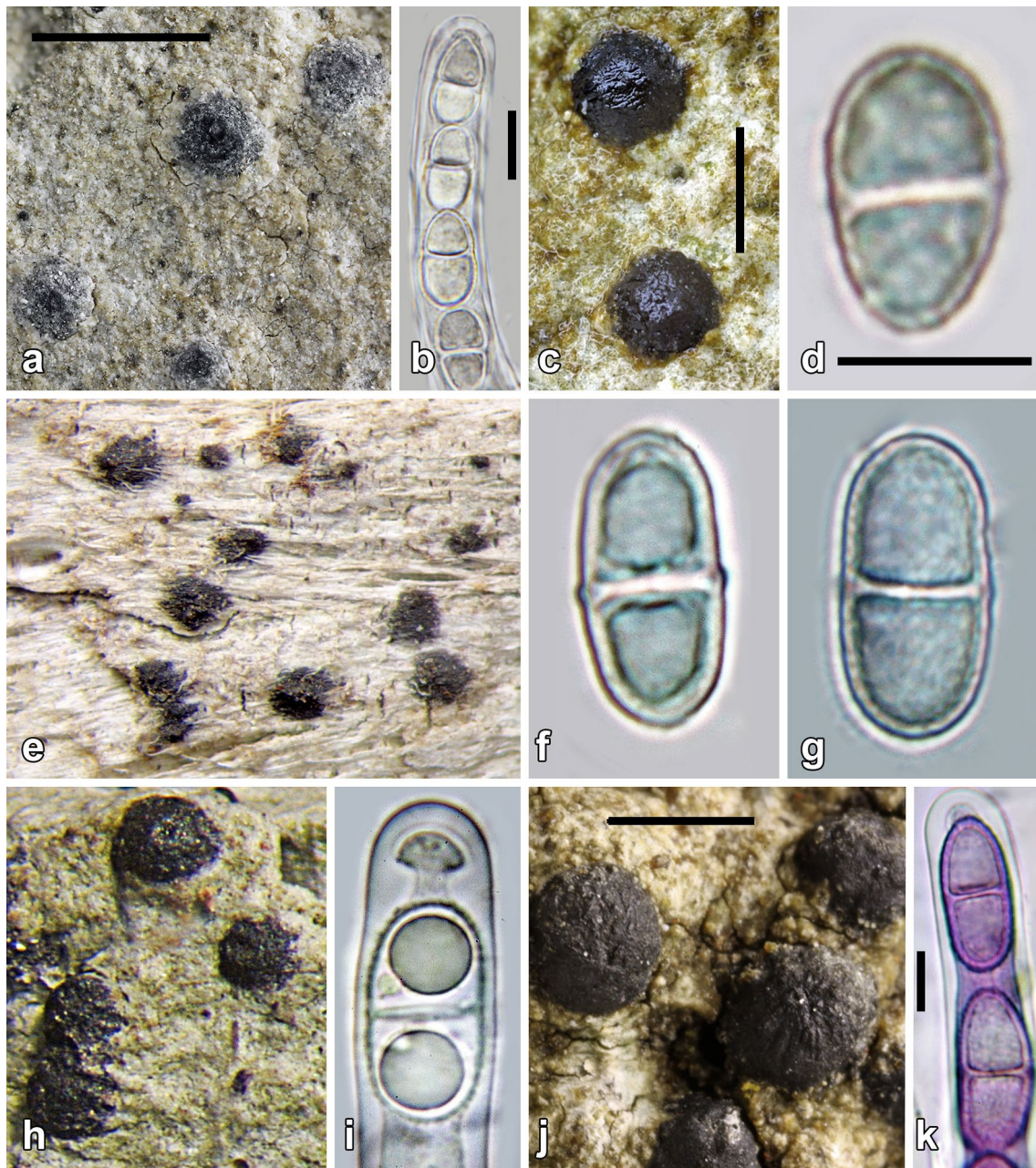
*Type species: Acrocordia garovaglii* A. Massal., Geneac. Lich. (Verona): 17 (1854) [= *A. conoidea* (Fr.) Körb. var. *conoidea*, Syst. Lich. Germ: 358 (1855)].

*Notes*: This genus was not treated in detail by Lücking et al. in Hyde et al. (2013). *Acrocordia* resembles both *Anisomeridium* and *Monoblastia* in general habit. It differs from the first in the broad ocular chamber of the asci and from the second in the 1-septate vs. aseptate ascospores (Fig. 50). The septum usually has characterizing endospore thickenings that make it appear laterally somewhat bulging (Fig. 50).

*Arthopyrenia endobrya* (≡ *Anisomeridium endobryum*; *Megalotremis endobrya*) is an unusual lichen that grows intracellularly within dead bryophytes, known from tropical montane forest in Brazil (type; Döbbeler and Poelt 1981) and Costa Rica (Aptroot et al. 2008). It is characterized by sessile, basally constricted, black perithecia and 1-septate ascospores 35–50 × 10–15 µm in size. Harris (1995) recognized its position within *Monoblastiaceae* and placed it in *Anisomeridium*. Because of its slight septal endospore thickenings, it was later recombined into *Megalotremis* (Aptroot et al. 2008), although the ascospore size range (see below *Megalotremis* for further discussion) fits *Anisomeridium* better. Given the ecorticate thallus, the fully exposed perithecia, the asci with broad ocular chamber, and the thin-walled ascospores lacking crystals and with the septa slightly bulging (Fig. 51), the species is actually best referred to *Acrocordia*, where several other species have sessile, subglobose perithecia, such as *A. subglobosa*. The biserially arranged ascospores apparently lacking granular ornamentation deviate from most of the other species in that genus, but such variation is also accepted in *Anisomeridium* (see below). The necessary combination is introduced below.

***Acrocordia endobrya*** (Döbbeler & Poelt) Lücking & Aptroot, **comb. nov.**

*Mycobank number*: MB 836365; *Index Fungorum number*: IF 836365; *Facesoffungi number*: FoF 08072.



**Fig. 50** Morphology, asci and ascospores in *Acrocordia* species. **a–d** *A. conoidea* (**a, b** Germany, Schumm 70; **c, d** Germany, Schumm 12542). **e–h** *A. gemmata* (**e–f** Portugal, Schumm 11491; **g** Portugal, Schumm 11547; **h, i** Germany, Schumm 11586). **j, k** *A. salweyi* (Por-

tugal, Aptroot & Schumm 14215). Scale bars: **a, c, j** = 1 mm, **b, d, k** = 10  $\mu$ m. For further illustrations of species of this genus, see also Schumm (2008, 2011) and Schumm and Aptroot (2013)

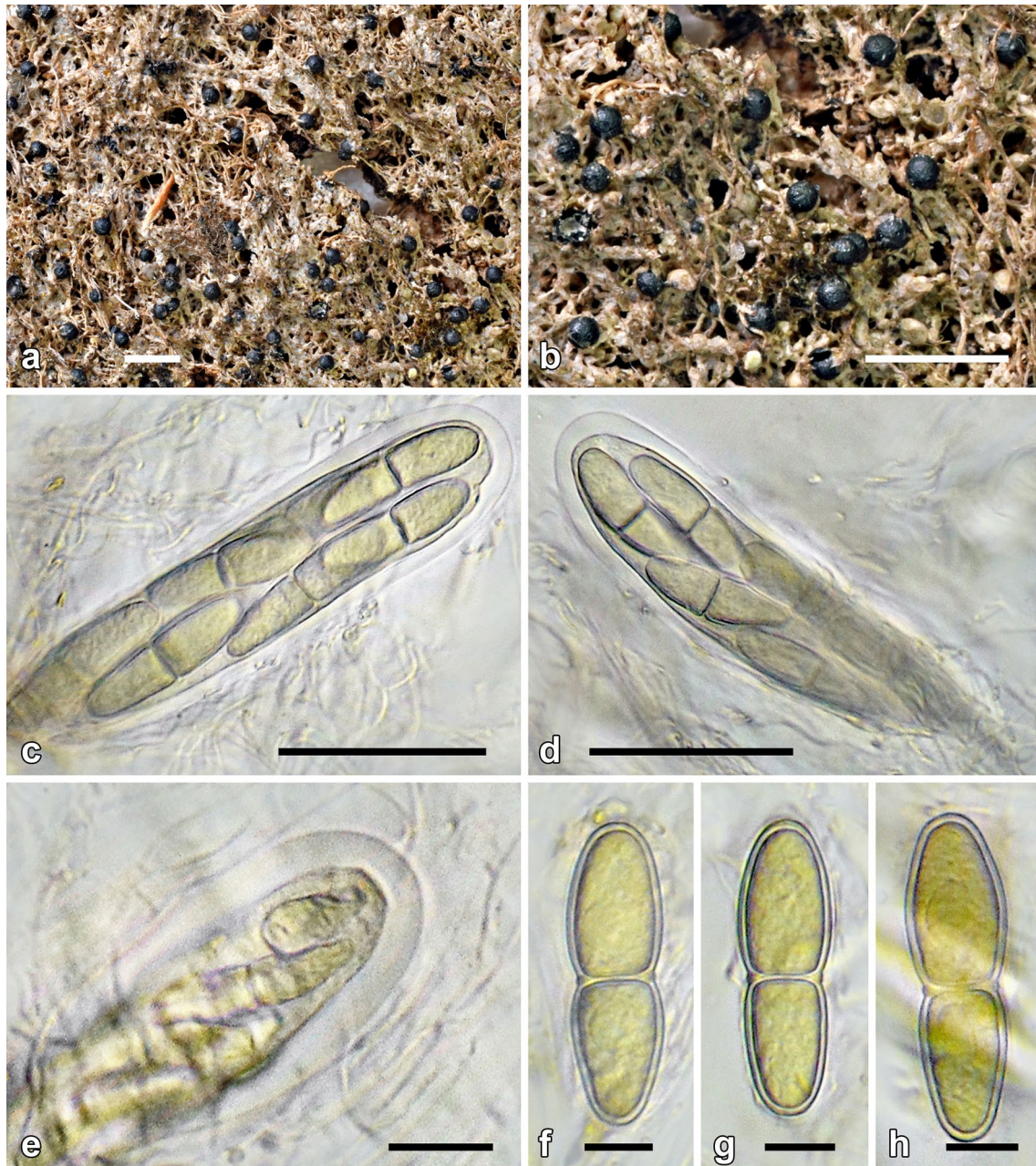
Bas.: *Arthopyrenia endobrya* Döbberler & Poelt, Pl Syst Evol 138: 276 (1981); *Anisomeridium endobryum* (Döbberler & Poelt) R.C. Harris, More Florida Lichens: 146 (1995); *Megalotremis endobrya* (Döbberler & Poelt) Aptroot in Aptroot et al., Biblioth Lichenol 97: 68 (2008).

*Anisomeridium* (Müll. Arg.) M. Choisy, Icon Lich Univ 1: 24 (1928).

*Mycobank number*: MB 201; *Index Fungorum number*: IF 201; *Facesoffungi number*: FoF 08073; approximately 60 morphologically defined species (this paper; Harada 2019), molecular data thus far available for four species.

$\equiv$  *Arthopyrenia* sect. *Anisomeridium* Müll. Arg., Flora 66: 290 (1883)

*Mycobank number*: MB 700075; *Index Fungorum number*: IF 700075; *Facesoffungi number*: FoF 08852.



**Fig. 51** Morphology, asci and ascospores of *Acrocordia endobrya* (Costa Rica, Sipman 51790). **a, b** Thallus on dead bryophytes with perithecia and perithecia enlarged. **c–e** Mature and immature asci

showing broad ocular chamber. **f–h** Ascospores. Scale bars: **a, b** = 1 mm, **c, d** = 50  $\mu$ m; **e, f, g** = 10  $\mu$ m

*Lichenized* on bark or more rarely on leaves or rocks, possibly lichenicolous; in lowland to montane tropical to subtropical habitats, with few species extending into temperate regions. *Thallus* usually ecorticate or sometimes with thin cortex, white or shades of grey-green to green. *Photobiont* *Trentepohlia*. *Ascomata* scattered or rarely clustered, erumpent to sessile, mostly black, carbonaceous, ostiolate, ostiole apical or lateral. *Involucrellum* present or reduced, carbonized. *Excipulum* dense, consisting of compressed

hyphae, appearing prosoplectenchymatous in thin, bleached sections, hyaline to brown or brown-black. *Hamathecium* comprising 0.5–0.7  $\mu$ m wide paraphyses, hyaline, straight, branched and anastomosing. *Asci* (2–)8-spored, bitunicate, fissitunicate, cylindrical, short pedicellate, with narrow, non-amyloid ocular chamber and fluorescent cap- or ring-structures. *Ascospores* uni- or biseriolate to irregularly arranged, ellipsoid-oval to broadly fusiform, small to medium-sized [(10–)15–45(–55)  $\times$  4.5–15(–20)  $\mu$ m], hyaline to very rarely



brown, 1(–3)-septate, with thin eusepta and rectangular lumina, smooth-walled or granular ornamented, sometimes slightly constricted at the septa, in 1-septate ascospores the upper cell often distinctly larger than the lower cell (very rarely the opposite). *Pycnidia* common, immersed to sessile, visible as black dots but sometimes conspicuous and flask-shaped. *Conidia* acrogenous, either macro- or microconidia; macroconidia usually aseptate, (globose to) broadly ellipsoid to bacillar,  $(2.5\text{--}5\text{--}15\text{--}45) \times (2\text{--}3\text{--}7\text{--}16) \mu\text{m}$  large, hyaline, often forming clusters embedded in a gelatinous matrix, these clusters in some species in the form of sacci or cirri; microconidia aseptate, globose to broadly ellipsoid or fusiform, small,  $2\text{--}4\text{--}(5) \times 1\text{--}2\text{--}(4) \mu\text{m}$  large, hyaline. *Chemistry*: Most species do not contain secondary substances; lichexanthone present in some taxa.

*Type species*: *Arthopyrenia xylogena* Müll.Arg., Flora 66: 290 (1883) [= *Anisomeridium subnectendum* (Nyl.) R.C.Harris, More Florida Lichens: 150 (1995)].

*Notes*: Lücking et al. (in Hyde et al. 2013) did not treat this genus in detail. Citing Riedl (1963), Harris (1995) considered *Arthopyrenia xylogena* Müll. Arg. the ‘lectotype’ of the genus. However, Müller (1883) only included a single species in *Arthopyrenia* sect. *Anisomeridium*, viz. *Arthopyrenia xylogena*, which is then by default the (holo-) type (although the terms ‘holo-’ and ‘lectotype’ technically do not apply to names above species [ICN Art. 10.1, Note 1]. Riedl’s (1963: 270) statement that “... *xylogena* muss als Typusart der Sektion *Anisomeridium* Müll. Arg. betrachtet werden.” [“... *xylogena* is to be considered the type species of section *Anisomeridium* Müll. Arg.”] refers to the differences between Müller’s protologue of the species description and the features observed by Riedl himself, casting doubt as to Müller properly described the taxon at hand. However, this only affects typification of the species itself, not typification of the genus, which is fixed by the single species name listed in the protologue.

The taxonomic delimitation between *Anisomeridium* and *Megalotremis* is elaborated in detail below under the latter genus (see below). Lücking et al. (2017) gave the number of species in *Anisomeridium* as 200, but revision of published literature revealed that only 57 species are currently to be accepted in the genus, after transferral of several taxa to *Megalotremis* (see below).

***Caprettia*** Bat. & H. Maia, Atas Inst Micol Univ Pernambuco 2: 377 (1965).

*Mycobank number*: MB 813; *Index Fungorum number*: IF 813; *Facesoffungi number*: FoF 08074; 8 morphologically defined species (this paper), molecular data thus far unavailable.

*Lichenized* on leaves, in tropical regions. *Thallus* ecorticate, greenish, subcuticular (subgenus *Caprettia*) or supra-cuticular (subgenus *Porinula*). *Photobiont* trentepohloid.

*Ascomata* scattered (absent in subgenus *Caprettia*), sessile, subglobose, yellowish to red-brown or brown-black, carbonaceous or not, glabrous or with short to conspicuous, horizontal setae, ostiolate, ostiole apical. *Involucrellum* reduced, carbonized or not. *Excipulum* dense, consisting of compressed hyphae, appearing prosoplectenchymatous in thin sections, hyaline to brown. *Hamathecium* comprising 0.5–0.7  $\mu\text{m}$  wide paraphyses, hyaline, straight, branched and anastomosing. *Asci* (2–)4–8-spored, bitunicate, fissitunicate, cylindrical, short pedicellate, with broad, non-amyloid ocular chamber and fluorescent cap-structures. *Ascospores* uniseriate, ellipsoid-oval to sometimes curved, hyaline, 1-septate, smooth. *Pycnidia* frequent, typically hair-like (subgenus *Caprettia*) or long-beaked with often slightly inflated base (subgenus *Porinula*). *Conidia* acrogenous, microconidia, aseptate, ellipsoid, small, hyaline, within pycnidial tube aggregated into gelatinous, rectangular sacci extruded from pycnidial beak as single diaspores. *Chemistry*: Secondary substances absent.

*Type species*: ***Caprettia amazonensis*** Bat. & H. Maia, Atas Inst Micol Univ Pernambuco 2: 378 (1965).

*Notes*: For illustrations of selected species, see Lücking et al. in Hyde et al. (2013). This genus includes several phenotypically disparate elements. The type species, *C. amazonensis*, grows subcuticularly and produces black, hair-like, straight pycnidia (no ascomata). Subgenus *Porinula* Lücking & Sérusiaux presents supracuticular growth and includes two distinct groups. The type species, *C. tanzanica*, as well as *C. ornata*, *C. setifera*, *C. goderei*, *C. neotropica*, and *C. nyssogenoides*, all frequently produce long-beaked pycnidia and intergrade from very pale and glabrous to black and distinctly setose ascomata. A further species, *C. confusa*, differs in the absence of pycnidia and the large ascospores, resembling those of *Trypetheliopsis* (Sérusiaux and Lücking 2003; Lücking 2008; Yeshitela et al. 2009). In lieu of molecular data, these taxa are here kept in a single genus, although it is unclear whether they form a monophyletic group and to what extent they are related to *Anisomeridium sensu lato* and *Trypetheliopsis* (see also Harris 1995).

Sérusiaux and Lücking (2003) introduced *Caprettia* subgenus *Porinula* as a combination based on *Porinula* [non *Porinula* (Nyl.) Flagey], overlooking that an illegitimate later homonym cannot serve as base for a legitimate combination. The name must therefore be considered a replacement name, *Caprettia* subgenus *Porinula* [ICN Art. 58.1]. At the genus level, however, the replacement name *Porinella* R. Sant. has priority.

***Eriomyces*** Huanraluek, Thambugala & K.D. Hyde in Hyde et al., Fungal Diversity 100: 146 (2020).

*Mycobank number*: MB 556538; *Index Fungorum number*: IF 556538; *Facesoffungi number*: FoF 06151; one

phylogenetically and morphologically defined species (Hyde et al. 2020b).

*Saprobic* on dead twigs of *Hevea brasiliensis* in terrestrial, lowland to montane tropical to habitats. *Ascomata* scattered to somewhat aggregate, immersed to erumpent, brown-black to greyish black, appanately wart-shaped to drop-shaped or angular, ostiolate, ostiole more or less eccentric, with periphyses. *Involucrellum* present apically, dark brown to carbonized, paraplectenchymatous in thin sections. *Excipulum* prosoplectenchymatous, hyaline to pale brown. *Hamathecium* comprising 1–3  $\mu\text{m}$  wide, branched cellular pseudoparaphyses. *Asci* polyspored, bitunicate, fissitunicate, clavate, long-pedicellate, with indistinct tholus and ocular chamber. *Ascospores* densely arranged, oblong, sometimes slightly curved, hyaline, aseptate, smooth-walled. *Conidiomata* not observed.

*Type species: Eriomyces heveae* Huanraluek, Thambugala & K.D. Hyde in Hyde et al., Fungal Diversity 100: 147 (2020).

*Notes:* This monospecific genus is characterized by the unusual, polyspored, clavate asci with long stipe, deviating from the other genera in this family in which ascomata are known. In the original description, the ostioles were given as central but based on the published photographic plate (Hyde et al. 2020b: Fig. 92) they appear to be irregularly excentric, also shown by the irregular shape of the ascomata.

**Funbolia** Crous & Seifert in Crous et al., Persoonia 26: 115 (2011).

*Mycobank number:* MB 560161; *Index Fungorum number:* IF 560161; *Facesoffungi number:* FoF 08075; 1 phylogenetically and morphologically defined species (Crous et al. 2011a).

*Type species: Funbolia dimorpha* Crous & Seifert in Crous et al., Persoonia 26: 115 (2011).

*Notes:* For description and illustrations see Crous et al. (2011a).

**Heleiosa** Kohlm., Volkm.-Kohlm. & O.E. Erikss., Can J Bot 74: 1830 (1996).

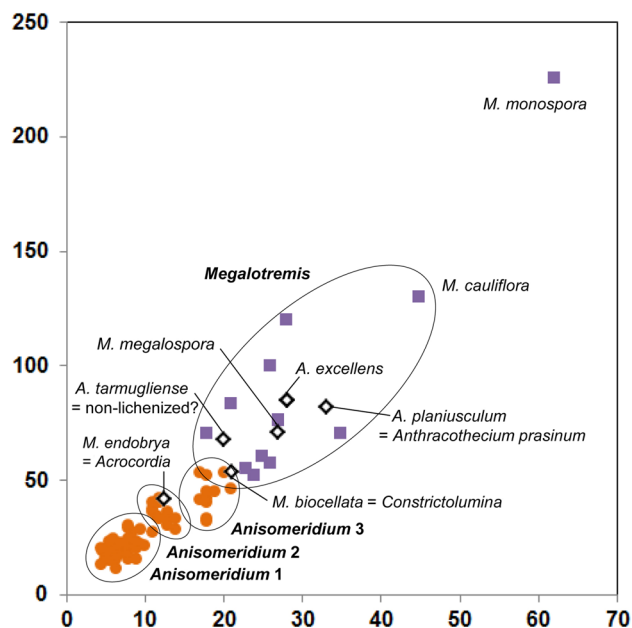
*Mycobank number:* MB 27767; *Index Fungorum number:* IF 27767; *Facesoffungi number:* FoF 08076; 1 phylogenetically and morphologically defined species (Kohlmeyer et al. 1996).

*Type species: Heleiosa barbatula* Kohlm., Volkm.-Kohlm. & O.E. Erikss., Can J Bot 74: 1830 (1996).

*Notes:* For description and illustrations see Kohlmeyer et al. (1996).

**Megalotremis** Aptroot, Biblioth Lichenol 44: 124 (1991).

*Mycobank number:* MB 26295; *Index Fungorum number:* IF 26295; *Facesoffungi number:* FoF 08077; 16



**Fig. 52** Ascospore size variation in *Anisomeridium* and *Megalotremis*, highlighting taxa of uncertain affinity to either genus and their current status. Axes denote maximum length and width reported for each species (in  $\mu\text{m}$ ). Note the formation of three smaller groups in *Anisomeridium*

morphologically defined species (this paper); molecular data available for one species.

*Lichenized* on bark, in tropical regions. *Thallus* usually with thin, cartilaginous cortex, rarely ecorticate, greenish grey to white. *Photobiont Trentepohlia*. *Ascomata* scattered, usually erumpent, black but at least partly covered by thalline layer, typically carbonaceous, ostiolate, ostiole apical or lateral. *Involucrellum* present, carbonized. *Excipulum* dense, consisting of compressed hyphae, appearing prosoplectenchymatous in thin, bleached sections, brown to brown-black. *Hamathecium* comprising 0.5–0.7  $\mu\text{m}$  wide paraphyses, hyaline, straight, branched and anastomosing. *Asci* (1–)2–8-spored, bitunicate, fissitunicate, cylindrical, short pedicellate, with broad, non-amyloid ocular chamber and fluorescent cap-structures. *Ascospores* uni-seriate to irregularly arranged, ellipsoid-fusiform, rather large [50–130(–225)  $\times$  (18–)20–45(–60)  $\mu\text{m}$ ], sometimes with the upper cell enlarged, hyaline, 1-septate, with internal, needle-shaped crystals. *Pycnidia* rare. *Conidia* acrogenous, either macro- or microconidia; macroconidia usually aseptate, (globose to) ellipsoid, (4–)5–9(–15)  $\times$  2–5(–15)  $\mu\text{m}$  large, hyaline; microconidia aseptate, globose to broadly ellipsoid or fusiform, small, 2–7(–7)  $\times$  1.5–2(–4)  $\mu\text{m}$  large, hyaline; macro- and/or microconidia in some species aggregated into conglutinate masses sometimes deposited outside the pycnidia. *Chemistry:* Secondary substances absent.

*Type species: Megalotremis verrucosa* (Makhija & Patw.) Aptroot, Biblioth. Lichenol. 44: 126 (1991).

*Notes:* In the protologue, Aptroot (1991) did not compare *Megalotremis* with *Anisomeridium* but placed the new genus in *Trypetheliaceae* because of the endospore thickenings; he also pointed out the ‘internal folds’ of the ascospores which were subsequently interpreted as crystals (Aptroot et al. 2008). Harris (1995) synonymized *Megalotremis* under *Anisomeridium*, stating that corticate thalli, one of the perceived differences, also occur in the latter genus. Harris (1995) further suspected that the second species of *Megalotremis* included in the protologue, *M. biocellata*, was related to *Arthopyrenia sensu lato*. Aptroot et al. (2008) differentiated *Megalotremis* from *Anisomeridium* by the corticate thallus and large ascospores with endospore thickenings, and from *Trypetheliopsis* (as *Musaespora*) by the absence of campylidioid asexual morphs.

Given that the currently available molecular data support this separation (Fig. 49), we analysed the species included under *Anisomeridium sensu lato* by Harris (1995) in terms of thallus morphology and ascospore size (and endospore thickenings). Of the 72 species included in the world-wide key, plus an additional eight species of *Megalotremis* not included or established subsequently, 55 have endoperidermal, ecorticate thalli with erumpent to prominent, usually exposed, black perithecia, and ascospores with rather thin walls and septa up to  $55 \times 20 \mu\text{m}$ , but in most cases smaller than  $30 \times 10 \mu\text{m}$  (Fig. 52), with smooth or granular ornamented walls. Notably, these species cluster in three ascospore size groups (Fig. 52). Fifteen species have epidermal, corticate thalli with immersed-erumpent perithecia partly covered by thallus, and ascospores with thickened walls and septa larger than  $55 \times 20 \mu\text{m}$  and up to  $130(-225) \times 45(-60) \mu\text{m}$ , typically with internal, needle-shaped crystals (or in two cases lack ascomata but have peculiar, tube-shaped pycnidia). These correspond to the current concept of *Megalotremis*, and of the eight species treated by Harris (1995), the following four are currently included in that genus: *M. infernale*, *M. megalospora*, *M. nemorosa*, and *M. verrucosa* (type of *Megalotremis*). Another four species are recombined into *Megalotremis* below.

Several species do not fit into the above scheme and deserve attention. A group of at least four species has corticate thalli but fully exposed, prominent, black perithecia and ascospores typical of *Anisomeridium*, including *A. glaucescens*, *A. indicum*, *A. stromaticum*, and *A. truncatum*. These taxa superficially resemble certain species of *Lithothelium*, although they differ fundamentally in anatomy, and require further study. Their thalli, although corticate, are opaque and differ from the usually shiny thalli of *Megalotremis*. The transference of *Anisomeridium endobryum* ( $\equiv$  *Megalotremis endobrya*) to *Acrocordia* is discussed above under that genus.

*Anisomeridium excellens* produces large ascospores ( $55-85 \times 20-28 \mu\text{m}$ ) fitting the range of *Megalotremis* and far above typical *Anisomeridium*, but the thallus is clearly endoperidermal and ecorticate, thus fitting *Anisomeridium* morphologically. Specimens identifiable with this species are not uncommon in the Caribbean, and usually also have at least partly clustered ascomata, and never any superficial thallus. The unusually large ascospores are granular ornamented, a rare feature in bitunicate lichenized *Ascomycota* and largely known from the genera *Anisomeridium* and *Bogoriella* (*Trypetheliaceae*); they also lack internal crystals, another feature pointing to *Anisomeridium* rather than *Megalotremis*. Thus, *A. excellens* is currently retained in *Anisomeridium* (see also further discussion under *M. biocellata* below), but represents an oddball due to its ascospore size and requires molecular study.

*Anisomeridium megalosporum* ( $\equiv$  *Megalotremis megalospora*) was described by Vainio (1923) almost as an afterthought in his work on Thaxter’s lichen collections from Trinidad, as he considered it non-lichenized. Aptroot (1995) found it to be lichenized, with the ascospores containing needle-shaped crystals, and therefore proposed its inclusion in *Megalotremis*. The only obstacle to this classification is the thallus morphology, keyed out as endoperidermal and ecorticate by Harris (1995), who also saw the type. Notably, Harris (1995) describes the ascospores as granular ornamented, not mentioning any crystals. In that respect, great similarities exist with *A. excellens*, which in Harris’s key strongly overlaps with his concept of *A. megalosporum* except for 2–4-spored vs. 2-spored asci. It is possible that part of Harris’s *A. megalosporum* represents a 2-spored form of *A. excellens*, whereas *A. megalosporum sensu stricto* is a different taxon. For the time being, we retain the latter in *Megalotremis* as an exception analogous to the case of *A. excellens* in *Anisomeridium*.

The presumably large-spored *Anisomeridium planiusculum* revealed a complex situation. Nylander (1858) described the ascospores as 1-septate, hyaline, and  $58-78 \times 20-30 \mu\text{m}$ . Harris (1995) reported the ascospores as 1-septate, hyaline, and  $62-82 \times (22-)27-33 \mu\text{m}$ , i.e. congruent with Nylander’s protologue, giving the diminutive specimen in H (H-NYL 732; H9505212) as holotype. Said holotype features a portion of an apparently endoperidermal, whitish thallus with erumpent ascomata not sharply delimited from the surrounding thallus. Harris’s drawings along with that material agree with his published measurements and depict the ascospore walls as uniform. However, the same type has an annotation and drawing by P. G. Patwardhan & U. Makhija date 1977, which shows secondary endospore constrictions (as in *Constrictolumina*) and give the size of the ascospores as considerably smaller, namely  $35-65 \times 13-20 \mu\text{m}$ . All this would point to similarities of the presumed ‘holotype’ with *M. biocellata* (see below). Two more collections from

Fée's herbarium with the name *Verrucaria planiuscula* are in G, one with three large pieces and (G00290329) one with a small portion of the same species abundantly present on the large pieces (G00290330), both featuring a lichen with well-developed, corticate thallus and sharply delimited, black perithecia. The large pieces feature a drawing of two ascospores with the size annotation “58–78 × 20–30 μm”, in Nylander's handwriting and with an additional annotation by Müller “= jun!”. The small piece has two ascospore drawings by Müller, one depicting a 1-septate and the other a muriform ascospore, with the size annotation “65–75 × 23–37 μm”, and the name annotation “*Anthracothecium planiusculum* Müll. Arg.’ Müller (1888) indeed published the combination *A. planiusculum* (Nyl.) Müll. Arg., stating that the 1-septate, hyaline ascospores are young and the mature ascospores become muriform and brown. While this sounds unlikely, precisely such ascospore ontogeny has been demonstrated e.g. for *Aptrootia terricola* in the *Trypetheliaceae* (Sweetwood et al. 2012; Aptroot and Lücking 2016). Given the agreement of the ascospore size annotation on the specimen with the three large pieces in G (G00290329) with Nylander's (1858) protologue, that specimen must be selected as lectotype: *Verrucaria planiuscula* Nyl., Expos. Synopt. Pyrenocarp.: 58 (1858); *Pyrenula planiuscula* (Nyl.) Tuck., Proc. Amer. Acad. Arts & Sci. 7: 233 (1868); *Anthracothecium planiusculum* (Nyl.) Müll. Arg., Flora 71: 208 (1888); *Arthopyrenia planiuscula* (Nyl.) Zahlbr., Cat. Lich. Univers. 1: 310 (1921); *Anisomeridium planiusculum* (Nyl.) R.C. Harris, More Florida Lichens: 149 (1995). Type. Jamaica, on *Quassia excelsa* (= *Q. amara*), s.dat., s.col. (G G00290329, lectotype, here selected, MycoBank MBT393283). The initially 1-septate ascospores and the morphology and substrate make a relationship of this taxon with *Aptrootia* unlikely and suggest correct placement in the genus *Anthracothecium*. Based on ascospore size, it would then largely agree with *A. prasinum*, although that species has 8-spored asci (Aptroot 2012), whereas Harris (1995) gives the asci of *Anisomeridium planiusculum* as 2–4-spored. The only other species of *Anthracothecium* with solitary ascospores and apical ostioles, *A. macrosporum*, agrees with the presumably 2–4-spored asci of *V. planiuscula* but has much larger ascospores. However, Nylander (1858) described the asci of *V. planiuscula* as “... 4<sup>nae</sup> (8<sup>nae</sup>?) ...” and Müller (1888) as “... 8-nae ...”. Notably, on the isoelectotype material of *Verrucaria prasina* in G (G00290128), which Müller (1884) renamed *Anthracothecium eschweileri*, because he considered the thallus not to be green (Latin: *prasinus*), Müller depicted a similar ascospore development as for *Verrucaria planiuscula*, with 1-septate ascospores next to muriform ones. We can therefore rather safely assume that *Verrucaria planiuscula* Nyl. is another synonym of *Anthracothecium prasinum* and not a species of *Anisomeridium* or *Megalotremis*.

*Anisomeridium tarmugliense* (≡ *Ditremsis tarmugliensis*) was described as having “vertically elongated” ascospores with wide open ostioles that are white inside (Makhija and Patwardhan 1990). The illustration shows an irregularly lobed ascospore circumference. These characters contradict placement in *Anisomeridium* or *Monoblastiaceae*. Except for the ascospores (the hamathecial filaments were not described), the morphology points to *Stictidaceae*, e.g. *Ostropa* or *Robergea*. We regard the position of this taxon as unresolved, but it is unlikely to be a lichenized bitunicate ascomycete.

*Megalotremis biocellata* Aptroot is characterized by an endoperidermal, ecorticate thallus and rather large ascospores with secondary endospore invaginations in each cell. Both the thallus and the ascospore type are characteristic for tropical, lichenized species of *Arthopyrenia sensu lato* currently placed in the genus *Constrictolumina* in *Trypetheliaceae* (Aptroot and Lücking 2016). Harris (1995) also related *M. biocellata* to *Arthopyrenia sensu lato* and suspected that it could be the same as *Tomasellia dispersa*. The latter was described as having 12-locular ascospores (Müller 1887, p. 427), but this is surely a lapsus for 2-locular, as Müller drew the ascospores on the holotype material (G-G00294870) as 1-septate. Harris (1995) annotated the holotype of *T. dispersa* as synonymous with *A. malaccitula* (≡ *Constrictolumina malaccitula*), although he did not list that name as synonym of the latter. Instead, he gave *A. bifera* and *Didymella gigantea* as synonyms. Examination of the type of *M. biocellata* supports its placement in *Constrictolumina*, but it was initially unclear whether it is actually conspecific with *C. malaccitula* or represents a closely related taxon with larger ascospores. Aptroot (1991) described the ascospores of *M. biocellata* as 47–53 × 17–21 μm in size. Harris (1995) studied the holotype of *Verrucaria malaccitula* (H-H9505214, H-NYL 1706) and, contrary to Nylander's (in Nylander and Crombie 1884) measurements (26–36 × 12–16 μm), gave the ascospores as 37–48 × 15–16 μm, a range adopted by Aptroot and Lücking (2016). A specimen from Papua New Guinea (Aptroot 19093) included under *C. malaccitula* in the latter work had mature ascospores measuring up to 49 × 17 μm. The type material of *T. dispersa* reportedly has ascospores 38–48 × 14–16 μm (Müller 1887), and that of *A. bifera* 42–45 × 15–16 μm (Zahlbruckner 1935), whereas *Didymella gigantea*, with smaller ascospores, does not seem to belong in this complex also on account of its morphology. Specimens identified as *M. biocellata* from Costa Rica (Aptroot et al. 2008) have ascospores 40–45 × 16–20 μm in size [due to a lapsus, the ascospores of Costa Rican material of that species (FH, Brenes 188; see Aptroot et al. 2008: 71, Fig. 11A–B) were due to a mixup of images erroneously also illustrated as those of *C. cinchonae* in Aptroot and Lücking 2016: 919, fig. 45L]. All this would point to a continuous range of about

40–50 × 15–20 µm large ascospores for a single species, with *malaccitula* as the oldest available epithet. We also discovered a lapsus in the protologue of *M. biocellata* (Aptroot 1991: 125): whereas in the description the ascospores were given as 47–53 × 17–21 µm in size, in the corresponding illustration (Aptroot 1991: fig. 48) they were depicted as 67–68 × 20–21 µm. Re-examination of the type material showed an ascospore size of 45–50 × 15–20 µm. Thus, we consider *M. biocellata*, another synonym of *C. malaccitula*, besides *T. dispersa* and *A. bifera* (see Lücking et al. in Hong-sanan et al. 2020, this volume: *Trypetheliaceae*).

***Megalotremis elegans*** (R.C. Harris) Lücking & Aptroot, **comb. nov.**

*Mycobank number*: MB 836366; *Index Fungorum number*: IF 836366; *Facesoffungi number*: FoF 08078.

Bas.: *Anisomeridium elegans* R.C. Harris, More Florida Lichens: 145 (1995).

***Megalotremis holopolia*** (Nyl.) Lücking & Aptroot, **comb. nov.**

*Mycobank number*: MB 836367; *Index Fungorum number*: IF 836367; *Facesoffungi number*: FoF 08079.

Bas.: *Verrucaria holopolia* Nyl., Bull. Soc. Linn. Normandie, Sér. 2(2): 131 (1868); *Anisomeridium holopolium* (Nyl.) R.C. Harris, More Florida Lichens: 147 (1995).

***Megalotremis immersa*** (Makhija & Patw.) Lücking & Aptroot, **comb. nov.**

*Mycobank number*: MB 836368; *Index Fungorum number*: IF 836368; *Facesoffungi number*: FoF 08080.

Bas.: *Ditremis immersa* Makhija & Patw., Biovigyanam 16: 17 (1990); *Anisomeridium immersum* (Makhija & Patw.) R.C. Harris, More Florida Lichens: 147 (1995).

***Megalotremis monospora*** (Makhija & Patw.) Lücking & Aptroot, **comb. nov.**

*Mycobank number*: MB 836369; *Index Fungorum number*: IF 836369; *Facesoffungi number*: FoF 08081.

Bas.: *Ditremis monospora* Makhija & Patw., Biovigyanam 16: 20 (1990); *Anisomeridium monosporum* (Makhija & Patw.) R.C. Harris, More Florida Lichens: 148 (1995).

***Phellinocrescentia*** Crous & Decock in Crous et al., Persoonia 33: 235 (2014)

*Mycobank number*: MB 810600; *Index Fungorum number*: IF 810600; *Facesoffungi number*: FoF 08082; one phylogenetically and morphologically defined species (Crous et al. 2014).

*Type species*: ***Phellinocrescentia guianensis*** Crous & Decock in Crous et al., Persoonia 33: 235 (2014).

*Notes*: For description and illustrations see Crous et al. (2014).

***Pseudopassalora*** Crous in Crous et al., Persoonia 27: 41 (2011).

*Mycobank number*: MB 560570; *Index Fungorum number*: IF 560570; *Facesoffungi number*: FoF 08083; one phylogenetically and morphologically defined species (Crous et al. 2014).

*Type species*: ***Pseudopassalora gouriqua*** Crous in Crous et al., Persoonia 27: 41 (2011).

*Notes*: For description and illustrations see Crous et al. (2011b).

***Trypetheliopsis*** Asahina, J. Jap. Bot. 13: 319 (1937).

*Mycobank number*: MB 5627; *Index Fungorum number*: IF 5627; *Facesoffungi number*: FoF 08084; 8 morphologically defined species (Harada 2017; Lücking et al. 2017), molecular data available for one species.

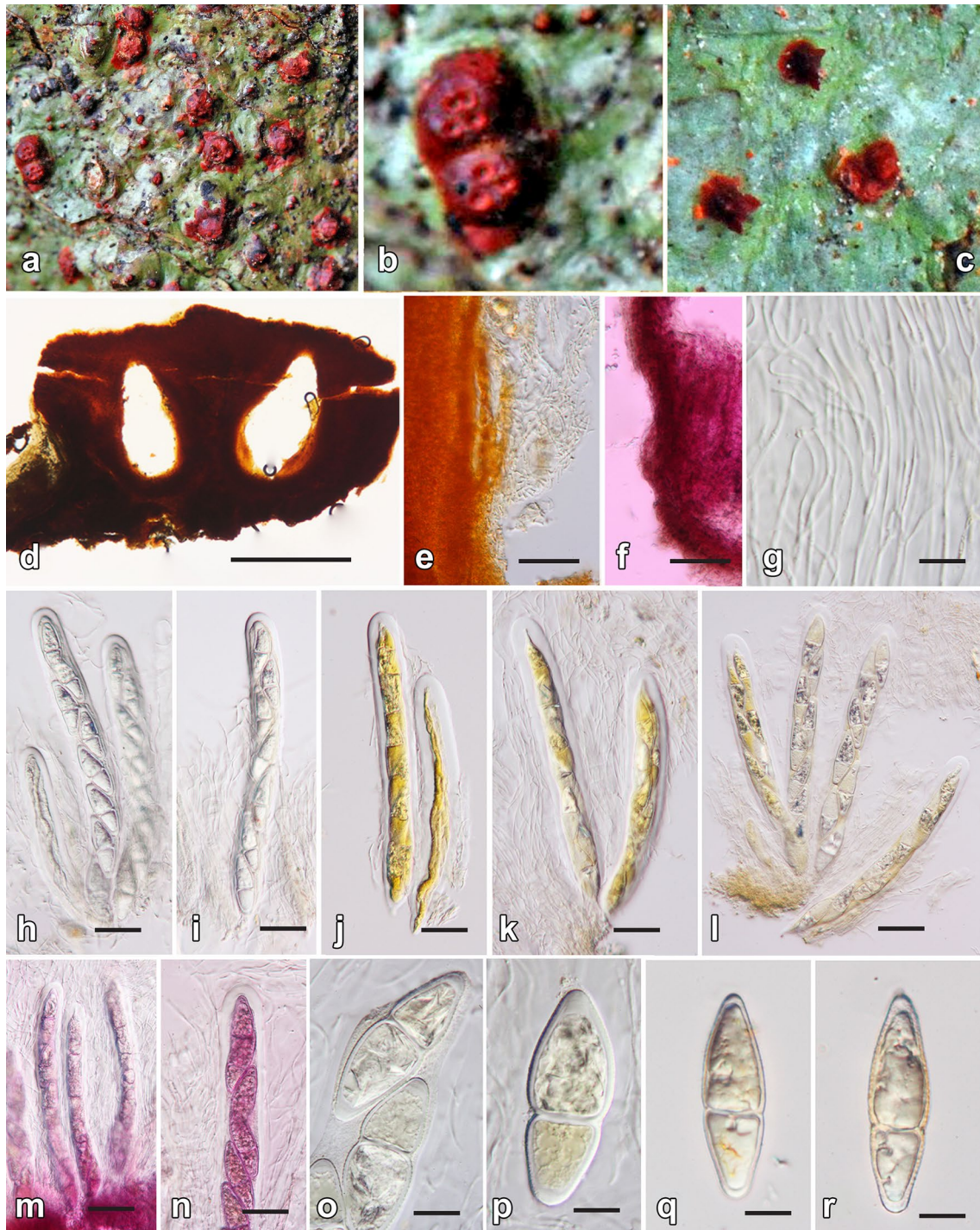
= *Musaespora* Aptroot & Sipman, Lichenologist 25(2): 123 (1993).

*Mycobank number*: MB 22430; *Index Fungorum number*: IF 22430; *Facesoffungi number*: FoF 08085.

*Lichenized* on bark or leaves, in tropical regions. *Thallus* corticate, olive-green to brownish. *Photobiont* *Trentepohlia*. *Ascomata* scattered or rarely pseudostromatic, erumpent to prominent, brown-black and carbonaceous or rarely with orange-red pigment, ostiolate, ostiole apical. *Involucrellum* present, carbonized. *Excipulum* dense, consisting of compressed hyphae, appearing prosoplectenchymatous in thin, bleached sections, brown to brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, straight, branched and anastomosing, usually interspersed. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, short pedicellate, with broad, non-amyloid ocular chamber and fluorescent cap-structures. *Ascospores* irregularly arranged, oval-oblong, typically slightly curved, hyaline, 1-septate, large (70–120 × 12–25 µm), with internal, needle-shaped crystals. *Conidiomata* campylidiiiform, brown black or rarely with orange-red pigment. *Conidia* acrogenous, microconidia, aseptate, drop-shaped, small, hyaline, aggregated in gelatinous mass. *Chemistry*: Secondary substances absent except for unidentified red pigment in the type and in *T. coccinea*.

*Type species*: ***Trypetheliopsis boninensis*** Asahina, J. Jap. Bot. 13: 319 (1937).

*Notes*: *Trypetheliopsis* was described as a monospecific genus for a corticolous lichen with pseudostromatic ascomata producing a bright, orange-red pigment and with large, 1-septate, fusiform ascospores with markedly submedian septum (Asahina 1937; Santesson 1970). The genus was largely forgotten, until Kashiwadani et al. (2009) resurrected it, considering it an earlier name for *Musaespora*, based on similarities (in particular the orange-red pigment) with *Musaespora coccinea*.



**Fig. 53** Morphology, asci and ascospores in *Trypetheliopsis boninensis*. **a–c** Thallus with ascomata, pycnidia, and campylidia (Japan, *Kashiwadani 52239 & Moon*). **d–r** Hamathecium, asci, and ascospores (holotype). Scale bars: **d** = 0.5 μm, **e, f, h–n** = 40 μm, **g, o–r** = 10 μm

*Trypetheliopsis boninensis* Asahina, J. Jap. Bot. 13(5): 319 (1937).

*Mycobank number*: MB 411966; *Index Fungorum number*: IF 411966; *Facesoffungi number*: FoF 08086; Fig. 53.

*Lichenized on bark in tropical regions. Thallus corticate, olive-green. Photobiont Trentepohlia. Ascomata pseudostromatic, prominent, with orange-red pigment, ostiolate, ostiole apical. Involucrellum present, carbonized. Excipulum dense, consisting of compressed hyphae, appearing*

prosoplectenchymatous in thin, bleached sections, brown. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, straight, branched and anastomosing, usually inspersed. *Asci* 8-spored. *Ascospores* irregularly arranged, oval-oblong, fusiform, 1-septate, with constrictions at septum, 40–50 × 15–20 µm, with internal, needle-shaped crystals. *Conidiomata* of two type, pycnidia and campylidiiform, with orange-red pigment. *Conidia* acrogenous, aseptate, drop-shaped, small, hyaline, aggregated in gelatinous mass. *Chemistry*: Several orange-red pigments, identified as skyrin, oxyskyrin and skyrinol (Santesson 1970).

*Material examined*: JAPAN, Ryukyu, Pref. Okinawa, Iriomote-jima, around Kanpirei Fall, Taketomi-cho, Yaeyamagun, 24°21'17" N, 123°48'29" E, alt. c. 70 m, on bark, 9 March 2018, Kashiwadani 52239 & Moon, TNS).

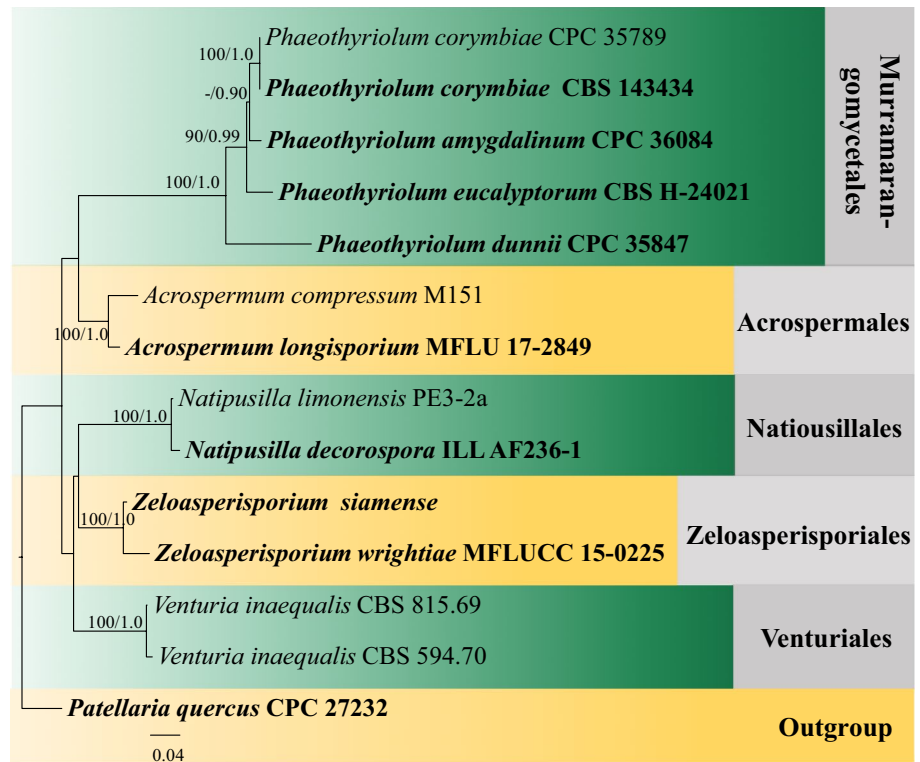
*Notes*: We were able to restudy the type and other material in detail (Fig. 53). The ascomata are pseudostromatic, with 5–10 perithecia per pseudostroma, rather closely resembling the pseudostromata of *Trypethelium sensu stricto* (Aptroot and Lücking 2016). The ascospores are distinctly fusiform with a marked submedian septum, resembling those of certain *Megalotremis* species. Recently collected material (Kashiwadani 52239 & Moon, TNS) shows two types of conidiomata: red pycnidia and dark red campylidia (Fig. 53). *Trypetheliopsis boninensis* is thus clearly congeneric with *Musaespora* and differs from the type of the latter, *M. corticola* (= *T. gigas*) largely in the sessile vs. prominent, strongly pigmented ascomata. The close relationship between these taxa is also illustrated by *T. coccinea*, which features a similar pigment as *T. boninensis* and differs from the latter in the foliicolous growth habit, distinctly verrucose thallus and erumpent to prominent, solitary ascomata.

**Key to genera of Monoblastiaceae:**

- 1. Ascomata absent; conidiomata present.....2
- 1. Ascomata present.....6
- 2. Conidiomata hyphomycetous; conidia brown.....3
- 2. Conidiomata coelomycetous (pycnidia, frequently beaked or campylidiiform).....4
- 3. Conidia pleurogenous, dimorphic, broadly ellipsoid and 1-septate to oblong-bacillar and tapering and (2–)3(–7)-septate, walls smooth; on bark.....*Funbolia*
- 3. Conidia acrogenous, uniform, oblong-fusiform, aseptate to 1-septate, walls finely verruculose; on leaves.....*Pseudopassalora*
- 4. Non-lichenized; growing on bracket fungi (*Phellinus*) .....*Phellinocrescentia*
- 4. Lichenized; growing on bark or leaves.....5
- 5. Conidiomata campylidiiform.....*Trypetheliopsis*
- 5. Conidiomata beaked pycnidia or entirely hair-like .....6

- 6. Pycnidia with distinctly inflated base and short beak; on bark.....*Anisomeridium p.p.*
- 6. Pycnidia with slightly inflated base or entirely hair-like; on leaves.....7
- 7. Thallus subcuticular, with *Cephaleuros*-like photobiont or appearing non-lichenized; ascomata unknown; pycnidia hair-like, very thin, straight, rather dense.....*Caprettia* subgenus *Caprettia*
- 7. Thallus supracuticular, with *Phycopeltis* photobiont; ascomata frequent; pycnidia setiform, thicker, often bent, usually scattered.....*Caprettia* subgenus *Porinula*
- 8. Non-lichenized; growing on leaves; either asci clavate with long stipe or ascospores with appendages.....9
- 8. Lichenized; growing on bark or rarely on rock; asci cylindrical, with short stipe, ascospores lacking appendages.....10
- 9. Asci distinctly clavate, with long stipe, polyspored; ascospores aseptate, oblong, without appendages; growing on dead twigs and leaves.....*Eriomyces*
- 9. Asci cylindrical, with short stipe, 8-spored; ascospores 1-septate, ellipsoid, with appendages; growing on senescent leaves of *Juncus* in salt marshes...*Heleiosa*
- 10. Ascospores aseptate, with granular or peg-like ornamentation.....*Monoblastia*
- 10. Ascospores 1–3-septate, smooth or with granular ornamentation.....11
- 11. Ascospores small to medium-sized (less than 50 × 20 µm) and with thin walls and septa or septa slightly bulging laterally; thallus mostly thin and ecorticate or with thin cortex and opaque.....12
- 11. Ascospores large (more than 50 × 20 µm) and with thickened walls and/or septa and often with internal, needle-shaped crystals; thallus usually well-developed, usually with cartilaginous cortex and often with metallic glance, very rarely endoperidermal and ecorticate.....14
- 12. Asci with broad ocular chamber; ascospores oblong, usually granular ornamented; perithecia often sessile; in temperate or tropical montane regions...*Acrocordia*
- 12. Asci with narrow ocular chamber; ascospores ellipsoid to fusiform, smooth to more rarely granular ornamented; perithecia usually immersed to prominent, rarely in sessile pseudostromata; mostly tropical.....13
- 13. Pycnidia hair-like or setiform; ascomata often non-carbonaceous; on leaves.....*Caprettia*
- 13. Pycnidia wart-shaped or at best flask-shaped with short beak; ascomata carbonaceous; usually on bark, rarely on leaves.....*Anisomeridium*
- 14. Pycnidia campylidiiform; ascospores usually slightly curved.....*Trypetheliopsis*

**Fig. 54** Phylogram generated from maximum likelihood analysis (RAxML) of Murramarangomycetales based on ITS, LSU, and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Patellaria quercus* (CPC 27232). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



14. Pycnidia variously shaped but not campylidiiform (or pycnidia absent); ascospores straight or slightly curved.....15
15. On leaves; ascospores slightly curved.....***Caprettia (confusa)***
15. On bark; ascospores straight.....16
16. Thallus epiperidermal, corticate and usually shiny; ascospores with internal, needle-shaped crystals.....***Megalotremis***
16. Thallus endoperidermal, ecorticate.....17
17. Ascospores with internal, needle-shaped crystals.....***Megalotremis (megalospora)***
17. Ascospores granular ornamented.....***Anisomeridium (excellens)***

#### Economic and ecological significance

*Monoblastiaceae* (including *Eriomycetaceae*) comprises both lichenized and non-lichenized ascomycetes. No economic significance has been reported for lichenized members of the family, but foliicolous representatives have been classified according to their potential to monitor environmental health of tropical forest ecosystems. Thus, *Anisomeridium foliicola*, *Trypetheliopsis epiphylla* and *T. kalbii* were listed as characteristic of mostly closed forest (Lücking 1997). Corticolous *Monoblastiaceae* also appear to be largely confined to closed forest (Rivas Plata et al. 2008), although Lucheta et al. (2019) characterized *Anisomeridium*

*leptospermum* as urban lichen. The anthraquinone pigments in *Trypetheliopsis* have been chemically studied (Santesson 1970) but their potential applications are unknown. In studies in the semi-arid vegetation of northeastern Brazil, species of *Anisomeridium* were shown to form part of the diet of termites (Barbosa-Silva and Vasconcellos 2019; Barbosa-Silva et al. 2019).

The non-lichenized lineages formerly separated in *Eriomycetaceae* are apparently mostly saprobic and hence function as decomposers of plant and fungal organic matter, but their exact ecology has not yet been assessed (Kohlmeyer et al. 1996; Crous et al. 2011a, b, 2014; Hyde et al. 2020b).

#### Murramarangomycetales Crous.

*Index Fungorum* number: IF 823433; *Facesoffungi* number: FoF 08087.

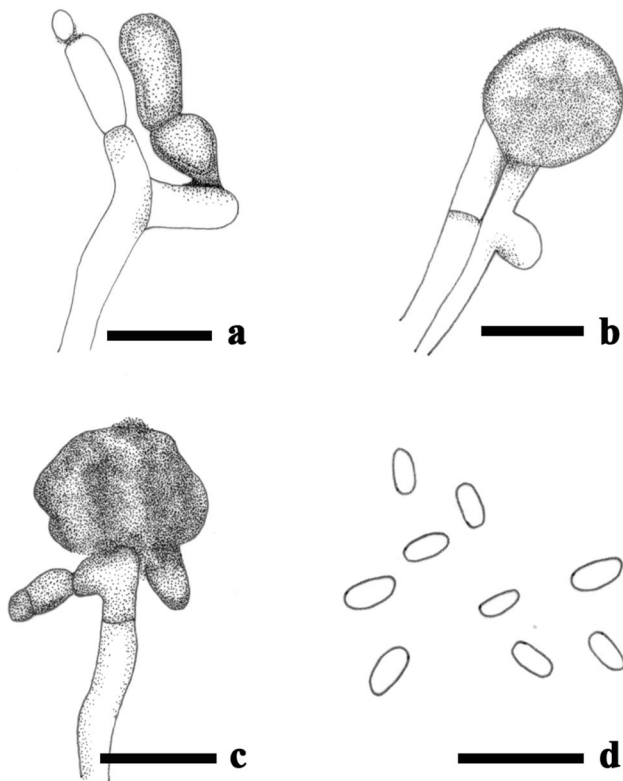
Murramarangomycetales was introduced by Crous et al. (2017) to accommodate *Murramarangomycetaceae*. The family formed a distinct lineage which could not be assigned to any orders in Dothideomycetes (Crous et al. 2017; Hong-sanan et al. 2020; this study, Fig. 54).

*Accepted families:* *Murramarangomycetaceae*.

***Murramarangomycetaceae*** Crous, in Crous et al., *Persoonia* 39: 385 (2017).

*Index Fungorum* number: IF 823434; *Facesoffungi* numbers: FoF 08088, 7 species.





**Fig. 55** *Phaeothyriolum corymbiae* (redrawn from Crous et al. 2017, CBS H-23281, **holotype**). **a** Mycelium becoming fertile conidiogenous cells. **b**, **c** Conidigenous cell aggregated in cauliflower-like form. **d** Conidia

Leaf spots, associated with several fungi in a leaf spot colony, confined to one side of the leaf. *Mycelium* interepidermal, brown, septate, branched, giving leaf spots a red-purple appearance without any superficial mycelium being present, mycelium aggregating in substomatal cavity. **Sexual morph:** *Thyrothecium* superficial, radial orientation or clusters, circular, flattened, with lobed, brown, smooth to irregular margin of cells of *textura epidermoidea* or *angularis*. *Hamathecium* comprising hypha-like, dissolving at maturity, or persistent, hyaline, septate, anastomosing or not, pseudo-paraphyses. *Asci* 8-spored, ellipsoid-obclavate, pedicellate, with small ocular chamber. *Ascospores* 3- to multi-seriate, fusoid-ellipsoid to obovoid, 1-septate, guttulate, granular, slightly constricted at median septum or not, encased in prominent mucoïd sheath which is absent at maturity, hyaline, becoming brown once discharged onto agar. **Asexual morph:** Hyphomycetous. Hypophyllous, circular, dark brown. *Mycelium in vitro* consisting of hyaline, smooth hyphae, irregular, constricted at septa. *Conidiogenous cells* thick-walled cells that become fertile conidiogenous cells, aggregated in cauliflower-like clusters of brown, doliiform to globose, brown conidiogenous cells, phialidic, giving rise

to solitary conidia. *Conidia* in slimy mass, aseptate, hyaline, smooth, bacilliform (adapted from Crous et al. 2017, 2019c).

**Type:** *Phaeothyriolum* Syd.

**Notes:** This family was introduced by Crous et al. (2017) to accommodate the monotypic genus, *Murramarangomyces* which contains a single species, *M. corymbiae*. Phylogenetic analyses indicated that *Murramarangomycetaceae* is different from other families and orders within Dothideomycetes, therefore, Crous et al. (2017) established a new order to accommodate this family. However, *Murramarangomyces* was synonymised under *Phaeothyriolum* by Crous et al. (2019c). *Murramarangomycetaceae* and *Murramarangomycetales* accommodates *Phaeothyriolum* base on the *Phaeothyriolum* clade not clustering with any other families and orders in Dothideomycetes. Sequence data of the type species of *Phaeothyriolum* is needed.

***Phaeothyriolum*** Syd., *Annls mycol.* 36(4): 305 (1938).

= *Murramarangomyces* Crous, in Crous et al., *Persoonia* 39: 385 (2017).

**Index Fungorum number:** IF 3962; **Facesoffungi number:** FoF 08089; 7 morphological species (Species Fungorum 2020), 4 species with molecular data.

**Type species:** *Phaeothyriolum eucalyptinum* Syd.

**Notes:** *Phaeothyriolum* was placed in genera *incertae sedis* in Dothideomycetes in Wijayawardene et al. (2017a). Sequence data of the type species is unavailable. *Murramarangomyces* based on a single species *M. corymbiae* was found to be asexual morph of *Phaeothyriolum corymbiae*. Thus, *Murramarangomyces* was synonymized under *Phaeothyriolum* (Crous et al. 2019c). Crous et al. (2019c) indicated that four species of *Phaeothyriolum* clustered together within Dothideomycetes, but its placement was not assigned. We were unable to obtain a fresh collection of species in this family, so a drawing is provided (Fig. 55)

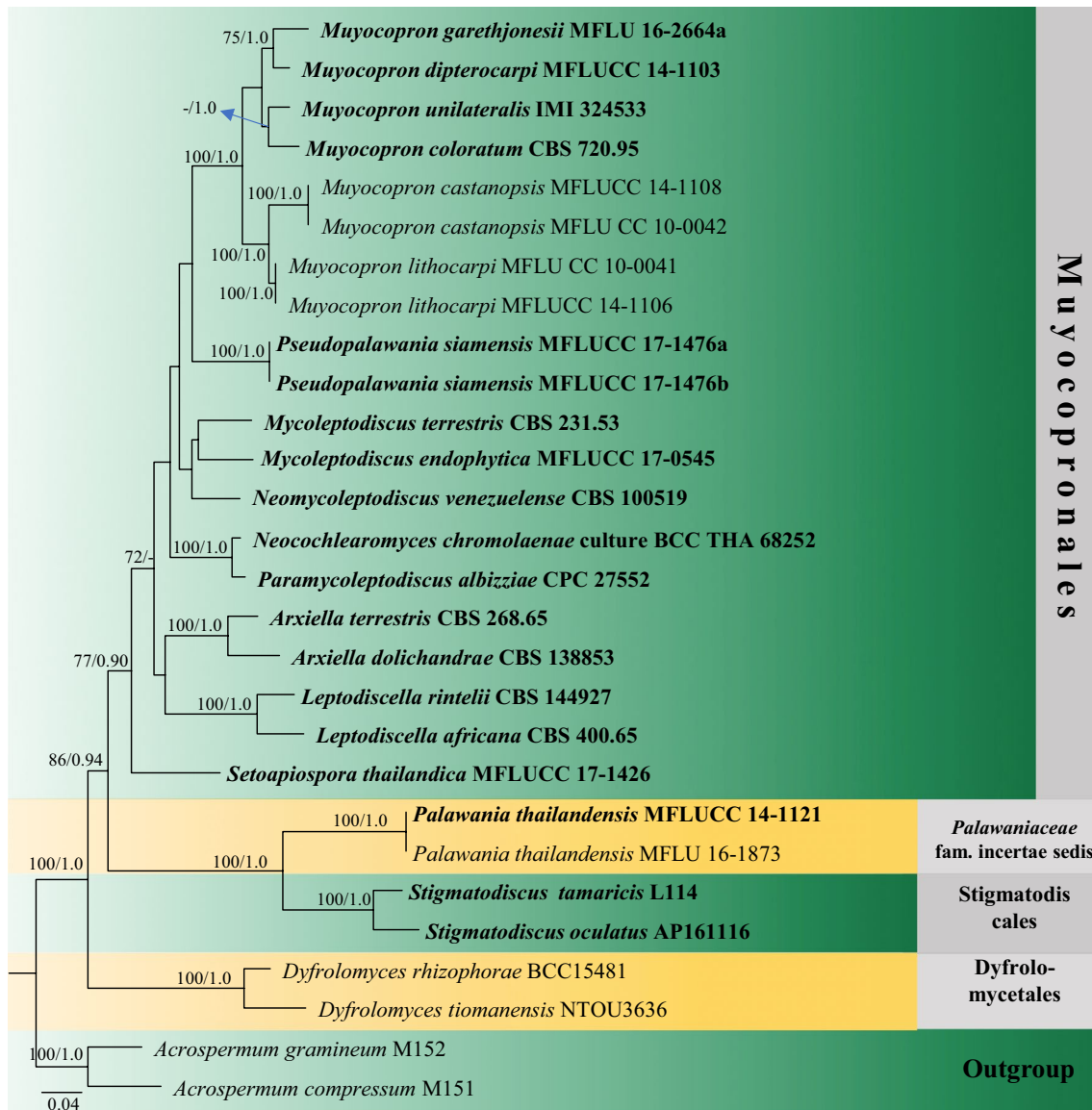
#### Economic and ecological significance

Species in this family cause leaf spots either on living leaves, or on leaf litter (Crous et al. 2019c), confined to one side of the leaf.

#### Muyocoprionales Mapook, Boonmee & K.D. Hyde.

**Index Fungorum number:** IF 551615; **Facesoffungi number:** FoF 01886.

This order was established by Mapook et al. (2016b) to accommodate a single family, *Muyocoproneae*. The order formed a distinct clade within Dothideomycetes and was related to Acrospermales and Dyfrolomycetales (Mapook et al. 2016b; this study). *Muyocoprionales* differs from Acrospermales and Dyfrolomycetales by superficial, flattened, carbonaceous, brittle ascomata, cellular pseudo-paraphyses that are longer than the asci and ellipsoidal to ovate, unicellular ascospores (Hyde et al. 2013; Mapook



**Fig. 56** Phylogram generated from maximum likelihood analysis (RAxML) of Muyocoprionales based on ITS, LSU, rpb-2, SSU and tef1 sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is

noted after the species name. The tree is rooted to *Acrospermum compressum* (M151) and *A. gramineum* (M152). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP

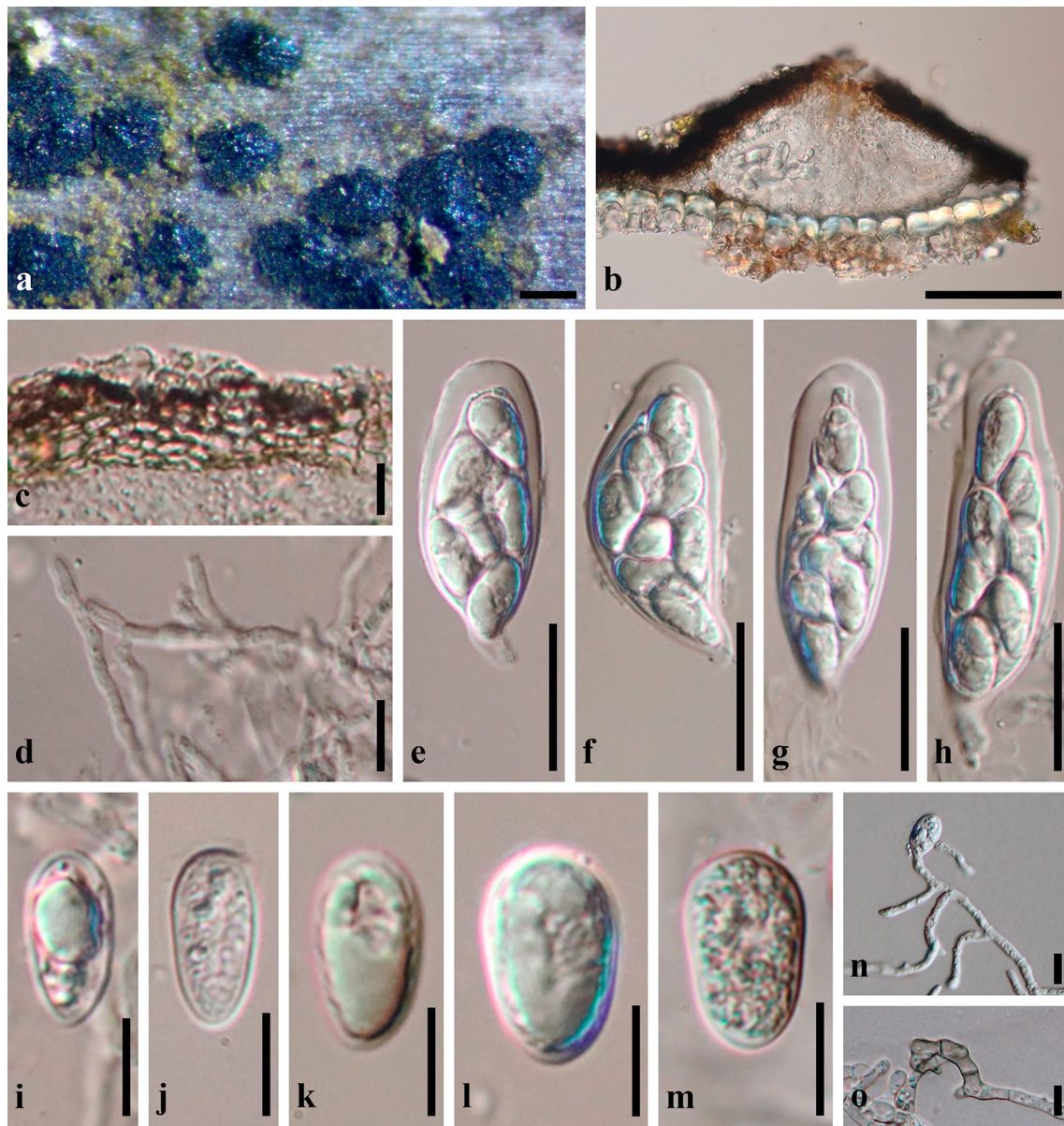
et al. 2016b). Our phylogenetic analyses indicate that the order comprises a single family, *Muyocoproneae*. *Palawaniaceae* is sister to the clade of *Muyocoproneae* (81% ML, Fig. 56). Thus, we do not include this family within *Muyocoprionales*. Currently there is one family with seven accepted genera in this order (this paper). The divergence time for *Muyocoprionales* is estimated as 171 MYA (stem age, Hongsanan et al. 2020).

*Accepted families: Muyocoproneae.*

***Muyocoproneae*** K.D. Hyde, in Hyde et al., *Fungal Diversity* 63: 164 (2013).

*Index Fungorum number:* IF 804506; *Facesoffungi numbers:* FoF 08090, 68 species.

*Saprobic*, common on the surface of dried twigs, stems and less common on leaves, appearing as black spots, mycelium absent. **Sexual morph:** *Ascomata* superficial on host surface, circular, scattered, flattened, rarely coalescing, carbonaceous and coriaceous, black, with a poorly developed basal layer, with a central irregular ostiole, lenticular when section. *Upper wall* irregularly arranged radiating cells,



**Fig. 57** *Muyocopron diptercarpi* (MFLU 18-1385). **a** Ascomata on host substrate. **b** Section through ascostroma. **c** Peridium **d** Pseudoparaphyses. **e–h** Asci. **i–m** Ascospores. **n** Germinated spores. **o** Appressoria. Scale bars **a** = 200  $\mu\text{m}$ , **b** = 100  $\mu\text{m}$ , **c, d, i–o** = 10  $\mu\text{m}$ , **e–h** = 30  $\mu\text{m}$

branched at margin cells. *Peridium* 2-layered, an outer layer comprises brown to black pseudoparenchymatous of compact thick-walled *textura epidermoidea* cells, light brown of *textura angularis* cells at inner layer. *Hamathecium* comprising dense, septate, cellular pseudoparaphyses which are longer than the asci and immersed in mucilage and inclined towards the centre. *Asci* 8-spored, bitunicate, fissionate, pedicellate, with small ocular chamber. *Ascospores* 2–3-seriate, ellipsoidal to ovate with obtuse ends, hyaline, aseptate, with or without granular appearance. **Asexual morph:** See Papendorf (1967), Crous et al. (2016b, 2018a), Hernández-Restrepo et al. (2019).

*Type: Muyocopron* Speg.

*Notes:* *Muyocopronaceae* was invalidly introduced by Luttrell (1951), and was synonymized under *Microthyriaceae* (Wu et al. 2011a, b). Hyde et al. (2013) accepted and formally introduced *Muyocopronaceae* as a distinct family, as well as provided an English diagnosis (Latin diagnosis no longer required). Phylogenetic analyses indicated that the family, *Muyocopronaceae* comprises nine genera *Arxiella*, *Leptodiscella*, *Mycocoleptodiscus*, *Muyocopron*, *Neocochlearomyces*, *Neomycocoleptodiscus*, *Paramycocoleptodiscus*, *Setoapiospora*, and *Pseudopalawania* (Mapook et al 2020; this study, Fig. 56)

**Muyocopron** Speg., Anal. Soc. cient. argent. 12(3): 113 (1881).

*Index Fungorum number*: IF 3294; *Facesoffungi number*: FoF 01887; 48 morphological species (Species Fungorum 2020), 5 species with molecular data.

*Type species*: **Muyocopron corrientinum** Speg.

*Notes*: *Muyocopron* was introduced by Spegazzini (1881), with the type species *M. corrientinum*. Saccardo (1883) re-described this genus and placed it in *Microthyriaceae*. *Muyocopron* was synonymized under *Ellisiodothis* by von Arx and Müller (1954). Later, it was transferred to *Botryosphaeriaceae* and *Microthyriaceae* (von Arx and Müller 1975; Lumbsch and Huhndorf 2007, 2010). However, *Muyocopron* differs from members of *Microthyriaceae* by pseudothyriothecia with the peridial wall comprising two layers, pseudoparaphyses longer than the asci, and aseptate ascospores (Hyde et al. 2013; Mapook et al. 2016b). Molecular studies indicated that *Muyocopron* is distantly related to the *Microthyriaceae* (Wu et al. 2011a, b; Mapook et al. 2016b, and Fig. 56). The genus clustered with *Dyfrolomycetaceae* (Dyfrolomycetales), but as a distinct order (Hyde et al. 2013; Mapook et al. 2016b).

**Muyocopron dipteroearpi** Mapook, Doilom, Boonmee & K.D. Hyde, Phytotaxa 265 (3): 223 (2016).

*Index Fungorum number*: IF 551617; *Facesoffungi number*: FoF 01889, Fig. 57

*Description*: see Senwana et al. (2019).

*Material examined*: Thailand, Phayao Province, Mueang District, Wiang Subdistrict, on dried twig (attached on tree) of *Hevea brasiliensis*, 2 October 2016, C. Senwana, BBPY036 (MFLU 18-1385).

#### Other genera included

**Arxiella** Papendorf, Trans. Br. mycol. Soc. 50(1): 73 (1967).

*Index Fungorum number*: IF 7233; *Facesoffungi number*: FoF 08091; – 3 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: **Arxiella terrestris** Papendorf, Trans. Br. mycol. Soc. 50(1): 73 (1967).

*Notes*: Species of *Arxiella* have been reported with asexual morphs (Papendorf 1967; Crous et al. 2014). *Arxiella terrestris* and *A. lunata* have hyphomycetous characters, while *A. dolichandrae* has coelomycetous characters. Coelomycetous *Arxiella* is characterized by sporodochial, brown conidiomata on agar surface, with globose to somewhat elongated, phialidic, brown conidiogenous cells, and reniform, medianly 1-septate conidia, with guttulate, horn-like appendages at the ends (Crous et al. 2014). Hyphomycetous *Arxiella* is characterized by septate, branched, hyaline to slightly olivaceous hyphae, with 1- to multi-celled, all cells conidiiferous conidiophores, and reniform, ends obliquely cornute, 1-septate, hyaline to slightly coloured

conidia, on short or elongate sterigma-like projections, single or in short chains or in small irregular groups (Papendorf 1967). *Arxiella* was treated as *incertae sedis* by Crous et al. (2014). Crous et al. (2018a) showed the placement of *Arxiella* within *Muyocopronaceae*. Subsequently, this was supported by Hernández-Restrepo et al. (2019) who provided a phylogenetic tree from four loci (ITS, LSU, rpb-2, and tef1) and concluded that this genus should be placed in *Muyocopronaceae*.

**Leptodiscella** Papendorf, Trans. Br. mycol. Soc. 53(1): 146 (1969).

*Index Fungorum number*: IF 8743; *Facesoffungi number*: FoF 08092; – 5 morphological species (Species Fungorum 2020), 5 species with molecular data.

*Type species*: **Leptodiscella africana** (Papendorf) Papendorf, Trans. Br. mycol. Soc. 53(1): 146 (1969).

≡ *Leptodiscus africanus* Papendorf, Trans. Br. mycol. Soc. 50(4): 687 (1967).

*Notes*: *Leptodiscella* was described based on hyphomycetous characters, producing conidia, long appendages, chlamydoconidia forming long or short chains or without chlamydoconidia present, ellipsoid to oblong-oval or obovoid appressoria or absent. Conidiogenous cells are solitary or aggregated, mono- or polyblastic, sympodial (Papendorf 1969; Udagawa and Toyazaki 1985; Madrid et al. 2012). Papendorf (1967) reported that *Leptodiscella* was isolated from leaf litter and soil of an *Acacia karroo* Heyne community in South Africa, but molecular data is unavailable. Madrid et al. (2012) provided sequence data of *Leptodiscella* based on phenotypic comparisons and presented taxonomic position. Crous et al. (2018a) used ITS region in their phylogenetic analysis and showed the placement of *Leptodiscella* within *Muyocopronaceae*.

**Mycoleptodiscus** Ostaz., Mycologia 59(6): 970 (1968) [1967].

*Index Fungorum number*: IF 9029; *Facesoffungi number*: FoF 08094; – 7 morphological species (Hernández-Restrepo et al. 2019), 3 species with molecular data.

*Type species*: **Mycoleptodiscus terrestris** (Gerd.) Ostaz., Mycologia 59(6): 970 (1968) [1967].

≡ *Leptodiscus terrestris* Gerd., Mycologia 45(4): 552 (1953).

*Notes*: The type species was included in the invalid genus *Leptodiscus* (Gerdemann 1953) which was placed in *Microthyriaceae* (von Arx and Müller 1975; Lumbsch and Huhndorf 2007). Thongkantha et al. (2009) provided the first phylogenetic analysis of a *Mycoleptodiscus* species (*M. coloratus*) based on LSU sequence data, and placed it in Magnaporthales (Sordariomycetes). However, Crous et al. (2018a) indicated that *Mycoleptodiscus*, based on phylogenetic placement of the type species, *M. terrestris*, is a

member of *Muyocoprionales*. More discussion can be seen in Hernández-Restrepo et al. (2019). The sexual morph of this genus has not been described, except for *M. affinis*, it however was introduced as *Omnidemptus affinis* by Cannon and Alcorn (1994). The major characters are restricted to species characterized by cylindrical conidia with appendages at one or both ends. Conidiogenous cells lack a collarette, are solitary or aggregated, mono- or polyblastic, sympodial, often denticulate or phialidic, globose or ampulliform. Conidia are cylindrical, the appressoria have a visible pore surrounded by dark radial lines, and sclerotia (Hernández-Restrepo et al. 2019)

***Neocochlearomyces*** Pinruan, Sommai, Suetrong, J.Z. Groenew. & Crous, in Crous et al., *Persoonia* 41: 381 (2018).

*Index Fungorum number*: IF 828085; *Facesoffungi number*: FoF 08095; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Neocochlearomyces chromolaenae*** Pinruan, Sommai, Suetrong, J.Z. Groenew. & Crous, in Crous et al., *Persoonia* 41: 381 (2018).

*Notes*: The phylogenetic analyses from ITS, LSU, rpb-2, and tef1 (Hernández-Restrepo et al. 2019) showed that *Neocochlearomyces* formed a distinct lineage within *Muyocoprionaceae*. The type species was sister to *Neomycoleptodiscus venezuelense* (CBS 100519) and *Mycoleptodiscus endophyticus* (MFLUCC 17-0545) in the analysis of Hernández-Restrepo et al. (2019). While, it is related to *Paramycoleptodiscus albizziae* in our analyses but as a distinct genus (Fig. 56). The genus is characterized by macronematous and mononematous, subcylindrical, septate, thick-walled conidiophores, with terminal and intercalary conidiogenous cells on one side of the swollen fan-like structure, and falcate, aseptate conidia that are equilateral, convex, obtuse to sub-obtusely rounded, forming a slimy spore mass (Crous et al. 2018a).

***Neomycoleptodiscus*** Hern.-Restr., J.D.P. Bezerra & Crous, in Hernández-Restrepo et al., *Persoonia* 42: 221 (2019).

*Index Fungorum number*: IF 829829; *Facesoffungi number*: FoF 08096; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Neomycoleptodiscus venezuelense*** Hern.-Restr., J.D.P. Bezerra & Crous, in Hernández-Restrepo et al., *Persoonia* 42: 221 (2019).

*Notes*: *Neomycoleptodiscus* was established by Hernández-Restrepo et al. (2019) to accommodate a single species *Neocochlearomyces venezuelense*. The genus has broadly lunate conidia and variable production of conidial appendages, smooth, hyaline to pale brown hyphae, sporodochium-like, brown conidiomata, with ampulliform to doliiform, angular, smooth, with a circular aperture situated conidiogenous cells, and one septate, cylindrical, guttulate conidia,

with a filamentous appendage at each end, produced in a mucous pale yellow to brown mass (Hernández-Restrepo et al. 2019). The only species in this genus was found on leaf litter of *Gyranthera caribensis* in Venezuela. In the phylogenetic analyses of Hernández-Restrepo et al. (2019), this genus formed a lineage within *Muyocoprionaceae* and sister to the strain of *Mycoleptodiscus endophyticus* (MFLUCC 17-0545) with good support (71% ML, 0.98 BYPP). In our analysis (Fig. 56), the genus is related to the clade containing *Mycoleptodiscus endophyticus* and *Mycoleptodiscus terrestris* with moderate support. However, both analyses showed that *Neomycoleptodiscus* is a distinct genus in *Muyocoprionaceae*.

***Paramycoleptodiscus*** Crous & M.J. Wingf., in Crous et al., *Persoonia* 36: 371 (2016).

*Index Fungorum number*: IF 817042; *Facesoffungi number*: FoF 08093; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Paramycoleptodiscus albizziae*** Crous & M.J. Wingf. [as ‘albizziae’], in Crous et al., *Persoonia* 36: 371 (2016).

*Notes*: The genus is characterised by mycelium consisting of hyaline to brown, branched, septate hyphae, chlamydospore-like cells that form a stroma, sporodochium of densely aggregated stroma, solitary or aggregated, subglobose to slightly ampulliform conidiogenous cells, and mono- or polyblastic, sympodial, aseptate conidia that are hyaline, smooth, granular, and base with well defined fusarium-like foot cell (Crous et al. 2016b). The phylogenetic analyses of Crous et al. (2018a) indicated that the type species of this genus is closely related to *Mycoleptodiscus terrestris*, but morphological characters are different. *Paramycoleptodiscus* differs from *Mycoleptodiscus* by aseptate conidia and basal appendage in the form of a foot cell, while *Mycoleptodiscus* has septate conidia with apical appendages.

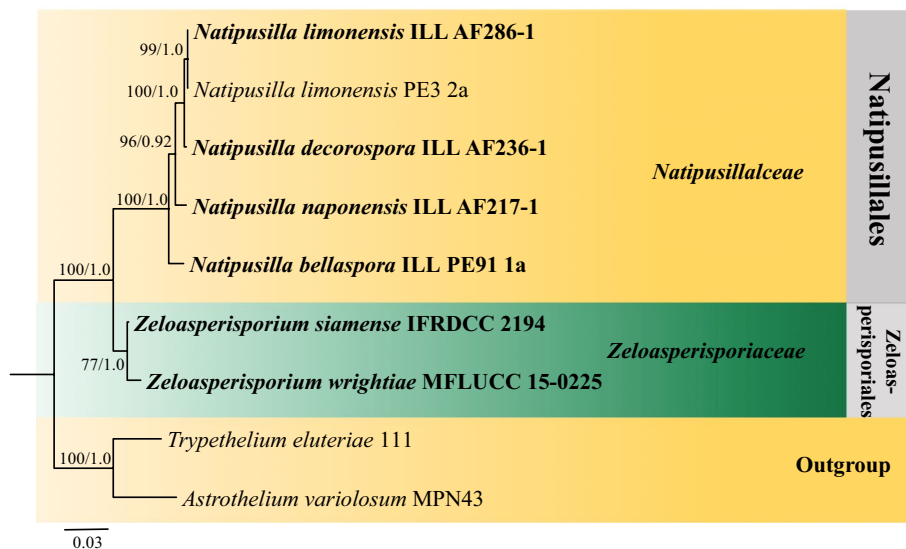
***Pseudopalawania*** Mapook. & K.D. Hyde, *Biomolecules*, 10: 569 (2020).

*Mycobank number*: MB834934; *Facesoffungi number*: FoF 08097; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Pseudopalawania siamensis*** Mapook & K.D. Hyde, *Biomolecules*, 10: 569 (2020).

*Notes*: The genus has sub-carbonaceous to superficial, flattened, carbonaceous ascomata, poorly developed basal layer and an irregular margin, with an ostioles, branching pseudoparaphyses, cylindrical-clavate asci, with an ocular chamber observed clearly when immature, and broadly fusiform to inequilateral, 1-septate, hyaline ascospores, guttulate when immature, with thin gelatinous sheath (Mapook et al. 2020). Although, morphology of *Pseudopalawania* is typical of *Palawania*, molecular analyses confirmed its

**Fig. 58** Phylogram generated from maximum likelihood analysis (RAxML) of Natipusillales based on LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%. Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. Isolate/specimen number is noted after the species name. The tree is rooted to *Astrothelium variolosum* (MPN43), *Trypethelium eluteriae* (111). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



placement within *Muyocoproneae* (Mapook et al. 2020; this study Fig. 56).

**Setoapiospora** Mapook & K.D. Hyde, Fungal Diversity 100: 5–277 (2020).

*Index Fungorum* number: IF 556905; *Facesoffungi* number: FoF 06793; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Setoapiospora thailandica* Mapook & K.D. Hyde, in Fungal Diversity 100: 5–277 (2020).

*Notes:* The genus is characterised by appearing as dark brown to black spots on branches of wood, carbonaceous ascomata, with dark brown setae, peridium composed of cells of *textura epidermoidea*, pseudoparaphyses, 8-spored asci, with an ocular chamber, and 1-septate ascospores, constricted at the septum, with a small lower cell and a large upper cell, tapering towards ends, with granular appearance. (Hyde et al. 2020b). In the phylogenetic analyses indicated that this genus formed a distinct lineage within *Muyocoproneae* (Hyde et al. 2020b, this study Fig. 56).

### Economic and ecological significance

Species of *Muyocoproneae* are commonly found as saprobes on dead twigs and stems, thus playing roles in decomposition.

**Natipusillales** Raja, Shearer, A.N. Mill. & K.D. Hyde.

*Index Fungorum* number: IF 805300; *Facesoffungi* number: FoF 08110.

Natipusillales was established to accommodate members of the freshwater ascomycetes belonging to *Natipusillaceae* based on LSU and SSU sequence data (Hyde et al. 2013). Phylogenetic analyses placed this order in Dothideomycetes (Hyde et al. 2013; Liu et al. 2017). Natipusillales was related

to Zeloasperisporiales which is not freshwater fungi and has very different morphological characters (Hongsanan et al. 2015b). There is a single family with one genus accepted in this order (Fig. 58). The divergence time for Natipusillales is estimated as 180 MYA (stem age, Hongsanan et al. 2020).

*Accepted families: Natipusillaceae.*

**Natipusillaceae** Raja, Shearer & A.N. Mill., Mycologia 104(2): 570 (2012).

*Index Fungorum* number: IF 561948; *Facesoffungi* number: FoF 08111, 4 species.

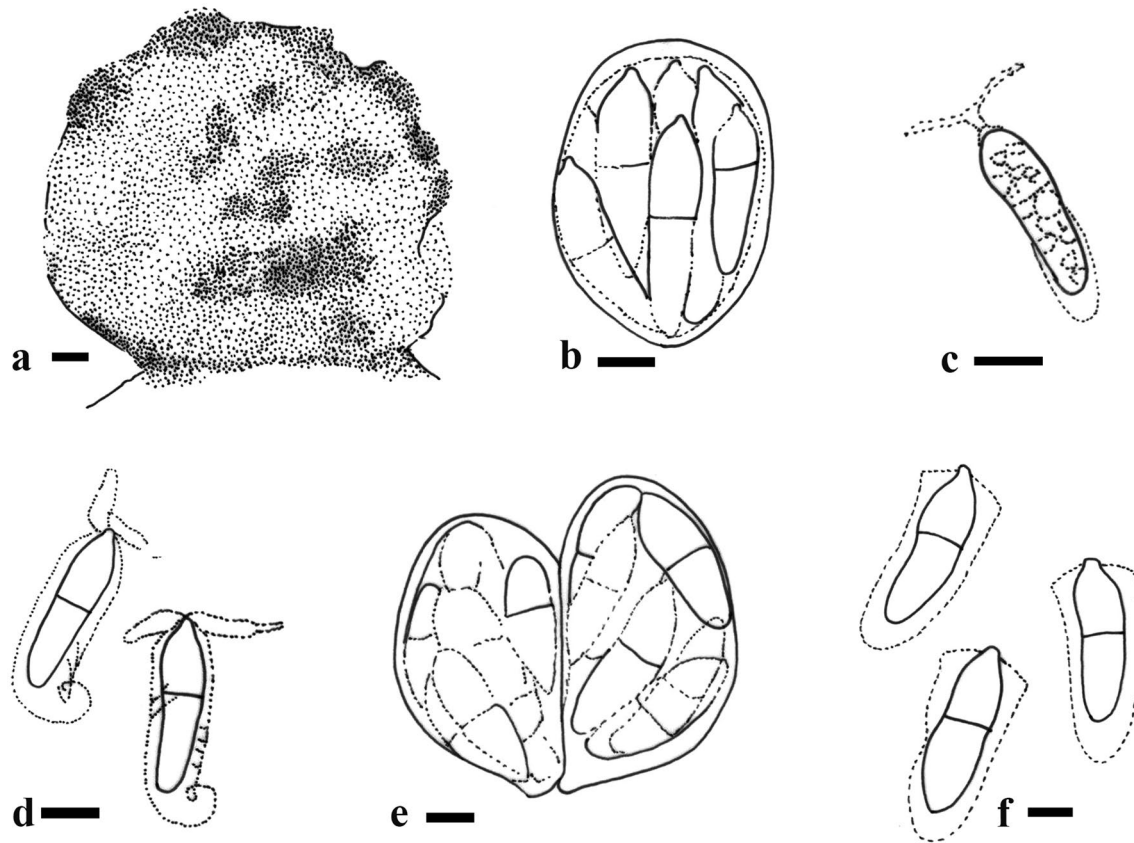
*Saprobic* on decaying wood. **Sexual morph:** *Ascomata* globose to subglobose, erumpent to superficial, hyaline to light brown. *Peridium* membranous, composed of pseudoparenchyma cells of *textura angularis* in surface view. *Hamathecium* comprising septate, sparse, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, fissionate, globose, subglobose or obclavate. *Ascospores* multi-seriate, fusiform to cylindrical, hyaline becoming brown with age, one to several septate, multiguttulate or not. **Asexual morph:** Undetermined.

*Type: Natipusilla* A. Ferrer, A.N. Mill. & Shearer.

*Notes:* *Natipusillaceae* comprises the freshwater genus *Natipusilla* with four species (Ferrer et al. 2011; Raja et al. 2012). Natipusillales was established to accommodate members of *Natipusillaceae* based on LSU and SSU sequence data (Hyde et al. 2013).

**Natipusilla** A. Ferrer, A.N. Mill. & Shearer, Mycologia 103(2): 417 (2011).

*Index Fungorum* number: IF 518365; *Facesoffungi* number: FoF 08112; 4 morphological species (Species Fungorum 2020), 4 species with molecular data.



**Fig. 59** Morphology of *Natipusilla* spp. (a–d = redrawn of *Natipusilla decorospora* from **holotype** AF236-1; e, f = redrawn of *N. limonensis* from **holotype** AF286-1). a Ascumata. b, e Asci. c, d, f Ascospores. Scale bars: a–f = 10  $\mu$ m

*Type species: Natipusilla decorospora* A. Ferrer, A.N. Mill. & Shearer.

*Notes:* Species of *Natipusilla* have small ascumata, none to few pseudoparaphyses, globose asci and mostly one-septate ascospores (Ferrer et al. 2011; Raja et al. 2012). There are four species accepted in this genus. We were unable to obtain a fresh collection of species in this family, so a drawing is provided (Fig. 59).

#### Economic and ecological significance

As typical lignicolous freshwater taxa, species of *Natipusillales* play an important role in nutrient and carbon cycling, biological diversity and ecosystem functioning of freshwater ecosystems with their ability to decompose lignocellulose in woody litter, softening the wood and releasing nutrients (Palmer et al. 1997; Wong et al. 1998; Yuen et al. 1998; Bucher et al. 2004; Hyde et al. 2016a).

#### Parmulariales D.Q. Dai & K.D. Hyde.

*Index Fungorum number:* IF 554065; *Facesoffungi number:* FoF 03913.

The order was established by Dai et al. (2018) based on its phylogeny and morphological characters which are different

from Asterinales. Taxonomic details can be seen in Dai et al. (2018). Only a single from Parmulariales has sequence data. The clade of Parmulariales is sister to the new family *Thyriulaceae* with high bootstrap support (Figs. 5, 60), and this result is similar to that found by Dai et al. (2018). The divergence time for Parmulariales is estimated as 115 MYA (stem age, Hongsanan et al. 2020).

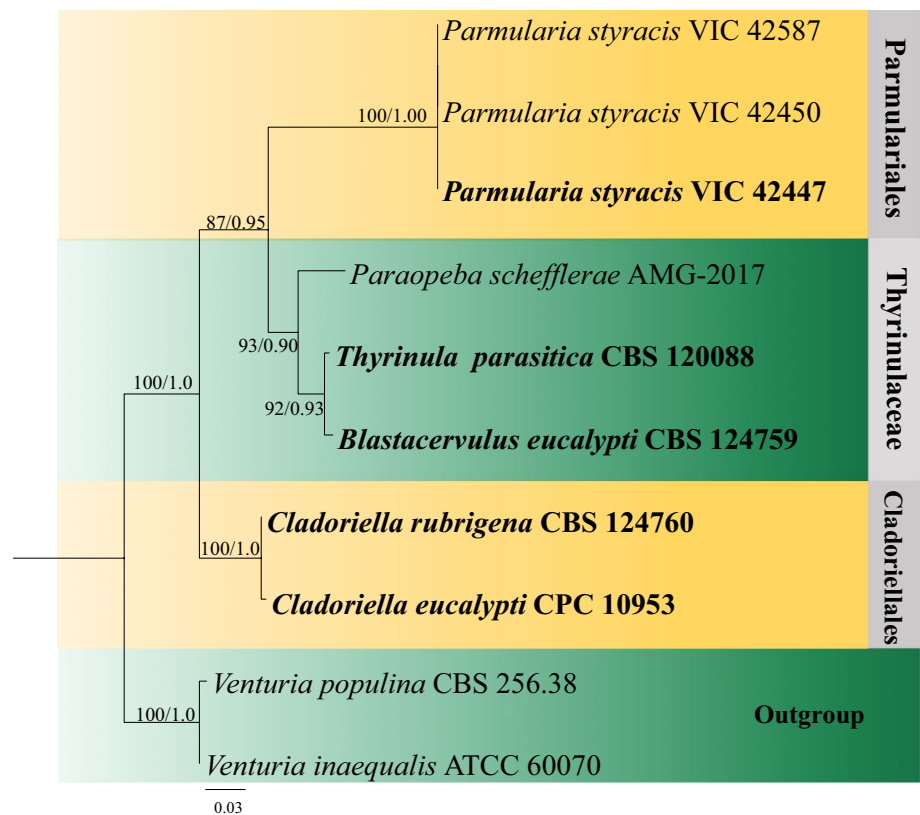
*Accepted families: Parmulariaceae.*

**Parmulariaceae** E. Müll. & Arx ex M.E. Barr, *Mycologia* 71(5): 944 (1979).

*Index Fungorum number:* IF 81109; *Facesoffungi number:* FoF 02296, 149 species.

*Epiphytic* or *parasitic* on living leaves of plants and ferns or thallus of lichens. *Colonies* foliicolous, superficial, dark brown to black. *Hyphae* spreading out from ascumata border, brown, septate, branching, sinuous, with or lacking appressoria. **Sexual morph:** *Ascostromata* solitary to gregarious, or in groups, superficial to immersed, shield-like to star-shaped, elliptical to boat-shaped, dark brown to black, carbonaceous to membranaceous, strongly flated, or longitudinal slits slightly protuberant, and contain numerous asci. *Locules* immersed in ascostromata or in longitudinal ridges

**Fig. 60** Phylogram generated from maximum likelihood analysis (RAxML) of Parmulariales based on LSU sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. Isolate/specimen number is noted after the species name. The tree is rooted to *Venturia inaequalis* (ATCC 60070) and *V. populina* (CBS 256.38). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



radiating from the centre. *Stromata* wall thin to thick, composed of black, large cells of *textura prismatica*. *Peridium of locules* thin to thick, composed of dark brown to hyaline smaller cells of *textura angularis*. *Hamathecium* comprising dark brown to hyaline, septate, pseudoparaphyses present or absent. *Asci* 8-spored, thick-walled, bitunicate, long ovate, broad cylindrical, broad-clavate, or obclavate, globose to subglobose, short pedicellate, with a distinct ocular chamber. *Ascospores* 2–multi-seriate, oblong to ellipsoid, ellipsoid to ovate, hyaline to dark brown, 1-septate, wall smooth to verrucose. **Asexual morph:** Undetermined.

**Type:** *Parmularia* Lév.

**Notes:** *Parmulariaceae* was invalidly introduced by Müller and von Arx (1962) for taxa with colonies growing on the surface of living plant tissues, mostly leaves, and later was validated by Barr (1979a). The family contains a range of ascomata types, asci and ascospores forms (Inácio and Cannon 2008). von Arx and Müller (1975) accepted 27 genera in this family and Lumbsch and Huhndorf (2007) included 34 genera. Inácio and Cannon (2008) excluded *Chaetaspis* and *Kentigia*, with 34 genera accepted. Hyde et al. (2013) accepted 30 genera including a new genus *Antoniomyces*, which was erected by Inácio et al. (2012). *Placostromella* was re-described by Thambugala et al. (2014b) and transferred to this family. *Placoasterella* and *Placosoma* were transferred to *Parmulariaceae*, as they were similar to taxa in this family (Hongsanan et al. 2014b). *Pleiostromellina*

was referred by Ariyawansa et al. (2014). *Dictyocyclus* was moved to *Myriangiaceae* based on morphological similarity (Dissanayake et al. 2014). Wijayawardene et al. (2014a) accepted 34 genera in *Parmulariaceae*. Wu et al. (2014) re-examined the holotype specimen of the type species of *Cirsosioopsis* and transferred the genus to *Parmulariaceae* based on its morphology. A new genus *Rhagadolobiopsis* was introduced by Guatimosim et al. (2014) and Jayasiri et al. (2016) re-examined herbarium of type species of *Cocconia* Sacc. and confirmed its placement within *Parmulariaceae*. Dai et al. (2018) excluded *Hemigrapha*, introducing *Hemigraphaceae* to accommodate it and re-examined *Inocyclus*, moving it to Asterinales genera *incertae sedis* based on the morphology and phylogenetic analysis. Doilom et al. (2018) transferred *Syrropeltis* to *Parmulariaceae* based on morphology. Thus, 34 genera are accepted in *Parmulariaceae*. *Parmulariaceae* is close to *Asterinaceae*, but differs in having ascostromata formed by several layers of pigmented cells, pseudoparaphyses, broadly ellipsoidal to obclavate asci, and lacks appressoria (Inácio and Cannon 2008; Inácio et al. 2012). Species of *Asterinaceae* have superficial hyphae mostly with appressoria, thyriothecia with a thin upper wall layer and poorly developed base and subglobose asci (Pirozynski and Shoemaker 1970; Inácio et al. 2012; Hongsanan et al. 2014b).

***Parmularia*** Lév., *Annls Sci. Nat., Bot., sér. 3* 5: 286 (1846).



*Index Fungorum number*: IF 3744; *Facesoffungi number*: FoF 02297; 12 morphological species (Species Fungorum 2020), 1 species with molecular data, 34 predicted number species.

*Type species*: *Parmularia styracis* Lév.

*Notes*: *Parmularia* typified by *Parmularia styracis*, was introduced by L veill  (1846). *Parmularia* is similar to *Mintera* in having elongate locules radiating from a central point. However, *Mintera* has mycelium with appresoria, and black ascostroma with a single locule which aggregate into a star shape. In *Parmularia* single ascostroma contain many locules. Guatimosim et al. (2015) re-collected the type species and provided ITS, LSU and tef1-  sequence data. For further morphological details of type species, see Dai et al. (2018). *Parmularia* is characterized by large, black, shield-like, flattened ascostromata with ridges radiating from the centre to the outer rim, and the ridges comprising elongated, radiating locules, filamentous pseudoparaphyses with brown and verrucose apices and ellipsoid, 1-septate ascospores (In cio and Cannon 2008; Hyde et al. 2013; Dai et al. 2018)

#### Other genera included

***Aldona*** Racib., Parasit. Alg. Pilze Java's (Jakarta) 1: 19 (1900).

*Index Fungorum number*: IF 115; *Facesoffungi number*: FoF 00309; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Aldona stella-nigra* Racib., Parasit. Alg. Pilze Java's (Jakarta) 1: 19 (1900).

*Notes*: *Aldona*, typified by *Aldona stella-nigra* was introduced by Raciborski (1900). The type was originally collected on living leaves of *Pterocarpus indicus* in Sumatra, western Indonesia. *Aldona* was initially placed in *Hysteriaceae*, then transferred to *Phacidiaceae*, and finally to *Parmulariaceae* (Saccardo 1904; von H hnel 1917; M ller and Patil 1973; von Arx and M ller 1975). The genus was reported as pathogenic occurring on terrestrial habitats and bearing an asexual ceolomycetous morph (for morphology see Tian et al. 2015; Wijayawardene et al. 2018, 2020). *Aldona* is characterized by semi-immersed to erumpent, black, linear, radial or star-shaped, branching, coriaceous, shiny ascostroma opening by longitudinal slits, black, shiny, globose or irregular spermatogonia growing on the spot, surrounded by ascostroma and elongate-clavate, hyaline, transseptate ascospores with upper cells larger and wider, basal cells short and narrow (Tian et al. 2015).

***Aldonata*** Sivan. & A.R.P. Sinha, Mycol. Res. 92(2): 248 (1989)

*Index Fungorum number*: IF 25242; *Facesoffungi number*: FoF 00311; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Aldonata pterocarpi* Sivan. & A.R.P. Sinha, Mycol. Res. 92(2): 249 (1989)

*Notes*: *Aldonata* was reported as a pathogen on living leaves of *Pterocarpus draco* in the Andaman Islands (Sivanesan and Sinha 1989). The asexual morph of this genus has not yet been reported (Tian et al. 2015). *Aldonata* is characterized by semi-immersed, globose to subglobose, black, shiny, ascostroma appearing as flexuous lines on the leaf spot surface with a clearly defined margin, solitary to gregarious, sub-immersed, black and shiny, carbonaceous, globose to irregular, spermatogonia mostly growing around the central of greyish white spot and ellipsoid to fusiform, muriform, hyaline ascospores with up to 8 transverse and longitudinal septa (Tian et al. 2015).

***Antoniomyces*** In cio, Mycol Progress 11: -6 (2012).

*Index Fungorum number*: IF 563246; *Facesoffungi number*: FoF 02299; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Antoniomyces loranthicola* In cio, Mycol Progress 11: -6 (2012).

*Notes*: This genus was introduced by In cio et al. (2012) according to its similarity of morphology with *Parmulariaceae*. This was followed in Wijayawardene et al. (2017a). *Antoniomyces* is characterized by solitary to gregarious, superficial, black, circular, ascostromata opening by longitudinal slits and forming in the central area of mycelium, clavate to subglobose asci and cylindric-ellipsoidal or ellipsoidal to narrowly ovoid, 1-septate ascospores (In cio et al. 2012).

***Aulacostroma*** Syd. & P. Syd., Philipp. J. Sci., C, Bot. 9: 176 (1914).

*Index Fungorum number*: IF 456; *Facesoffungi number*: FoF 02301; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Aulacostroma palawanense* Syd. & P. Syd., Philipp. J. Sci., C, Bot. 9(2): 176 (1914).

*Notes*: *Aulacostroma* was reported as pathogenic on *Pandanus merrillii* in Philippines (see morphology in In cio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Aulacostroma* is characterized by stromatic, solitary to gregarious, superficial, black ascostroma, broadly clavate, globose to subglobose, obovoid asci and brown ellipsoid, 1-septate ascospores (In cio and Cannon 2008).

***Campoia*** Speg., Boln Acad. nac. Cienc. C rdoba 25: 90 (1921).

*Index Fungorum number*: IF 778; *Facesoffungi number*: FoF 02303; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Campoa pulcherrima* Speg., Boln Acad. nac. Cienc. Córdoba 25: 90 [no. 173, reprint pages 92] (1921).

*Notes:* *Campoa* comprises five species, which were collected from Phillipines, Chile, Japan and the Dominican Republic (Inácio and Cannon 2008). The genus was reported as pathogenic on living leaves of *Temu divaricatum* (Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Campoa* is characterized by superficial, flat, black ascostromata with filamentous pseudoparaphyses, cylindrical to cylindrical-clavate asci and ellipsoidal ascospores (Inácio and Cannon 2008).

**Cirsiosiosis** Butin & Speer, Sydowia 31(1–6): 10 (1979) [1978].

*Index Fungorum number:* IF 1068; *Facesoffungi number:* FoF 08113; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Cirsiosiosis violacescens* Butin & Speer, Sydowia 31(1–6): 10 (1979) [1978].

*Notes:* The monotypic genus was introduced by Butin and Speer (1978) with its family placement in *Microthyriaceae*. Wu et al. (2014) re-examined the holotype of type species *C. violacescens* and transferred it to *Parmulariaceae* based on its morphological similarity with *Parmularia*. This genus is characterized by black and discoid ascostromata opening by irregular disintegration at the centre, globose to subglobose asci and 1-septate, ellipsoid to ovate ascospores (Wu et al. 2014).

**Cocconia** Sacc., Syll. fung. (Abellini) 8: 738 (1889).

*Index Fungorum number:* IF 1149; *Facesoffungi number:* FoF 00558; – 14 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Cocconia placenta* (Berk. & Broome) Sacc., Syll. fung. (Abellini) 8: 738 (1889).

≡ *Rhytisma placenta* Berk. & Broome, J. Linn. Soc., Bot. 14(no. 74): 131 (1873) [1875].

*Notes:* Jayasiri et al. (2016) re-examined the holotype and confirmed its family level placement within *Parmulariaceae*. The genus was reported as pathogenic on living leaves of *Symplocos spicata* (see morphology in Inácio and Cannon 2008; Jayasiri et al. 2016; Wijayawardene et al. 2018, 2020). *Cocconia* is characterized by superficial, shield-like, dark brown to black, carbonaceous, flated ascostromata producing thick-walled, cylindrical asci and ellipsoidal, 1-septate, brown ascospores (Jayasiri et al. 2016).

**Cycloshizon** Henn., Bot. Jb. 33: 39 (1902).

*Index Fungorum number:* IF 1376; *Facesoffungi number:* FoF 02305; – 13 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Cycloshizon brachylaenae* (Rehm) Henn., Bot. Jb. 33: 39 (1902).

≡ *Schneepia brachylaenae* Rehm, Hedwigia 40(Beibl.): (173) (1901).

*Notes:* The type species *Cycloshizon brachylaenae* was collected on living leaves of *Brachylaena neriifolia* from South Africa. Index Fungorum (2019) lists 14 species, whereas Inácio and Cannon (2008) compared 12 taxa by their hosts, distributions and main morphological characters. *Cycloshizon* is characterized by clustered, superficial, black, circular, flat ascomata opening by one circumferential, producing broadly clavate to subglobose, thick-walled asci and ellipsoidal ascospores with one septum (Inácio and Cannon 2008). For a drawing and other details, see Inácio and Cannon (2008), Wijayawardene et al. (2018, 2020).

**Cyclostomella** Pat., Bull. Herb. Boissier 4: 656 (1896).

*Index Fungorum number:* IF 1378; *Facesoffungi number:* FoF 02307; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Cyclostomella disciformis* Pat., Bull. Herb. Boissier 4: 656 (1896).

*Notes:* *Cyclostomella* comprises four species (Inácio and Cannon 2008). The genus was reported as pathogenic on living leaves, usually in tropical regions such as Costa Rica, Cuba and Brazil. A comparison of morphological features of four taxa of *Cyclostomella* was provided by Inácio and Cannon (2008). *Cyclostomella* is characterized by superficial, circular to elliptical, disc-like, black, rather flat ascostromata producing cylindrical to clavate to subglobose asci and ellipsoid, dark brown, 1-septate ascospores (Inácio and Cannon 2008).

**Dothidasteroma** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1509 (1909).

*Index Fungorum number:* IF 1691; *Facesoffungi number:* FoF 08114; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Dothidasteroma pterygotae* (Berk. & Broome) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1510 (1909).

≡ *Rhytisma pterygotae* Berk. & Broome, J. Linn. Soc., Bot. 14(no. 74): 131 (1873) [1875].

*Notes:* *Dothidasteroma* was erected by von Höhnel (1909a) with *D. pterygotae* as type species. This genus is characterized by fruiting bodies forming a 1-cell layer, superficial, flat ascostromata with irregular locules. Inácio and Cannon (2008) accepted three species in *Dothidasteroma*. Inácio et al. (2011) introduced a new species. Thus, four species are accepted in *Dothidasteroma*.

**Ferrarisia** Sacc., Atti Inst. Veneto Sci. lett., ed Arti 10: 61 (1919).

*Index Fungorum number*: IF 1986; *Facesoffungi number*: FoF 02309; – 8 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Ferrarisia philippina*** Sacc., Atti Soc. Veneto-Trent. Sci. Nat., Padova 23: 61 (1917).

*Notes*: *Ferrarisia philippina* was synonymized under *F. ipomoeae*. Thus, the current name for the generic type is *F. ipomoeae* (Inácio and Cannon 2008). *Ferrarisia jasmini* was transferred to *Palawaniella* by von Arx and Müller (1975). Eight species are accepted in *Ferrarisia* by Inácio and Cannon (2008). *Ferrarisia* was reported as pathogenic on living leaves and usually occurs in tropics (Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Ferrarisia* is characterized by small, superficial, circular to elliptical, black ascostromata with subglobose asci and ellipsoid, brown ascospores with one septum (Inácio and Cannon 2008).

***Hysterostomella*** Speg., Anal. Soc. cient. argent. 19(6): 260 (1885).

*Index Fungorum number*: IF 2476; *Facesoffungi number*: FoF 02313; – 25 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Hysterostomella guaranitica*** Speg., Anal. Soc. cient. argent. 19(6): 260 [no. 305] (1885).

*Notes*: This genus is widely distributed throughout the tropics and is pathogenic on living leaves of palms (Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Hysterostomella* is characterized by circular or elliptical, flat, black ascostromata opening by irregular slits, with filamentous pseudoparaphyses above the asci, which are subglobose, obovoid, and clavate (Inácio and Cannon 2008).

***Kiehlia*** Viégas, Bragantia 4(1–6): 156 (1944).

*Index Fungorum number*: IF 2567; *Facesoffungi number*: FoF 08115; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Kiehlia obscura*** Viégas, Bragantia 4(1–6): 156 (1944).

*Notes*: *Kiehlia obscuraw* was originally collected on living leaves of bamboo from Brazil. Inácio and Cannon (2008) re-examined two varieties of the second species *K. bambusina*, and provided illustrations of sexual and asexual morphs. Index Fungorum (2020) listed *K. bambusina* as *Phyllachora bambusina*, hence only the type species is accepted in this genus. *Kiehlia* is characterized by elongate, immersed stromata and conidiomata growing in a same locule, clavate asci and ovoid, hyaline ascospores with one septum (Viégas 1944).

***Mintera*** Inácio & P.F. Cannon, Mycol. Res. 107(1): 86 (2003).

*Index Fungorum number*: IF 28710; *Facesoffungi number*: FoF 02317; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Mintera reticulata*** (Starbäck) Inácio & P.F. Cannon, Mycol. Res. 107(1): 86 (2003).

≡ *Parmularia reticulata* Starbäck, Ark. Bot. 5(no. 7): 6 (1905).

*Notes*: This genus was reported as pathogenic on living leaves with only sexual morph found. *Mintera* is characterized by stromatic, gregarious, black ascostromata grouping into a pyrethrum-like shape on mycelium, cylindrical-clavate, subglobose asci and ellipsoid, brown, 1-septate ascospores (Inácio and Cannon 2008).

***Pachypatella*** Theiss. & Syd., Anns mycol. 13(3/4): 228 (1915).

*Index Fungorum number*: IF 3670; *Facesoffungi number*: FoF 02319; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Pachypatella alsophilae*** (Racib.) Theiss. & Syd., Anns mycol. 13(3/4): 228 (1915).

≡ *Hysterostomella alsophilae* Racib., Parasit. Alg. Pilze Java's (Jakarta) 2: 22 (1900).

*Notes*: *Pachypatella* was reported as pathogenic on living leaves of ferns. Two species including the type are described (morphology see Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Pachypatella* is characterized by superficial, circular or elliptical, flat ascostromata, becoming irregular in shape, with clavate, or cylindrical to cylindrical-clavate asci and cylindrical-ellipsoidal to ellipsoidal or occasionally oblong ascospores (Inácio and Cannon 2008).

***Palawaniella*** Doidge, Bothalia 1(1): 16 (1921).

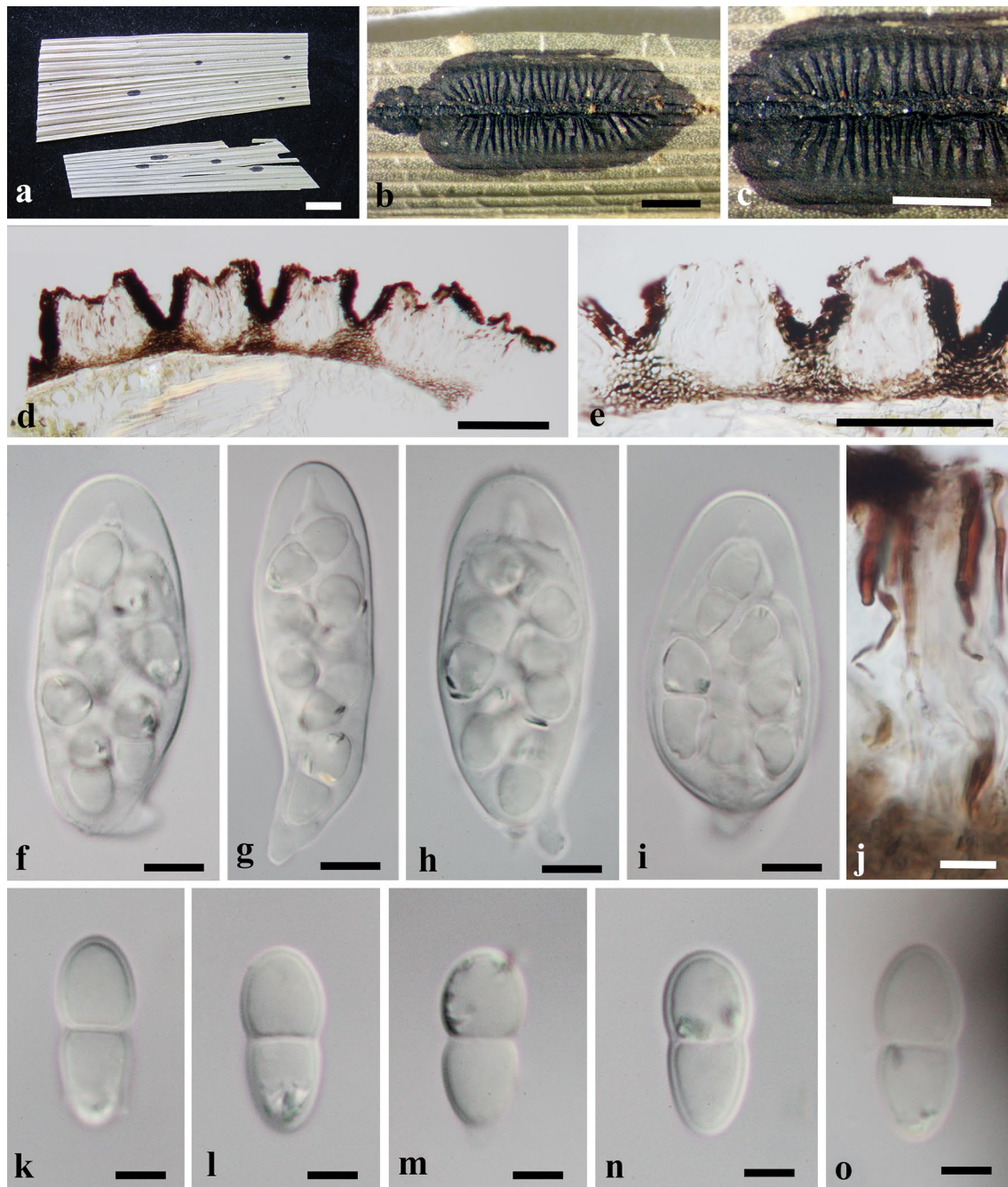
*Index Fungorum number*: IF 3683; *Facesoffungi number*: FoF 02321; – 6 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Palawaniella eucleae*** Doidge, Bothalia 1(1): 16 (1921).

*Notes*: Doidge (1942) synonymized *P. eucleae* under *P. orbiculata*. Currently, seven taxa are placed in this genus. It was reported as pathogenic occurring on living leaves from South Africa and Brazil (morphology see Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Palawaniella* is characterized by stromatic ascostromata that are gregarious in the centre of black spots, becoming flattened and with a single locule (Inácio and Cannon 2008).

***Parmulariopsella*** Sivan., Trans. Br. mycol. Soc. 55(3): 509 (1970).

*Index Fungorum number*: IF 3746; *Facesoffungi number*: FoF 02323; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.



**Fig. 61** *Parmulariopsis pulchella* (W No: 10820, holotype). **a** Type material. **b, c** Appearance of black ascostromata on the host. **d** Section of ascostroma. **e** Peridium. **f–i** Asci with ascospores. **j** Interthe-

cial, dark brown filamentous pseudoparaphyses. **k–o** Ascospores. Scale bars: **a** = 10 mm, **b, c** = 1 mm, **d, e** = 100  $\mu$ m, **f–j** = 10  $\mu$ m, **k–o** = 5  $\mu$ m

*Type species: Parmulariopsella burseracearum* Sivan., Trans. Br. mycol. Soc. 55(3): 509 (1970).

*Notes:* This monotypic genus was collected on *Santiria trimera* from Africa. This genus is similar to *Parmularia*, but differs as the ascostromata are covered by dark hyphae (Inácio and Cannon 2008). *Parmulariopsella* was reported as pathogenic on living leaves (morphology see Inácio and

Cannon 2008; Wijayawardene et al. 2018, 2020). This genus is characterized by solitary ascostromata growing in the centre of the black mycelium, globose to subglobose, obovoid asci and ellipsoid, brown, 1-septate ascospores (Inácio and Cannon 2008).

*Parmulariopsis* Petr., Sydowia 8(1–6): 186 (1954).

*Index Fungorum number:* IF 3747; *Facesoffungi number:* FoF 02325; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Parmulariopsis pulchella* Petr., Sydowia 8(1–6): 186 (1954).

*Notes:* This genus forms large, black ascostromata on living leaves and is only known from the type collection from Malaysia (Inácio and Cannon 2008). *Parmulariopsis* is characterized by its shield-like ascostromata with locules radiating from the centre. It looks similar to *Parmularia*, but *Parmulariopsis* has elliptical to oblong, or long fusiform stromata, whereas *Parmularia* has rounded stromata.

***Parmulariopsis pulchella*** Petr., Sydowia 8(1–6): 186 (1954).

*Index Fungorum number:* IF 302295; *Facesoffungi number:* FoF 02326, Fig. 61

*Parasitic* on lower surface of leaves. **Sexual morph:** *Ascostromata* 2–20 long × 1–4 mm wide, solitary to gregarious, superficial, elliptical to oblong, or long fusiform, or irregular, shield-like, black, carbonaceous, flated, with ridges radiating from the centre to the outer rim; ridges containing elongated locules, which open by a longitudinal slit and contain numerous asci, cells of ascostromata thick-walled and elongate and composed of black, amorphous tissues in the stromatic crust. *Locules* in vertical section 70–150 diam. × 65–85 µm high, subglobose, immersed in ascostromata. *Peridium of ascostromata* 30–40 µm thick, comprises of several black layers, composed of dark brown cells of *textura prismatica*. *Cells between locules* 30–55 µm thick, composed of brown to hyaline cells of *texture angularis*. *Hamathecium* comprising interthecial, hyaline to brown, septate, filamentous pseudoparaphyses, 50–65 × 1.5–2.5 µm, with swollen and brown tips. *Asci* 40–70 × 20–30 µm ( $\bar{x}$  = 52.4 × 23.3 µm, n = 20), 8-spored, thick-walled, bitunicate, clavate to subglobose, short-pedicellate, with a distinct ocular chamber. *Ascospores* 19–25 × 8.5–9 µm ( $\bar{x}$  = 19.7 × 8.7 µm, n = 20), irregularly arranged, ellipsoidal, with larger and rounder upper cells, with narrow and longer lower cells, hyaline, 1-septate, constricted at the septum, smooth-walled. **Asexual morph:** Undetermined.

*Material examined:* Malaysia, Sabah, Mt. Kinabalu, Tenmopok, 5000 ft., on leaves of *Joinvillea* sp., 9 March 1932, J. & M. S. Clemens (W No: 10820, **holotype**).

*Notes:* *Parmulariopsis* was typified by *P. pulchella*, without designating any type specimens. Inácio and Cannon (2008) re-examined the isotypes from S and K. In the present study, a specimen deposited in W labeled with the same collecting information as in the original article is thought to be the holotype.

***Parmulina*** Theiss. & Syd., Anns mycol. 12(2): 194 (1914).

*Index Fungorum number:* IF 3748; *Facesoffungi number:* FoF 08116; – 5 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Parmulina exsculpta* (Berk.) Theiss. & Syd. [as ‘exculpta’], Anns mycol. 12(1): 45 (1914).

≡ *Dothidea exsculpta* Berk., Hooker’s J. Bot. Kew Gard. Misc. 6: 233 (1854).

*Notes:* Inácio and Cannon (2008) re-examined a specimen from K, and designated it as neotype, as the authors considered the holotype was missing. This genus was reported as pathogenic on living leaves (morphology see Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Parmulina* is characterized by superficial, circular to irregular, rather flat, black ascostromata (Inácio and Cannon 2008).

***Placoasterella*** Sacc. ex Theiss. & Syd., Anns mycol. 13(3/4): 236 (1915).

*Index Fungorum number:* IF 4121; *Facesoffungi number:* FoF 08117; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Placoasterella schweinfurthii* (Henn.) Theiss. & Syd., Anns mycol. 13(3/4): 236 (1915).

≡ *Asterella schweinfurthii* Henn., Bull. Herb. Boissier 1: 118 (1893).

*Notes:* *Placoasterella* was erected with two species. Another two species were introduced with their family placement in *Asterinaceae* (Müller and von Arx 1962). Hongsanan et al. (2014b) re-examined holotype of *P. schweinfurthii* and transferred the genus to *Parmulariaceae* based on morphology. *Placoasterella* is characterized by superficial, circular, flat, black, carbonaceous ascostromata with small, solitary, subglobose locules, lacking pseudoparaphyses, ovoid asci and ellipsoid to fusoid ascospores with one septum (Hongsanan et al. 2014b).

***Placosoma*** Syd., Anns mycol. 22(3/6): 302 (1924).

*Index Fungorum number:* IF 4139; *Facesoffungi number:* FoF 08118; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Placosoma nothopanacis* Syd., Anns mycol. 22(3/6): 303 (1924).

*Notes:* *Placosoma* was introduced by Sydow (1924) with a single species. Prasad et al. (1961) described a second species *P. salvadorae*. Thus, two species are accepted in this genus. *Placosoma* was placed in *Asterinaceae* by Lumbsch and Huhndorf (2010). However, Hongsanan et al. (2014b) re-examined the type species *P. nothopanacis* and suggested that *Placosoma* is typical of *Parmulariaceae*. *Placosoma* is characterized by superficial, circular, flattened, blackened, carbonaceous ascostromata, subglobose to oblong asci and broadly ellipsoidal ascospores with one septum (Hongsanan et al. 2014b).

**Placostromella** Petr., Sydowia 1(1–3): 9 (1947).

*Index Fungorum number*: IF 4141; *Facesoffungi number*: FoF 08119; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Placostromella macrospora** Petr., Sydowia 1(1–3): 9 (1947).

*Notes*: *Placostromella* was introduced by Petrak (1947d) with *Placostromella macrospora* as type species. Later *P. amazonensis* and *P. castanopsis* were transferred to *Placostromella* (Inácio et al. 2005). Three taxa including the type are accepted in *Placostromella* (morphology see Thambugala et al. 2014b; Wijayawardene et al. 2018, 2020). This genus is characterized by subcuticular, carbonaceous, black, rounded or broadly ellipsoid ascostromata with a single locule, cylindrical to clavate asci and cylindrical-ellipsoidal or oblong to obovate ascospores (Thambugala et al. 2014b).

**Pleiomellina** Bat., J.L. Bezerra & H. Maia, in Batista & Bezerra, Portug. acta biol., Sér. B 7(4): 373 (1964).

*Index Fungorum number*: IF 4204; *Facesoffungi number*: FoF 08120; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Pleiomellina pernambucensis** Bat., J.L. Bezerra & Cavalc., in Batista & Bezerra, Portug. acta biol., Sér. B 7(4): 374 (1964).

*Notes*: The monotypic genus was introduced by Batista and Bezerra (1964). Ariyawansa et al. (2014) referred *Pleiomellina* to *Parmulariaceae* based on its similarities with *Parmularia*. *Pleiomellina* is characterized by superficial, flattened carbonaceous ascostromata with numerous locules in a circle, subglobose asci without a pedicel and 2–3-seriate, ellipsoidal, brown, 1-septate ascospores (Ariyawansa et al. 2014).

**Polycyclina** Theiss. & Syd., Anns mycol. 13(3/4): 212 (1915).

*Index Fungorum number*: IF 4310; *Facesoffungi number*: FoF 02327; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Polycyclina rhytismoides** (Speg.) Theiss. & Syd., Anns mycol. 13(3/4): 212 (1915).

≡ *Hysterostomella rhytismoides* Speg., Boln Acad. nac. Cienc. Córdoba 11(4): 580 (1889).

*Notes*: The monotypic genus *Polycyclina* is parasitic on living leaves of *Lomaria imperialis* (drawing see Thambugala et al. 2014b; Wijayawardene et al. 2018, 2020). *Polycyclina* is characterized by solitary, superficial, circular to elliptical to irregular, disc-like, black, rather flat ascostromata, clavate to cylindrical-clavate asci and ellipsoid to cylindrical-ellipsoid, dark brown, aseptate ascospores (Thambugala et al. 2014b).

**Polycyclus** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1542 [82 repr.] (1909).

*Index Fungorum number*: IF 4312; *Facesoffungi number*: FoF 02329; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Polycyclus andinus** (Pat.) Theiss. & Syd., Anns mycol. 13(3/4): 210 (1915).

≡ *Hysterostomella andina* Pat., in Patouillard & Lagerheim, Bull. Herb. Boissier 3(1): 73 (1895).

*Notes*: *Polycyclus* was introduced by von Höhnel (1909a), however, the type species was selected by Theissen and Sydow (1915). Inácio and Cannon (2008) compared *P. andinus* and *P. marginalis*, and considered they were possibly conspecific. This genus was reported as pathogenic on living leaves of ferns (morphology see Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Polycyclus* is characterized by superficial, circular to elliptical, disc-like, black, flat ascostromata with the fissured centre raised up to the wart shape, and with 1–5 locules disposed as a ring around a central column, opening by longitudinal to irregular fissures (Inácio and Cannon).

**Protothyrium** G. Arnaud, C. r. hebd. Séanc. Acad. Sci., Paris 164: 574 (1917).

*Index Fungorum number*: IF 4395; *Facesoffungi number*: FoF 02331; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Protothyrium salvadorae** (Cooke) G. Arnaud, Annals d'École National d'Agric. de Montpellier, Série 2 16(1–4): 101 (1918) [1917].

≡ *Phyllachora salvadorae* Cooke, Grevillea 13(no. 67): 65 (1885).

*Notes*: Four species are accepted in *Protothyrium* (Inácio and Cannon 2008). Species were reported as pathogenic on living leaves (morphology see Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Protothyrium* is characterized by superficial, circular or elliptical, flat, black ascostromata, becoming irregular in shape, opening by irregular slits (Inácio and Cannon 2008).

**Pseudolembosia** Theiss., Anns mycol. 11(5): 432 (1913).

*Index Fungorum number*: IF 4448; *Facesoffungi number*: FoF 02333; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Pseudolembosia geographica** (Masse) Theiss., Anns mycol. 11(5): 432 (1913).

≡ *Lembosia geographica* Masee, Bull. Misc. Inf., Kew: 181 (1899).

*Notes*: *Pseudolembosia* was introduced by Theissen (1913) with *P. geographica* as the type species. Index Fungorum (2020) listed five epithets, but only four taxa are accepted by Inácio and Cannon (2008). This genus was reported as pathogens on living leaves (morphology see Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). *Pseudolembosia* is characterized by superficial, circular to

elliptical, disc-like, black, rather flat ascostromata raised up to Y-shaped to irregular near the center (Inácio and Cannon 2008).

**Rhagadolobiosis** Guatim. & R.W. Barreto, Mycologia 106(2): 277 (2014).

*Index Fungorum number*: IF 802297; *Facesoffungi number*: FoF 08121; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Rhagadolobiosis thelypteridis** Guatim. & R.W. Barreto, Mycologia 106(2): 277 (2014).

*Notes*: **Rhagadolobiosis** was erected by Guatimosim et al. (2014), with a single species, *R. thelypteridis*. This species is reported as a pathogen on living leaves of *Thelypteris serrata* from Brazil (morphology and key of genera of *Parmulariaceae* on fern see Guatimosim et al. 2014; Wijayawardene et al. 2018, 2020). **Rhagadolobiosis** is characterized by numerous, scattered, black, stromata forming superficial, ellipsoid tar spot-like colonies on the abaxial surfaces of leaves, multiloculate ascomata, opening by radiating fissures, cylindrical-clavate to clavate asci and fusiform, aseptate, hyaline ascospores (Guatimosim et al. 2014).

**Rhagadolobium** Henn. & Lindau, Bot. Jb. 23: 287 (1897).

*Index Fungorum number*: IF 4688; *Facesoffungi number*: FoF 02335; – 11 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Rhagadolobium hemiteliae** Henn. & Lindau [as ‘*Rhagadolobium hemitheliae*’], (1897).

*Notes*: **Rhagadolobium** is characterized by superficial, circular or elliptical, flattened, black ascostromata with upper wall of stromata comprising a thin dark brown tissue (Guatimosim et al. 2014).

**Rhipidocarpon** (Theiss.) Theiss. & Syd., Anns mycol. 13(3/4): 197 (1915).

≡ *Parmularia* subgen. *Rhipidocarpon* Theiss., Anns mycol. 11(5): 456 (1913).

*Index Fungorum number*: IF 4703; *Facesoffungi number*: FoF 02337; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Rhipidocarpon javanicum** (Pat.) Theiss. & Syd., Anns mycol. 13(3/4): 197 (1915).

≡ *Schneepia javanica* Pat., Ann. Jard. Bot. Buitenzorg, suppl. 1: 122 (1897).

*Notes*: This genus is only known from type location Indonesia. It was reported as pathogenic on living leaves of palm (morphology see Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). **Rhipidocarpon** is characterized by solitary to gregarious, superficial, black, irregular, carbonaceous, flat ascostromata with ridges irregularly radiating from the centre to the outer rim (Inácio and Cannon 2008).

**Symphaeophyma** Speg., Anal. Mus. nac. Hist. nat. B. Aires 23: 97 (1912).

*Index Fungorum number*: IF 5316; *Facesoffungi number*: FoF 02339; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Symphaeophyma subtropicale** Speg., Anal. Mus. nac. Hist. nat. B. Aires 23: 97 (1912).

*Notes*: This monotypic genus was introduced by Spegazzini (1912) to accommodate *S. subtropicale*, collected from a tropical region. This species was reported as pathogenic on living leaves of *Pouteria salicifolia* (morphology see Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). **Symphaeophyma** is characterized by superficial, circular or elliptical, pulvinate, sinuate, black ascostromata with thick internal part (Inácio and Cannon 2008).

**Syrropeltis** Bat., J.L. Bezerra & Matta, in Batista & Bezerra, Portug. acta biol., Sér. B 7(4): 376 (1964).

*Index Fungorum number*: IF 5344; *Facesoffungi number*: FoF 08122; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Syrropeltis xylopia** Bat., J.L. Bezerra & Matta, in Batista & Bezerra, Portug. acta biol., Sér. B 7(4):377 (1964).

*Notes*: The monotypic genus was introduced by Batista and Bezerra (1964), and was treated as Dothideomycetes genera *incertae sedis* by Wijayawardene et al. (2014a, 2018). Doilom et al. (2018) re-examined the holotype of *S. xylopia* and transferred **Syrropeltis** to *Parmulariaceae* based on its morphologic similarity to this family. **Syrropeltis** is characterized by large and black ascostromata on host substrate and 1-septate ascospores that are ovoid with upper cell broader and longer, slightly constricted and pale brown to brown at the septum (Doilom et al. 2018).

**Thallomyces** H.J. Swart, Trans. Br. mycol. Soc. 65(1): 84 (1975).

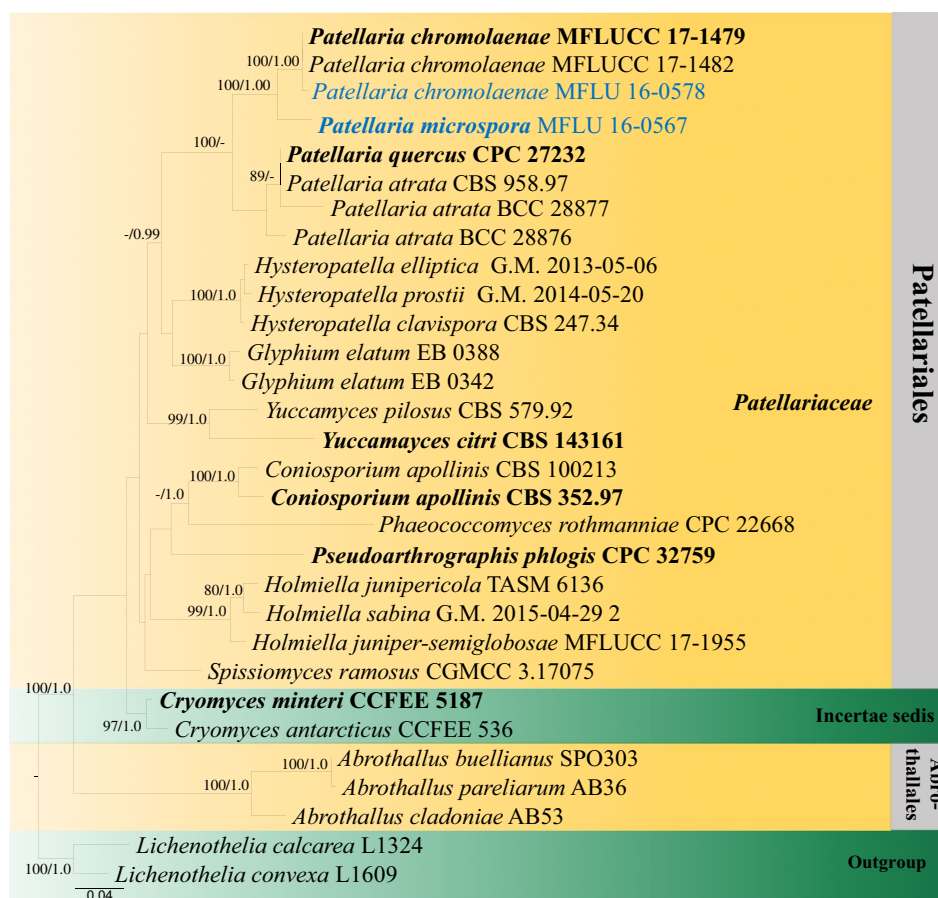
*Index Fungorum number*: IF 5395; *Facesoffungi number*: FoF 02341; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Thallomyces oritis** (Hansf.) H.J. Swart, Trans. Br. mycol. Soc. 65(1): 85 (1975).

≡ *Stigmatea oritis* Hansf. [as ‘*oritidis*’], Proc. Linn. Soc. N.S.W. 79(3–4): 102 (1954).

*Notes*: This genus is only known from the type collection, which was pathogenic on living leaves of *Orites lancifolius* (morphology see Inácio and Cannon 2008; Wijayawardene et al. 2018, 2020). **Thallomyces** is characterized by superficial, dark brown to black, coriaceous, flat ascomata forming on branching, brown hyphae, which produce round to irregular, brown to dark brown appressoria (Inácio and Cannon 2008).

**Fig. 62** Phylogram generated from maximum likelihood analysis (RAxML) of Patellariales based on ITS, LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%. Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. Isolate/specimen number is noted after the species name. The tree is rooted to *Lichenothelia calcarea* (L1324) and *L. convexa* (L1609). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



**Viegasella** Inácio & P.F. Cannon, Mycol. Res. 107(1): 82 (2003).

*Index Fungorum number*: IF 28709; *Facesoffungi number*: FoF 02343; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Viegasella pulchella*** (Speg.) Inácio & P.F. Cannon, Mycol. Res. 107(1): 83 (2003).

≡ *Schneepia pulchella* Speg., Anal. Soc. cient. argent. 26(1): 55 (1888).

*Notes*: *Viegasella* was revised by Inácio and Cannon (2003) with description and illustration. It was reported as pathogen on living leaves in Brazil (morphology see Inácio and Cannon 2003,2008; Tian et al. 2015; Wijayawardene et al. 2018, 2020). *Viegasella* is characterized by gregarious to solitary, black ascostromata with multi-ascostromata gregarious and star-shaped, olive-cream, clavate to cylindrical asci and brown, ellipsoid, 1-septate ascospores (Inácio and Cannon 2003,2008; Tian et al. 2015).

### Economic and ecological significance

*Parmulariaceae* is a large family, usually distributed in tropical regions. Taxa in this family are usually epiphytic or pathogenic on fern fronds or plant leaves, occasionally on thallus of lichens (Inácio and Cannon 2008; Guatimosim

et al. 2015). Some genera, such as *Aulacostroma* are reported as plant pathogens which can cause leaf spots.

**Patellariales** D. Hawksw. & O.E. Erikss.

*Index Fungorum number*: IF 90491; *Facesoffungi number*: FoF 08123.

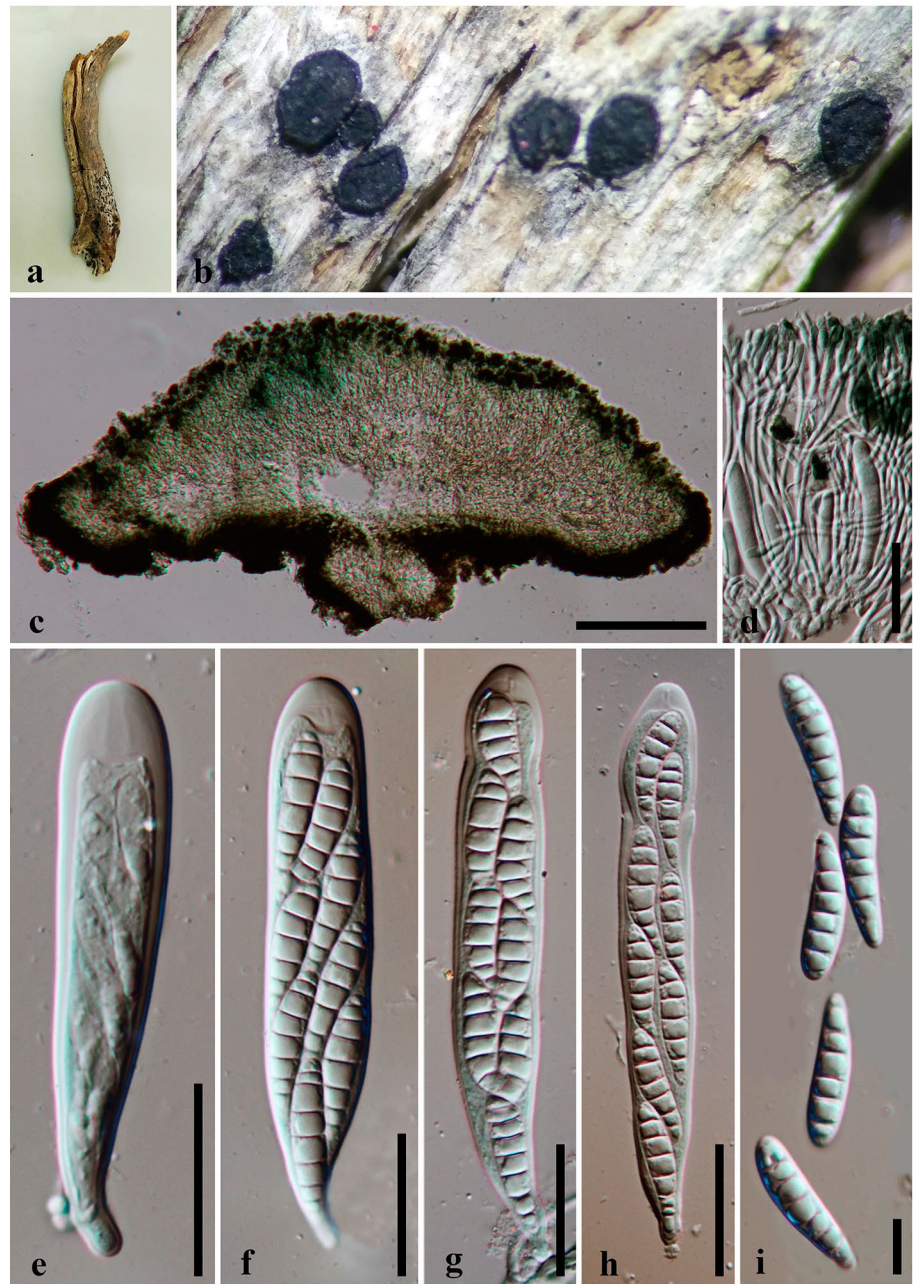
Species of the Patellariales are saprobes on bark or wood, although some are lichenized (Jones et al. 2015). Ascostromata are apothecial. Pseudoparaphyses are initially attached to both the base and apex, but later become free at the apex. Asci are cylindrical-clavate and ascospores are mostly fusoid (Kutorga and Hawksworth 1997). Some species have apothecia-like and diplodia-like asexual morphs (Yacharoen et al. 2015), but these are rarely observed. Species are frequently found in terrestrial habitats and occasionally in aquatic habitats (Kirk et al. 2008; Jones et al. 2015). Multi-gene phylogenetic study on this group was provided by Pem et al. (2018). Phylogenetic placement of genera in this order are shown in Fig. 62. The divergence time for Patellariales is estimated as 276 MYA (stem age, Hongsanan et al. 2020).

*Accepted families*: *Patellariaceae*.

***Patellariaceae*** Corda, Icon. fung. (Prague) 2: 37 (1838).



**Fig. 63** *Patellaria atrata* (MFLU 18-1818). **a** Substrate. **b** Apothecia on wood. **c** Cross section of an apothecium. **d** Filiform paraphyses. **e–g, h** Cylindrical asci. **i** Clavate ascospores. Scale bars: **e** = 100  $\mu$ m, **d** = 50  $\mu$ m, **e–h** = 75  $\mu$ m, **i** = 10  $\mu$ m



*Index Fungorum* number: IF 81111; *Facesoffungi* number: FoF 00342, 143 species.

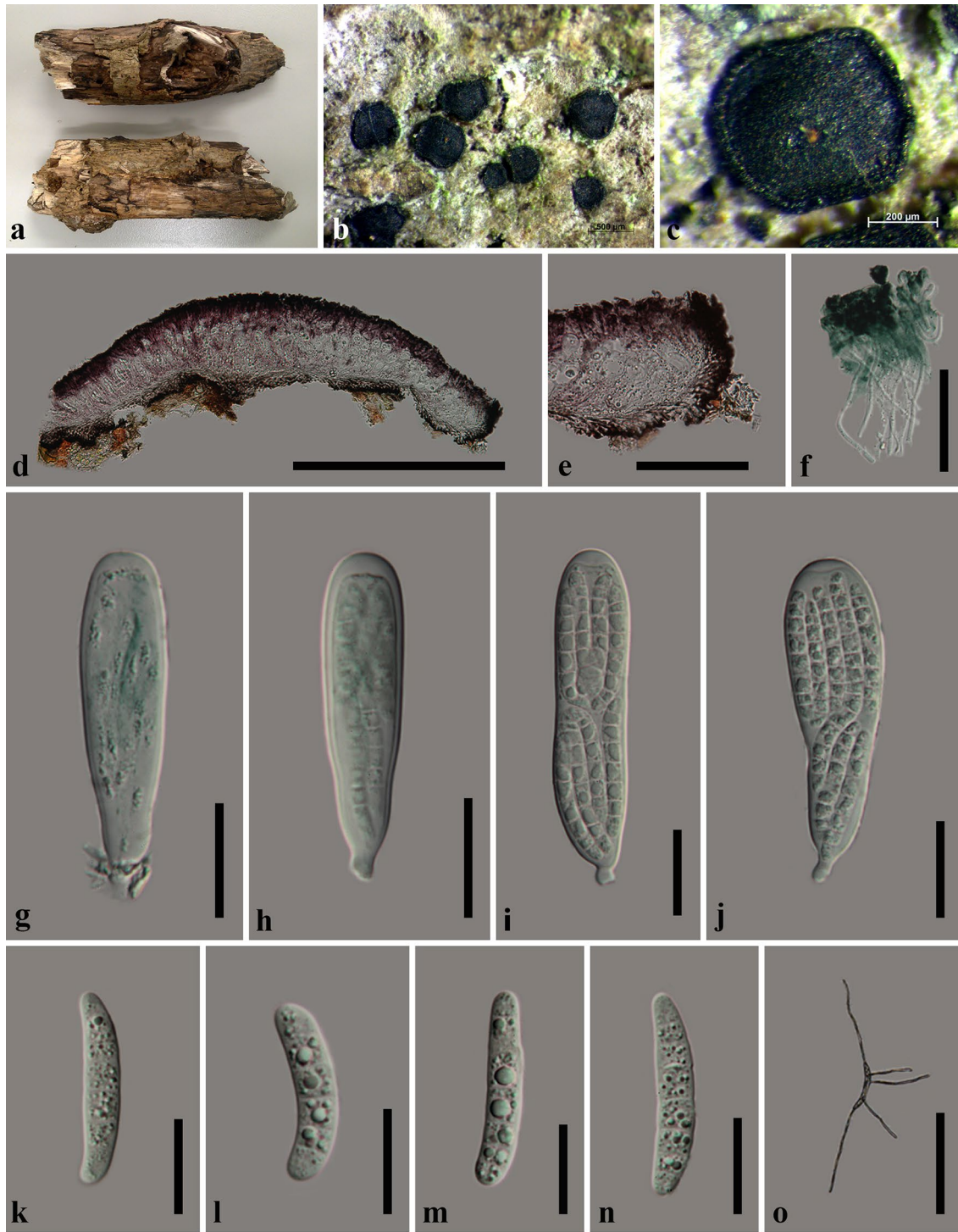
**Sexual morph:** *Apothecia* sessile, black, circular, humidity sensitive and turn into hysterothecia when dry. *Ectal excipulum* composed of carbonized pseudoparenchymatous tissue. *Hamathecium* comprising paraphysoids or paraphyses, their apices are branched, pigmented and covered by dark exudates. *Asci* cylindrical, fissitunicate and arising from croziers. *Ascospores* overlapping 2–3-seriate, cylindrical, ellipsoid, fusiform, or clavate, hyaline or brown, with septa (Kutorga and Hawksworth 1997; Yacharoen et al. 2015). **Asexual morph:** Coelomycetous (Yacharoen et al. 2015).

*Type: Patellaria* Fr.

*Notes:* *Patellariaceae* was introduced by Corda (1838). The family includes 21 genera and around 52 species (Jaklitsch et al 2016; Wijayawardene et al. 2017a). This is a widely distributed family mostly found on bark or wood as saprobes (Kutorga and Hawksworth 1997; Yacharoen et al. 2015; Jaklitsch et al 2016).

*Patellaria* Fr., *Syst. mycol.* (Lundae) 2(1): 158 (1822).

*Index Fungorum* number: IF 3765; *Facesoffungi* number: FoF 00343; 48 morphological species (Species Fungorum 2020; this study), 4 species with molecular data



**Fig. 64** *Patellaria chromolaenae* (MFLU 16-0578). **a** Substrate. **b** Apothecia on wood. **c** Apothecium on wood, **d**: Cross section of an apothecium (in lacto glycerine). **e** Vertical section of the apothecium at margin (in lacto glycerine). **f** Apically enlarged paraphyses. **g–j**

Cylindrical asci, **k–n** allantoid ascospores. **o** germinating spore. Scale bars: **b** = 500  $\mu$ m, **c** = 200  $\mu$ m, **d** = 300  $\mu$ m, **e** = 70  $\mu$ m, **f** = 40  $\mu$ m, **g–j** = 20  $\mu$ m, **k–n** = 15  $\mu$ m, **o** = 100  $\mu$ m

*Type species: Patellaria atrata* (Hedw.) Fr.

*Notes:* This genus was introduced by Fries (1822) and is characterized by black or dark coloured, sessile or

sub-pedicellate apothecia which appear to be hysterothecia when dry, filiform paraphyses with branched, pigmented apices, cylindrical, fissitunicate asci which arise from croziers,

and hyaline, brown or greenish ascospores (Kutorga and Hawksworth 1997; Yacharoen et al. 2015).

**Patellaria atrata** (Hedw.) Fr., Syst. mycol. (Lundae) 2(1): 158 (1822).

≡ *Lichen atratus* Hedw., Descr. micr.-anal. musc. frond. (Lipsiae) 2: 61 (1789).

*Index Fungorum number*: IF 398671; *Facesoffungi number*: FoF 00344; Fig. 63

*Saprobic* on dead stems. **Sexual morph**: *Apothecia* 600–1000 × 250–350 μm ( $\bar{x}$  = 700 × 270 μm, n = 10) arising singly or in small groups, sessile, erumpent from the substrate, black when fresh. *Receptacle* pulvinate, disc convex, disc and the margins are black in when fresh. *Ectal excipulum* 20–25 μm ( $\bar{x}$  = 22.7 μm, n = 10) a narrow layer, 3–4 cells deep, thick, black cells of subglobose to subangularis. *Medullary excipulum* 10–15 μm ( $\bar{x}$  = 13.5 μm, n = 10) composed of narrow, long, thin-walled, hyaline to brownish cells of *textura porrecta*. *Hymenium* brownish to greenish. *Hamathecium* comprising 2–3 μm wide ( $\bar{x}$  = 2.7 μm, n = 20) at the apex, numerous, filiform, septate, branched and swollen at the apex, apices glued together to form epithecium, paraphyses. *Epithecium* dark green. *Asci* 75–120 × 12–20 μm ( $\bar{x}$  = 101.5 × 17.3 μm, n = 30) 8-spored, short to medium pedicellate, cylindrical to clavate, rounded at the apex, J-, croziers absent at the asci base. *Ascospore* 25–30 × 6–10 μm ( $\bar{x}$  = 28.1 × 6.8 μm, n = 40), partially bi-seriate, upper and lower spores are uni-seriate, sometimes multi-seriate, hyaline, smooth-walled, ellipsoid, 6–7-septate, distinctly more tapered towards the distal end. **Asexual morph**: Undetermined.

*Material examined*: UK, New Forest, on Ulex wood, 9 June 2015, E. B. G. Jones, GJ183 (MFLU 18-1818).

*Notes*: Our collection failed in ascospore germination and DNA extraction. However, characteristics of our collection are similar to the description of *Patellaria atrata* provided by Yacharoen et al. (2015).

**Patellaria chromolaenae** Mapook & K.D. Hyde, in Mapook et al., Fungal Diversity 101: 127 (2020).

*Index Fungorum number*: IF 557350; *Facesoffungi number*: 07836; Fig. 64

*Saprobic* on dead stems. **Sexual morph**: *Apothecia* 622–693 × 108–182 μm ( $\bar{x}$  = 652.2 × 150.4 μm, n = 10) arising singly or in small groups, sessile, erumpent from the substrate, black when fresh. *Receptacle* pulvinate, disc convex, disc and the margins are greenish black when fresh, in lacto glycerin colour change in to magenta. *Excipulum* 18–32 μm ( $\bar{x}$  = 25.1 μm, n = 10) ectal excipulum and medullary excipulum are not clearly separable, ectal excipulum a narrow layer, 3–4 cells deep, thick, greenish black colour cells of subglobose to subangularis, medullary excipulum composed of narrow, long, thin-walled, hyaline to greenish

cells of *textura porrecta*. *Hymenium* hyaline or greenish. *Hamathecium* comprising 1.2–1.8 μm wide ( $\bar{x}$  = 1.5 μm, n = 20), numerous, obtuse, exceed asci in length, apically enlarged and pigmented, apices glued together to form pseudo epithecium, paraphyses. *Asci* 60–80 × 15–20 μm ( $\bar{x}$  = 69.3 × 17.1 μm, n = 30) 8-spored, short pedicellate, cylindrical–globose, rounded at the apex, J–at the ascus apex, croziers absent at the base of asci. *Ascospore* 27–34 × 5.2–6.0 μm ( $\bar{x}$  = 31.5 × 5.8 μm, n = 40), multi-seriate, hyaline to greenish, smooth-walled, amerosporae, allantoid, regularly seven septate. **Asexual morph**: Undetermined

*Material examined*: Thailand, Chiang Rai Province, Mae Fah Luang University, 21 March 2015, A. H. Ekanayaka, HD 016, (MFLU 16-0578).

*GenBank number*: ITS: MW136695, LSU: MW142387, SSU: MW127179

*Notes*: *Patellaria chromolaenae* is originally identified from dead stems of *Chromolaenae odorata*. The dead stem of the present collection was not identified. In the phylogenetic analysis (Fig. 62), our collection grouped with the holotype of *Patellaria chromolaenae* with strong bootstrap support. In our collection of *P. chromolaenae* (MFLU 16-0578), we observed slightly larger apothecia and the ascospores with 7 septa which was not observed in the holotype collection (Mapook et al. 2020).

**Patellaria microspora** Ekanayaka & K.D. Hyde, **sp. nov.**

*Index Fungorum number*: IF 557819; *Facesoffungi number*: FoF 08125; Fig. 65

*Etymology*: The specific epithet *microspora* refers small ascospores.

*Holotype*: MFLU 16-0567.

*Saprobic* on dead stems. **Sexual morph**: *Apothecia* 396–402 × 165–170 μm ( $\bar{x}$  = 395.4 × 167.9 μm, n = 10) arising singly or in small groups, sessile, erumpent from the substrate, black when fresh. *Receptacle* turbinate, disc slightly convex, disc and the margins are black when fresh. *Ectal excipulum* 15–21 μm ( $\bar{x}$  = 16.7 μm, n = 10) a narrow layer, 3–4 cells deep, thick, black colour cells of subglobose to subangularis. *Medullary excipulum* 22–30 μm ( $\bar{x}$  = 27.1 μm, n = 10) composed of narrow, long, thin-walled, hyaline to brownish cells of *textura porrecta*. *Hymenium* brownish. *Hamathecium* 1.3–1.8 μm wide ( $\bar{x}$  = 1.5 μm, n = 20), numerous, filiform towards the apex, branched, septate, paraphyses. *Asci* 27–38 × 6.2–7.0 μm ( $\bar{x}$  = 30.6 × 6.8 μm, n = 30), 8-spored, short to medium pedicellate, cylindrical to clavate, rounded at the apex, asci become orange to brown with the presence of Meltzer's reagent, croziers absent at the base of asci. *Ascospores* 19.2–20.3 × 8.7–9.5 μm ( $\bar{x}$  = 19.88 × 9.21 μm, n = 40), partially bi-seriate, lower spores are uni-seriate, hyaline, smooth-walled, ellipsoid, regularly eight septate, distinctly more tapered towards the distal end. **Asexual morph**: Undetermined



**Fig. 65** *Patellaria microspora* (MFLU 16-0567, holotype). **a** Substrate. **b** Apothecia on wood. **c** Apothecium on wood. **d** Cross section of an apothecium. **e** Vertical section of the apothecium at margin. **f** Ectal excipular hypha. **g–i** Cylindrical asci. **j** Reaction of the ascus

in the Meltzer's reagent. **k** Septate and branched paraphyses. **l** Germinated spore. **m–p** clavate ascospores. Scale bars: **b** = 500 µm, **c** = 200 µm, **d** = 100 µm, **e**, **i**, **j** = 50 µm, **f** = 40 µm, **g**, **h**, **l** = 30 µm, **k**, **m–p** = 20 µm

**Material examined:** UK, Lulworth Cove, Dorset, 5 February 2015, E. B. G. Jones, GJ95082 (MFLU 16-0567, **holotype**).

**GenBank number:** ITS: MW136696, LSU: MW142388.

**Note:** *Patellaria microspora* is phylogenetically related to *P. atrata*. However, *P. atrata* has larger ascospores (Yacharoen et al. 2015).

#### Other genera included

**Baggea** Auersw., Hedwigia 5: 1 (1866).

**Index Fungorum number:** IF 491; **Facesoffungi number:** FoF 00345; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Baggea pachyascus* Auersw., Hedwigia 5: 1 (1866).

**Note:** *Baggea* is characterized by apothecial or hysterothecia-like ascomata, polysporous asci and allantoid ascospores (Yacharoen et al. 2015).

**Banhegyia** L. Zeller & Tóth, Sydowia 14: 326 (1960).

**Index Fungorum number:** IF 509; **Facesoffungi number:** FoF 00601; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Banhegyia setispora* L. Zeller & Tóth, Sydowia 14: 327 (1960).

**Note:** *Banhegyia* is characterized by apothecia-like ascomata, bitunicate asci and epithecium formed from pseudo-paraphyses, and 8-spored, bitunicate, subglobose to obovoid asci (Yacharoen et al. 2015).

**Colensoniella** Hafellner, Beihefte zur Nova Hedwigia 62: 160 (1979).

**Index Fungorum number:** IF 1172; **Facesoffungi number:** FoF 08126; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Colensoniella torulispora* (W. Phillips) Hafellner, Beihefte zur Nova Hedwigia 62: 160 (1979).

≡ *Patellaria torulispora* W. Phillips, Grevillea 15(no. 73): 16 (1886).

**Note:** *Colensoniella* is characterized by superficial apothecia with raised margins, 8-spored asci, and oblong ascospores which break into two part-spores at maturity (Tian et al. 2014).

**Endotryblidium** Petr., Sydowia 13 (1–6): 244 (1959).

**Index Fungorum number:** IF 1812; **Facesoffungi number:** FoF 00347; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Endotryblidium insculptum* (Cooke) Petr., Sydowia 13 (1–6): 245 (1959).

≡ *Triblidium insculptum* Cooke [as ‘Tryblidium’], Grevillea 4(no. 32): 182 (1876)

**Note:** *Endotryblidium* is characterized by apothecia aggregated on the host, a pseudoparenchymatous peridium, 4–6-, rarely 8-spored, short pedicellate, clavate asci, numerous filamentous paraphyses and oblong to ellipsoidal ascospores (Yacharoen et al. 2015).

**Glyphium** Nitschke ex F. Lehm., Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur.: 139 (1886).

**Index Fungorum number:** IF 2095 **Facesoffungi number:** FoF 08127; – 6 morphological species (Species Fungorum 2020), 2 species with molecular data.

**Type species:** *Glyphium dolabriforme* (Wallr.) F. Lehm.: 139 (1886).

≡ *Lophium dolabriforme* Wallr., Fl. crypt. Germ. (Norimbergae) 2: 433 (1833).

**Note:** *Glyphium* is characterized by erect, carbonaceous ligulate to dolabrate ascomata that are strongly laterally compressed and dehisce along a longitudinal slit (Boehm et al. 2015).

**Haematomyxa** Sacc., Botanisches Centralblatt 18: 250 (1884).

**Index Fungorum number:** IF 2198; **Facesoffungi number:** FoF 08128; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Haematomyxa vinosa* (Cooke & Ellis) Sacc., Sylloge Fungorum 8: 646 (1889).

≡ *Haematomyces vinosus* Cooke & Ellis, Grevillea 4(no. 32): 179 (1876).

**Note:** *Haematomyxa* is characterized by subglobose, gelatinous apothecia, broadly clavate, 8-spored asci, and muriform, brown ascospores (Seaver 1951).

**Holmiella** Petrini, Samuels & E. Müll., Berichte der Schweizerischen Botanischen Gesellschaft 89: 83 (1979).

**Index Fungorum number:** IF 2344; **Facesoffungi number:** FoF 00349; – 4 morphological species (Species Fungorum 2020), 3 species with molecular data.

**Type species:** *Holmiella sabina* (De Not.) Petrini, Samuels & E. Müll., Berichte der Schweizerischen Botanischen Gesellschaft 89: 84 (1979).

≡ *Triblidium sabinum* De Not. [as ‘Tryblidium’], Comm. Soc. crittog. Ital. 2(fasc. 3): 491 (1867).

**Note:** *Holmiella* is characterized by globose, black apothecia, filamentous, septate pseudoparaphyses, bitunicate, clavate asci and clavate to ellipsoidal, 1-septate ascospores (Yacharoen et al. 2015).

**Hysteropatella** Rehm, Rabenhorst’s Kryptogamen-Flora, Pilze - Ascomyceten 1(3): 367 (1890).

**Index Fungorum number:** IF 2469; **Facesoffungi number:** FoF 00351; – 7 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species: Hysteropatella prostii* (Duby) Rehm, Rabenhorst's Kryptogamen-Flora, Pilze - Ascomyceten 1(3): 367 (1890).

≡ *Hysterium prostii* Duby, Mém. Soc. Phys. Hist. nat. Genève 16(1): 38 (1861) [1862].

*Note: Hysteropatella* is characterized by hysterothecial ascomata, carbonaceous excipulum, bitunicate asci and reniform to ellipsoid or fusoid, 3-septate ascospores (Yacharoen et al. 2015).

***Hysteropeltella*** Petr., Annales Mycologici 21 (1–2): 9 (1923).

*Index Fungorum number:* IF 2470; *Facesoffungi number:* FoF 00352; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Hysteropeltella moravica* Petr., Annales Mycologici 21 (1–2): 10 (1923).

*Note: Hysteropeltella* is characterized by apothecial ascomata, bitunicate asci and hyaline ascospores with a sheath (Yacharoen et al. 2015).

***Lahmiomyces*** Cif. & Tomas., Atti Ist. bot. Univ. Lab. crittog. Pavia, sér. 5 10: 39, 66 (1953).

*Index Fungorum number:* IF 2632; *Facesoffungi number:* FoF 08129; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Lahmiomyces piceae* Cif. & Tomas., Atti Ist. bot. Univ. Lab. crittog. Pavia, sér. 5 10(2–3): 270 (1953).

*Note:* Jaklitsch et al. (2016) treated *Lahmiomyces* as a genus in *Patellariaceae*.

***Lecanidiella*** Sherwood, Sydowia 38: 272 (1986).

*Index Fungorum number:* IF 25053; *Facesoffungi number:* FoF 00353; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Lecanidiella contortae* Sherwood, Sydowia 38: 274 (1986).

*Note: Lecanidiella* is characterized by apothecia, erumpent, black, serrated at the rim, a brown and powdery epithecium, bitunicate asci, and 3-septate ascospores (Yacharoen et al. 2015).

***Lirellodisca*** Aptroot, Nova Hedwigia 67: 485 (1998).

*Index Fungorum number:* IF 27901; *Facesoffungi number:* FoF 00355; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Lirellodisca pyrenulispota* Aptroot, Nova Hedwigia 67: 485 (1998).

*Note: Lirellodisca* is characterized by subglobose, deeply cup-shaped apothecia, filamentous, individual, apically branched, hyaline pseudoparaphyses and thick-walled disseptate ascospores (Yacharoen et al. 2015).

***Murangium*** Seaver, The North American Cup-fungi (Inoperculates) (3): 367 (1951).

*Index Fungorum number:* IF 3289; *Facesoffungi number:* FoF 00357; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Murangium sequoiae* (Plowr.) Seaver, The North American Cup-fungi (Inoperculates) (3): 368 (1951).

≡ *Cenangium sequoiae* Plowr., Grevillea 7(no. 41): 23 (1878).

*Note: Murangium* is characterized by cup-shaped apothecia, bitunicate asci and muriform ascospores (Yacharoen et al. 2015).

***Poetschia*** Körb., Parerga lichenologica. Ergänzungen zum Systema lichenum Germaniae: 280 (1861).

*Index Fungorum number:* IF 4289; *Facesoffungi number:* FoF 00359; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Poetschia buellioides* Körb., Parerga lichenologica. Ergänzungen zum Systema lichenum Germaniae: 280 (1861).

*Note: Poetschia* is characterized by globose, black apothecial ascomata, pseudoparenchymatous excipulum, obovoid, clavate asci and ellipsoidal to obovoid, 1-septate ascospores (Yacharoen et al. 2015).

***Pseudoparodia*** Theiss. & Syd., Annl. mycol. 15 (1–2): 138 (1917).

*Index Fungorum number:* IF 4466; *Facesoffungi number:* FoF 00377; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Pseudoparodia pseudopeziza* (Pat.) Theiss. & Syd., Sydowia 1 (4–6): 169 (1947).

≡ *Parodiella pseudopeziza* Pat., in Patouillard & Lagerheim, Bull. Herb. Boissier 3(1): 67 (1895).

*Note: Pseudoparodia* is characterized by apothecia which are superficial and swollen, with dense pseudoparaphyses forming epithecium above the asci (Yacharoen et al. 2015).

***Rhizodiscina*** Hafellner, Beihefte zur Nova Hedwigia 62: 195 (1979).

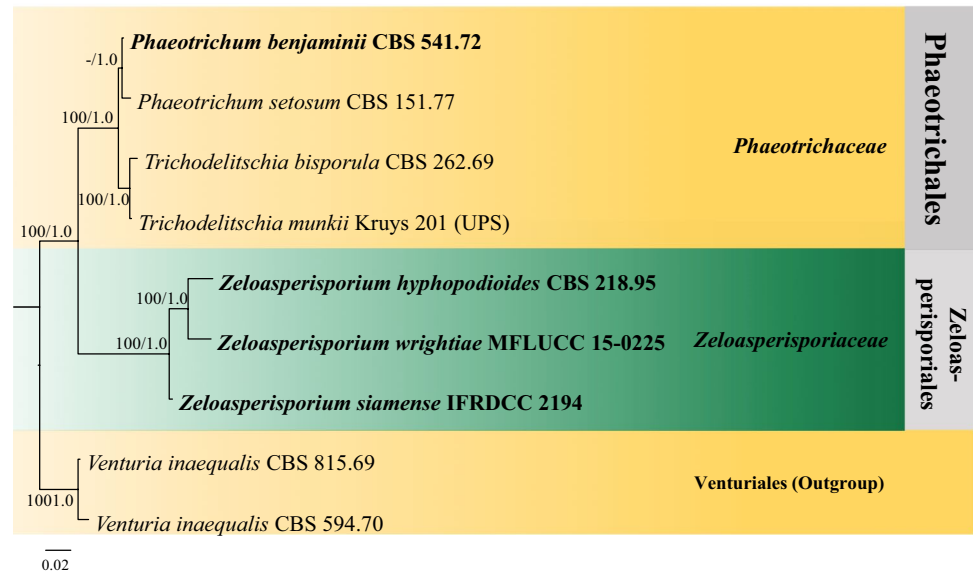
*Index Fungorum number:* IF 4709; *Facesoffungi number:* FoF 00361; – 2 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Rhizodiscina lignyota* (Fr.) Hafellner, Beihefte zur Nova Hedwigia 62: 195 (1979).

≡ *Peziza lignyota* Fr., Syst. mycol. (Lundae) 2(1): 150 (1822).

*Note: Rhizodiscina* is characterized by apothecial ascomata, massive exciple and bitunicate asci (Yacharoen et al. 2015).

**Fig. 66** Phylogram generated from maximum likelihood analysis (RAxML) of Phaeotrichales based on LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%. Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. Isolate/specimen number is noted after the species name. The tree is rooted to *Venturia inaequalis* (CBS 815.69 and CBS 594.70). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



**Rimula** Velen., Monographia Discomycetum Bohemiae: 38 (1934).

*Index Fungorum number*: IF 4756; *Facesoffungi number*: FoF 08130; – 28 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Rimula faginea*** Velen., Monogr. Discom. Bohem. (Prague): 38 (1934).

*Note*: Jaklitsch et al. (2016) treated *Rimula* as a genus in *Patellariaceae*.

**Schrakia** Hafellner, Nova Hedwigia, Beihefte zur 62: 204(1979).

*Index Fungorum number*: IF 4917; *Facesoffungi number*: FoF 00363; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Schrakia crassula*** (Starbäck) Hafellner, Nova Hedwigia, Beihefte zur. 62: 204 (1979).

≡ *Karschia crassula* Starbäck, Bih. K. svenska VetenskAkad. Handl., Afd. 3 25(no. 1): 10 (1899).

*Note*: The characters of this genus are typical of *Patellariaceae* and characterised by carbonaceous apothecia and exciple with thick-walled and pseudoparenchymatous cells and bitunicate asci (Yacharoen et al. 2015).

**Stratisporella** Hafellner, Beihefte zur Nova Hedwigia 62: 207 (1979).

*Index Fungorum number*: IF 20613; *Facesoffungi number*: FoF 00365; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Stratisporella epismoides*** (Nyl.) Hafellner, Beih. Nova Hedwigia 62: 207 (1979).

≡ *Lecidea epismoides* Nyl., Bull. Soc. linn. Normandie, sér. 2 2: 515 (1868).

*Note*: Taxa form apothecioid ascomata and are characterized by carbonaceous excipulum, unitunicate asci and 1-septate ascospores with thick exospores (Yacharoen et al. 2015).

**Tryblidaria** (Sacc.) Rehm, *Hedwigia* 42(Beibl.): (172) (1903).

≡ *Blitridium* subgen. *Tryblidaria* Sacc., Syll. fung. (Abellini) 8: 805 (1889).

*Index Fungorum number*: IF 5620; *Facesoffungi number*: FoF 00367; – 27 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Tryblidaria fenestrata*** (Cooke & Peck) M.E. Barr, Bulletin of the New York State Museum 459: 22 (1986).

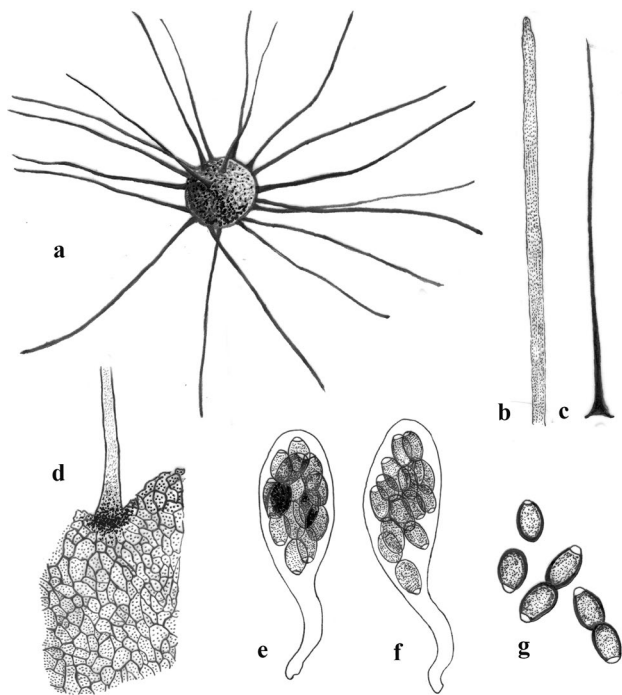
≡ *Patellaria fenestrata* Cooke & Peck, Ann. Rep. N.Y. St. Mus. nat. Hist. 28: 68 (1876) [1875].

*Note*: *Tryblidaria* taxa are saprobic and mostly found in terrestrial, subtropical environments. Sexual morphs are apothecial cupulate and carbonaceous (Yacharoen et al. 2015). Asexual morphs are undetermined (Yacharoen et al. 2015).

#### Economic and ecological significance

*Patellariaceae* is a widely distributed family. Most *Patellariaceae* taxa are saprobes and weak parasites on a wide variety of plants. Few members are recorded on lichen thalli. Rarely reported endophytic and fungicolous life styles are also known. For example, *Rhizodiscina lignyota* was recorded from Basidiomycetes and *Holmiella sabina* was recorded from living needles and wood of *Juniperus* spp. (Kutorga and Hawksworth 1997).

**Phaeotrichales** Ariyaw., Jian K. Liu & K.D. Hyde, in Hyde et al.



**Fig. 67** *Phaeotrichum hystricinum* (redrawn from Cain 1956). **a** Ascomata with black appendages. **b, c** Appendages. **d** Black and opaque basal appendages. **e, f** Asci. **g** Ascospores

*Index Fungorum number*: IF 805301; *Facesoffungi number*: FoF 08131.

Phaeotrichales was introduced by Hyde et al. (2013) to accommodate *Phaeotrichum* as the type genus. Phaeotrichales is considered an order of coprophilous fungi within the class Dothideomycetes. Species in this order are characterized by unilocular, stromatic, globose ascomata with a thin, carbonaceous peridium and dark brown to reddish brown ascospores with terminal germ pores (Hyde et al. 2013). According to the recent outline of Wijayawardene et al. (2018), only a single family (*Phaeotrichaceae*) is placed in Phaeotrichales. Phylogenetic placement of genera in this order are shown in Fig. 66. The divergence time for Phaeotrichales is estimated as 229 MYA (stem age, Hong-sanan et al. 2020).

*Accepted families*: *Phaeotrichaceae*.

***Phaeotrichaceae*** Cain, Can. J. Bot. 34: 676 (1956).

*Index Fungorum number*: IF 81144; *Facesoffungi numbers*: FoF 08131, 11 species.

*Saprobic* (coprophilous) in terrestrial habitats. **Sexual morph**: Ascomata superficial, solitary, or in small groups, dark brown to black, globose, stromatic, perithecial or cleistothecial setose. *Peridium* thin-walled, carbonaceous, membranous. *Hamathecium* comprising tissue absent or of evanescent cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, clavate, pedicellate, in irregular

or arranged in little groups or bundles and evanescent at maturity. *Ascospores* overlapping, dark brown to reddish brown, sometimes fragmenting, composed of terminal germ pores, with or without a sheath. **Asexual morph**: Unknown (adapted from Hyde et al. 2013).

*Type*: *Phaeotrichum* Cain & M.E. Barr.

*Notes*: *Phaeotrichaceae* was introduced by Cain (1956) to accommodate a single genus *Phaeotrichum*, characterized by dark brown, septate ascospores with terminal germ pores. Two coprophilous species were described, *P. hystricinum* (type species) and *P. circinatum* from porcupine dung and lemming dung, respectively. Cain (1956) pointed out some morphological similarities of *Phaeotrichum* with *Trichodelitschia* species based on features of the ascospores and setose ascomata. Lundqvist (1964) assigned *Trichodelitschia* to *Phaeotrichaceae*. The family comprises three genera, *Echinoascotheca*, *Phaeotrichum* and *Trichodelitschia* (Zhang et al. 2012; Hyde et al. 2013).

***Phaeotrichum*** Cain & M.E. Barr, Can. J. Bot. 34: 676 (1956).

*Index Fungorum number*: IF 3967; *Facesoffungi number*: FoF 08132; 5 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species*: *Phaeotrichum hystricinum* Cain & M.E. Barr.

*Notes*: *Phaeotrichum* was introduced by Cain (1956) to accommodate two coprophilous species, *P. hystricinum* and *P. circinatum*. *Phaeotrichum* species are characterized by dark brown, septate ascospores with terminal germ pores, superficial cleistothecial ascomata covered by long hairy appendages and a coprophilous habitat (Cain 1956). *Phaeotrichum* contains only five species (Index Fungorum 2020). Four species occur in dung and one from soil: *P. benjaminii* (on dung of *Rodentia*), *P. circinatum* (on dung of *Lemmini*), *P. cylindrosporum* (on dung of *Erythizon dorsatus*), *P. hystricinum* (on dung of porcupine) and *P. setosum* (from soil) (Fig. 67).

**Other genera included:**

***Echinoascotheca*** Matsush., Matsush. Mycol. Mem. 8: 19 (1995).

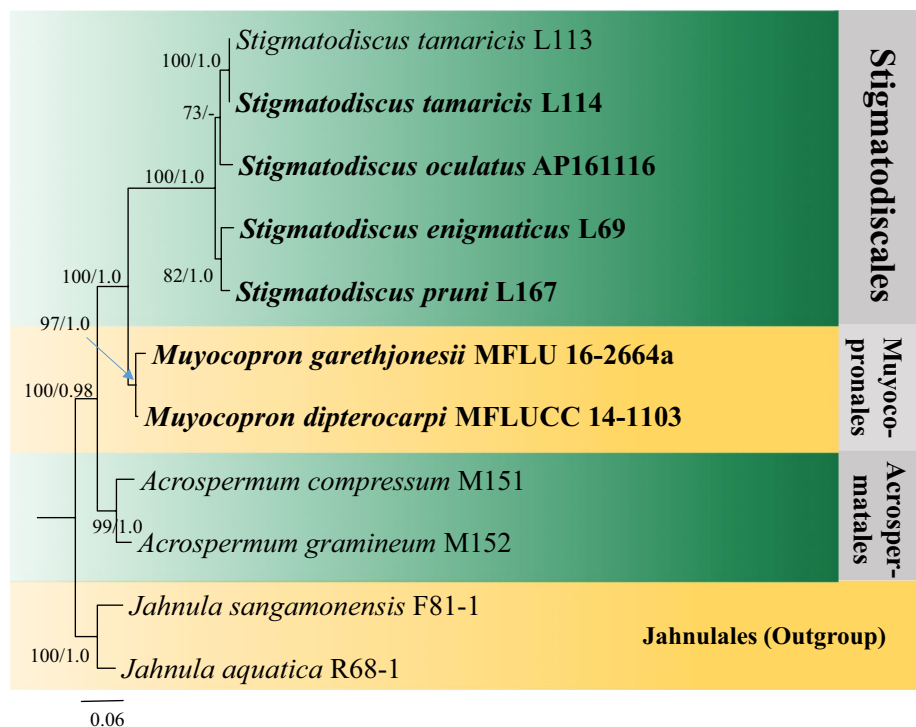
*Index Fungorum number*: IF 27584; *Facesoffungi number*: FoF 08133; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Echinoascotheca duploiformis* Matsush., Matsush. Mycol. Mem. 8: 19 (1995).

*Notes*: *Echinoascotheca* is a monotypic genus (Species Fungorum 2020). *Trichodelitschia* species differ from *Echinoascotheca* in having an apical ring in asci (Hyde et al. 2013). For more details on morphology of *Echinoascotheca* species see Matsushima (1995).



**Fig. 68** Phylogram generated from maximum likelihood analysis (RAxML) of *Stigmatodisciales* based on ITS, LSU, SSU and *tef1* sequence data. Maximum likelihood bootstrap values equal or above 70%. Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. Isolate/specimen number is noted after the species name. The tree is rooted to *Jahnula aquatica* (R68-1) and *J. sangamonensis* (F81-1). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



*Trichodelitschia* Munk, Dansk bot. Ark. 15(no. 2): 109 (1953).

*Index Fungorum number*: IF 5552; *Facesoffungi number*: FoF 08134; – 5 morphological species (Species Fungorum 2020), 2 species molecular data.

*Type species*: *Trichodelitschia bisporula* (P. Crouan & H. Crouan) Munk, Dansk bot. Ark. 15(no. 2): 109 (1953).

≡ *Hormospora bisporula* P. Crouan & H. Crouan, Florule Finistère (Paris): 21 (1867).

*Notes*: *Trichodelitschia* was erected by Munk (1953) to accommodate *Trichodelitschia bisporula*, which was previously known as *Hormospora bisporula*. Initially, *Trichodelitschia* was placed in *Sporormiaceae* by Munk (1957), but later Lundqvist (1964) suggested it be transferred to *Phaeotrichaceae*. *Trichodelitschia* species are characterized by having dark thick-walled spiny appendages, dark two-celled ascospores with hyaline to subhyaline tenninal apophyses and circular germ pores at the spore apices (Ebersohn and Eicker 1992). Five *Trichodelitschia* species are accepted in Species Fungorum (2020), i.e. *T. adelphica*, *T. bisporula*, *T. lundqvistii*, *T. microspora*, and *T. munkii*.

### Economic and ecological significance

Most *Phaeotrichaceae* species have been recorded on dung of various animals as saprobes.

**Stigmatodisciales** Voglmayr & Jaklitsch, in Voglmayr, Gardiennet & Jaklitsch.

*Index Fungorum number*: IF 815325; *Facesoffungi number*: FoF 08771.

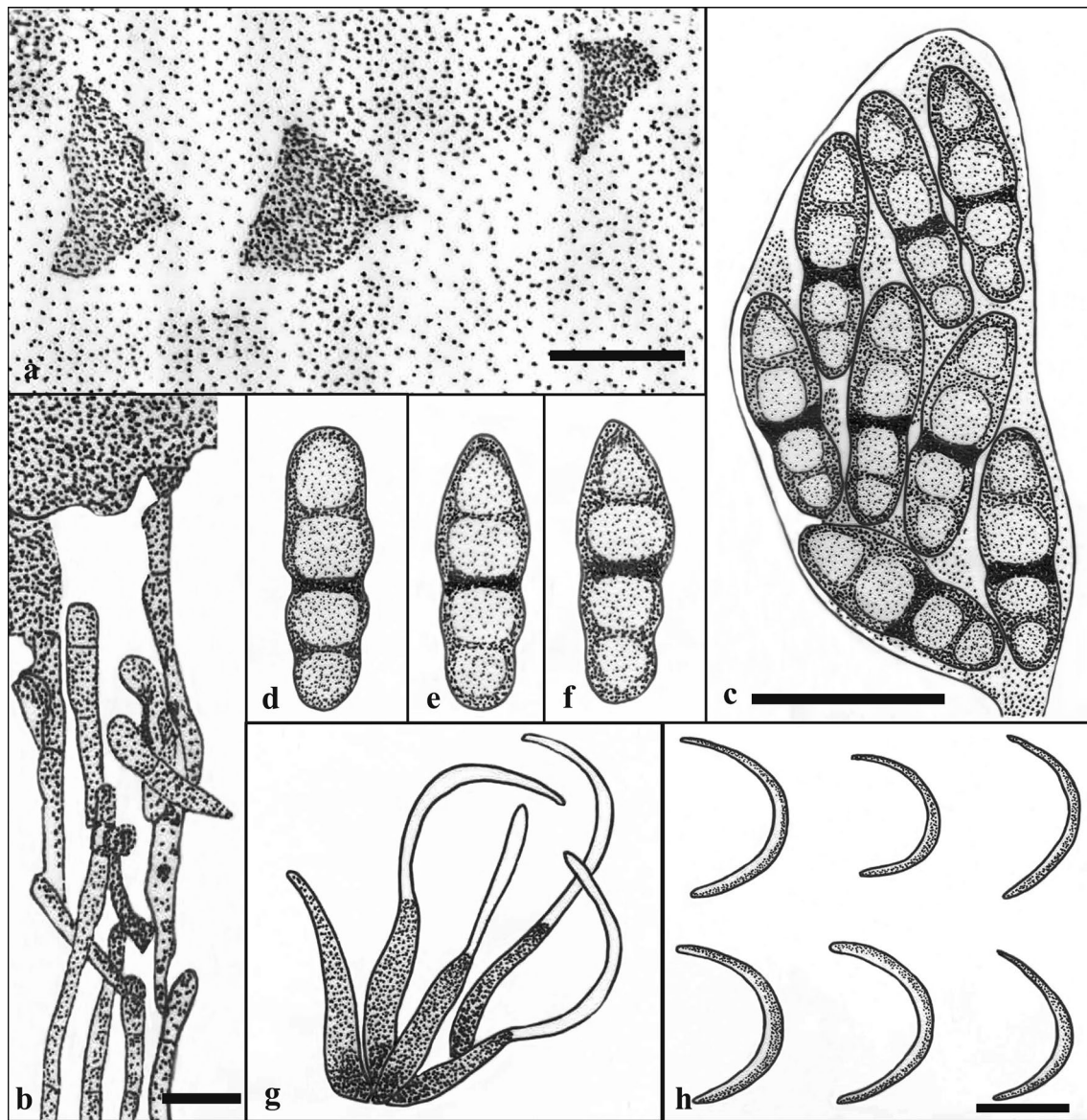
This order was established by Voglmayr et al. (2016) to accommodate a single family, *Stigmatodiscaceae*. Two genera (*Asterodiscus* and *Stigmatodiscus*) were included in the family based on differences in ascomatal shape and hyaline versus brown ascospores. However, Voglmayr and Amengual (2018) synonymized *Asterodiscus* under *Stigmatodiscus*. Our phylogenetic tree (Fig. 68) indicates the same result as in Voglmayr and Amengual (2018) which supports *Stigmatodisciales* as a distinct order in Dothideomycetes. The divergence time for *Stigmatodisciales* is estimated as 114 MYA (stem age, Hongnan et al. 2020).

*Accepted families*: *Stigmatodiscaceae*.

**Stigmatodiscaceae** Voglmayr & Jaklitsch, in Voglmayr et al., Fungal Diversity 80: 275 (2016): 77 (1903).

*Index Fungorum number*: IF 815326; *Facesoffungi numbers*: FoF 08772, 6 species species.

On dead twigs. **Sexual morph**: *Ascomata* apothecoid, embedded in cortex of dead twigs, dark brown to black, without distinct margin. *Hamathecium* comprising septate, unbranched or rarely branched and anastomosing above, with swollen free apical ends, paraphyses, embedded in a rubber-like gel matrix and covered by an epithecium. *Hymenial gel* I-. *Asci* 8-spored, bitunicate, fissitunicate, J-, variable in shape from fusoid to saccate or clavate to broadly fusiform broadly, with thin ecto- and thick endotunica, with wide ocular chamber, without a ring. *Ascospores* 2–3-seriate,



**Fig. 69** *Stigmatodiscus enigmaticus* (redrawn from Voglmayr et al. 2016). **a** Ascogonia erupting from bark in face view. **b** Paraphyses. **c** Ascus, **d–f** Ascospores. **g** Phialides producing conidia. **h** Falcate

conidia. Notes: **a, b, d–f** from WU 35914 (holotype), **c** from WU 35925, **g** from WU 35925, **h** from WU 35922

slightly to strongly asymmetric, broadly fusiform, upper cell broader, with broadly rounded, hyaline to brown, 1-euseptate when immature, with 2 distosepta at maturity, slightly to strongly constricted at the septum, particularly the middle septum, surrounded by a separate gelatinous sheath. **Asexual morph:** Coelomycetous. *Conidiomata* in nature immersed, peridermal, pycnidial (adapted from Voglmayr et al. 2016).

**Type:** *Stigmatodiscus* Voglmayr & Jaklitsch.

**Notes:** Voglmayr et al. (2016) established *Stigmatodiscaceae* to accommodate two genera, *Asterodiscus* and *Stigmatodiscus*, with two new species, *Asterodiscus tamaricis* and *Stigmatodiscus enigmaticus* based on phylogenetic

placement and morphological characters. However further phylogenetic analyses in Voglmayr and Amengual (2018) with additional strains indicated that *Asterodiscus* should be synonymized under *Stigmatodiscus*. Thus, *Stigmatodiscaceae* currently comprises only *Stigmatodiscus*.

***Stigmatodiscus*** Voglmayr & Jaklitsch, in Voglmayr et al., *Fungal Diversity* 80: 278 (2016).

**Index Fungorum number:** IF 815327; **Facesoffungi number:** FoF 01654; 6 morphological species (Species Fungorum 2020), 6 species with molecular data.

= *Asterodiscus* Voglmayr, Gardiennet & Jaklitsch, Fungal Diversity 80: 275 (2016)

*Type species: Stigmatodiscus enigmaticus* Voglmayr & Jaklitsch.

*Notes:* *Stigmatodiscus* was placed in *Stigmatodiscaceae* based on morphology and phylogeny. Four new species were added to this genus by Voglmayr et al. (2017) and Voglmayr and Amengual (2018). *Asterodiscus* was also synonymized under *Stigmatodiscus* based on sequence data of *A. tamaricis* that formed among other *Sigmatodiscus* species (Voglmayr and Amengual 2018). Six species are accepted in this genus based on both morphology and phylogeny. Sequence data are available for all *Sigmatodiscus* species.

*Stigmatodiscus enigmaticus* Voglmayr & Jaklitsch, in Voglmayr et al., Fungal Diversity 80: 278 (2016).

*Index Fungorum number:* IF 815328; *Facesoffungi number:* FoF08773; Fig. 69

*Description:* see Voglmayr et al. (2016).

### Economic and ecological significance

Species in this genus were found on dead twigs and we assume that they are saprobic.

### Strigulales Lücking, M.P. Nelsen & K.D. Hyde.

*Index Fungorum number:* IF 805302; *Facesoffungi number:* FoF 08774.

The order was established by Hyde et al. (2013) to accommodate lichenized fungi in Dothideomycetes. Members of Strigulales differ from most Trypetheliales in having euseptate ascospores with few septa and the lack of secondary chemistry (Hyde et al. 2013). It also differs from Monoblastiales in having unbranched physes and the macroconidia producing gelatinous appendages (Hyde et al. 2013). Two families are accepted in this order. The divergence time for Strigulales is estimated as 201 MYA (stem age, Hongsanan et al. 2020).

*Accepted families:* *Strigulaceae*, *Tenuitholiascaceae*.

*Strigulaceae* Zahlbr. in Engler, Syllabus, Edn 2 (Berlin): 46 (1898).

*Mycobank number:* MB 81870; *Index Fungorum number:* IF 81870; *Facesoffungi number:* FoF 08853; approximately 80 species (Lücking et al. 2017).

= *Phyllobatheliaceae* Bitter & F. Schill., Hedwigia, Beibl. 67: 272 (1927). *Type: Phyllobathelium* (Müll. Arg.) Müll. Arg., Flora, Regensburg 73: 195 (1890).

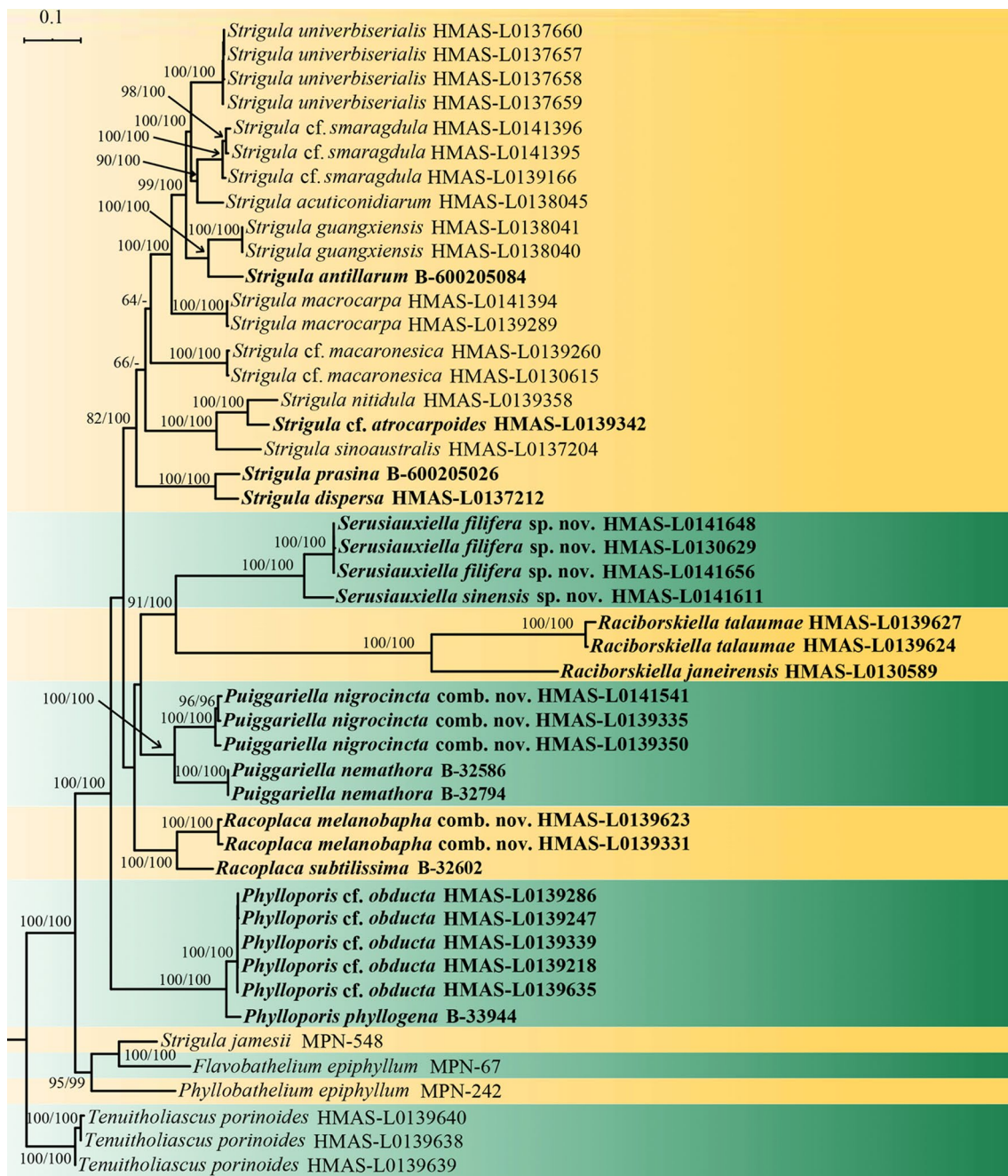
*Lichenized* on leaves, bark or rocks in terrestrial, chiefly lowland to montane tropical to subtropical habitats, with few species extending into temperate regions. *Thallus* reduced and ecorticate, often white, to (pseudo-)corticate, grey-green to bright green, sometimes with metallic appearance. *Photobiont Trentepohlia sensu lato* (including

*Cephaleuros* and *Phycopeltis*). **Sexual morph:** *Ascomata* perithecia, scattered, clustered, or aggregated in pseudostromata, immersed to prominent (to rarely sessile), mostly brown or black, rarely pale, often at least partly covered by thallus, globose to pear-shaped or conical, coriaceous to carbonaceous, ostiolate, ostiole round. *Involucrellum* present in some genera, usually carbonized. *Excipulum* dense, consisting of compressed hyphae, appearing prosoplectenchymatous in thin sections, but structure may be difficult to observe due to carbonization, hyaline to brown or brown-black. *Hamathecium* comprising 0.5–0.7(–1.5)  $\mu\text{m}$  wide paraphyses, hyaline, flexuous, unbranched or branched to sparsely anastomosing. *Asci* (1–)8-spored, bitunicate, fissitunicate, obclavate to mostly cylindrical, shortly pedicellate, with narrow to somewhat broader, ocular chamber, non-amyloid. *Ascospores* irregularly arranged to uni- or biseriata, fusiform to ellipsoid, hyaline, septate to muriform, with eusepta and rectangular lumina, smooth-walled, often constricted at the septa. **Asexual morph:** *Pycnidia* common, immersed to erumpent, often visible as black dots, rarely pale and inconspicuous, sometimes in specific, pseudostromatic areas, or whole thalli only producing pycnidia. *Conidia* acrogenous, either macro- or microconidia; macroconidia 1-septate to rarely muriform, ellipsoid to bacillar, sometimes becoming rather large, with variously shaped gelatinous appendages, hyaline; microconidia usually aseptate, fusiform-ellipsoid to bacillar, small, hyaline.

*Chemistry:* Most species do not contain secondary substances. Crystalline anthraquinone pigments are found in *Flavobathelium*.

*Type: Strigula* Fr., Syst. Mycol. 2(2): 535 (1823).

*Notes:* For a general discussion of the family see Lücking & Nelsen in Hyde et al. (2013; *Strigulaceae*). Recently, a new family, *Tenuitholiascaceae*, with the single genus, *Tenuitholiascus*, was established to accommodate a novel lineage sister to *Strigulaceae*, but with a different ascus type (Jiang et al. 2020a). Simultaneously, molecular phylogenetic analysis focusing on a broad set of foliicolous species hitherto assigned to the genus *Strigula* demonstrated that the latter is heterogeneous and can be divided into six genera, all characterized by a combination of morphological and anatomical features (Jiang et al. 2020b). Given that *S. jamesii*, the only non-foliicolous representative of *Strigula sensu lato* sequenced so far, is unrelated to the six foliicolous clades and positioned far from *Strigula sensu stricto* (Fig. 70), here we consequently also reassess the generic classification of non-foliicolous representatives so far placed in this genus. Based on characters of the ascospores and macro- and microconidia, three further genera are recognized: *Phyllocharis* Fée, for the anatomically unique foliicolous taxon, *Strigula orbicularis* Fr.; *Dichoporis* Clem., for non-foliicolous species with 1-septate ascospores, 1-septate macroconidia and chiefly fusiform microconidia; and the newly



**Fig. 70** Best scoring maximum-likelihood tree (also including Bayesian posterior probabilities) of *Strigulaceae* showing the currently recognized and sequenced genera (adapted from Jiang et al. 2020b; see that reference for further details)

established genus *Swinscowia* S.H. Jiang, Lücking & Sérus., for non-foliicolous species with multi-septate to muriform ascospores, multi-septate to muriform macroconidia and chiefly bacillar microconidia. *Dichoporis* is closely related to *Phylloporis* Clem., but we keep the two groups separate largely based on the different substrate and photobiont, as molecular data for foliicolous lineages indicate photobiont preference, to be interpreted as a mycological character of mycobiont-photobiont compatibility, be consistent within a

lineage. The same applies to *Swinscowia* in relation to the foliicolous genus *Phyllocratera* Sérus. & Aptroot.

Both Index Fungorum and MycoBank list *Strigulaceae* A.B. Frank (Frank in Leunis 1877) as valid name for the family, antedating *Strigulaceae* Zahlbr. However, this is not correct. Frank did not publish a new name but cited *Strigulini* Fr., which was originally established as the name of a suborder (Fries 1825). Names cannot be used unchanged at different ranks unless they are descriptive and not

automatically typified (ICN Art. 6, Note 3, and Art. 16.1), and the name *Strigulini* is derived from the genus name *Strigula* and hence automatically typified. Also, the use of names at different ranks, yet unchanged, does not apply to the level of family. Therefore, Frank's use of the name *Strigulini* Fr. as "Familie" (Frank in Leunis 1877: 1699) does not constitute valid publication of a name at family level that is to be corrected with unchanged authorship (ICN 18.4); instead it is to be considered a misapplication of an existing name at a different rank.

***Strigula*** Fr., Syst. Mycol. 2(2): 535 (1823) [nom. sanct.]; Fries, Kongl. Vet.-Akad. Handl. 1821: 323 (1821) [nom. nud.].

*Mycobank number*: MB 5285; *Index Fungorum number*: IF 5285; *Facesoffungi number*: FoF 07706; 30 morphologically delimited species (Jiang et al. 2020b); molecular data available for approximately 15 species (Jiang et al. 2016, 2017a, b, 2020b, Ford et al. 2019; Oh et al. 2019; Woo et al. 2020).

= *Nemathora* Fée, Essai Crypt. Écorc. 1: LVIII, XCIV, XCIX (1825); Santesson, Symb. Bot. Upsal. 12(1): 138 (1952). *Type species*: *Nemathora viridissima* Fée [= *Strigula smaragdula* Fr.].

= *Craspedon* Fée, Essai Crypt. Écorc. 1: LIX, XCIV, C (1825); Santesson, Symb. Bot. Upsal. 12(1): 138 (1952). *Type species*: *Craspedon concretum* Fée [= *Strigula concreta* (Fée) R. Sant.].

= *Melanophthalmum* Fée, Essai Crypt. Écorc. 1: LX, XCIV, C (1825); Santesson, Symb. Bot. Upsal. 12(1): 138 (1952). *Type species*: *Melanophthalmum antillarum* Fée [= *Strigula antillarum* (Fée) Müll. Arg.].

= *Haploblastia* Trevis., Conspectus Verrucarinarum: 16 (1860); Santesson, Symb. Bot. Upsal. 12(1): 138 (1952). *Type species*: *Haploblastia nitidula* (Mont.) Trevis. [= *Strigula nitidula* Mont.].

= *Discosiella* Syd. in Sydow & Sydow, Leaf. Philipp. Bot. 5: 1546 (1912); Eriksson & Hawksworth, Syst. Ascomycetum 11: 56 (1992). *Type species*: *Discosiella cylindropora* Syd. [= *Strigula* sp.].

= *Strigulomyces* [as *Strigulomyces*] Cif. & Tomas., Atti Ist. Bot. Univ. Lab. Crittogam. Pavia, Ser. 5, 10: 61 (1953) [nom. illeg.]; Harris, More Florida Lichens: 152 (1995); Lücking & Hawksworth, Taxon 56: 1274 (2007). *Type species*: *Strigula elegans* (Fée) Müll. Arg. [= *Strigula smaragdula* Fr.].

= *Catenata* Bat. in Batista & Bezerra, Publ. Inst. Micol. Univ. Recife 321: 15 (1961) [nom. inval.]; Lücking et al., Lichenologist 30: 161. (1998). *Original species*: *Catenata antillarum* (Fée) Bat. [= *Strigula antillarum* (Fée) Müll. Arg.].

= *Kilikiostroma* Bat. & J. L. Bezerra, Publ. Inst. Micol. Univ. Recife 321: 13 (1961); Lücking et al., Lichenologist

30: 144 (1998). *Type species*: *Kilikiostroma peresii* Bat. & J. L. Bezerra [= *Strigula prasina* Müll. Arg.].

= *Pycnociliospora* Bat. in Batista et al., Publ. Inst. Micol. Univ. Recife 251: 6 (1962); Lücking et al., Lichenologist 30: 154 (1998). *Type species*: *Pycnociliospora belluciae* Bat. & J. A. Lima [= *Strigula antillarum* (Fée) Müll. Arg.].

= *Porina* sect. *Sagediastrella* Vain., Ann. Acad. Sci. Fenn., Ser. A, 19: 10 (1923); Santesson, Symb. Bot. Upsal. 12(1): 138. 1952. *Type species*: *Porina nitens* Vain. [= *Strigula nitidula* Mont.].

= *Shanoria* Anahosur in Harris, More Florida Lichens: 144 (1995) [nom. inval., non *Shanoria* Subram. & K. Ramakr., non *Shanoria* sensu Anahosur (1967)]. *Original species*: *Shanoria indica* Anahosur [= *Strigula* cf. *nitidula* Mont.].

*Lichenized* on leaves in terrestrial, lowland to montane, tropical to subtropical, and extending into temperate, habitats. *Thallus* (pseudo-)corticate, grey-green to bright green, subcuticular and sometimes damaging the supporting leaf. *Photobiont* *Cephaleuros*. **Sexual morph**: *Ascomata* perithecia, erumpent to prominent, black or covered by thallus layer, lens-shaped to wart-shaped or conical, carbonaceous, ostiolate. *Involucrellum* present, carbonized. *Excipulum* prosoplectenchymatous, dark brown to brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, flexuose, unbranched or very rarely branched and anastomosing. *Asci* usually 8-spored but sometimes appearing 9–16-spored due to ascospores breaking in halves within the asci, bitunicate, fissitunicate, cylindrical to narrowly obclavate, shortly pedicellate, with narrow ocular chamber, non-amyloid. *Ascospores* irregularly arranged to uni- or biseriate, fusiform to ellipsoid or bacillar, hyaline, 1-septate, rarely 3-septate, with thin eusepta and rectangular lumina, smooth-walled, often constricted (and sometimes breaking apart) at the septa. **Asexual morph**: *Pycnidia* common, immersed to erumpent, visible as black dots, rarely in pseudostromatic clusters, often whole thalli only producing pycnidia. *Conidia* acrogenous, either macro- or microconidia; macroconidia mostly 1-septate, ellipsoid to bacillar, with gelatinous appendages, hyaline; microconidia usually aseptate, ellipsoid to fusiform, small, hyaline.

*Chemistry*: No secondary substances known.

*Type species*: ***Strigula smaragdula*** Fr., Linnaea 5: 550 (1830).

*Notes*: *Strigula* as here defined includes the bulk of foliicolous species centered around *S. smaragdula*, after separation of the genera *Dichoporis*, *Phyllocharis*, *Phylloporis*, *Puiggariella*, *Raciborskiella*, and *Racoplaca*, and introduction of the new genera *Serusiauxiella* and *Swinscowa* (see below). As shown by Jiang et al. (2020b), a much more narrowly defined *Strigula* is still heterogeneous: whereas the species with a morphology similar to *S. smaragdula* form a supported clade, three basal lineages differ in morphology

and/or anatomy, including the *S. nitidula* and *S. prasina* groups and *S. macaronesica*. While *Strigula sensu stricto* forms thickened, usually bright green thalli, those of the *S. nitidula* group are very thin and more similar to those of *Racoplaca*, and *S. prasina* and relatives have hypophyllous thalli with bluish tinge and branched and anastomosing paraphyses. Should these be confirmed as separate clades in a broader sampling of taxa, the names *Haploblastia* (*S. nitidula* group) and *Kilikiostroma* (*S. prasina* group) would be available. Currently, about 30 exclusively foliicolous species are to be assigned to the genus *Strigula sensu stricto* as here defined.

Harris (1995) listed the name *Shanoria* Anahosur as a synonym of *Strigula*, given that the only species described by that author, *S. indica* Anahosur, represents the pycnidial stage of *Strigula cf. nitidula*. While the latter is correct (see also Raj 1981), Harris (1995) misinterpreted its protologue, since Anahosur (1967) did not establish a new genus but placed his new species in the already existing genus, *Shanoria* Subram. & K. Ramakr., typified by *S. bambusarum* Subram. & K. Ramakr. (Subramanian and Ramakrishnan 1956). The latter has been established as a synonym of *Placonema* (Sacc. & D. Sacc.) Petr. (asexual morph; Sutton 1977) and *Kiehlia* Viégas (sexual morph; Farr 1968), with *Placonema* having priority. The name *Shanoria* Anahosur does therefore not exist with that place and date of publication (Anahosur 1967), but was inadvertently, yet effectively created by Harris (1995), who ascribed the name to Anahosur. Unfortunately, this is a rather common lapsus, frequently seen in early mycological literature, which has perpetuated many presumed homonyms that were in fact never established as such by their ascribed authors. The *Code* (Shenzhen Code; Turland et al. 2018) does not include a specific provision for names created through erroneous citation, and so various rules must be consulted to ascertain whether such a name is actually valid (and consequently illegitimate). In the case of *Shanoria* Anahosur in Harris (1995), Harris (1995) provided a full and direct reference to the Latin description of *S. indica* and cited the latter as type of the genus, so the provisions of ICN Art. 38.1, 38.13, 39.1 and 40.1 are theoretically fulfilled. Since Harris (1995) did not use an explicit rank designation, such as ‘gen. nov.’, because he did not intend to describe a new genus, one could cite ICN Art. 37.1 to render the name invalid; however, that article does not include a specific provision how it should be applied to genus names, and the genus rank of the name is clear from context. Further, ICN Art. 36.1(b) may suggest the name as not validly published, since it is merely cited in synonymy. However, that article specifically refers to the intention of the author of the name, not the author of the publication. As Harris (1995) ascribed the name to Anahosur and not to himself [ICN Art. 46.2], his placement of *Shanoria* as synonym of *Strigula* appears irrelevant with

respect to ICN Art. 36.1(b). ICN Art. 38.5 provides another potential avenue, as for a simultaneously established new genus and species, validation through reference to an earlier description is not possible. That article does not apply, though, as Harris (1995) only established a new genus name, whereas the name *Shanoria indica* Anahosur had already been validly described earlier (Anahosur 1967). Fortunately, this case finds its solution in ICN Art. 38.11(b), which specifies that “...for a name of a genus or subdivision of a genus, the earlier description or diagnosis must be that of a genus or subdivision of a genus”. Hence, the name *Shanoria* Anahosur in Harris (1995) is not validated by reference to the Latin description of *Shanoria indica* Anahosur (1967), and it is therefore invalid. It appears ineffective that one has to fully explore the *Code* to eventually render a name invalid that was inadvertently created through erroneous citation. ICN Art. 48.1 may seemingly reflect such cases, but in reality it does not apply, as it specifically refers to names intentionally adopted by an author but in a sense different from the protologue, i.e. deliberately excluding the type of the name. Harris (1995) did not intentionally adopt the name *Shanoria* in a different sense, he simply cited it incorrectly, due to a misinterpretation of Anahosur’s (1967) paper. He also did not explicitly exclude its original type but did so by implication, through citing another species erroneously as type of a name that did not actually exist, and through indicating *Shanoria* Anahosur as illegitimate, which means Harris (1995) was aware of the existence of *Shanoria* Subram. & K. Ramakr. but did not realize that Anahosur (1967) was using precisely that name.

Molecular data show that the type species, *Strigula smaragdula*, in its current definition is a collective species (Jiang et al. 2016, 2017a, b; Oh et al. 2019; Woo et al. 2020). Given that the type is from Nepal, the name is possibly to be applied to a taxon restricted to eastern Asia, whereas the bulk of tropical species will have to be redispositioned using in part available names currently in synonymy of *S. smaragdula*. This may include reinstatement of the epithet *elegans* for a common and possibly widespread tropical taxon, with the type being from the Caribbean region.

#### Other genera:

*Dichoporis* Clem., Genera of Fungi: 40, 173 (1909).

*Mycobank number*: MB 1517; *Index Fungorum number*: IF 1517; *Facesoffungi number*: FoF 08854; 18 morphologically delimited species (this paper); molecular data not available.

= *Diporina* Clem., Genera of Fungi: 40, 173 (1909). *Type species*: *Diporina subsimplicans* (Nyl.) Clem. [= *Dichoporis subsimplicans* (Nyl.) S.H. Jiang, Lücking & Sérus.].

*Lichenized* on bark and rocks in terrestrial, (sub-)tropical to rarely temperate habitats. *Thallus* usually ecorticate, whitish to brownish. *Photobiont Trentepohlia*. **Sexual morph**:

*Ascomata* perithecia, usually dispersed but often dense, very rarely fused, immersed-erumpent to prominent, usually black or covered by thallus layer, lens-shaped to wart-shaped, usually carbonaceous, ostiolate. *Involucrellum* usually present and carbonized, very rarely reduced or absent. *Excipulum* prosoplectenchymatous, pale to brown. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, flexuose, typically branched and sometimes somewhat anastomosing. *Asci* usually 8-spored, bitunicate, fissitunicate, cylindrical to narrowly obclavate, shortly pedicellate, with narrow ocular chamber, non-amyloid. *Ascospores* irregularly arranged to uni- or biseriate, fusiform to ellipsoid or bacillar, hyaline, 1-septate, very rarely with two obscure, additional septa, with thin eusepta and rectangular lumina, smooth-walled, often constricted (and sometimes breaking apart) at the septa. **Asexual morph:** *Pycnidia* common, immersed to erumpent, usually visible as black dots. *Conidia* typically acrogenous, either macro- or microconidia; macroconidia 1-septate, oblong-bacillar, typically with narrow gelatinous appendages 1–2 µm broad, about 3–6 times as long as broad, and about one fifth to half as long as the conidia, hyaline; microconidia aseptate, typically fusiform, small, hyaline.

**Chemistry:** No secondary substances known.

**Type species:** *Dichoporis schizospora* (Vain.) Clem., [as ‘*schizospora*’], Gen. Fung.: 173 (1909) [= *Dichoporis ziziphi* (A. Massal.) S.H. Jiang, Lücking & Sérus. (see below)].

**Notes:** *Dichoporis* is here adopted for a group of non-foliicolous species that was already recognized as separate group (*Strigula taylorii* group) by Roux and Sérusiaux (2004), though not exactly in the same sense. Two names are available for this group, besides *Dichoporis* also *Diporina* Clem., established in the same work (Clements 1909) and based on *D. subsimplicans* (Nyl.) Clem. We prefer to use *Dichoporis*, as it better expresses the potential relationships with the genus *Phylloporis* and is less confusing than *Diporina*, since these lichen fungi are entirely unrelated to *Porina* and its allies. The implied differences between the two genera as given by Clements (1909), namely ascospores remaining intact (*Diporina*) vs. breaking into two part spores (*Dichoporis*) are not considered taxonomically relevant at the genus level, as molecular data show foliicolous species with ascospores remaining intact or breaking into part spores to be closely related (Jiang et al. 2020b).

*Dichoporis* is one of two genera here recognized for the bulk of non-foliicolous species thus far placed in *Strigula sensu lato*, the other one being *Swinscowia*, established below. The difference between these two groups was also recognized by Roux and Sérusiaux (2004) and can be emended as follows, including their *Strigula affinis*, *S. calcarea*, and *S. tagananae* groups within *Swinscowia*: ascospores and macroconidia 1-septate in *Dichoporis* vs. 3-septate to muriform in *Swinscowia*; macroconidial appendages relatively long and narrow, 1–2 µm broad, 3–6 times as

long as wide, about 20–50% of conidial length in *Dichoporis* vs. relatively short and broad, (1–)2–4 µm, 1–2(–5) times as long as narrow, 15–30% of conidial length in *Swinscowia*; and microconidia typically fusiform(–oblong) in *Dichoporis* vs. (oblong–)bacillar in *Swinscowia*. Thus far, only the type of *Swinscowia*, *S. jamesii*, has been sequenced and shown to be outside the clade containing the foliicolous species of *Strigula sensu stricto* and *sensu lato*, being more closely related to *Flavobathelium* and *Phyllobathelium* (Fig. 70). The latter two genera, although predominantly foliicolous, share the multi-septate to muriform ascospores and macroconidia with *Swinscowia*. We therefore predict *Dichoporis* to form part of the clade containing *Strigula sensu stricto* and relatives, as it shares ascospore and conidial features with the latter (see also Roux and Sérusiaux 2004).

Whereas the separation of *Dichoporis* from *Swinscowia* is straightforward, it is currently unclear how both genera relate to the foliicolous *Phylloporis* and *Phyllocratera*, respectively. Apart from the substrate, the principal difference lies in the photobiont, which in the chiefly foliicolous taxa represents the *Phycopeltis* morphodeme, with cells forming specific, plate-like arrangements (Aptroot et al. 1997; Lücking 2008). This is even the case in occasional corticolous occurrences of e.g. *Phylloporis* (see below). The nature of the photobiont is generally considered a non-mycological character of no taxonomic value (e.g. Harris 1995), but this is an oversimplification. Photobiont choice is clearly a mycological character, as it is determined by genetically fixed preferences of the mycobiont for specific photobiont types, amply documented in numerous cases. This does not mean that closely related mycobionts cannot associate with disparate photobiont lineages, but it implies that each case has to be evaluated in a phylogenetic context. Whereas such comparative data are currently unavailable for the target taxa, i.e. *Dichoporis* vs. *Phylloporis* (only the latter sequenced) and *Swinscowia* vs. *Phyllocratera* (only the former sequenced), data from foliicolous lineages show that each genus-level mycobiont lineage consistently associates with a specific photobiont lineage representing either *Cephaleuros*, *Phycopeltis* or *Trentepohlia* (Jiang et al. 2020b), although the generic delimitation within *Trentepohlia sensu lato* is not settled (Lopez-Bautista et al. 2006; Rindi et al. 2009; Nelsen et al. 2011b; Hametner et al. 2014; Zhu et al. 2017). We therefore maintain this concept to keep *Dichoporis* and *Swinscowia* separate from *Phylloporis* and *Phyllocratera*, respectively. This appears also supported by the unbranched paraphyses in the latter two genera vs. the generally branched and sometimes anastomosing paraphyses in *Dichoporis* and *Swinscowia*.

While the bulk of the 18 species here included in *Dichoporis* appears rather homogeneous, one taxon is placed in this genus with great hesitation, namely *D. dichosporidii*. The latter was described in *Strigula* due to its 1-septate

macroconidia with gelatinous appendages, but differs from all other species by its lichenicolous habit [on thalli of *Dichosporidium nigrocinctum* (Ehrenb.) G. Thor], the urn-shaped perithecia, and the lack of an involucrellum (Etayo 2002). It is unclear whether this species actually belongs in *Strigulaceae*, but in lieu of a more convincing alternative placement, it is here provisionally assigned to *Dichoporis*.

Among *Strigulaceae*, *Dichoporis* is the genus most similar and most easily confused with *Anisomeridium*, as the latter typically features a similar thallus morphology and photobiont, black perithecia, and mostly 1-septate ascospores (Harris 1995). In the presence of pycnidia producing macroconidia, the distinction is straightforward, as *Anisomeridium* produces aseptate macroconidia lacking gelatinous appendages but typically embedded in a gelatinous mass extruded as drops from the pycnidia, very different from *Strigulaceae*. In the absence of macroconidia, the distinction may pose difficulties, as the differences in ascus structure are rather subtle, although the asci of *Anisomeridium* are usually cylindrical and those of *Strigula* obclavate-fusiform. The paraphyses, usually stated to be unbranched in *Strigula sensu lato* vs. anastomosing in *Anisomeridium*, can be branched and slightly anastomosing in the former as well. Still, the paraphyses in *Anisomeridium* typically appear net-like with numerous anastomoses, whereas those of *Strigula* are usually lax and not net-like. Also, many species of *Anisomeridium* have lateral ostioles and/or larger ascospores, often with granular ornamentation. In addition, the ascospores in *Anisomeridium* are usually relatively broader, with a length/width ratio in the range of 2–3(–3.5), whereas those of *Dichoporis* are in the range of (2.5–)3–5.5. This somewhat narrows down the number of species that could potentially be confused, to about seven taxa in *Dichoporis* with relatively broader ascospores (2.5–3.5 times as long as broad) and those species of *Anisomeridium* with apical ostiole and smooth ascospores shorter than 30 µm and relatively narrow (about 2.5–3.5 times as long as broad). Unfortunately, that still involves about 20 taxa in *Anisomeridium*, many of them frequent and widespread. These taxa are largely summarized in the world key to *Anisomeridium* by Harris (1995: 126), between couplets 12 and 19 (for species growing on bark or wood) and couplets 67 and 72 (for species growing on rock). Thus, when in doubt whether a specimen at hand is indeed a *Dichoporis*, species of *Anisomeridium* with similar ascospore dimensions should be checked.

#### New combinations in *Dichoporis*:

***Dichoporis bermudana*** (Tuck.) S.H. Jiang, Lüicking & Sérus. **comb. nov.**

*Mycobank number*: MB 836370; *Index Fungorum number*: IF 836370; *Facesoffungi number*: FoF 08855.

*Bas.*: *Verrucaria bermudana* Tuck. in Nylander, Sert. Lich. Trop. Labuan Singapore: 43 (1891); *Porina*

*bermudana* (Tuck.) Zahlbr., Cat. Lich. Univers. 1: 367 (1922); *Strigula bermudana* (Tuck.) R.C. Harris, More Florida Lichens: 155 (1995).

*Notes*: The species is usually cited as “Tuck ex Nyl.” but Nylander (1891) ascribed the name to Tuckerman (ICN Art. 46.2), so the ‘ex’ citation format does not apply.

***Dichoporis brevis*** (Bricaud & Cl. Roux) S.H. Jiang, Lüicking & Sérus. **comb. nov.**

*Mycobank number*: MB 836371; *Index Fungorum number*: IF 836371; *Facesoffungi number*: FoF 08856.

*Bas.*: *Strigula brevis* Bricaud & Cl. Roux in Roux & Sérusiaux, Biblioth. Lichenol. 90: 53 (2004); *Strigula brevis* Bricaud & Cl. Roux in Roux & Bricaud, Bull. Soc. Linn. Provence 44: 107 (1993) [nom. inval., ICN Art. 36.1(a)].

***Dichoporis connivens*** (R.C. Harris) S.H. Jiang, Lüicking & Sérus. **comb. nov.**

*Mycobank number*: MB 836372; *Index Fungorum number*: IF 836372; *Facesoffungi number*: FoF 08857.

*Bas.*: *Strigula connivens* R.C. Harris, More Florida Lichens: 155 (1995).

***Dichoporis dichosporidii*** (Etayo) S.H. Jiang, Lüicking & Sérus. **comb. nov.**

*Mycobank number*: MB 836373; *Index Fungorum number*: IF 836373; *Facesoffungi number*: FoF 08858.

*Bas.*: *Strigula dichosporidii* Etayo, Biblioth. Lichenol. 84: 127 (2002).

***Dichoporis elixii*** (P.M. McCarthy) S.H. Jiang, Lüicking & Sérus. **comb. nov.**

*Mycobank number*: MB 836374; *Index Fungorum number*: IF 836374; *Facesoffungi number*: FoF 08859.

*Bas.*: *Strigula elixii* P.M. McCarthy, Biblioth. Lichenol. 78: 279 (2001).

***Dichoporis fractans*** (P.M. McCarthy) S.H. Jiang, Lüicking & Sérus. **comb. nov.**

*Mycobank number*: MB 836375; *Index Fungorum number*: IF 836375; *Facesoffungi number*: FoF 08860.

*Bas.*: *Strigula fractans* P.M. McCarthy, Lichenologist 29: 516 (1997).

***Dichoporis maritima*** (H. Harada) S.H. Jiang, Lüicking & Sérus. **comb. nov.**

*Mycobank number*: MB 836376; *Index Fungorum number*: IF 836376; *Facesoffungi number*: FoF 08861.

*Bas.*: *Strigula maritima* H. Harada, Bryologist 101: 605 (1998).

***Dichoporis minutula*** (P.M. McCarthy) S.H. Jiang, Lüicking & Sérus. **comb. nov.**



*Mycobank number*: MB 836377; *Index Fungorum number*: IF 836377; *Facesoffungi number*: FoF 08862.

Bas.: *Strigula minutula* P.M. McCarthy, *Muelleria* 8: 327 (1995).

***Dichoporis natalis*** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836378; *Index Fungorum number*: IF 836378; *Facesoffungi number*: FoF 08863.

Bas.: *Strigula natalis* P.M. McCarthy, *Biblioth. Lichenol.* 78: 281 (2001).

***Dichoporis nipponica*** (H. Harada) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836379; *Index Fungorum number*: IF 836379; *Facesoffungi number*: FoF 08864.

Bas.: *Strigula nipponica* H. Harada, *Nova Hedwigia* 60: 488 (1995).

***Dichoporis occulta*** (P.M. McCarthy & Malcolm) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836380; *Index Fungorum number*: IF 836380; *Facesoffungi number*: FoF 08865.

Bas.: *Strigula occulta* P.M. McCarthy & Malcolm, *Mycotaxon* 60: 323 (1996).

***Dichoporis phaea*** (Ach.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836381; *Index Fungorum number*: IF 836381; *Facesoffungi number*: FoF 08866.

Bas.: *Verrucaria phaea* Ach., *Syn. Meth. Lich.*: 88 (1814); *Porina phaea* (Ach.) Müll. Arg., *Flora* 68: 261 (1885); *Strigula phaea* (Ach.) R.C. Harris in Tucker & Harris, *Bryologist* 83: 18 (1980).

= *Porina mundula* Müll. Arg., *Bot. Jahrb.* 6: 402 (1885).

= *Strigula diderichiana* Etayo, Cl. Roux & Sérus. in Roux & Bricaud, *Bull. Soc. Linn. Provence* 44: 129 (1993) [nom. inval., ICN Art. 36.1].

***Dichoporis subprospersella*** (Vain.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836382; *Index Fungorum number*: IF 836382; *Facesoffungi number*: FoF 08867.

Bas.: *Porina subprospersella* Vain., *Mycologia* 21: 39 (1929); *Strigula subprospersella* (Vain.) P.M. McCarthy, *Biblioth. Lichenol.* 78: 281 (2001).

***Dichoporis subsimplicans*** (Nyl.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836383; *Index Fungorum number*: IF 836383; *Facesoffungi number*: FoF 08868.

Bas.: *Verrucaria subsimplicans* Nyl., *Lich. Nov. Zeland.*: 130 (1888); *Diporina subsimplicans* (Nyl.) Clem., *Gen.*

*Fung.*: 40, 173 (1909); *Porina subsimplicans* (Nyl.) Müll. Arg., *Bull. Herb. Boissier* 2(1): 91 (1894); *Segestria subsimplicans* (Nyl.) Hellb., *Bih. K. Svenska Vetensk. Akad. Handl., Afd. 3*, 21(13): 132 (1896); *Strigula subsimplicans* (Nyl.) R.C. Harris, *Biblioth. Lichenol.* 57: 175 (1995).

***Dichoporis taylorii*** (Carroll) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836384; *Index Fungorum number*: IF 836384; *Facesoffungi number*: FoF 08869.

Bas.: *Verrucaria taylorii* Carroll [as ‘taylori’] in Nylander, *Expos. Synopt. Pyrenocarp.*: 82 (1858); *Arthopyrenia taylorii* (Carroll) Mudd, *Man. Brit. Lich.*: 302 (1861); *Porina taylorii* (Carroll) Swinscow, *Lichenologist* 2: 169 (1962); *Spermatodium taylorii* (Carroll) Trevis. *Conspect. Verruc.*: 11 (1860); *Strigula taylorii* (Carroll) R.C. Harris in Hawksworth et al., *Lichenologist* 12: 107 (1980).

*Notes*: The species is usually cited as “Carroll ex Nyl.” but Nylander (1858) ascribed the name to Carroll (ICN Art. 46.2), so the ‘ex’ citation format does not apply.

***Dichoporis tenuis*** (R.C. Harris) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836385; *Index Fungorum number*: IF 836385; *Facesoffungi number*: FoF 08870.

Bas.: *Arthopyrenia tenuis* R.C. Harris, *Michigan Bot.* 12: 16 (1973); *Strigula americana* R.C. Harris in Tucker & Harris, *Bryologist* 83: 18 (1980).

*Notes*: Unfortunately, in the new generic disposition, the original epithet *tenuis* has priority over the rather well-established replacement name *Strigula americana*.

***Dichoporis viridiseda*** (Nyl.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836386; *Index Fungorum number*: IF 836386; *Facesoffungi number*: FoF 08871.

Bas.: *Verrucaria viridiseda* Nyl., *Expos. Synopt. Pyrenocarp.*: 55 (1858); *Strigula viridiseda* (Nyl.) R.C. Harris in Tucker & Harris, *Bryologist* 83: 18 (1980).

***Dichoporis wilsonii*** (Riddle) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836387; *Index Fungorum number*: IF 836387; *Facesoffungi number*: FoF 08872.

Bas.: *Porina wilsonii* Riddle in Britton & Millspaugh, *The Bahama Flora*: 523 (1920); *Porina wilsonii* Riddle, *Mycologia* 15: 73 (1923) [nom. inval., ICN Art. 6.23, Note 2]; *Strigula wilsonii* (Riddle) R.C. Harris in Egan, *Bryologist* 90: 164 (1987).

*Notes*: The publication of *Porina wilsonii* by Riddle (1923) is an exact copy of the earlier publication by the same author in the chapter “Lichenes” in Britton & Millspaugh’s (1920) Bahama Flora. The later publication is

usually considered a superfluous validation, but likely there was some confusion about publishing the same content twice in different outlets. Riddle had possibly overlooked that he had already published the species, because in the treatment on the Bahamas he included several species that he simultaneously described from other areas, such as in this case the Isle of Pines (Cuba), and in 1923 he focused on taxa from the latter area, without referring back to the Bahama Flora.

***Dichoporis ziziphi*** (A. Massal.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836388; *Index Fungorum number*: IF 836388; *Facesoffungi number*: FoF 08873.

*Bas.*: *Sagedia ziziphi* A. Massal., *Miscell. Lichenol.*: 30 (1856); *Porina ziziphi* (A. Massal.) Zahlbr., *Cat. Lich. Univers.* 1: 410 (1922); *Spermatodium ziziphi* (A. Massal.) Trevis., *Conspect. Verruc.*: 12 (1860); *Strigula ziziphi* (A. Massal.) Cl. Roux & Sérus. in Roux & Sérusiaux, *Biblioth. Lichenol.* 90: 55 (2004).

= *Strigula mediterranea* Etayo, *Lichenologist* 25: 258 (1993); *Porina schizospora* Vain., *Term. Füz.* 22: 340 (1899) [non *Strigula schizospora* R. Sant., *Symb. Bot. Upsal.* 12(1): 175 (1952)].

*Notes*: The epithet *schizospora*, based on *Porina schizospora* Vain. (Vainio 1899), was blocked for use in *Strigula* by *S. schizospora* R. Sant. (Santesson 1952), which required the replacement name *S. mediterranea* (Etayo 1993). The epithet *schizospora* is theoretically available in *Dichoporis* but is predated by *Sagedia ziziphi* (Massalongo 1856). The identity of both taxa was established by Roux and Sérusiaux (2004). The species was recently reported also from Brazil (Cavalcante and Cáceres 2014).

#### Key to species of *Dichoporis*:

1. Lichenicolous (on *Dichosporidium*); involucrellum absent.....*Dichoporis dichosporidii*
1. Lichenized (on bark, wood or rock); involucrellum present.....2
2. On bark.....3
2. On rock.....10
3. Ascumata aggregate-fused; ascospores 7–12 µm long; southeastern North America.....*Dichoporis connivens*
3. Ascumata solitary (but sometimes dense); ascospores (9–)12–28 µm long.....4
3. Thallus rather dark olive-brown to olive-green, with the black perithecia barely contrasting in colour; perithecia 0.1–0.3(–0.35) mm diam.....5
4. Thallus white-grey, with the black perithecia strongly contrasting; perithecia (0.3–)0.4–0.6 mm diam.....8

5. Ascospores 9–14 µm long; macroconidia 6–10 × 1.5–2.5 µm; macroconidiogenous cells rather long (mostly 15–25 µm); pantropical.....*Dichoporis phaea*
5. Ascospores 13–27 µm long; macroconidia 8–20 × (2–)2.5–3.5 µm; macroconidiogenous cells rather short (mostly 5–10 µm).....6
6. Ascospores 13–20 µm long, partly obscurely 3-septate, remaining intact; perithecia 0.1–0.15 mm diam.; New Zealand.....*Dichoporis subsimplicans*
6. Ascospores 17–27 µm long, consistently 1-septate, partly breaking into part spores outside the asci; perithecia 0.2–0.3 mm diam.; Europe.....7
7. Macroconidia 8–14 µm long.....*Dichoporis brevis*
7. Macroconidia 13–20 µm long.....*Dichoporis taylorii*
8. Ascospores 12–17 µm long; macroconidia 7–10 × 2–2.5 µm; North America.....*Dichoporis viridiseda*
8. Ascospores 15–28 µm long; macroconidia 8–19 × 3–4.5 µm.....9
9. Macroconidia 8–12 µm long; mediterranean Europe.....*Dichoporis ziziphi*
9. Macroconidia 14–19 µm long; eastern North America.....*Dichoporis tenuis* (= *Strigula americana*)
10. On calcareous rock (limestone).....11
10. On siliceous rock (granite).....15
11. Ascospores 8–12 × 2.5–3.5 µm; perithecia 0.15–0.2 mm diam.; strongly prominent to sessile; Australasia (Christmas Island).....*Dichoporis natalis*
11. Ascospores 11–22 × (3–)3.5–6(–7.5) µm; perithecia 0.2–0.5(–0.9) mm diam.; immersed-erumpent to prominent (if smaller than 0.2 mm then immersed-erumpent).....12
12. Perithecia 0.4–0.9 mm diam.; ascospores 5–7.5 µm broad; chiefly Caribbean including southeasternmost North America, also reported from Papua New Guinea.....*Dichoporis wilsonii*
12. Perithecia (0.15–)0.2–0.5 mm diam.; ascospores 3.5–5(–6) µm broad.....13
13. Ascospores 11–15 µm long; macroconidia 10–15 µm long, about the same length as the ascospores; Caribbean and Australasia (Christmas Island).....*Dichoporis bermudana*
13. Ascospores 13–21 µm long; macroconidia (known from *D. elixii*) 8–12 µm long, much shorter than the ascospores.....14
14. Perithecia 0.15–0.2 mm diam., immersed-erumpent; ascospores 16–25 µm long; Caribbean.....*Dichoporis subprospersella*
14. Perithecia 0.25–0.5 mm diam., erumpent to prominent; ascospores 13–20 µm long; Australasia (Christmas Island).....*Dichoporis elixii*
15. Ascospores 6–10 × 2–3 µm; Australasia.....*Dichoporis minutula*
15. Ascospores 11–32 × 3.5–6.5 µm.....16

16. Ascospores breaking into part spores outside the asci; perithecia 0.2–0.4 mm diam.; macroconidia (known from *D. fractans*) 6–8 × 2.5–3 µm; Australasia.....17
16. Ascospores remaining intact; perithecia 0.3–0.8 mm diam.; macroconidia 12–19 × 2–4 µm; Japan.....18
17. Ascospores 22–32 × 4–6.5 µm; New Zealand.....  
.....*Dichoporis occulta*
17. Ascospores 11–15 × 3.5–5 µm; Australia (Lord Howe Island).....*Dichoporis fractans*
18. Ascospores 15–26 µm long; perithecia partly covered by thallus; montane.....*Dichoporis nipponica*
18. Ascospores 13–17 µm long; perithecia more or less exposed; maritime rocks..... *Dichoporis maritima*

**Flagellostrigula** Lücking, S.H. Jiang & Sérus. **gen. nov.**

*Mycobank number*: MB 836389; *Index Fungorum number*: IF 836389; *Facesoffungi number*: FoF 08874; one morphologically delimited species (this paper); molecular data not available.

*Lichenized* on bark in terrestrial, (sub-)tropical habitats. *Thallus* corticate, greenish. *Photobiont Trentepohlia*. **Sexual morph**: *Ascomata* unknown. **Asexual morph**: *Pycnidia* common, prominent, hemispherical to wart-shaped, rather large (up to 0.8 mm diam.), covered by rather thick thalline layer. *Conidia* typically acrogenous, only macroconidia known; macroconidia 1-septate, broadly bacillar, with long and thin (15–35 × 1 µm) gelatinous appendage at one end only, hyaline.

*Chemistry*: No secondary substances known.

*Type species*: **Flagellostrigula laureriformis** (Aptroot & Lücking) Lücking, S.H. Jiang & Sérus. (see below).

*Notes*: This new genus is established for an oddball that agrees with *Dichoporis* in its 1-septate macroconidia. *Flagellostrigula laureriformis* is only known through pycnidia producing macroconidia, which differ from *Dichoporis* and other genera in having only a single, very long, name-giving flagelliform appendage at the proximal end, about 3–4 times as long as the conidia (Aptroot et al. 2008; Jiang et al. 2016; Cáceres et al. 2017). In addition, the pycnidia are unusually large and covered by a rather thick thalline layer. The single species is with certainty known from the Neotropics only (Costa Rica, Brazil; Aptroot et al. 2008; Cáceres et al. 2017). The report from China (Jiang et al. 2016) may represent an additional species, given the slightly deviating morphology of the pycnidia.

**Flagellostrigula laureriformis** (Aptroot & Lücking) Lücking, S.H. Jiang & Sérus. **comb. nov.**

*Mycobank number*: MB 836390; *Index Fungorum number*: IF 836390; *Facesoffungi number*: FoF 08875.

Bas.: *Strigula laureriformis* Aptroot & Lücking in Aptroot et al., *Biblioth Lichenol.* 97: 131 (2008).

**Flavobathelium** Lücking, Aptroot & Thor, *Lichenologist* 29: 221 (1997).

*Mycobank number*: MB 27825; *Index Fungorum number*: IF 27825; *Facesoffungi number*: FoF 08876; one morphologically and phylogenetically delimited species (Nelsen et al. 2011a).

*Lichenized* on leaves in terrestrial, lowland to lower montane tropical forests. *Thallus* thinly corticate, grey-green with characteristic metallic appearance. *Photobiont Trentepohlia*. **Sexual morph**: *Ascomata* perithecia, immersed in groups in slightly prominent pseudostromata covered by thallus layer and with a medulla containing ochraceous-yellow, K+ dark red, powdery crystals; individual perithecia ostiolate. *Involucrellum* absent. *Excipulum* prosoplectenchymatous, brown. *Hamathecium* comprising 1.5–2 µm wide paraphyses, hyaline, flexuose, unbranched to sparsely branched at the base. *Asci* 8-spored, bitunicate, fissitunicate, narrowly clavate to oblong-fusiform, shortly pedicellate, with narrow ocular chamber, non-amyloid. *Ascospores* irregularly arranged to biseriolate, fusiform, hyaline, 3(–5)-septate, with thin eusepta and rectangular lumina, smooth-walled, not or slightly constricted at the septa. **Asexual morph**: *Pycnidia* common, immersed in groups in slightly prominent pseudostromata covered by thallus layer and with a medulla containing ochraceous-yellow, K+ dark red, powdery crystals; often whole thalli producing pycnidia only. *Conidia* acrogenous, only macroconidia known; macroconidia 3(–5)-septate, narrowly bacillar to acicular, distal end with a very narrow, ciliate appendage about one third as long as the conidia, proximal end with a short, gelatinous cap, hyaline.

*Chemistry*: Unidentified ochraceous-yellow anthraquinone crystals in ascomatal and pycnidial pseudostromata.

*Type species*: **Flavobathelium epiphyllum** Lücking et al., *Lichenologist* 29: 221 (1997).

*Notes*: *Flavobathelium* is thus far a monospecific, tropical genus growing on living leaves (Lücking et al. 1997; Lücking 2008). Given the inclusion of non-foliicolous species with multi-septate to muriform ascospores and macroconidia in a single genus, *Swinscowia* (see below), one could theoretically consider *Flavobathelium* and *Phyllobathelium* conspecific. However, the two genera are not directly related phylogenetically, with *Flavobathelium* sister to *Swinscowia* and *Phyllobathelium* sister to the clade including the two other genera, with strong support (Fig. 70). This also supports the separation of *Swinscowia* from *Phyllocratera* and may indicate that *Swinscowia* as here circumscribed is still heterogeneous, requiring assessment of some of the genuinely muriform-spored species currently included in the latter genus.

**Phyllobathelium** (Müll. Arg.) Müll. Arg., Flora 73: 195 (1890).

*Mycobank number*: MB 4057; *Index Fungorum number*: IF 4057; *Facesoffungi number*: FoF 08877; five morphologically delimited species (Lücking et al. 2017); molecular data available for one species (Nelsen et al. 2011a).

*Lichenized* on leaves or rarely on bark in terrestrial, lowland to lower montane tropical to subtropical forests. *Thallus* corticate, grey-green with characteristic metallic appearance, often minutely verrucose. *Photobiont Trentepohlia*. **Sexual morph**: *Ascomata* perithecia, scattered, prominent to sessile, wart-shaped but often irregularly bumpy, immersed in pseudostromata covered by thallus layer and usually filled with a mass of black, powdery crystals, ostiolate. *Involucrellum* reduced. *Excipulum* prosoplectenchymatous, colourless. *Hamathecium* comprising 1.5–2 µm wide paraphyses, hyaline, flexuose, unbranched to sparsely branched. *Asci* 8-spored, bitunicate, fissionate, broadly cylindrical, shortly pedicellate, with broad ocular chamber, non-amyloid. *Ascospores* irregularly arranged to uni- or 2-seriate, fusiform to ellipsoid, hyaline, muriform, with thin eusepta and rectangular lumina, smooth-walled, often constricted at the septa. **Asexual morph**: *Pycnidia* common, immersed in slightly raised, appanate to conical pseudostromata filled with black, powdery crystals, visible as brown to black dots, often whole thalli only producing pycnidia. *Conidia* acrogenous, only macroconidia known; macroconidia septate to muriform, ellipsoid to bacillar, with more or less ciliate but rather thick gelatinous appendages, hyaline.

*Chemistry*: Unidentified black, powdery crystals in ascomata warts and pycnidial pseudostromata.

*Type species*: *Phyllobathelium epiphyllum* (Müll. Arg.) Müll. Arg. [= *Phyllobathelium firmum* (Stirt.) Vězda in Lücking & Kalb, Bot. Jb. 122: 44 (2000)].

*Notes*: For a detailed discussion of this genus, see Lücking (2008) and Lücking & Nelsen (in Hyde et al. 2013; *Strigulaceae*). Over time, 13 taxa, including 11 at species level, have been assigned to *Phyllobathelium*. Of these, two were subsequently transferred to *Strigula* (Harris 1995) and are currently treated in *Swinscowia* (see below), namely *P. albolinitum* (Nyl.) H. Mayrhofer and *P. obtectum* (Vain.) H. Mayrhofer. *Phyllobathelium nudum* Zahlbr. was recognized as a second species of *Phyllocratera* (Lücking & Sérusiaux 2013). Of the remaining ten names, *P. epiphyllum* (Müll. Arg.) Müll. Arg. and *P. epiphyllum* var. *majus* F. Schill. are synonyms of *P. firmum* (Stirt.) Vězda, and *P. thaxteri* (Vain.) Zahlbr., *P. thaxteri* var. *heterogena* (Vain.) Zahlbr., and *P. megapotamicum* (Malme) R. Sant. are synonymous with *P. chlorogastricum* (Müll. Arg.) Aptroot & Lücking (Lücking 2008; Aptroot and Lücking 2016). This leaves five species currently accepted in the genus, including also *P. anomalum* Lücking, *P. leguminosae* (Cavalc. & A.A. Silva) Lücking & Sérus., and *P. nigrum* R. Sant. & Tibell. The

pseudostromatic perithecia with black, crystalline medulla are particularly well-developed in *P. firmum* and *P. chlorogastricum*, whereas in the other three species, the perithecia appear naked, with only remnants of a black medullary mass as irregular outer cover on the perithecia.

The macroconidia of *Phyllobathelium chlorogastricum* are perhaps the largest known among all fungi, reaching 200 × 35 µm in size (Lücking 2008, as *P. thaxteri*).

**Phyllocharis** Fée, Essai Crypt Écorc. 1: LIX, XCIV, XCIX (1825).

*Mycobank number*: MB 4062; *Index Fungorum number*: IF 4062; *Facesoffungi number*: FoF 08878; one morphologically delimited species (this paper); molecular data not available.

*Lichenized* on leaves in terrestrial, lowland to montane, tropical to subtropical habitats. *Thallus* (pseudo-)corticate, pale grey-green, usually subcuticular and sometimes damaging the supporting leaf. *Photobiont Cephaleuros*. **Sexual morph**: *Ascomata* perithecia, prominent, black but largely covered by thallus layer, wart-shaped, carbonaceous, ostiolate. *Involucrellum* present, weakly carbonized. *Excipulum* prosoplectenchymatous, brownish. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, flexuose, unbranched. *Asci* 8-spored, bitunicate, fissionate, obclavate to fusiform, shortly pedicellate, with narrow ocular chamber, non-amyloid. *Ascospores* irregularly arranged to biserial, oblong, hyaline, 3-septate, with thin eusepta and rectangular lumina, smooth-walled. **Asexual morph**: *Pycnidia* common, immersed to erumpent, visible as black dots. *Conidia* acrogenous, either macro- or microconidia; macroconidia 3–9-septate, long-filiform, with gelatinous appendages, hyaline; microconidia aseptate, fusiform, small, hyaline.

*Chemistry*: No secondary substances known.

*Type species*: *Phyllocharis complanata* Fée [= *Phyllocharis orbicularis* (Fr.) S.H. Jiang, Lücking & Sérus. (see below)].

*Notes*: Although no genuine molecular data are available for *Strigula orbicularis*, the 3-septate ascospores set it apart from all other foliicolous, subcuticularly growing genera (Jiang et al. 2020b), and the peculiar, filiform macroconidia are unique among the entire family. The genus *Phyllocharis* is therefore resurrected here to reflect this. The name *Phyllocharis* Fée has a later homonym, *Phyllocharis* Diels, a plant genus in the family *Lobeliaceae*. The latter had been proposed for conservation (van den Brink et al. 1961), but the proposal was not accepted (Rickett 1963). Fée's name is therefore available.

Based on ascospore and macroconidial features, we predict *S. orbicularis* to cluster in the clade with *Flavobathelium*, *Phyllobathelium*, and *Swinscowia*. Incidentally, an ITS sequence for *S. orbicularis* (GenBank accession KU509981)

was published by Krishnamurthy and Subramanya (2016), based on material from India, but unfortunately that sequence represents a contaminant in the genus *Aspergillus*.

#### New combination in *Phyllocharis*:

***Phyllocharis orbicularis*** (Fr.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836391; *Index Fungorum number*: IF 836391; *Facesoffungi number*: FoF 08879.

*Bas.*: *Strigula orbicularis* Fr., *Linnaea* 5: 549 (1830).

#### ***Phyllocraterina*** Sérus. & Aptroot **nom. nov.**

*Mycobank number*: MB 836392; *Index Fungorum number*: IF 836392; *Facesoffungi number*: FoF 08880; two morphologically delimited species (Lücking and Sérusiaux 2013); molecular data not available.

Replaced syn.: *Phyllocratera* Sérus. & Aptroot in Aptroot et al., *Biblioth. Lichenol.* 64: 132 (1997) [nom. illeg., ICN Art. 53.2; non *Phyllocrater* Wernham].

*Lichenized* on leaves in terrestrial, lowland to montane, tropical habitats. *Thallus* thinly corticate, grey-green, supracuticular. *Photobiont Phycopeltis*. **Sexual morph**: *Ascomata* perithecia, prominent, black, wart-shaped with spreading base, carbonaceous, ostiolate. *Involucrellum* present, carbonized. *Excipulum* prosoplectenchymatous, brownish to blackish. *Hamathecium* comprising 1.5–2 µm wide paraphyses, hyaline, unbranched. *Asci* 8-spored, bitunicate, fissitunicate, clavate, shortly pedicellate, with rather broad ocular chamber, non-amyloid. *Ascospores* irregularly arranged, fusiform-ellipsoid, hyaline, muriform, with thin eusepta and rectangular lumina, smooth-walled, slightly constricted at the median septum. **Asexual morph**: unknown.

*Chemistry*: No secondary substances known.

*Type species*: ***Phyllocraterina papuana*** (Sérus. & Aptroot.) Sérus. & Aptroot (see below).

*Notes*: As response to an anonymous request, the *Nomenclatural Committee for Fungi* considered the name *Phyllocratera* and *Phyllocrater*, a monospecific plant genus in the family *Rubiaceae* known from Indonesia (Wernham in Gibbs 1914), sufficiently alike to be confused and recommended to consider them as homonyms (so-called parahomonyms; Norvell 2011). We therefore introduce here a slightly altered replacement name ascribed to the original authors, in order to limit nomenclatural disruption and to honor original authorship of this enigmatic taxon.

This small, exclusively foliicolous genus, currently containing two species (Lücking and Sérusiaux 2013), largely corresponds to non-foliicolous species of *Swinscowia* with muriform ascospores. *Phyllocraterina* is here maintained as a separate genus because of the different substrate and photobiont and because of the unbranched paraphyses (see below *Dichoporis* for further discussion). However, its

relationships to some of the muriform-spored species placed in *Swinscowia* need to be investigated further.

#### New combinations in *Phyllocraterina*:

***Phyllocraterina papuana*** (Sérus. & Aptroot.) Sérus. & Aptroot. **comb. nov.**

*Mycobank number*: MB 836393; *Index Fungorum number*: IF 836393; *Facesoffungi number*: FoF 08881.

*Bas.*: *Phyllocratera papuana* Sérus. & Aptroot in Aptroot et al., *Biblioth. Lichenol.* 64: 132 (1997).

#### ***Phyllocraterina nuda*** (Zahlbr.) Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836394; *Index Fungorum number*: IF 836394; *Facesoffungi number*: FoF 09210.

*Bas.*: *Phyllobathelium nudum* Zahlbr., *Annals Cryptog. Exot.* 1: 115 (1928); *Phyllocratera nuda* (Zahlbr.) Lücking & Sérus., *Lichenologist* 45: 691 (2013).

***Phylloporis*** Clem., *Gen. Fungi*: 41, 173 (1909); Vězda, *Folia Geobot. Phytotax.* 19: 185 (1984); Jiang et al., *Fung. Div.* 102: 287.

*Mycobank number*: MB 4070; *Index Fungorum number*: IF 4070; *Facesoffungi number*: FoF 08882; nine morphologically delimited species (Jiang et al. 2020b; this paper); molecular data available for two species (Jiang et al. 2020b).

= *Porinomyces* Bat. in Bezerra et al., *Atas Inst. Micol. Univ. Pernambuco* 5: 410 (1967) [nom. inval.]; Lücking et al., *Lichenologist* 30: 168 (1998). Original species: *Porinomyces phyllogenus* (Müll. Arg.) Bat. [= *Strigula phyllogena* (Müll. Arg.) R. C. Harris].

= *Didymaster* Bat. & H. Maia, *Atas Inst. Micol. Univ. Pernambuco* 5: 58 (1967); Lücking et al., *Lichenologist* 30: 140 (1998). *Type species*: *Didymaster myrtaciicola* Bat., H. Maia & Castro [= *Strigula platypoda* (Müll. Arg.) R. C. Harris].

= *Manastrum* Cavalc. & A. A. Silva in Cavalcante et al., *Publ. Inst. Micol. Univ. Fed. Pernambuco* 647: 13 (1972); Lücking et al., *Lichenologist* 30: 146 (1998). *Type species*: *Manastrum palmae* Cavalc. & A. A. Silva [= *Strigula multipunctata* (R. Sant.) R. C. Harris].

= *Porina* sect. *Sagediastrum* Müll. Arg., *Flora* 66: 335 (1883); Vainio, *Ann. Acad. Sci. Fenn., Ser. A*, 15 (1921); Santesson, *Symb. Bot. Upsal.* 12(1): 202 (1952). Sectional type. *Porina phyllogena* Müll. Arg. [= *Strigula phyllogena* (Müll. Arg.) R. C. Harris].

*Lichenized* on leaves or more rarely on bark and rock in terrestrial, lowland to montane, tropical (to subtropical) habitats. *Thallus* ecorticate, grey-green to grey, supracuticular. *Photobiont Phycopeltis*. **Sexual morph**: *Ascomata* perithecia, erumpent to prominent, black or covered by thallus layer, wart-shaped to conical, carbonaceous, ostiolate. *Involucrellum* present, carbonized. *Excipulum*

prosoplectenchymatous, dark brown to brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, flexuose, unbranched. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, shortly pedicellate, with narrow ocular chamber, non-amyloid. *Ascospores* irregularly arranged to biseriate, fusiform to ellipsoid, hyaline, 1-septate, with thin eusepta and rectangular lumina, smooth-walled, slightly constricted at the septa. **Asexual morph:** *Pycnidia* common, erumpent, visible as black dots, often whole thalli only producing pycnidia. *Conidia* acrogenous, either macro- or microconidia; macroconidia 1-septate, ellipsoid to bacillar, with gelatinous appendages, hyaline; microconidia aseptate, ellipsoid to fusiform, small, hyaline.

**Chemistry:** No secondary substances known.

**Type.** *Phylloporis phyllogena* (Müll. Arg.) Clem., Gen. Fung.: 173 (1909).

**Notes:** This genus has long been recognized as a separate group within *Strigula sensu lato* (Clements 1909; Vězda 1984) and has even been treated under *Porina* instead of *Strigula* (Santesson 1952). Its inclusion in *Strigula* based on internal anatomy and ascus type (e.g. Harris 1995; Lücking 2008) expresses close phylogenetic relationship, but a schematic broad genus concept, based on shared anatomical features, is not warranted, as shown in numerous other fungal families where genera agree in ascoma anatomy but differ in thallus morphology (e.g. *Parmeliaceae*). *Phylloporis* is a basally diverging clade among the foliicolous clades of *Strigula sensu lato* (Jiang et al. 2020b), indicating that its supracuticular growth may be a plesiomorphy shared with *Flavobathelium* and *Phyllobathelium* and the subcuticular growth of all other clades evolved as a single synapomorphy.

*Phylloporis* currently includes seven foliicolous species (Jiang et al. 2020b). Here, we also accept two at least partly non-foliicolous species in this genus (see new combinations proposed below). One of these, *P. cinefaciens*, is chiefly foliicolous but also rarely found on smooth bark, whereas the other, *P. hypothallina*, is thus far only known from the corticolous type material. Both may be distinguished from *Dichoporis* by the very thin thallus featuring a *Phycopeltis*-like photobiont (see also above).

#### New combinations in *Phylloporis*:

***Phylloporis cinefaciens*** (Nyl.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

**Mycobank number:** MB 836708; **Index Fungorum number:** IF 836708; **Facesoffungi number:** FoF 08883.

**Bas.:** *Verrucaria cinefaciens* Nyl., Ann. Sci. Nat., Bot., Sér. 5(7): 180 (1873); *Arthopyrenia cinefaciens* (Nyl.) Zahlbr., Cat. Lich. Univers. 1: 320 (1921); *Strigula cinefaciens* (Nyl.) R.C. Harris, More Florida Lichens: 155 (1995).

= *Porina multipunctata* G. Merr. ex R. Sant., Symb. Bot. Upsal. 12(1): 216 (1952); *Phylloporina multipunctata* (G. Merr. ex R. Sant.) Szatala, Ann. Mus. Natn. Hung., N.S. 7:

21 (1956); *Phylloporis multipunctata* (G. Merr. ex R. Sant.) Vězda, Folia Geobot. Phytotax. 19: 183 (1984); *Strigula multipunctata* (G. Merr. ex R. Sant.) R.C. Harris, More Florida Lichens: 158 (1995).

**Notes:** This species agrees with the foliicolous *Phylloporis austropunctata* (P.M. McCarthy) S.H. Jiang, Lücking & J.C. Wei and *P. multipunctata* (G. Merr. ex R. Sant.) Vězda in the thallus featuring numerous black dots. Apart from the corticolous growth, it is in fact identical to the latter, with ascospores 14–15 × 4–5 µm large and breaking into part spores outside the asci; the ascospore size range for *P. multipunctata* was given as 12–16 × 3.5–4.5 µm (Lücking 2008; McCarthy 2009). We therefore synonymize the latter with *P. cinefaciens*.

***Phylloporis hypothallina*** (R.C. Harris) S.H. Jiang, Lücking & Sérus. **comb. nov.**

**Mycobank number:** MB 836709; **Index Fungorum number:** IF 836709; **Facesoffungi number:** FoF 08884.

**Bas.:** *Strigula hypothallina* R.C. Harris, More Florida Lichens: 149 (1995).

**Notes:** This corticolous species is also placed in *Phylloporis*, rather than *Dichoporis*, based on its thallus anatomy.

***Puiggariella*** Speg., Anal. Soc. Cient. Argentina 12: 99 (1881); Jiang et al., Fung. Div. 102: 280.

**Mycobank number:** MB 4546; **Index Fungorum number:** IF 4546; **Facesoffungi number:** FoF 08885; four morphologically delimited species (Jiang et al. 2020b); molecular data available for two species (Jiang et al. 2020b).

= *Amoebomyces* Bat. & H. Maia, Atas Inst. Micol. Univ. Pernambuco 2: 353 (1965); Lücking et al., Lichenologist 30: 135 (1998). **Type species:** *Amoebomyces pseudolmediae* Bat. & H. Maia [= *Strigula nemathora* Mont.].

**Lichenized** on leaves in terrestrial, lowland to montane, tropical habitats. **Thallus** (pseudo-)corticate, light grey-green to whitish green, subcuticular, typically rugose-plicate and with numerous small, white papillae. **Photobiont** *Cephaleuros*. **Sexual morph:** *Ascomata* perithecia, erumpent to prominent, pale, usually covered by thallus layer, wart-shaped, non-carbonaceous, ostiolate. *Involucrellum* present, pale to brownish. *Excipulum* prosoplectenchymatous, pale to brownish. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, flexuose, unbranched or very rarely branched and anastomosing. *Asci* 8-spored, bitunicate, fissitunicate, narrowly obclavate, shortly pedicellate, with narrow ocular chamber, non-amyloid. *Ascospores* irregularly arranged to biseriate, fusiform, hyaline, 1-septate, with thin eusepta and rectangular lumina, smooth-walled, constricted at the septa. **Asexual morph:** *Pycnidia* infrequent, immersed, visible as dark dots. *Conidia* acrogenous, either macro- or microconidia; macroconidia 1-septate,

bacillar, with gelatinous appendages, hyaline; microconidia usually aseptate, ellipsoid to fusiform, small, hyaline.

**Chemistry:** No secondary substances known.

**Type species:** *Puiggariella apiahyna* Speg. [= *Puiggariella nemathora* (Mont.) S.H. Jiang, Lücking & J.C. Wei in: Jiang et al., Fungal Div. 102: 282.

**Notes:** The only species previously recognized in this group by Santesson (1952) and subsequent workers, *Strigula nemathora*, was long considered unique due to its pale, non-carbonized perithecia, in combination with its thallus appearing folded and featuring numerous small, white papillae. Phylogenetically, this taxon not only forms a separate clade, but the available data also indicate that *Puiggariella nemathora* is a collective species, including several related lineages differing largely in their morphology (Jiang et al. 2020b). Currently, three species are accepted in the genus (Jiang et al. 2020b).

#### New combinations in *Puiggariella*:

***Puiggariella hypothelia*** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus. **comb. nov.**

**Mycobank number:** MB 836710; **Index Fungorum number:** IF 836710; **Facesoffungi number:** FoF 08886.

**Bas.:** *Strigula hypothelia* Nyl., Bull. Soc. Linn. Normandie, Sér. 2(2): 520 (1868); *S. nemathora* var. *hypothelia* (Nyl.) R. Sant., Symb. Bot. Upsal. 12(1): 156 (1952); *S. nemathora* f. *hypothelia* (Nyl.) Lücking, Fl. Neotrop., Monogr. 103: 248 (2008).

***Raciborskiella*** Höhnelt, Sitzber. Math.-Nat. Kl. Akad. Wiss. Wien, Ser. 1, 118: 1176 (1909); Santesson, Symb. Bot. Upsal. 12(1): 194 (1952); Jiang et al., Fungal Div. 102: 278.

**Mycobank number:** MB 4636; **Index Fungorum number:** IF 4636; **Facesoffungi number:** FoF 08887; two morphologically and phylogenetically delimited species (Jiang et al. 2020b).

**Lichenized** on the underside of leaves in terrestrial, lowland to montane, tropical habitats. **Thallus** (pseudo-) corticate, greenish to bluish grey, subcuticular. **Photobiont** *Cephaleuros*. **Sexual morph:** *Ascomata* perithecia, prominent, black, conical, carbonaceous, ostiolate. *Involucrellum* present, carbonized. *Excipulum* prosoplectenchymatous, dark brown to brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, flexuose, unbranched or very rarely branched and anastomosing. *Asci* 8-spored but appearing 9–16-spored due to ascospores breaking in halves within the asci, bitunicate, fissitunicate, cylindrical to narrowly obclavate, shortly pedicellate, with narrow ocular chamber, non-amyloid. *Ascospores* irregularly arranged to biseriate, fusiform, hyaline, 1-septate, with thin eusepta and rectangular lumina, smooth-walled, strongly constricted and breaking apart at the septa, comparatively large (over 30 µm and up to 70 µm long). **Asexual morph:** *Pycnidia* common,

erumpent, visible as black dots. *Conidia* acrogenous, either macro- or microconidia; macroconidia 1-septate, bacillar, with gelatinous appendages, hyaline; microconidia usually aseptate, ellipsoid to fusiform, small, hyaline.

**Chemistry:** No secondary substances known.

**Type species:** *Raciborskiella talaumae* (Racib.) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1176 (1909).

**Notes:** This genus was kept separate by Santesson (1952), on account of the hypophyllous growth and the branched and anastomosing paraphyses particularly in *Raciborskiella janeirensis*. However, molecular data demonstrate that *R. prasina*, which differs considerably from *R. janeirensis* in morphology and anatomy, is unrelated to the latter and belongs in the genus currently recognized as *Strigula sensu stricto* above. As a result, the most distinctive character of *Raciborskiella* are the unusually large ascospores, up to three to four times longer than in species of *Strigula sensu stricto*.

Santesson (1952) included *Clypeolum talaumae* Racib. and *Melanopsamma areolatum* Rehm in the synonymy of *Raciborskiella janeirensis*, in spite of the reportedly smaller ascospores of the former. Revision of type material and specimens with molecular data showed that indeed two species with differently sized ascospores are involved, the one with smaller ascospores represented by the eastern paleotropical *C. talaumae*, which was therefore reinstated (Jiang et al. 2020b). However, the Brazilian type of *M. areolatum* has mostly immature and in part larger ascospores, indicating its conspecificity with *R. janeirensis*, which appears to be a neotropical species. Thus, currently two species are recognized in this genus.

The name '*Raciborskiella* Speg.' (Mycobank: MB 4637), a presumed illegitimate later homonym of *Raciborskiella* Höhn., does not exist. When Spegazzini (1919) made the combination *R. montana* (Racib.) Speg., he did not describe a new genus, so his use of the name must refer to von Höhnelt's (1909c) genus. This non-lichenized fungus is currently treated as *Trichopeltella montana* (Racib.) Höhn. (Hyde et al. in Hyde et al. 2013; *Brefeldiaceae*; Wu et al. 2014). von Höhnelt (1909a) also recombined *Micropeltis orbicularis* Cooke into *Raciborskiella*, as *R. orbicularis* (Cooke) Höhn.; this name is a synonym of *Strigula nitidula* (Santesson 1952). *Raciborskiella parva* L. Xavier is a synonym of *Racoplaca subtilissima* (see below), *R. zollerniae* Bat. & J.A. Lima [nom. inval.] is the same as *S. microspora* Lücking (Lücking et al. 1998), and *R. minor* Vězda is currently treated in the genus *Strigula* (Roux and Sérusiaux 2004).

***Racoplaca*** Fée, Essai Crypt Écorc. 1: LVIII, XCIV, XCIX (1825); Jiang et al., Fungal Div. 102: 285.

**Mycobank number:** MB 4640; **Index Fungorum number:** IF 4640; **Facesoffungi number:** FoF 08888; five

morphologically delimited species (Jiang et al. 2020b); molecular data available for two species (Jiang et al. 2020b).

= *Heterodothis* Syd. in Sydow & Sydow, Philip. J. Sci. Bot. 9: 170 (1914). *Type species*: *Heterodothis leptotheca* Syd. [= *Strigula maculata* (Cooke & Masee) R. Sant.].

*Lichenized* on leaves in terrestrial, lowland to montane, tropical habitats. *Thallus* (pseudo-)corticate, olive-brown to dark (olive-)green, usually with metallic glance, subcuticular and sometimes damaging the supporting leaf, lacinate, with a thin black, continuous or interrupted line along the margins of the lacinae. *Photobiont* *Cephaleuros*.

**Sexual morph**: *Ascomata* perithecia, prominent, black or covered by thin thallus layer, wart-shaped or mostly conical, carbonaceous, ostiolate. *Involucrellum* present, carbonized. *Excipulum* prosoplectenchymatous, dark brown to brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, flexuose, unbranched or very rarely branched and anastomosing. *Asci* 8-spored, bitunicate, fissionate, cylindrical to narrowly obclavate, shortly pedicellate, with narrow ocular chamber, non-amyloid. *Ascospores* irregularly arranged to biseriata, ellipsoid to fusiform, hyaline, 1-septate, with thin eusepta and rectangular lumina, smooth-walled, at least slightly constricted at the septa. **Asexual morph**: *Pycnidia* common, erumpent, visible as black dots. *Conidia* acrogenous, either macro- or microconidia; macroconidia aseptate or 1-septate, bacillar, with gelatinous appendages, hyaline; microconidia aseptate, ellipsoid to fusiform, small, hyaline.

*Chemistry*: No secondary substances known.

*Type species*: *Racoplaca subtilissima* Fée, Essai Crypt. Exot. (Paris): xciv, xcix (1825).

*Notes*: This newly recognized genus includes some of the prettiest foliicolous lichens, characterized by narrowly lacinate thalli bordered by a thin black line. It appears to be an early diverging clade within *Strigula sensu lato* but has no supported relationship with any of the other newly recognized genera (Jiang et al. 2020b). Five species are currently assigned to this genus (Jiang et al. 2020b).

#### New combinations in *Racoplaca*:

***Racoplaca melanobapha*** (Kremp.) S.H. Jiang, Lücking & J.C. Wei **comb. nov.**

*Mycobank number*: MB 836395; *Index Fungorum number*: IF 836395; *Facesoffungi number*: FoF 09211.

*Bas.*: *Verrucaria melanobapha* Kremp., Lich. Foliic. Leg. Beccari: 18 (1874); *Strigula melanobapha* (Kremp.) R. Sant., Symb. Bot. Upsal. 12(1): 188 (1952).

*Notes*: This combination was published invalidly in Jiang et al. (2020b) as the basionym was not indicated.

***Serusiauxiella*** S.H. Jiang, Lücking & J.C. Wei in Jiang et al., Fung. Div. 102: 274.

*Mycobank number*: MB 833565; *Index Fungorum number*: IF 833565; *Facesoffungi number*: FoF 08889; three morphologically and phylogenetically delimited species (Jiang et al. 2020b).

*Lichenized* on leaves in terrestrial, lowland to montane, tropical to subtropical habitats. *Thallus* (pseudo-)corticate, light grey-green, subcuticular. *Photobiont* *Trentepohlia*. **Sexual morph**: *Ascomata* perithecia, immersed-erumpent, black but mostly covered by thallus layer, lens-shaped to wart-shaped, carbonaceous, ostiolate. *Involucrellum* present, carbonized. *Excipulum* prosoplectenchymatous, pale. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, flexuose, unbranched or very rarely branched and anastomosing. *Asci* 8-spored, bitunicate, fissionate, cylindrical to narrowly obclavate, shortly pedicellate, with narrow ocular chamber, non-amyloid. *Ascospores* irregularly arranged to biseriata, fusiform, hyaline, 1-septate, with thin eusepta and rectangular lumina, smooth-walled, constricted at the septa. **Asexual morph**: *Pycnidia* common, immersed-erumpent, visible as black dots. *Conidia* acrogenous, either macro- or microconidia; macroconidia 1-septate, bacillar, with gelatinous appendages becoming extremely long in squash mounts (as if suspended on gelatinous threads), hyaline; microconidia aseptate, ellipsoid to fusiform, small, hyaline.

*Chemistry*: No secondary substances known.

*Type species*: *Serusiauxiella filifera* S.H. Jiang, Lücking & J.C. Wei in Jiang et al., Fung. Div. 102: 275.

*Notes*: This entirely novel genus was discovered in eastern Asia, with three species known thus far from China (Jiang et al. 2020b). It most closely resembles *Strigula sensu stricto* and differs mainly in the highly unusual macroconidial appendages. The known species otherwise have a morphology akin towards *S. microspora*.

#### ***Swinscowa*** S.H. Jiang, Lücking & Sérus. **gen. nov.**

*Mycobank number*: MB 836396; *Index Fungorum number*: IF 836396; *Facesoffungi number*: FoF 08890; 34 morphologically delimited species (this paper); molecular data available for one species (Nelsen et al. 2011a).

*Lichenized* on bark and rocks in terrestrial, temperate-subalpine to tropical habitats. *Thallus* usually ecorticate, whitish to brownish. *Photobiont* *Trentepohlia*. **Sexual morph**: *Ascomata* perithecia, usually dispersed but often dense, immersed-erumpent to prominent, usually black or covered by thallus layer, rarely pale, lens-shaped to wart-shaped, usually carbonaceous, rarely with pale to brownish walls, ostiolate. *Involucrellum* usually present and carbonized, rarely reduced or pale. *Excipulum* prosoplectenchymatous, pale to brown or blackish. *Hamathecium* comprising 0.5–0.7 µm wide paraphyses, hyaline, flexuose, typically



branched and sometimes somewhat anastomosing. *Asci* usually 8-spored, rarely as little as 2-spored, bitunicate, fisitunicate, cylindrical to narrowly obclavate, shortly pedicellate, with narrow, non-amyloid ocular chamber. *Ascospores* irregularly arranged to uni- or biseriate, fusiform to ellipsoid or bacillar, hyaline, 1-septate to mostly 3–7-septate to (sub-)muriform, with thin eusepta and rectangular lumina, smooth-walled, often constricted (and sometimes breaking apart) at the septa. **Asexual morph:** *Pycnidia* common, immersed to erumpent, usually visible as black dots. *Conidia* typically acrogenous, either macro- or microconidia; macroconidia (1–)3–7(–11)-septate to more rarely submuriform, oblong-ellipsoid to bacillar, with variably shaped gelatinous appendages, hyaline; microconidia aseptate, ellipsoid to fusiform, small, hyaline.

**Chemistry:** No secondary substances known.

**Type species:** *Swinscowa jamesii* (Swinscow) S.H. Jiang, Lücking & Sérus. (see below).

**Notes:** This new genus, named after the British lichenologist Thomas Douglas Victor Swinscow, who first described the type species, *Geissleria jamesii* (Swinscow 1967), is here introduced for non-foliicolous species centered around *Strigula jamesii*. Since the latter is the only species sequenced so far, it is unclear whether the taxa included here all form a monophyletic group. Given the phylogenetic and morpho-anatomical differentiation in the foliicolous lineages, likely more than one genus may be recognized for the non-foliicolous species here placed in *Swinscowa*. In their treatment of European taxa, Roux and Sérusiaux (2004) already arranged the non-foliicolous species into two major groups, their *Strigula affinis-tagananae-calcarea* group (“ensemble 2”) corresponding to *Swinscowa*.

#### New combinations in *Swinscowa*:

***Swinscowa affinis*** (A. Massal.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

**Mycobank number:** MB 836397; **Index Fungorum number:** IF 836397; **Facesoffungi number:** FoF 08891.

**Bas.:** *Sagedia affinis* A. Massal., Memor. Lich.: 138 (1853); *Spermatodium affine* (A. Massal.) Trevis., Consp. Verruc.: 10 (1860); *Segestria affinis* (A. Massal.) Zwackh, Flora 45: 550 (1862); *Verrucaria affinis* (A. Massal.) Cromb., J. Bot., Lond. 14: 360 (1876); *Porina affinis* (A. Massal.) Zahlbr., Öst. Bot. Z. 51: 277 (1901); *Arthopyrenia affinis* (A. Massal.) R.C. Harris, Michigan Bot. 12: 10 (1973); *Strigula affinis* (A. Massal.) R.C. Harris in Hawksworth et al., Lichenologist 12: 107 (1980).

= *Pyrenula minuta* Nägeli, in Hepp, Flecht. Europ.: no. 458 (1857); *Sagedia affinis* var. *sporophorum* Wartm. & B. Schenk, Schweiz. Kryptogam.: no. 673.

**Notes:** The name *Sagedia affinis* var. *sporophorum* was published in Wartmann & Schenk’s Exsiccate *Schweizerische Kryptogamen*, listing *Pyrenula minuta* based on

Hepp’s Flechten Europas no. 458 as synonym. The variety name is thus validly published, as it formally constitutes a replacement name at species level, based on the same type.

***Swinscowa albicascens*** (Nyl.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

**Mycobank number:** MB 836398; **Index Fungorum number:** IF 836398; **Facesoffungi number:** FoF 08892.

**Bas.:** *Verrucaria albicascens* Nyl., Lich. Nov. Zeland. (Paris): 129 (1888); *Porina albicascens* (Nyl.) Müll. Arg., Bull. Soc. R. Bot. Belg. 31(2): 38 (1892); *Segestria albicascens* (Nyl.) Hellb., Bih. K. Svenska Vetensk Akad. Handl., Afd. 3, 21(13): 132 (1896); *Strigula albicascens* (Nyl.) R.C. Harris, More Florida Lichens: 154 (1995).

= *Verrucaria indutula* Nyl., Lich. Nov. Zeland.: 129 (1888); *Porina indutula* (Nyl.) Müll. Arg., Bull. Herb. Boissier 2(1): 92 (1894); *Segestria indutula* (Nyl.) Hellb., Bih. K. Svenska Vetensk. Akad. Handl., Afd. 3, 21(13): 133 (1896); *Strigula indutula* (Nyl.) R.C. Harris, More Florida Lichens: 157 (1995).

**Notes:** See discussion under *Swinscowa glabra*.

***Swinscowa albolinita*** (Nyl.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

**Mycobank number:** MB 836399; **Index Fungorum number:** IF 836399; **Facesoffungi number:** FoF 08893.

**Bas.:** *Verrucaria albolinita* Nyl., Lich. Ins. Guin.: 38 (1889); *Microglaena albolinita* (Nyl.) Zahlbr., Cat. Lich. Univers. 1: 188 (1921); *Phyllobatelium albolinitum* (Nyl.) H. Mayrhofer, Biblioth. Lichenol. 26: 79 (1987); *Strigula albolinita* (Nyl.) R.C. Harris [as ‘albolinitum’], More Florida Lichens: 155 (1995).

***Swinscowa alpestris*** (Vězda) S.H. Jiang, Lücking & Sérus. **comb. nov.**

**Mycobank number:** MB 836400; **Index Fungorum number:** IF 836400; **Facesoffungi number:** FoF 08894.

**Bas.:** *Porina faginea* var. *alpestris* Vězda, Acta Mus. Silesiae, Ser. A, 10: 5 (1961); *Arthopyrenia faginea* var. *alpestris* (Vězda) Swinscow, Lichenologist 3: 73 (1965); *Strigula stigmatella* var. *alpestris* (Vězda) Coppins in Hawksworth et al., Lichenologist 12: 107 (1980); *Strigula alpestris* (Vězda) Hafellner, Mitt. Naturw. Ver. Steierm. 132: 131 (2002).

**Notes:** We follow here Hafellner (2002) in separating this taxon from *Swinscowa stigmatella* (see also discussion under *S. glabra*), on account of the different habitat and substrate ecology and the longer asci. McCarthy & Malcolm (1996) reported *Strigula stigmatella* var. *alpestris* as silicicolous from Australia, but later this was apparently reidentified as *Strigula decipiens*.

***Swinscowia amphora*** (Aptroot & Lücking) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836401; *Index Fungorum number*: IF 836401; *Facesoffungi number*: FoF 08895.

Bas.: *Strigula amphora* Aptroot & Lücking in Aptroot et al., *Biblioth. Lichenol.* 97: 130 (2008).

***Swinscowia aquatica*** (H. Harada) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836402; *Index Fungorum number*: IF 836402; *Facesoffungi number*: FoF 08896.

Bas.: *Strigula aquatica* H. Harada, *Nova Hedwigia* 66: 420 (1998).

***Swinscowia australiensis*** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836403; *Index Fungorum number*: IF 836403; *Facesoffungi number*: FoF 08897.

Bas.: *Strigula australiensis* P.M. McCarthy, *Muelleria* 8: 323 (1995).

***Swinscowia bahamensis*** (Riddle) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836404; *Index Fungorum number*: IF 836404; *Facesoffungi number*: FoF 08898.

Bas.: *Lithothelium bahamense* Riddle in Britton & Millspaugh, *The Bahama Flora*: 532 (1920); *Strigula bahamensis* (Riddle) R.C. Harris, *More Florida Lichens*: 155 (1995)

***Swinscowia bispora*** (Aptroot & K.H. Moon) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836405; *Index Fungorum number*: IF 836405; *Facesoffungi number*: FoF 08899.

Bas.: *Strigula bispora* Aptroot & K.H. Moon, *Herzogia* 27: 354 (2014).

***Swinscowia calcarea*** (Bricaud & Cl. Roux) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836406; *Index Fungorum number*: IF 836406; *Facesoffungi number*: FoF 08900.

Bas.: *Strigula calcarea* Bricaud & Cl. Roux, *Bull. Soc. Linn. Provence* 42: 131 (1991).

***Swinscowia cavicola*** (Cl. Roux & Bricaud) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836407; *Index Fungorum number*: IF 836407; *Facesoffungi number*: FoF 08901.

Bas.: *Strigula cavicola* Cl. Roux & Bricaud in Roux & Sérusiaux, *Biblioth. Lichenol.* 90: 87 (2004).

***Swinscowia confusa*** (A. Massal.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836408; *Index Fungorum number*: IF 836408; *Facesoffungi number*: FoF 08902.

Bas.: *Strigula confusa* Fryday, Coppins & Common in Fryday & Coppins, *Lichenologist* 36: 92 (2004).

***Swinscowia decipiens*** (Malme) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836409; *Index Fungorum number*: IF 836409; *Facesoffungi number*: FoF 08903.

Bas.: *Porina decipiens* Malme, *Ark. Bot.* 23A(1): 26 (1929); *Strigula decipiens* (Malme) P.M. McCarthy, *Lichenologist* 29: 513 (1997).

***Swinscowia divisa*** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus. **comb. et stat. nov.**

*Mycobank number*: MB 836410; *Index Fungorum number*: IF 836410; *Facesoffungi number*: FoF 08904.

Bas.: *Strigula decipiens* var. *divisa* P.M. McCarthy, *Lichenologist* 32: 34 (2000).

*Notes*: McCarthy (2000) considered this taxon a subspecies of *S. decipiens*, stating that the only difference were occasional longitudinal septa in otherwise similarly sized ascospores. However, not only is ascospore septation an important taxonomic criterion in this genus, but the ascospores of *S. decipiens* are also distinctly longer and narrower (see key below). As the few other known species with submuriform ascospores are different in ascospore size, morphology and/or substrate ecology, the recognition of *S. divisa* as a separate species is justified.

***Swinscowia endolitheia*** (Cl. Roux & Bricaud) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836411; *Index Fungorum number*: IF 836411; *Facesoffungi number*: FoF 08905.

Bas.: *Strigula endolitheia* Cl. Roux & Bricaud in Roux & Sérusiaux, *Biblioth. Lichenol.* 90: 88 (2004); *S. endolitheia* Cl. Roux & Bricaud, *Bull. Soc. Linn. Provence* 44: 129 (1993) [nom. inval.; ICN Art. 36.1].

*Notes*: Tretiach (2006) provided a detailed description of the perithecia, asci, and ascospores of this species, which originally was described based on pycnidia and macroconidia only (Roux and Sérusiaux 2004).

***Swinscowia fracticonidia*** (R.C. Harris) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836412; *Index Fungorum number*: IF 836412; *Facesoffungi number*: FoF 08906.

Bas.: *Strigula fracticonidia* R.C. Harris, *More Florida Lichens*: 156 (1995).

***Swinscowia glabra*** (A. Massal.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836413; *Index Fungorum number*: IF 836413; *Facesoffungi number*: FoF 08907.

Bas.: *Sagedia glabra* A. Massal., Ric. Auton. Lich. Crost.: 161 (1852); *Spermatodium glabrum* (A. Massal.) Trevis., Conspect. Verruc.: 11 (1860); *Porina glabra* (A. Massal.) Zahlbr., Cat. Lich. Univers. 1: 382 (1922); *Arthopyrenia glabra* (A. Massal.) J. Nowak & Tobol., Flora Polska: 1117 (1975); *Strigula glabra* (A. Massal.) V. Wirth, Flechtenflora: 531 (1980).

= *Pyrenula netrospora* Nägeli, Flecht. Europ.: no. 461 (1857); *Spermatodium netrosporum* (Nägeli) Trevis., Conspect. Verruc.: 11 (1860); *Sagedia netrospora* (Nägeli) Anzi, Comm. Soc. Crittog. Ital. 1(3): 162 (1862); *Arthopyrenia netrospora* (Nägeli) Müll. Arg., Mém. Soc. Phys. Hist. Nat. Genève 16(2): 429 (1862); *Verrucaria netrospora* (Nägeli) Nyl., Jahresber. St. Gall. Naturw. Ges.: 504 (1882); *Porina netrospora* (Nägeli) Lettau, Hedwigia 52: 104 (1912).

= *Sagedia candida* Anzi, Comm. Soc. Crittog. Ital. 1(3): 162 (1862).

*Notes*: *Swinscowia glabra* forms a species complex with *S. albicascens* and *S. stigmatella*, all three growing on bark and producing chiefly 7-septate ascospores with overlapping size ranges. There seem to be no discernable differences between the Australasian *S. albicascens* and the European *S. glabra*. Roux and Sérusiaux (2004) do not discuss *S. albicascens* in the context of *S. glabra*, and McCarthy (2009) does not mention *S. glabra* in the discussion of *S. albicascens*, although he did synonymize *Verrucaria indutula* with the latter. We keep *S. glabra* and *S. albicascens* separate for the time being, as macroconidia have not yet been reported for the latter and might turn out to provide a diagnostic difference, although we consider this unlikely. Roux & Sérusiaux (2004) discuss the similarity between *S. glabra* and *S. stigmatella* and keep both separate on account of slightly different ascospore length (22–26 µm in *S. glabra* vs. 26–36 µm in *S. stigmatella*) and differences in substrate (smooth bark in *S. glabra* and rough bark in *S. stigmatella*). Harris (1995) gives ascospore length for North American material of *S. stigmatella* as 24–42 µm, whereas McCarthy (2009) cites 16–32 µm for Australasian *S. albicascens*. McCarthy (1993) reported *S. stigmatella* as saxicolous from Australia but later corrected these records to *S. decipiens* (McCarthy 2009). Thus, the taxonomic treatments for corticolous taxa with 7-septate ascospores are inconsistent between North America, Europe, and Australasia, using one name in North America (*stigmatella*), two in Europe (*glabra*, *stigmatella*), and one but a different name in Australasia (*albicascens*). This problem is aggravated by the notion that the type of *Lichen stigmatellus* Ach. grows on smooth bark and apparently fits the concept of *S. glabra* by Roux & Sérusiaux (2004). This requires a critical revision of the available material and a reassessment of the types to properly name the taxa distinguished in this complex.

*Swinscowia griseonitens* (R.C. Harris) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836414; *Index Fungorum number*: IF 836414; *Facesoffungi number*: FoF 08908.

Bas.: *Strigula griseonitens* R.C. Harris, More Florida Lichens: 156 (1995).

*Swinscowia jamesii* (Swinscow) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836415; *Index Fungorum number*: IF 836415; *Facesoffungi number*: FoF 08909.

Bas.: *Geisleria jamesii* Swinscow, Lichenologist 3: 420 (1967); *Strigula jamesii* (Swinscow) R.C. Harris in Hawksworth et al., Lichenologist 12(1): 107 (1980).

*Swinscowia johnsonii* (P.M. McCarthy) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836416; *Index Fungorum number*: IF 836416; *Facesoffungi number*: FoF 08910.

Bas.: *Strigula johnsonii* P.M. McCarthy, Muelleria 8: 324 (1995).

*Swinscowia laceribracae* (R.C. Harris) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836417; *Index Fungorum number*: IF 836417; *Facesoffungi number*: FoF 08911.

Bas.: *Strigula laceribracae* R.C. Harris, More Florida Lichens: 158 (1995).

*Swinscowia muriconidiata* (Aptroot, L.I. Ferraro & M. Cáceres) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836418; *Index Fungorum number*: IF 836418; *Facesoffungi number*: FoF 08912.

Bas.: *Strigula muriconidiata* Aptroot, L.I. Ferraro & M. Cáceres, Lichenologist 46: 99 (2014).

*Notes*: This taxon may be the macroconidial stage of *S. obtecta*.

*Swinscowia muriformis* (Aptroot & Diederich) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836419; *Index Fungorum number*: IF 836419; *Facesoffungi number*: FoF 08913.

Bas.: *Strigula muriformis* Aptroot & Diederich in Aptroot et al., Biblioth. Lichenol. 64: 188 (1997).

*Swinscowia muscicola* (F. Berger, Coppins, Cl. Roux & Sérus.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836420; *Index Fungorum number*: IF 836420; *Facesoffungi number*: FoF 08914.

Bas.: *Strigula muscicola* F. Berger, Coppins, Cl. Roux & Sérus. in Sérusiaux et al., Lichenologist 37: 481 (2005).

**Swinscowa obtecta** (Vain.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836421; *Index Fungorum number*: IF 836421; *Facesoffungi number*: FoF 08915.

Bas.: *Thelenella obtecta* Vain., Acta Soc. Fauna Flora Fenn. 7(2): 218 (1890); *Polyblastiopsis obtecta* (Vain.) Zahlbr., Cat. Lich. Univers. 1: 351 (1922); *Phyllobathelium obtectum* (Vain.) H. Mayrhofer, Biblioth. Lichenol. 26: 82 (1987); *Strigula obtecta* (Vain.) R.C. Harris, More Florida Lichens: 158 (1995).

**Swinscowa pallida** (Aptroot & K.H. Moon) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836422; *Index Fungorum number*: IF 836422; *Facesoffungi number*: FoF 08916.

Bas.: *Strigula pallida* Aptroot & K.H. Moon in Moon & Aptroot, Biblioth. Lichenol. 99: 308 (2009); *Strigula pallidocarpa* Aptroot & K.H. Moon, Herzogia 27: 354 (2014) [nom. illeg., ICN Art. 52.1] [non *Strigula pallida* Kalchbr. in Stizenberger, Ber. Tät. St Gall. Naturw. Ges.: 218 (1891); nom. inval., ICN Art. 38.1–3].

*Notes*: Aptroot and Moon (2014) provided a replacement name for their *Strigula pallida*, described five years prior (Moon and Aptroot 2009), under the impression that the name *S. pallida* had already been used for another species, namely *S. pallida* Kalchbr. in Stizenberger (1891). However, as already pointed out by Santesson (1952), that name is invalid, as it does not have a validating description [ICN Art. 38.3] and hence has no standing under the *Code* [ICN Art. 12.1]. Thus, the name *S. pallida* Aptroot & K.H. Moon is legitimate, although it does not follow the recommendation of the *Code* to avoid giving a previously invalidly published name to a different taxon [ICN Rec. 38C.1].

**Swinscowa porinoides** (Canals, Boqueras & Gómez-Bolea) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836423; *Index Fungorum number*: IF 836423; *Facesoffungi number*: FoF 08917.

Bas.: *Strigula porinoides* Canals, Boqueras & Gómez-Bolea, Mycotaxon 55: 391 (1995).

**Swinscowa rhodinula** (Zahlbr.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836424; *Index Fungorum number*: IF 836424; *Facesoffungi number*: FoF 08918.

Bas.: *Porina rhodinula* Zahlbr., Denkschr. Akad. Wiss. Wien Math.-Naturwiss. Kl. 104: 254 (1941); *Strigula rhodinula* (Zahlbr.) P.M. McCarthy, Australas. Lichenol. 78: 3 (2016).

**Swinscowa rostrata** (R.C. Harris & Aptroot) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836425; *Index Fungorum number*: IF 836425; *Facesoffungi number*: FoF 08919.

Bas.: *Strigula rostrata* R.C. Harris & Aptroot in Harris, More Florida Lichens: 159 (1995).

**Swinscowa rupestris** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836426; *Index Fungorum number*: IF 836426; *Facesoffungi number*: FoF 08920.

Bas.: *Strigula rupestris* P.M. McCarthy, Lichenologist 29: 518 (1997).

**Swinscowa stigmatella** (Ach.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836427; *Index Fungorum number*: IF 836427; *Facesoffungi number*: FoF 08921.

Bas.: *Lichen stigmatellus* Ach., Lich. Suec. Prodr.: 15 (1799); *Verrucaria stigmatella* (Ach.) Ach., Methodus, Sectio Prior: 117 (1803); *Verrucaria punctiformis* var. *stigmatella* (Ach.) Ficus & C. Schub., Fl. Dresden 2: 147 (1823); *Arthopyrenia stigmatella* (Ach.) A. Massal., Symmict. Lich.: 119 (1855); *Leiophloea punctiformis* var. *stigmatella* (Ach.) Trevis., Conspect. Verruc.: 9 (1860); *Verrucaria epidermidis* var. *stigmatella* (Ach.) Garov., Tentam. Dispos. Lich. Langob.: 85 (1865); *Verrucaria epidermidis* f. *stigmatella* (Ach.) Malbr., Bull. Soc. Amis Sci. Nat. Rouen, Sér. II, 5: 315 (1869); *Arthopyrenia cinereopruinosa* var. *stigmatella* (Ach.) Jatta, Syll. Lich. Ital.: 530 (1900); *Didymella stigmatella* (Ach.) Szatala in Degen, Flora Velebitica 3: 309 (1938); *Strigula stigmatella* (Ach.) R.C. Harris in Hawksworth et al., Lichenologist 12: 107 (1980).

= *Porina faginea* var. *alpestris* Vězda, Acta Mus. Silesiae, Ser. A 10: 5 (1961); *Arthopyrenia faginea* var. *alpestris* (Vězda) Swinscow, Lichenologist 3: 73 (1965); *Strigula stigmatella* var. *alpestris* (Vězda) Coppins in Hawksworth et al., Lichenologist 12: 107 (1980); *Strigula alpestris* (Vězda) Hafellner, Mitt. Naturw. Ver. Steierm. 132: 131 (2002).

*Mycobank*: MB 351488

*Notes*: See discussion under *Swinscowa glabra*.

**Swinscowa submuriformis** (R.C. Harris) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836428; *Index Fungorum number*: IF 836428; *Facesoffungi number*: FoF 08922.

Bas.: *Arthopyrenia submuriformis* R.C. Harris, Michigan Bot. 12: 15 (1973); *Strigula submuriformis* (R.C. Harris) R.C. Harris in Egan, Bryologist 90: 164 (1987).

**Swinscowa tagananae** (Harm.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

*Mycobank number*: MB 836429; *Index Fungorum number*: IF 836429; *Facesoffungi number*: FoF 08923.

Bas.: *Verrucaria tagananae* Harm. in Pitard & Harmand, Bull. Soc. Bot. Fr. 58(22): 68 (1911); *Polyblastiopsis tagananae* (Harm.) Zahlbr., Cat. Lich. Univers. 1: 352 (1922); *Strigula tagananae* (Harm.) R.C. Harris, More Florida Lichens: 160 (1995).

= *Strigula lateralis* Aptroot & van den Boom, Mycotaxon 56: 3 (1995).

Mycobank: MB 414225

***Swinscowia thelopsidoides*** (Coppins, Cl. Roux & Sérus.) S.H. Jiang, Lücking & Sérus. **comb. nov.**

Mycobank number: MB 836430; Index Fungorum number: IF 836430; Facesoffungi number: FoF 08924.

Bas.: *Strigula thelopsidoides* Coppins, Cl. Roux & Sérus. in Roux & Sérusiaux, Biblioth. Lichenol. 90: 90 (2004).

**Key to species of *Swinscowia*:**

1. Ascospores transversely 3–7(–9)-septate, very rarely few ascospores with some longitudinal septa, mostly less than 7 µm broad; macroconidia transversely septate.....2
1. Ascospores regularly submuriform to muriform (i.e. most or all ascospores with at least a few longitudinal septa); macroconidia transversely septate to muriform.....17
2. On bark.....3
2. On rock (or rarely mosses over rock).....9
3. Ascospores regularly 3-septate; macroconidia (where known) 13–18 µm long.....4
3. Ascospores irregularly 3–7(–9)-septate to regularly 7-septate, very rarely few ascospores with some longitudinal septa; macroconidia (where known) 18–30 µm long.....7
4. Perithecial with carbonized involucrellum, black; pycnidia with macroconidia frequent; macroconidia 13–18 × 2.5–4 µm; chiefly Europe.....5
4. Perithecial lacking or with non-carbonized involucrellum, pale to orange-brown; pycnidia with macroconidia unknown.....6
5. Ascospores 15–24 × 4.5–6 µm.....*Swinscowia affinis*
5. Ascospores 13–17 × 3.5–5.5 µm.....*Swinscowia jamesii*
6. Ascospores 17–22 × 6–8 µm; perithecia pale; Korea.....*Swinscowia pallida*
6. Ascospores 10–14 × 2.5–3.5 µm; perithecia orange-brown; Europe.....*Swinscowia thelopsidoides*
7. Ascospores 25–42 µm long, largely over 30 µm; typically on rough bark; subcosmopolitan.....*Swinscowia stigmatella*
7. Ascospores 16–30 µm long; typically on smooth bark.....8
8. Collected in Europe; macroconidia 18–28 × 3.5–4 µm.....*Swinscowia glabra*

8. Collected in Australasia, including New Zealand; macroconidia unknown..... *Swinscowia albicascens*  
Notes: See discussion for the three species keyed out under couplets 7 and 8 under *Swinscowia glabra*
9. On calcareous rock (limestone).....10
9. On siliceous rock (granite) or over mosses.....14
10. Perithecial with carbonized involucrellum, black; extra-European.....11
10. Perithecial lacking involucrellum, pale; Europe.....12
11. Perithecia with lateral ostioles, fused; ascospores irregularly 3–7-septate; Caribbean...*Swinscowia bahamensis*
11. Perithecia with apical ostioles, solitary; ascospores regularly 3-septate; New Zealand...*Swinscowia rhodinula*
12. Ascospores (5–)7-septate; macroconidia (3)4–7-septate, 20–30 µm long..... *Swinscowia endolitheia*
12. Ascospores (where known) 3-septate; macroconidia 3(–4)-septate, 10–20 µm long.....13
13. Macroconidia 15–20 µm long...*Swinscowia calcarea*
13. Macroconidia 10–15 µm long...*Swinscowia cavicola*  
Notes: *Strigula cavicola* is here keyed out together with *S. calcarea* following Roux and Sérusiaux (2004), who hypothesized a close relationship between these taxa. However, perithecia and ascospores are thus far unknown from *S. cavicola*
14. Ascospores 3-septate, 18–21 µm long; over mosses; Europe.....*Swinscowia muscicola*
14. Ascospores 7(–9)-septate, 25–42 µm long; on rock, rarely over mosses on rock.....15
15. Over mosses on rock; involucrellum carbonized but developed only around ostiole...*Swinscowia alpestris*
15. Directly on rock; involucrellum carbonized and reaching down to substrate, or involucrellum pale to brownish.....16
16. Involucrellum carbonized, reaching down to substrate; pantropical.....*Swinscowia decipiens*
16. Involucrellum pale to brownish, developed only around ostiole; Japan.....*Swinscowia aquatica*  
Notes: *Swinscowia aquatica* was considered by McCarthy (2001) to possibly represent a pale form of *S. decipiens*, but the structure of the involucrellum suggests a closer relationship with *S. alpestris*
17. On bark.....18
17. On rock (or rarely mosses over rock).....27
18. Ascospores 20–33 × 6–10 µm long, submuriform with few longitudinal septa; macroconidia transversely septate to submuriform.....19
18. Ascospores 35–135 × 8–48 µm long, regularly muriform; macroconidia submuriform to muriform.....23
19. Perithecial wall pale; North America.....*Swinscowia griseonitens*
20. Perithecial wall carbonized.....20

20. Pycnidia producing macroconidia rostrate; macroconidia submuriform; Madagascar.....*Swinscowia rostrata*
21. Pycnidia producing macroconidia not rostrate; macroconidia transversely septate.....21
21. Ostiole lateral; macroconidia 7–11-septate, 35–45 × 4–5 µm; Europe, Australia.....*Swinscowia tagananae*
22. Ostiole apical; macroconidia 3–7-septate, 20–25 × 3–10 µm.....22
22. Macroconidia 3-septate, 15–20 × 3–4 µm, about 5–6 times as long as broad, fragmenting into part spores; New Zealand.....*Swinscowia fracticonidia*
23. Macroconidia 7-septate, 20–25 × 8–10 µm, about 2–3 times as long as broad, remaining intact; North America.....*Swinscowia submuriformis*
23. Ascomata unknown; macroconidia regularly muriform, 90–105 × 30–35 µm; South America.....*Swinscowia muriconidiata*
24. Ascomata present; macroconidia unknown.....24
24. Ostiole lateral; ascospores 42–50 × 14–17 µm, about 2.5–3.5 times as long as broad; Neotropics (Costa Rica).....*Swinscowia amphora*
25. Ostiole apical; ascospores variously sized but relatively narrower, about 3.5–4.5 times as long as broad.....25
25. Ascospores 115–135 × 38–48 µm, 2/ascus; Korea.....*Swinscowia bispora*
26. Ascospores 35–90 × 8–26 µm, 8/ascus.....26
26. Ascospores 35–45 × 8–10 µm; perithecial wall pale; North America.....*Swinscowia laceribracae*
27. Ascospores 60–90 × 18–26 µm; perithecial wall carbonized but covered by thallus; Neotropics (Brazil).....*Swinscowia obtecta*
27. On calcareous rock (limestone) or mosses over limestone; Europe.....28
28. On siliceous rock (granite); Africa, Australasia.....29
28. Directly on rock; ascospores submuriform, 20–33 × 5–10 µm; macroconidia submuriform, 14–27 × 4–9 µm.....*Swinscowia porinoides*
29. On mosses over rock; ascospores muriform, 35–60 × 7–12 µm; macroconidia unknown.....*Swinscowia confusa*
29. Ascospores 16–36 × 5.5–11.5 µm.....30
30. Ascospores 37–63 × 10–27 µm.....32
30. Macroconidia muriform, 19–30 × 6–9 µm; ascospores muriform, 23–36 × 7–11.5 µm; continental Australia.....*Swinscowia australiensis*
30. Macroconidia 3-septate, 11–20 × 3–4.5 µm, or macroconidia unknown; ascospores submuriform, 16–30 × 5.5–9 µm.....31
31. Perithecia 0.2–0.3 mm diam.; involucrellum 30–60 µm thick; thallus thin; Cook Islands.....*Swinscowia divisa*
31. Perithecia 0.3–0.6 mm diam.; involucrellum 50–120 µm thick; thallus thick; Lord Howe Island.....*Swinscowia rupestris*
32. Perithecial wall pale; ascospores 2–2.5 times as long as broad; African Paleotropics (São Tomé and Príncipe).....*Swinscowia albolinita*
32. Perithecial wall carbonized; ascospores 2.5–4 times as long as broad.....33
33. Perithecia 0.2–0.3 mm diam.; Papua New Guinea.....*Swinscowia muriformis*
33. Perithecia 0.4–0.8 mm diam.; New Zealand.....*Swinscowia johnsonii*

#### Excluded genera:

*Oletheriostrigula* Huhndorf & R.C. Harris, Brittonia 48: 551 (1996).

*Mycobank number*: MB 27751; *Index Fungorum number*: IF 27751; *Facesoffungi number*: FoF 08925.

*Type species*: *Oletheriostrigula papulosa* (Durieu & Mont.) Huhndorf & R.C. Harris, Brittonia 48: 551 (1996); *Sphaeria papulosa* Durieu & Mont., Expl. Sci. Alg., Fl. Algér. 1(14): 536 (1848) [1846–49]; *Leptosphaeria papulosa* (Durieu & Mont.) Sacc., Nuovo G. Bot. Ital. 7: 313 (1875); *Metasphaeria papulosa* (Durieu & Mont.) Sacc., Syll. Fung. 2: 168 (1883); *Massarina papulosa* (Durieu & Mont.) S.K. Bose, Phytopath. Z. 41: 176 (1961).

*Notes*: Huhndorf and Harris (1996) suggested placement of this unique, non-lichenized, apparently saprotrophic fungus in *Strigulaceae*, based on hamathecium and ascus structure. Close relationship of non-lichenized and lichenized fungi has been demonstrated for other lineages, such as *Heleiosa* in the *Monoblastiaceae* (Nelsen et al. 2011a; Lücking et al. in Hongsanan et al. 2020, this volume; *Monoblastiaceae*). The paraphyses, asci and ascospores of *Oletheriostrigula* indeed closely resemble those of e.g. *Flavobathelium*. However, based on Bose (1961), Huhndorf and Harris (1996) gave the asexual morph of *Oletheriostrigula* as *Diplodia* stage, which is described as forming rather large (around 20–40 × 10–15 µm), aseptate, oval-ellipsoid, rather thick-walled conidia that remain mostly hyaline but partially become brown and septate with age and never produce gelatinous appendages (Burgess et al. 2003; Alves et al. 2004; Damm et al. 2007; Phillips et al. 2007). Bose (1961) described the conidia of *Massarina populosa* as 7–16 × 2.5–5 µm in size, gradually (not abruptly in age) turning brown, and irregularly pyriform-clavate to elliptical, thus different from *Diplodia sensu stricto*. Even so, while the conidia of *Oletheriostrigula* do not seem to represent a

genuine *Diplodia* asexual morph, they are also very different from macroconidia in *Strigulaceae*, which are septate to muriform, persistently hyaline, and with gelatinous appendages; hence *Oletheriostrigula* must be excluded from that family.

On a side note, the genus *Diplodia* was established in Montagne (1834: 302), ascribed to Fries, based on *Sphaeria mutila* Fr., with the description “*Asci elliptico-oblongi, didymi, sporidiis binis referti*”. Also, Fries (1823) had originally described the species in *Sphaeria*, which he explicitly characterized as producing asci. In spite of this, the name *Diplodia* has become firmly established for a frequently encountered, economically important asexual morph of various ascomycetous fungi (Kirk et al. 2008). This interpretation, which is in conflict with the protologue, goes back to Stevens (1933), who reportedly saw only pycnidia with conidia in the material identified in Montagne (1834; cited as no. 498) and therefore established the name *Diplodia mutila* (Fr.) Mont. [sic] as having priority over the previously used name *Sphaeropsis malorum* (Berk.) Berk. for said asexual morph. The ascospores and conidia of *Botryosphaeria stevensii*, the current name covering *Sphaeria mutila* and *Diplodia mutila* (Shoemaker 1964; Alves et al. 2004), are remarkably similar in size, shape, and development, remaining aseptate and hyaline for a long time and eventually becoming brown and septate in part. Thus, in superficial observation, it is conceivable that pycnidia with conidia might be mistaken for perithecia with asci, and vice-versa. However, if that was the case and the original material seen by Fries and Montagne only contained pycnidia, one would still have to prove that neither author actually saw at least one perithecium with asci, in order to supersede the explicit description of asci in the protologue of *Diplodia* (Montagne 1834). That seems impossible, given that both stages may occur together, both perithecia and pycnidia are formed in black stromata, and perithecia possibly present in the original material might have been used up by previous examinations. Fries (1849) himself later elaborated on the formation of ascospores and conidia in otherwise identical fruiting bodies of *Sphaeria sensu lato* species, including *Diplodia*. According to Sutton (1980) and Alves et al. (2004), original material of *Sphaeria mutila* seen by Fries (*Scleromyces Suecici* 164, 385) contains only empty fruiting bodies, which at least in one case (164) were interpreted by Sutton (1980) as ascospores, who therefore suggested to adopt the name for a sexual morph. Alves et al. (2004) also argued that Montagne (1834) did not ascribe to Fries a new combination for *Sphaeria mutila* Fr., as *Diplodia mutila* (Fr.) Fr., but instead ascribed to that author a new species, *Diplodia mutila* Fr. This is incorrect, as Montagne (1834, p. 302) clearly states that “... *this species* ...”, namely *Sphaeria mutila* Fr., will be the type of *Diplodia* Fr., providing a valid description for the latter, ascribed to Fries. Hence, the genus

*Diplodia* is to be based on *Sphaeria mutila*, with its type to be cited as *D. mutila* (Fr.) Fr., and cannot be interpreted otherwise. This also means that the relevant elements to assess the status of *Diplodia* as representing a sexual or asexual morph genus are the material used by Fries (*Scleromyces Suecici* 164, 385), with only empty fruiting bodies at least partly interpreted as perithecia, plus Fries’s description in Montagne (1834) explicitly describing asci. The assessment of Stevens (1933) and Alves et al. (2004) of Montagne’s no. 498 is insofar irrelevant as it does not prove that Fries’s original material contained only pycnidia and that therefore Fries’s placement of the species in a genus characterized by the formation of asci was in error; neither does it prove that Fries did not see asci in Montagne’s material either. Consequently, if *Sphaeria mutila* is accepted as name of a sexual morph and placed in the genus *Botryosphaeria* Ces. & De Not., *Diplodia* Fr. has priority over the latter name.

On top of this, there is also confusion with the correct name applying to the species originally described as *Sphaeria mutila* and currently known as *Botryosphaeria stevensii* Shoemaker (Shoemaker 1964; Alves et al. 2004). Stevens (1936) claimed to have discovered the sexual morph of *Sphaeria mutila* (Fr.) for the first time and proposed the combination into *Physalospora*, as *P. mutila* (Fr.) N.E. Stevens. At the time when Shoemaker (1964) treated this taxon, the *Montreal Code* (Lanjouw et al. 1961) was in effect, which included Art. 59 on dual nomenclature and the phrase: “*The author who first describes a perfect state may adopt the specific epithet applied to the corresponding imperfect state, but his binomial for the perfect state is to be attributed to him alone, and is not to be regarded as a new combination.*” Thus, assuming that Stevens’s (1936) description was the first discovery of the sexual morph and applying the *Montreal Code*, Shoemaker (1964) changed Stevens’s name to *Physalospora mutila* N.E. Stevens, i.e. a new taxon with a type different from *Sphaeria mutila* Fr. This is problematic for two reasons: (1) the *Cambridge Rules* (Briquet 1935), which were in effect in 1936, did not include such a provision, and hence Stevens’s combination was legitimate, and (2) said provision hinges on the correct assessment of what constitutes the first description of a sexual morph. For the reasons outlined above, the name *Sphaeria mutila* Fr. must be associated with the sexual morph, even if Fries (1823) did not explicitly describe asci and ascospores for that species, because by placing the species in *Sphaeria*, Fries (1823) implicitly adopted the name for a taxon producing asci. Therefore, Stevens (1936) cannot be claimed as the first description of the sexual morph, even if he provided essential details beyond Fries’s (1823) morphological diagnosis. Shoemaker (1964) also erroneously thought that the combination of *Physalospora mutila* N.E. Stevens, when interpreted according to the *Montreal Code*, into *Botryosphaeria* was blocked by the name *Botryosphaeria*

*mutila* Cooke [sic]. As so often in mycological literature, that name does not exist. Cooke (1885) explicitly referred to *Sphaeria mutila* as treated in Schweinitz's (1832) work on North American fungi, who in turn explicitly used the name *Sphaeria mutila* Fr. for his North American material. Therefore, Cooke's name is a combination of *Sphaeria mutila* Fr. into *Botryosphaeria*, as *B. mutila* (Fr.) Cooke, accepting that the fungus in question was a widespread species conspecific with Fries's original material. Incidentally, Cooke (1885) gave a description of the asci and ascospores of the taxon five decades prior to Stevens (1936), a fact overlooked by Shoemaker (1964), hence also clearly associating the name *Sphaeria mutila* Fr. with a sexual morph. This further underlines the complications from the provisions in Art. 59 of the *Montreal Code*, since the description of the asexual morph for *S. mutila* by Stevens (1936) was arguably not the first, and hence that rule did not apply. In subsequent version of the *Code* (starting with the *Edinburgh Code* and ending with the *Vienna Code*; Lanjouw et al. 1966; McNeill et al. 2006), this provision was amended in a way that only combinations accompanied by elements required for valid publication of a new taxon, e.g. a Latin description or diagnosis, were to be corrected to names of new taxa and else were to be treated as new combinations. Thus, under the rules applicable at the time, under the amendment in the *Edinburgh Code* and thereafter, and particularly starting with the *Melbourne Code* (Barrie et al. 2012), not only is the name *Physalospora mutila* (Fr.) N.E. Stevens legitimate, but the correct name for the species to be adopted in the genus *Botryosphaeria* is *B. mutila* (Fr.) Cooke. The name *B. stevensii* Shoemaker is thus a superfluous, illegitimate replacement name and all names considered here, namely *Sphaeria mutila* Fr., *Diplodia mutila* (Fr.) Fr., *Botryosphaeria mutila* (Fr.) Cooke, *Physalospora mutila* (Fr.) N.E. Stevens, and *Botryosphaeria stevensii* Shoemaker, are based on the same type and are to be attributed to a sexual morph or holomorph. Given that Fries's original material is sterile, it is an entirely different matter what species *Botryosphaeria mutila* exactly represents, and this can only be settled by epitypification.

#### Key to genera of *Strigulaceae*:

1. Growing on living leaves (foliicolous).....2
1. Growing on bark or rock or sometimes over bryophytes or rarely lichenicolous on other lichens (corticulous, saxicolous, muscicolous, hepaticulous, lichenicolous).....11
2. Ascospores 1-septate, very rarely with two obscure additional septa.....3
2. Ascospores 3-septate to muriform .....8
3. Growing supracuticularly, easily removable from the leaf surface; photobiont representing the *Phycopeltis*

- morphodeme, with more or less rectangular cells forming net-like plates (Fig. 71a, b).....*Phylloporis*
3. Growing subcuticularly, difficult to remove from the leaf surface; photobiont representing the *Cephaleuros* or *Trentepohlia* morphodeme, with rounded to oblong cells forming irregular groups or plates often in more than one layer.....4
4. Perithecial wall not carbonized; thallus often conspicuously folded or lacinate, with numerous white papillae (Fig. 71c).....*Puiggariella*
4. Perithecial wall carbonized; thallus smooth to uneven, rarely with white papillae.....5
5. Ascospores rather large, over 30 µm long; thallus thin, typically dark bluish grey, always hypophyllous (Fig. 71d).....*Raciborskiella*
5. Ascospores small to medium-sized, up to 25 µm; thallus thin to thickened, usually bright to dark green to grey-green or olive-brown, usually epiphyllous, very rarely bluish grey or hypophyllous.....6
6. Thallus olive-brown to dark green with often metallic glance, composed of dichotomously branched but sometimes confluent lacinia bordered by a continuous or interrupted black line; perithecia covered by thin thallus layer up to ostiole, therefore not pure black (Fig. 71e, f).....*Racoplaca*
6. Thallus bright green to grey-green or rarely with bluish tinge, with entire to crenulate or lobed margin but rarely lacinate, not bordered by a thin black line except in the *S. nitidula* aggregate and then thallus green and perithecia exposed, black.....7
7. Macroconidia with appendages becoming very long after release from pycnidia (up to 70–100 µm), appearing as if suspended along gelatinous strands; photobiont representing the *Trentepohlia* morphodeme, forming a single layer (Fig. 71g, h).....*Serusiauxiella*
7. Macroconidia with appendages remaining rather short after release from pycnidia (below 35 µm or typically much shorter); photobiont representing the *Cephaleuros* morphodeme, forming more than one layer (Fig. 71i–o).....*Strigula sensu stricto*
8. Ascospores 3(–5)-septate; macroconidia acicular to filiform, multi-septate.....9
8. Ascospores muriform; macroconidia bacillar to oblong-ellipsoid, multi-septate to muriform.....10
9. Thallus supracuticular; perithecia aggregate in slightly raised pseudostromata filled with ochraceous-yellow, K+ dark red crystals; macroconidia acicular, 3(–5)-septate (Fig. 72a, b).....*Flavobathelium*
9. Thallus subcuticular; perithecia solitary, strongly prominent and laterally covered by a thin thallus layer; macroconidia filiform, 3–9-septate (Fig. 72c).....*Phyllocharis*



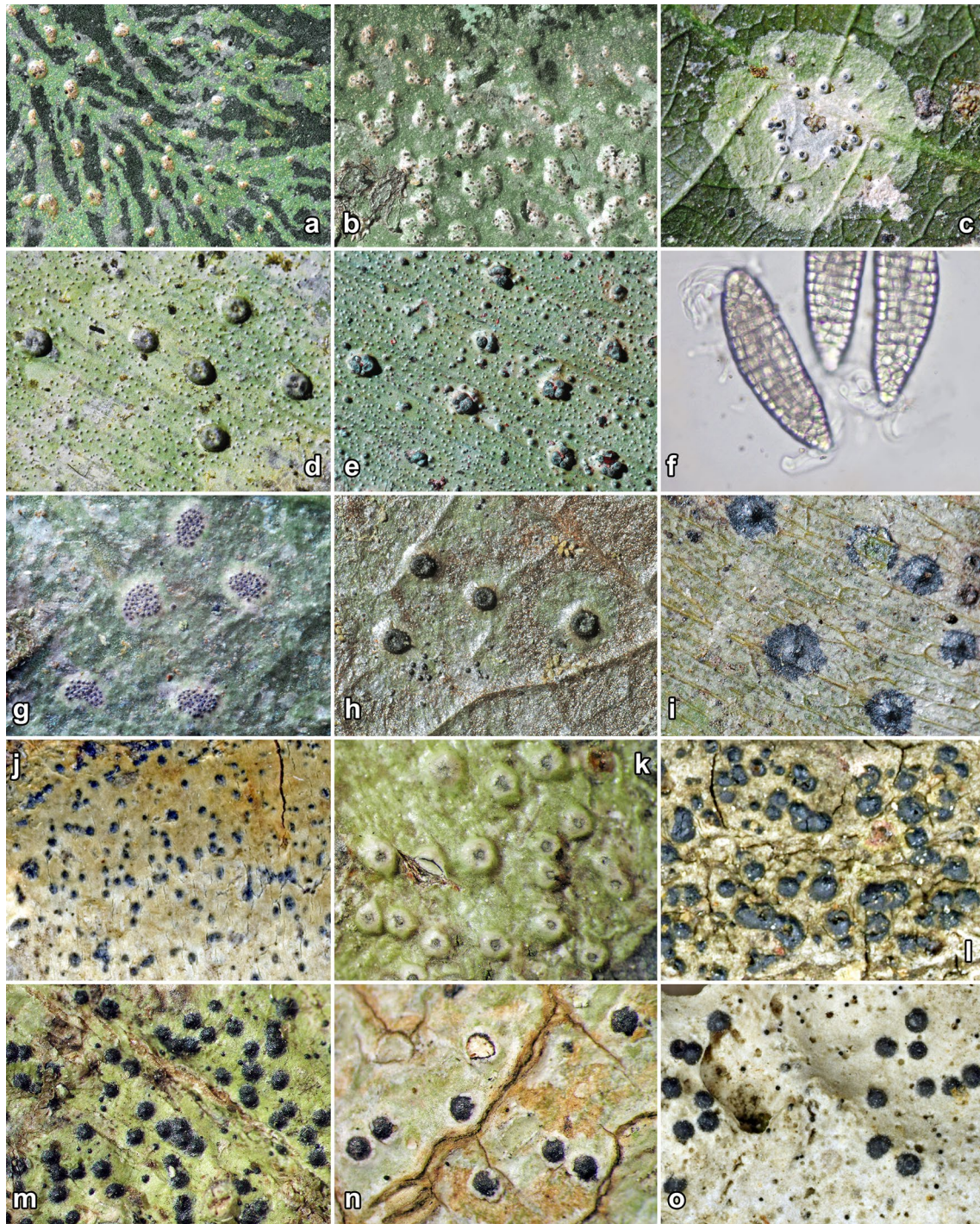


**Fig. 71** Habit of genera and species in *Strigulaceae*. **a** *Phylloporis phyllogena*. **b** *P. obducta*. **c** *Puiggariella nemathora*. **d** *Raciborskiella janeirensis*. **e** *Racoplaca subtilissima*. **f** *R. melanobapha*. **g** *Seru-*

*siauxiella sinensis*. **h** *S. filifera*. **i** *Strigula smaragdula*. **j** *S. macrocarpa*. **k** *S. schizospora*. **l** *S. antillarum*. **m** *S. bella*. **n** *S. prasina*. **o** *S. nitidula*

10. Perithecia immersed in thalline verrucae filled with black, pulveraceous crystals or exposed and then with somewhat roughened surface and wart-shaped to subglobose; pycnidia usually aggregate in pseudostromata,

rarely solitary in thalline verrucae (Fig. 72d–h).....  
 .....*Phyllobathelium*  
 10. Perithecia exposed or covered by very thin thallus layer, not immersed in thalline verrucae, with smooth



**Fig. 72** Habit of genera and species in *Strigulaceae*. **a, b** *Flavobathelium epiphyllum*. **c** *Phyllocharis orbicularis*. **d** *Phyllobathelium firmum*. **e, f** *P. thaxteri* (in **f** macroconidia). **g** *P. leguminosae*. **h** *P.*

*anomalum*. **i** *Phyllocraterina papuana*. **j** *Swinscowia glabra*. **k** *Flagellostrigula laureriformis*. **l** *Dichoporis ziziphii*. **m** *D. phaea*. **n** *D. viridiseda*. **o** *D. wilsonii*

surface, lens-shaped to hemispherical; pycnidia not known (Fig. 72i).....*Phyllocraterina*

- 11. Ascospores and macroconidia 3-septate to muriform; macroconidial appendages relatively short and broad, (1–)2–4 μm, 1–2(–5) times as long as narrow, 15–30%

of conidial length in *Swinscowia*; microconidia typically (oblong-)bacillar (Fig. 72j).....*Swinscowia*

- 11. Ascospores and macroconidia 1-septate; macroconidial appendages relatively long and narrow, 1–2 μm broad, 3–6 times as long as wide, about 20–50% of conidial

- length (or rarely much longer); microconidia typically fusiform(-oblong)..... 12
12. Perithecia and ascospores unknown; macroconidia with a single, flagelliform, very long appendage at the proximal end, about 3–4 times as long as the conidia; pycnidia producing macroconidia very large (0.4–0.8 mm diam.), covered by rather thick thallus layer (Fig. 72k)..... **Flagellostrigula**
12. Perithecia and ascospores frequently present; macroconidia with similar appendages at each end, up to half of the length of the conidia; pycnidia small (usually less than 0.2 mm diam.), visible as dark dots..... 13
13. Photobiont representing the *Phycopeltis* morphodeme, with more or less rectangular cells forming net-like plates; paraphyses unbranched.....  
..... **Phylloporis** (rare instances on bark)
13. Photobiont representing the *Trentepohlia* morphodeme, with rounded to oblong cells forming irregular groups or plates; paraphyses generally branched and sometimes slightly anastomosing (Fig. 72l–o).....  
..... **Dichoporis**

#### Checklist of names published in the genus *Strigula*:

- Strigula abietina* Fr. [nom. inval.] = **Lophodermium abietis** Rostr. (*Rhytismataceae*)
- Strigula actinoplaca* Nyl. = **Actinoplaca strigulacea** Müll. Arg. (*Gomphillaceae*)
- Strigula actinoplacoides* Vain. = **Puiggariella nemathora** (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula acuticonidiarum*** S.H. Jiang, X.L. Wei & J.C. Wei
- Strigula affinis* (A. Massal.) R.C. Harris ≡ ***Swinscowia affinis*** (A. Massal.) S.H. Jiang, Lücking & Sérus.
- Strigula africana* Vain. = ***Strigula smaragdula*** Fr.
- Strigula africana* var. *africana* Vain. = ***Strigula smaragdula*** Fr.
- Strigula africana* var. *crenulata* Vain. = ***Strigula smaragdula*** Fr.
- Strigula africana* var. *natalensis* Vain. ex Van der Byl = ***Strigula smaragdula*** Fr.
- Strigula africana* var. *vegetior* Vain. = ***Strigula subelegans*** Vain.
- Strigula albicascens* (Nyl.) R.C. Harris ≡ ***Swinscowia albicascens*** (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula albolinita* (Nyl.) R.C. Harris ≡ ***Swinscowia albolinita*** (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula albomaculata*** Sérus.
- Strigula alpestris* (Vězda) Hafellner ≡ ***Swinscowia alpestris*** (Vězda) S.H. Jiang, Lücking & Sérus.
- Strigula amblyoloba* Müll. Arg. = ***Racoplaca subtilissima*** (Fée) S.H. Jiang, Lücking & J.C. Wei
- Strigula americana* R.C. Harris ≡ ***Dichoporis tenuis*** (R.C. Harris) S.H. Jiang, Lücking & Sérus.

- Strigula amphora* Aptroot & Lücking ≡ ***Swinscowia amphora*** (Aptroot & Lücking) S.H. Jiang, Lücking & Sérus.
- Strigula angustata*** Cl. Roux & Sérus.
- Strigula angustata* Sérus. & Cl. Roux [nom. inval.] ≡ ***Strigula angustata*** Cl. Roux & Sérus.
- Strigula angustissima* Vain. = ***Phyllocharis orbicularis*** (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula antillarum*** (Fée) Müll. Arg.
- Strigula aquatica* H. Harada ≡ ***Swinscowia aquatica*** (H. Harada) S.H. Jiang, Lücking & Sérus.
- Strigula argentea* (Fée) Trevis. = *Strigula* sp.
- Strigula argyronema* Müll. Arg. = ***Puiggariella nemathora*** (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula argyronema* var. *argyronema* Müll. Arg. = ***Puiggariella nemathora*** (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula argyronema* var. *confluens* Müll. Arg. ≡ ***Puiggariella confluens*** (Müll. Arg.) S.H. Jiang, Lücking & J.C. Wei
- Strigula astroidea* Vain. = ***Strigula smaragdula*** Fr.
- Strigula astroidiza* Vain. = ***Puiggariella nemathora*** (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula atrocarpa* Vain. = ***Strigula concreta*** (Fée) R. Sant.
- Strigula atrocarpa* var. *atrocarpa* Vain. = ***Strigula concreta*** (Fée) R. Sant.
- Strigula atrocarpa* var. *fumigata* Vain. [in Zahlbruckner (1931)] ≡ *Strigula atrocarpoides* var. *fumingata* Vain. = ***Strigula nitidula*** Mont.
- Strigula atrocarpoides* Vain. = ***Strigula nitidula*** Mont.
- Strigula atrocarpoides* var. *atrocarpoides* Vain. = ***Strigula nitidula*** Mont.
- Strigula atrocarpoides* var. *fumigata* Vain. [in Zahlbruckner (1931)] ≡ *Strigula atrocarpoides* var. *fumingata* Vain. = ***Strigula nitidula*** Mont.
- Strigula atrocarpoides* var. *fumingata* Vain. = ***Strigula nitidula*** Mont.
- Strigula australiensis* P.M. McCarthy ≡ ***Swinscowia australiensis*** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus.
- Strigula austropunctata* P.M. McCarthy ≡ ***Phylloporis austropunctata*** (P.M. McCarthy) S.H. Jiang, Lücking & J.C. Wei
- Strigula babingtonii* Berk. ≡ ***Dennisiella babingtonii*** (Berk.) Bat. & Cif. (*Coccodiniaceae*)
- Strigula bahamensis* (Riddle) R.C. Harris ≡ ***Swinscowia bahamensis*** (Riddle) S.H. Jiang, Lücking & Sérus.
- Strigula banksii* Schwein. [nom. inval.] = [unidentified fungus]
- Strigula bella*** G. Thor, Lücking & Tat. Matsumoto
- Strigula bermudana* (Tuck. ex Nyl.) R.C. Harris ≡ ***Dichoporis bermudana*** (Tuck.) S.H. Jiang, Lücking & Sérus.
- Strigula bispora* Aptroot & K.H. Moon ≡ ***Swinscowia bispora*** (Aptroot & K.H. Moon) S.H. Jiang, Lücking & Sérus.

- Strigula brevis* Bricaud & Cl. Roux ≡ ***Dichoporis brevis*** (Bricaud & Cl. Roux) S.H. Jiang, Lücking & Sérus.
- Strigula brevis* Bricaud & Cl. Roux [nom. inval.] ≡ ***Dichoporis brevis*** (Bricaud & Cl. Roux) S.H. Jiang, Lücking & Sérus.
- Strigula buxi*** Chodat
- Strigula caerulensis*** P.M. McCarthy
- Strigula calcarea* Bricaud & Cl. Roux ≡ ***Swinscowia calcarea*** (Bricaud & Cl. Roux) S.H. Jiang, Lücking & Sérus.
- Strigula cavicola* Cl. Roux & Bricaud ≡ ***Swinscowia cavicola*** (Cl. Roux & Bricaud) S.H. Jiang, Lücking & Sérus.
- Strigula ciliata* Mont. = *Cephaleuros* sp. (*Trentepohliaceae*)
- Strigula cinefaciens* (Nyl.) R.C. Harris ≡ ***Phylloporis cinefaciens*** (Nyl.) S.H. Jiang, Lücking & J.C. Wei
- Strigula complanata* (Fée) Nyl. [IF 370567] ≡ *Strigula complanata* (Fée) Mont. = ***Phyllocharis orbicularis*** (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula complanata* Mont. [IF 547404] ≡ *Strigula complanata* (Fée) Mont. = ***Phyllocharis orbicularis*** (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula complanata* f. *complanata* Mont. = ***Phyllocharis orbicularis*** (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula complanata* f. *major* Nyl. = ***Puiggariella nemathora* f. *hypothelia*** (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula complanata* var. *ciliata* (Mont.) Müll. Arg. = *Cephaleuros* sp. (*Trentepohliaceae*)
- Strigula complanata* var. *complanata* Mont. = ***Phyllocharis orbicularis*** (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula complanata* var. *diplomorpha* Müll. Arg. = ***Phyllocharis orbicularis*** (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula complanata* var. *genuina* Müll. Arg. [nom. inval.] ≡ *Strigula complanata* var. *complanata* (Fée) Mont. = ***Phyllocharis orbicularis*** (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula complanata* var. *major* Nyl. = ***Puiggariella nemathora* f. *hypothelia*** (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula complanata* var. *mesotropa* Müll. Arg. = *Cephaleuros* sp. (*Trentepohliaceae*)
- Strigula complanata* var. *stellata* Nyl. & Cromb. ex H.M. Ward ≡ ***Strigula smaragdula* var. *stellata*** (Nyl. & Cromb. ex H.M. Ward) Farkas
- Strigula complanata* var. *subtilis* Müll. Arg. = *Phycopeltis* sp. (*Trentepohliaceae*)
- Strigula complanata* var. *virescens* Nyl. [IF 604058] ≡ *Strigula complanata* var. *virescens* (Kunze ex Fr.) Nyl. ≡ ***Cephaleuros virescens*** Kunze ex Fr. (*Trentepohliaceae*)
- Strigula concentrica* Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula concreta*** (Fée) R. Sant.
- Strigula confusa* Fryday, Coppins & Common ≡ ***Swinscowia confusa*** (A. Massal.) S.H. Jiang, Lücking & Sérus.
- Strigula connivens* R.C. Harris ≡ ***Dichoporis connivens*** (R.C. Harris) S.H. Jiang, Lücking & Sérus.
- Strigula contristans* Zahlbr. = ***Racoplaca maculata*** (Cooke & Masee) S.H. Jiang, Lücking & J.C. Wei
- Strigula dacrydiospora* Zahlbr. = ***Strigula subelegans*** Vain.
- Strigula decipiens* (Malme) P.M. McCarthy ≡ ***Swinscowia decipiens*** (Malme) S.H. Jiang, Lücking & Sérus.
- Strigula decipiens* var. *decipiens* (Malme) P.M. McCarthy ≡ ***Swinscowia decipiens*** (Malme) S.H. Jiang, Lücking & Sérus.
- Strigula decipiens* var. *divisa* P.M. McCarthy ≡ ***Swinscowia divisa*** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus.
- Strigula delicata* Sérus. ≡ ***Strigula delicata*** Sérus.
- Strigula deplanata* Müll. Arg. = ***Puiggariella nemathora* f. *hypothelia*** (Nyl.) (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula dichosporidii* Etayo ≡ ***Dichoporis dichosporidii*** (Etayo) S.H. Jiang, Lücking & Sérus.
- Strigula diderichiana* Etayo, Cl. Roux & Sérus. = ***Dichoporis phaea*** (Ach.) S.H. Jiang, Lücking & Sérus.
- Strigula difformis* Vain. = ***Puiggariella nemathora*** (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula difformis* var. *arimensis* Vain. = ***Puiggariella nemathora*** (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula difformis* var. *difformis* Vain. = ***Puiggariella nemathora*** (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula dilatata* Vain. [IF 454751] ≡ *Porina dilatata* Vain. = ***Strigula nitidula*** Mont.
- Strigula dispersa* Vain. = ***Strigula prasina*** Müll. Arg.
- Strigula donacis* Vain. = ***Puiggariella nemathora* f. *hypothelia*** (Nyl.) (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula effusa* Fr. = *Echinoplaca* sp. (*Gomphillaceae*)
- Strigula elatior* Stirt. = ***Strigula smaragdula*** Fr.
- Strigula elegans* (Fée) Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* f. *elegans* (Fée) Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* f. *feei* (Mont.) Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* f. *fuscata* Müll. Arg. [as var. *genuina* f. *fuscata*; nom. inval.] ≡ *Strigula elegans* var. *elegans* f. *fuscata* Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* f. *hirtella* (Fée) Nyl. [IF 477956] ≡ *Strigula elegans* var. *elegans* f. *hirtella* Müll. Arg. = *Cephaleuros* sp. (*Trentepohliaceae*)
- Strigula elegans* f. *hirtella* Müll. Arg. [as var. *genuina* f. *hirtella*; nom. inval.] ≡ *Strigula elegans* var. *elegans* f. *hirtella* Müll. Arg. = *Cephaleuros* sp. (*Trentepohliaceae*)

- Strigula elegans* subsp. *elegans* (Fée) Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* subsp. *intermedia* Müll. Arg. [IF 451609] ≡ *Strigula elegans* var. *intermedia* Müll. Arg. = ***Strigula concreta*** (Fée) R. Sant.
- Strigula elegans* var. *antillarum* (Fée) R. Sant. ≡ ***Strigula antillarum*** (Fée) Müll. Arg.
- Strigula elegans* var. *concreta* (Fée) Zahlbr. ≡ ***Strigula concreta*** (Fée) R. Sant.
- Strigula elegans* var. *elatio*r (Stirt.) Zahlbr. = ***Strigula smaragdula*** Fr.
- Strigula elegans* var. *elegans* (Fée) Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* var. *eumorpha* Müll. Arg. = ***Strigula microspora*** Lücking
- Strigula elegans* var. *feei* (Mont.) Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* var. *genuina* Müll. Arg. [nom. inval.] ≡ *Strigula elegans* var. *elegans* (Fée) Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* var. *hirtella* Fée [IF 451584] ≡ *Strigula elegans* var. *elegans* f. *hirtella* Müll. Arg. = *Cephaleuros* sp. (*Trentepohliaceae*)
- Strigula elegans* var. *intermedia* Müll. Arg. = ***Strigula concreta*** (Fée) R. Sant.
- Strigula elegans* var. *nemator*a (Nyl.) Müll. Arg. [IF 588134] ≡ *Strigula elegans* var. *nemator*a (Mont.) Müll. Arg. = ***Puiggariella nemathora*** (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula elegans* var. *oxyloba* Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* var. *pertenuis* Müll. Arg. = *Cephaleuros* sp. (*Trentepohliaceae*)
- Strigula elegans* var. *stellata* (Nyl. & Cromb. ex H.M. Ward) R. Sant. ≡ ***Strigula smaragdula*** var. *stellata* (Nyl. & Cromb. ex H.M. Ward) Farkas
- Strigula elegans* var. *subciliata* Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* var. *tremula* Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegans* var. *viridissima* Müll. Arg. = ***Strigula smaragdula*** Fr.
- Strigula elegantior* Vain. = ***Strigula subelegans*** Vain.
- Strigula elixii* P.M. McCarthy ≡ ***Dichoporis elixii*** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus.
- Strigula endolithe*a Cl. Roux & Bricaud ≡ ***Swinscowia endolithe*a** (Cl. Roux & Bricaud) S.H. Jiang, Lücking & Sérus.
- Strigula endolithe*a Cl. Roux & Bricaud [nom. inval.] ≡ ***Swinscowia endolithe*a** (Cl. Roux & Bricaud) S.H. Jiang, Lücking & Sérus.
- Strigula epiphylla* Eschw. [IF 454754] ≡ *Verrucaria epiphylla* Eschw. [nom. illeg.] = ***Strigula smaragdula*** Fr.
- Strigula feei* Mont. = ***Strigula smaragdula*** Fr.
- Strigula fibrillosa* Zahlbr. = ***Racoplaca melanobapha*** (Kremp.) S.H. Jiang, Lücking & J.C. Wei
- Strigula fossulicola*** P.M. McCarthy, Streimann & Elix
- Strigula fossulicoloides*** Sérus.
- Strigula fractans* P.M. McCarthy ≡ ***Dichoporis fractans*** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus.
- Strigula fracticonidia* R.C. Harris ≡ ***Swinscowia fracticonidia*** (R.C. Harris) S.H. Jiang, Lücking & Sérus.
- Strigula gibberosa* Müll. Arg. = ***Strigula schizospora*** R. Sant. [nom. cons.]
- Strigula gibbosa* Vain. = ***Strigula smaragdula*** Fr.
- Strigula glabra* (A. Massal.) V. Wirth ≡ ***Swinscowia glabra*** (A. Massal.) S.H. Jiang, Lücking & Sérus.
- Strigula glaziovii* Müll. Arg. = *Cephaleuros* sp. (*Trentepohliaceae*)
- Strigula graminicola*** R. Sant.
- Strigula griseonitens* R.C. Harris ≡ ***Swinscowia griseonitens*** (R.C. Harris) S.H. Jiang, Lücking & Sérus.
- Strigula guangxiensis*** S.H. Jiang, X.L. Wei & J.C. Wei
- Strigula hymenaicola* Bat. & J.L. Bezerra [nom. inval.] = *Strigula* sp.
- Strigula hypothallina* R.C. Harris ≡ ***Phylloporis hypothallina*** (R.C. Harris) S.H. Jiang, Lücking & Sérus.
- Strigula hypothelia* Nyl. ≡ ***Puiggariella nemathora*** f. *hypothelia* (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula indutula* (Nyl.) R.C. Harris = ***Swinscowia albica-scens*** (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula insignis* Jatta = ***Racoplaca melanobapha*** (Kremp.) S.H. Jiang, Lücking & J.C. Wei
- Strigula jamesii* (Swinscow) R.C. Harris ≡ ***Swinscowia jamesii*** (Swinscow) S.H. Jiang, Lücking & Sérus.
- Strigula janeirensis* (Müll. Arg.) Lücking ≡ ***Raciborskiella janeirensis*** (Müll. Arg.) R. Sant.
- Strigula johnsonii* P.M. McCarthy ≡ ***Swinscowia johnsonii*** (P.M. McCarthy) S.H. Jiang, Lücking & Sérus.
- Strigula kaitokensis*** Sérus. & Polly
- Strigula laceribracae* R.C. Harris ≡ ***Swinscowia laceribracae*** (R.C. Harris) S.H. Jiang, Lücking & Sérus.
- Strigula lacericola*** P.M. McCarthy
- Strigula lacunculata* Vain. = ***Phyllocharis orbicularis*** (Fr.) S.H. Jiang, Lücking & Sérus.

- Strigula lacinulata* var. *compactior* Zahlbr. = *Phyllocharis orbicularis* (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula lacinulata* var. *lacinulata* Vain. = *Phyllocharis orbicularis* (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula lamellosa* Zahlbr. = *Strigula subelegans* Vain.
- Strigula lamprocarpa* Müll. Arg. [IF 454755] = *Porina lamprocarpa* Müll. Arg. = *Strigula nitidula* Mont.
- Strigula lateralis* Aptroot & van den Boom = *Swinscowia tagananae* (Harm.) S.H. Jiang, Lücking & Sérus.
- Strigula laureriformis* Aptroot & Lücking = *Flagellostrigula laureriformis* (Aptroot & Lücking) Lücking, S.H. Jiang & J.C. Wei
- Strigula linearis* Vain. = *Racoplaca melanobapha* (Kremp.) S.H. Jiang, Lücking & J.C. Wei
- Strigula lobulosa* Kunze ex Fr. = *Strigula* sp.
- Strigula mabae* Zahlbr. = *Strigula smaragdula* Fr.
- Strigula macaronesica* Sérus.
- Strigula macrocarpa* Vain.
- Strigula maculata* (Cooke & Masee) R. Sant. = *Racoplaca maculata* (Cooke & Masee) S.H. Jiang, Lücking & J.C. Wei
- Strigula maritima* H. Harada = *Dichoporis maritima* (H. Harada) S.H. Jiang, Lücking & Sérus.
- Strigula mediterranea* Etayo = *Dichoporis ziziphi* (A. Massal.) S.H. Jiang, Lücking & Sérus.
- Strigula melanobapha* (Kremp.) R. Sant. = *Racoplaca melanobapha* (Kremp.) S.H. Jiang, Lücking & J.C. Wei
- Strigula melanophthalma* Mont. = *Strigula antillarum* (Fée) Müll. Arg.
- Strigula microspora* Lücking
- Strigula microthyrium* Mont. = [unidentified fungus]
- Strigula minor* (Vezda) Cl. Roux & Sérus.
- Strigula minuta* Lücking
- Strigula minutula* P.M. McCarthy = *Dichoporis minutula* (P.M. McCarthy) S.H. Jiang, Lücking & Sérus.
- Strigula mori* Schulzer ex Keissl. = [unidentified fungus]
- Strigula multipunctata* (G. Merr. ex R. Sant.) R.C. Harris = *Phylloporis cinefaciens* (Nyl.) S.H. Jiang, Lücking & J.C. Wei
- Strigula muriconidiata* Aptroot, L.I. Ferraro & M. Cáceres = *Swinscowia muriconidiata* (Aptroot, L.I. Ferraro & M. Cáceres) S.H. Jiang, Lücking & Sérus.
- Strigula muriformis* Aptroot & Diederich = *Swinscowia muriformis* (Aptroot & Diederich) S.H. Jiang, Lücking & Sérus.
- Strigula muscicola* F. Berger, Coppins, Cl. Roux & Sérus. = *Swinscowia muscicola* (F. Berger, Coppins, Cl. Roux & Sérus.) S.H. Jiang, Lücking & Sérus.
- Strigula natalis* P.M. McCarthy = *Dichoporis natalis* (P.M. McCarthy) S.H. Jiang, Lücking & Sérus.
- Strigula nemathora* Mont. = *Puiggariella nemathora* (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula nemathora* f. *hypothelia* (Nyl.) Lücking = *Puiggariella nemathora* f. *hypothelia* (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula nemathora* f. *nemathora* Mont. = *Puiggariella nemathora* (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula nemathora* var. *hypothelia* (Nyl.) R. Sant. = *Puiggariella nemathora* f. *hypothelia* (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula nemathora* var. *nemathora* Mont. = *Puiggariella nemathora* (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula nemathora* var. *pulchella* (Müll. Arg.) R. Sant. = *Puiggariella nemathora* (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula nemathora* var. *pulchella* Mont. [IF 451376] = *Strigula nemathora* var. *pulchella* (Müll. Arg.) R. Sant. = *Puiggariella nemathora* (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula nemator* Nyl. [in Zahlbruckner 1922] = *Puiggariella nemathora* (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula nigrocarpa* Lücking
- Strigula nigrocincta* Müll. Arg. = *Puiggariella nigrocincta* (Müll. Arg.) S.H. Jiang, Lücking & J.C. Wei
- Strigula nigrocincta* var. *nigrocincta* Müll. Arg. = *Puiggariella nigrocincta* (Müll. Arg.) S.H. Jiang, Lücking & J.C. Wei
- Strigula nigrocincta* var. *soluta* Müll. Arg. = *Puiggariella nigrocincta* (Müll. Arg.) S.H. Jiang, Lücking & J.C. Wei
- Strigula nipponica* H. Harada = *Dichoporis nipponica* (H. Harada) S.H. Jiang, Lücking & Sérus.
- Strigula nitidula* Mont.
- Strigula novae-zelandiae* (Nag Raj) Sérus.
- Strigula nylanderii* Vain. = *Strigula smaragdula* Fr.
- Strigula nylanderiana* F. Schill. = *Puiggariella nemathora* f. *hypothelia* (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula obducta* (Müll. Arg.) R.C. Harris = *Phylloporis obducta* (Müll. Arg.) R. Sant. & Tibell
- Strigula obtecta* (Vain.) R.C. Harris = *Swinscowia obtecta* (Vain.) S.H. Jiang, Lücking & Sérus.
- Strigula obvelata* Vain. = *Strigula macrocarpa* Vain.
- Strigula occulta* P.M. McCarthy & Malcolm = *Dichoporis occulta* (P.M. McCarthy & Malcolm) S.H. Jiang, Lücking & Sérus.
- Strigula oceanica* P.M. McCarthy, Streimann & Elix
- Strigula orbicularis* Fr. = *Phyllocharis orbicularis* (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula pachyneura* Müll. Arg. = *Phyllocharis orbicularis* (Fr.) S.H. Jiang, Lücking & Sérus.
- Strigula pallida* Aptroot & K.H. Moon = *Swinscowia pallida* (Aptroot & K.H. Moon) S.H. Jiang, Lücking & Sérus.
- Strigula pallida* Kalchbr. & Stizenb. [IF 479700; nom. inval.] = *Strigula pallida* Kalchbr. = *Strigula* sp.

- Strigula pallidocarpa* Aptroot & K.H. Moon ≡ *Swinscowia pallida* (Aptroot & K.H. Moon) S.H. Jiang, Lücking & Sérus.
- Strigula parksii* Räsänen = *Strigula subelegans* Vain.
- Strigula phaea* (Ach.) R.C. Harris ≡ *Dichoporis phaea* (Ach.) S.H. Jiang, Lücking & Sérus.
- Strigula philippina* Vain. = *Strigula smaragdula* Fr.
- Strigula phyllogena* (Müll. Arg.) R.C. Harris ≡ *Phylloporis phyllogena* (Müll. Arg.) Clem.
- Strigula plana* Müll. Arg. = *Strigula smaragdula* Fr.
- Strigula platypoda* (Müll. Arg.) R.C. Harris ≡ *Phylloporis platypoda* (Müll. Arg.) Vězda
- Strigula porinoides* Canals, Boqueras & Gómez-Bolea ≡ *Swinscowia porinoides* (Canals, Boqueras & Gómez-Bolea) S.H. Jiang, Lücking & Sérus.
- Strigula prasina* Müll. Arg.
- Strigula pulchella* Müll. Arg. = *Puiggariella nemathora* (Mont.) S.H. Jiang, Lücking & J.C. Wei
- Strigula puncticulata* Müll. Arg. = *Puiggariella nemathora* f. *hypothelia* (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula racoplaca* Mont. = *Racoplaca subtilissima* (Fée) S.H. Jiang, Lücking & J.C. Wei
- Strigula radiata* Lücking ≡ *Phylloporis radiata* (Lücking) S.H. Jiang, Lücking & J.C. Wei
- Strigula rhodinula* (Zahlbr.) P.M. McCarthy ≡ *Swinscowia rhodinula* (Zahlbr.) S.H. Jiang, Lücking & Sérus.
- Strigula rostrata* R.C. Harris & Aptroot ≡ *Swinscowia rostrata* (R.C. Harris & Aptroot) S.H. Jiang, Lücking & Sérus.
- Strigula rotula* Mont. ≡ *Mazosia rotula* (Mont.) A. Massal. (*Roccellaceae*)
- Strigula rugulosa* Müll. Arg. = *Strigula concreta* (Fée) R. Sant.
- Strigula rugulosa* var. *irregularis* Müll. Arg. = *Strigula microspora* Lücking
- Strigula rugulosa* var. *rugulosa* Müll. Arg. = *Strigula concreta* (Fée) R. Sant.
- Strigula rupestris* P.M. McCarthy ≡ *Swinscowia rupestris* (P.M. McCarthy) S.H. Jiang, Lücking & Sérus.
- Strigula schizospora* R. Sant. [nom. cons.]
- Strigula setacea* Müll. Arg. = *Cephaleuros* sp. (*Trentepohliaceae*)
- Strigula sinoaustralis* S.H. Jiang, X.L. Wei & J.C. Wei
- Strigula smaragdula* Fr.
- Strigula smaragdula* var. *smaragdula* Fr. ≡ *Strigula smaragdula* Fr.
- Strigula smaragdula* var. *stellata* (Nyl. & Cromb. ex H.M. Ward) Farkas ≡ *Strigula smaragdula* var. *stellata* (Nyl. & Cromb. ex H.M. Ward) Farkas
- Strigula stigmatella* (Ach.) R.C. Harris ≡ *Swinscowia stigmatella* (Ach.) S.H. Jiang, Lücking & Sérus.
- Strigula stigmatella* var. *alpestris* (Vězda) Coppins = *Swinscowia stigmatella* (Ach.) S.H. Jiang, Lücking & Sérus.
- Strigula stigmatella* var. *stigmatella* (Ach.) R.C. Harris ≡ *Swinscowia stigmatella* (Ach.) S.H. Jiang, Lücking & Sérus.
- Strigula stilboideum* Bat. = *Strigula* sp.
- Strigula subelegans* Vain.
- Strigula submuriformis* (R.C. Harris) R.C. Harris ≡ *Swinscowia submuriformis* (R.C. Harris) S.H. Jiang, Lücking & Sérus.
- Strigula subprospersella* (Vain.) P.M. McCarthy ≡ *Dichoporis subprospersella* (Vain.) S.H. Jiang, Lücking & Sérus.
- Strigula subsimplicans* (Nyl.) R.C. Harris ≡ *Dichoporis subsimplicans* (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula subtilissima* (Fée) Müll. Arg. ≡ *Racoplaca subtilissima* (Fée) S.H. Jiang, Lücking & J.C. Wei
- Strigula sulcata* Vain. = *Strigula concreta* (Fée) R. Sant.
- Strigula sychnogonoides* (Nitschke) R.C. Harris ≡ *Geisleria sychnogonoides* Nitschke (*Stictidaceae*)
- Strigula tagananae* (Harm.) R.C. Harris ≡ *Swinscowia tagananae* (Harm.) S.H. Jiang, Lücking & Sérus.
- Strigula taylorii* (Carroll ex Nyl.) R.C. Harris ≡ *Dichoporis taylorii* (Carroll) S.H. Jiang, Lücking & Sérus.
- Strigula tenuis* Müll. Arg. = *Strigula smaragdula* Fr.
- Strigula thelopsidoides* Coppins, Cl. Roux & Sérus. ≡ *Swinscowia thelopsidoides* (Coppins, Cl. Roux & Sérus.) S.H. Jiang, Lücking & Sérus.
- Strigula transversoundulata* Sipman ≡ *Racoplaca transversoundulata* (Sipman) S.H. Jiang, Lücking & J.C. Wei
- Strigula tremens* Müll. Arg. ≡ *Racoplaca tremens* (Müll. Arg.) S.H. Jiang, Lücking & J.C. Wei
- Strigula umbilicata* Müll. Arg. ≡ *Asterothyrium umbilicatum* (Müll. Arg.) Müll. Arg. (*Gomphillaceae*)
- Strigula undulata* Müll. Arg. = *Strigula smaragdula* Fr.
- Strigula urticae* Bonord. = [unidentified fungus]
- Strigula vincentina* Vain. [IF 454756] ≡ *Porina vincentina* Vain. = *Racoplaca subtilissima* (Fée) S.H. Jiang, Lücking & J.C. Wei
- Strigula virescens* (Kunze ex Fr.) Trevis. ≡ *Cephaleuros virescens* Kunze ex Fr. (*Trentepohliaceae*)
- Strigula viridis* (Lücking) R.C. Harris ≡ *Phylloporis viridis* Lücking
- Strigula viridiseda* (Nyl.) R.C. Harris ≡ *Dichoporis viridiseda* (Nyl.) S.H. Jiang, Lücking & Sérus.
- Strigula viridissima* (Fée) Trevis. = *Strigula smaragdula* Fr.
- Strigula vulgaris* (Müll. Arg.) Lücking ≡ *Phylloporis vulgaris* (Müll. Arg.) S.H. Jiang, Lücking & J.C. Wei
- Strigula wandae* M. Cáceres & Lücking
- Strigula wilsonii* (Riddle) R.C. Harris ≡ *Dichoporis wilsonii* (Riddle) S.H. Jiang, Lücking & Sérus.
- Strigula xylopieae* Bat. & Cavalc. = *Strigula schizospora* R. Sant. [nom. cons.]

*Strigula ziziphi* (A. Massal.) Cl. Roux & Sérus. ≡ *Dichoporis ziziphi* (A. Massal.) S.H. Jiang, Lücking & Sérus.

### Economic and ecological significance

For foliicolous species of *Strigulaceae*, indicator values have been published that allow applications in monitoring the conservation status of forest ecosystems (Lücking 1997). Particularly species of *Strigula sensu lato* now dispositioned in the genera *Phylloporis*, *Puiggariella*, *Raciborskiella*, *Racoplaca*, and *Strigula sensu stricto* allow for a rather precise monitoring, as their scores are highly specific to individual genera and species (Lücking 1997). In a recent study, the population genetics of a new species segregated from *Strigula smaragdula*, *S. multiformis*, and its correlation with modeled habitat preferences was studied (Oh et al. 2019).

***Tenuitholiascaceae*** S.H. Jiang, Lücking & J.C. Wei, in Jiang et al., IMA Fungus 11: 1 (2020).

*Fungal Names*: FN570578; *Facesoffungi number*: FoF 08775, 1 species.

*Lichenized* on leaves chiefly in lowland to montane tropical to subtropical habitats. *Thallus* supracuticular, easily separated from the leaf surface, smooth, pale green. *Photobiont Phycopeltis*, cells rectangular, composed of anastomosing filaments in one layer forming regular, radiating plates. *Ascomata* perithecia, wart-shaped, scattered or somewhat clustered, ostiolate, exposed but covered by thin thallus layer up to the ostiole, with the basal part spreading to form a horizontal plate. *Involucrellum* carbonized, black. *Exciple* dense, prosoplectenchymatous, colourless to brown. *Hamathecium* comprising unbranched paraphyses. *Asci* bitunicate in structure but lacking a distinct tholus, apex rounded, I-, appearing nearly unitunicate in some stages, clavate to almost cylindrical, I-, KI-, 8-spored. *Ascospores* irregularly arranged to 2-seriate, fusiform, 3-septate, hyaline. *Asexual state*: *Pycnidia* common, wart-shaped, immersed to erumpent, visible as black dots. *Conidia* acrogenous, only microconidia known; microconidia fusiform, hyaline, aseptate. *Chemistry*: No secondary substances detected in TLC.

*Type*: *Tenuitholiascus* S.H. Jiang, Lücking & J.C. Wei.

*Notes*: The family was introduced by Jiang et al. (2020a) to accommodate a novel lineage sister to *Strigulaceae*, but with a different ascus type. To assess placement of the new lineage within *Dothideomycetes*, a dataset consisting of three loci (SSU, LSU, and *tef1-α*) was constructed and analysed. Even if superficially similar to *Porina* in *Lecanoromycetes*, it was evident that the new lineage was a member of class *Dothideomycetes*, forming a clade supported sister to *Strigulaceae*. Since the asci of the novel lineage differed from those of *Strigulaceae* in lacking a thickened tholus and ocular chamber, it was considered prudent to introduce the monospecific family *Tenuitholiascaceae* and genus *Tenuitholiascus* for this taxon. The specific epithet, *T. porinoides*,

thereby refers to the remarkable similarity with *Porina* both in morphological and anatomical features.

***Tenuitholiascus*** S.H. Jiang, Lücking & J.C. Wei, IMA Fungus 11: 1 (2020).

*Fungal Names*: FN570581; *Facesoffungi number*: FoF 08776, 1 morphological species (Jiang et al. 2020a), 1 species with molecular data.

*Type species*: *Tenuitholiascus porinoides* S.H. Jiang, Lücking & J.C. Wei.

*Notes*: Besides ascus type, the only genus in the family is distinguished from genera in the sister family *Strigulaceae* as follows: from *Phylloporis* in the 3-septate, oblong ascospores, from *Phyllocratera* in the small, 3-septate ascospores, and from *Flavobathelium* in the external habit with exposed perithecia. *Tenuitholiascus* closely resembles *Porina* in external morphology and ascospore type, as well as the thin-walled asci and unbranched paraphyses. Yet, it is entirely unrelated to the latter, which belongs in Gyalectales in class *Lecanoromycetes* (Kraichak et al. 2018; Lücking 2019).

***Tenuitholiascus porinoides*** S.H. Jiang, Lücking & J.C. Wei, IMA Fungus 11: 1 (2020).

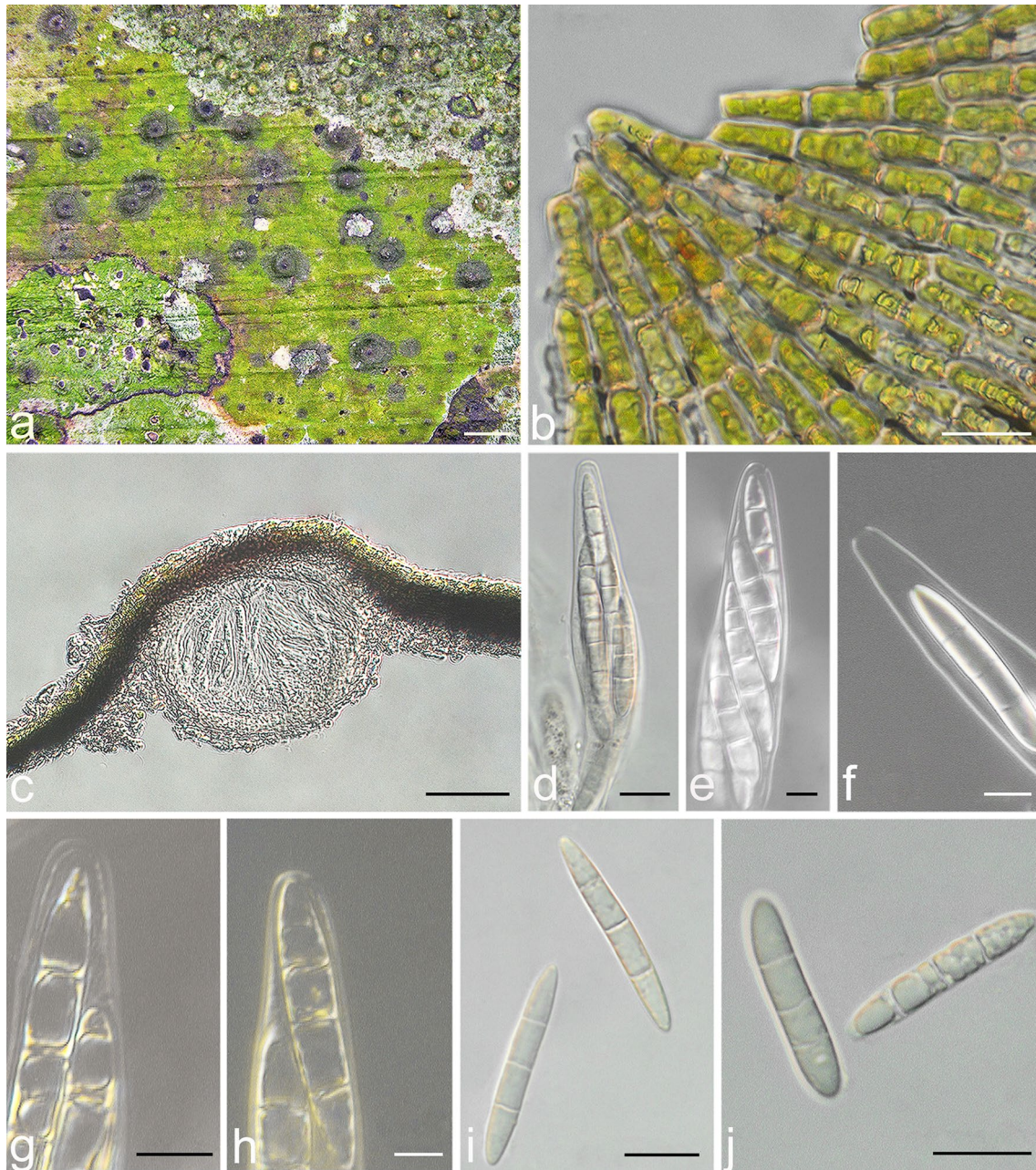
*Fungal Names*: FN570580; Fig. 73

*Thallus* supracuticular, easily separated from the leaf surface, continuous, smooth, pale green, 3–12 mm diam, 30–52.5 μm thick. *Algal partner*: *Phycopeltis*, cells rectangular, 8–14 × 3–5 μm, composed of anastomosing filaments lying in one layer and forming regular radial plates or irregular nets. *Ascomata* perithecia, globose, scattered or clustered, exposed but covered by thin thallus layer up to the ostiole, central part wart-shaped, sometimes basal part broadly spreading to form horizontal plate, 0.25–0.5 mm diam and 80–150 μm high, greyish black. *Involucrellum* carbonized, black, 55–125 μm thick. *Exciple* dense, prosoplectenchymatous, 10–12.5 μm thick, colourless to brown. *Interascal filaments*: unbranched or simply branched, thin. *Asci* bitunicate in structure, apex with a I- rounded, sometimes appearing almost unitunicate in some developmental stages, due to the gradually thinner inner walls (Fig. 73f), clavate to cylindrical, 75–90 × 10–12.5 μm, I-, KI-, 8-spored. *Ascospores* fusiform, 3-septate, colourless, 25–30 × 6–8 μm. *Pycnidia* common, wart-shaped, immersed to erumpent, 0.05–0.1 mm diam, black. *Conidia* (microconidia) fusiform, hyaline, aseptate, 4–5 × 1.5–2 μm.

### Economic and ecological significance

Since this family is poorly known, it is difficult at the moment to elaborate on this topic. As foliicolous lichen apparently found in shady conditions, *Tenuitholiascaceae* is a potential indicator of well-reserved forest ecosystems,





**Fig. 73** *Tenuitholiascus porinoides* (HMAS–L0139638). **a** Thallus. **b** The *Phycopeltis* algal partner. **c** Perithecia in vertical section. **d** Ascus (HMAS–L0139639). **e** Ascus (HMAS–L0139640). **f** Ascus apex (HMAS–L0141346). **g** Ascus with iodine reaction (HMAS–

L0139638). **h** Ascus with iodine reaction (HMAS–L0141348). **i** Ascospores (HMAS–L0139639). **j** Ascospores (HMAS–L0139638). Scale bars: **a** = 300  $\mu$ m, **c** = 20  $\mu$ m, **b**, **d**, **i**, **j** = 10  $\mu$ m, **e–h** = 5  $\mu$ m

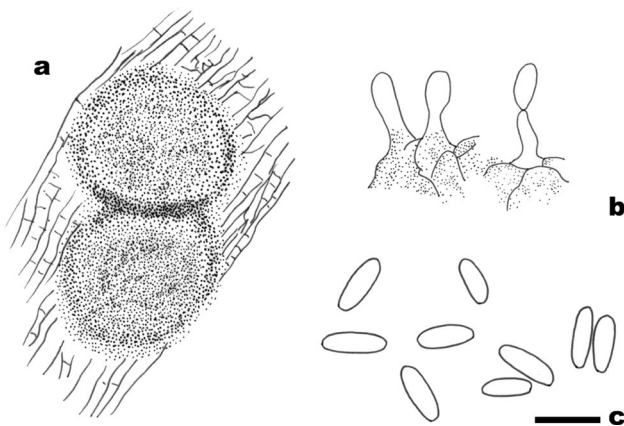
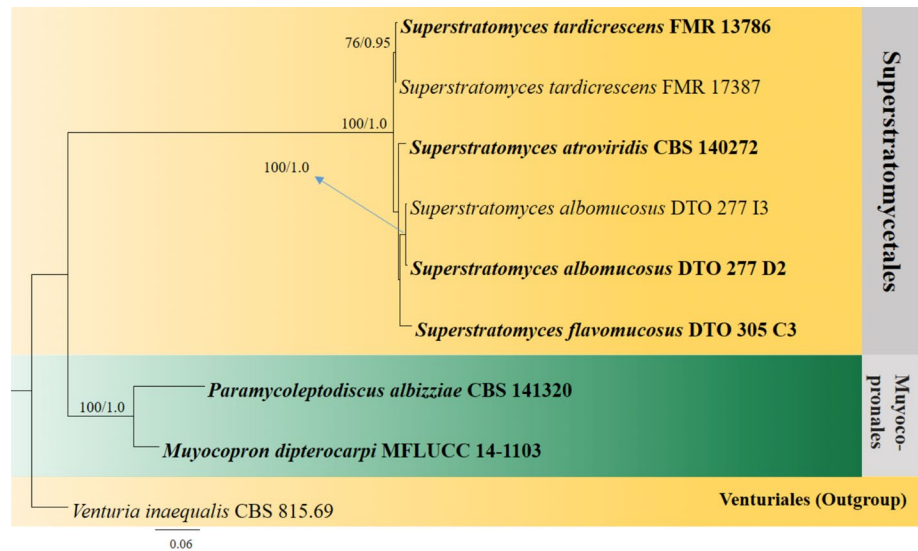
similar to other ecologically equivalent foliicolous lichens (Lücking 1997).

**Superstratomyceales** van Nieuwenh., Miqdl., Houbraken, Adan, Lutzoni & Samson.

*Index Fungorum* number: IF 819160; *Facesoffungi* number: FoF 08926.

Superstratomyceales was introduced to accommodate previously unknown taxa in Pezizomycotina which were recovered from oil-treated timber after outdoor exposure in Australia and the Netherlands (Nieuwenhuijzen et al. 2016). The phylogenetic tree (Fig. 74) indicates that species of *Superstratomyces* form a clade with high support (100% ML, 1.0 PP, Fig. 74) within Dothideomycetes. The

**Fig. 74** Phylogram generated from maximum likelihood analysis (RML) of genera in Superstratomyceales based on ITS, LSU, rpb-2, SSU and tef1 sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Venturia inaequalis* (CBS 815.69). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



**Fig. 75** *Superstratomyces albomucosus* (redrawn from holotype H-22668 in van Nieuwenhuijzen et al. 2016). **a** Pycnidia. **b** Conidiogenous cells. **c** Conidia. Scale bar: c = 5  $\mu$ m

divergence time for Superstratomyceales is estimated as 156 MYA (stem age, Hongsanan et al. 2020).

Accepted families: *Superstratomycetaceae*.

**Superstratomycetaceae** van Nieuwenh., Miädl., Houbraken, Adan, Lutzoni & Samson, Stud. Mycol. 85: 115 (2016).

*Index Fungorum number*: IF 819161; *Facesoffungi numbers*: FoF 08777, 4 species.

*Saprobic* on oil treated wood or darkened surface of a wall, further nature of the substrates varied from human and environmental, therefore probably they showed a wide distribution. **Sexual morph**: Undetermined. **Asexual morph**: Coelomycetous. *Colonies* olive to grey-green or light grey-green with thin white edge; reverse dark green or dark green with thin white edge; knotted cone-shaped. *Hyphae* hyaline to brown, smooth- and thin- to thick-walled, septate. *Conidiomata* pycnidial, superficial, solitary or confluent, brown

to black, glabrous, globose, filled by a white mass of slimy conidia; pycnidial wall pseudoparenchymatous, of *textura angularis* cells, composed of several layers of pale brown to brown, flattened. Setae erect to recurved, hyaline to subhyaline at apex and turning brown towards the base, 1–2-septate, strongly verrucose to tuberculate. *Conidiophores* branched, hyaline, smooth-walled, bearing lateral conidiogenous cells. *Conidiogenous cells* phialidic, hyaline, cylindrical to barrel-shaped or ampulliform, smooth-walled, solitary or laterally disposed on the conidiophores. *Conidia* cylindrical to navicular, hyaline, aseptate, smooth- and thin-walled, guttulate.

*Type*: ***Superstratomyces*** van Nieuwenh., Miädl. & Samson.

*Notes*: *Superstratomycetaceae* comprises one genus named *Superstratomyces*, and it was typified by *Superstratomyces albomucosus*. Multi-locus phylogenies are necessary for the identification of species in *Superstratomyces*. *Superstratomycetaceae* lacks unique characteristics and, therefore, cannot be identified based only on morphology. With the recent introduction of *Superstratomyces tardicrescens*, the number of species in *Superstratomyces*, family *Superstratomycetaceae* has been increased up to four (Crous et al. 2018a).

***Superstratomyces*** van Nieuwenh., Miädl. & Samson, in van Nieuwenhuijzen et al., Stud. Mycol. 85: 115 (2016).

*Index Fungorum number*: IF 819162; *Facesoffungi number*: FoF 08778; 4 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species*: ***Superstratomyces albomucosus*** van Nieuwenh. & Samson.

*Notes*: *Superstratomyces* was introduced by van Nieuwenhuijzen et al. (2016) to accommodate the species that was recovered from outdoor wood in the Netherlands. Currently there are four *Superstratomyces species* including

*S. albomucosus*, *S. flavomucosus*, *S. atroviridis* and *S. tardicrescens*.

***Superstratomyces albomucosus*** van Nieuwenh., Miádl. & Samson, in van Nieuwenhuijzen et al., *Stud. Mycol.* 85: 115 (2016).

*Index Fungorum*: IF 819163; *Facesoffungi number*: FoF 08779, Fig. 234

*Description*: see van Nieuwenhuijzen et al. (2016) (Fig. 75).

### Economic and ecological significance

*Superstratomyces albomucosus* and *S. atroviridis* were isolated from exposed, oil-treated wood and may decay wood. *Superstratomyces flavomucosus* and *S. tardicrescens* were recovered from leaves of *Hakea multilinearis* in Australia and a human eye specimen in the USA (Crous et al. 2018a).

**Trypetheliales** Lücking, Aptroot & Sipman.

*Index Fungorum number*: IF 90793; *Facesoffungi number*: FoF 08780.

Aptroot et al. (2008) established *Trypetheliales* to accommodate a lichen-forming family *Trypetheliaceae*, which is phylogenetically distinct from other orders and families in Dothideomycetes (Del Prado et al. 2006). Based on molecular phylogeny and morphology, a second family *Polycoccaceae*, with lichenicolous fungi, was introduced by Ertz et al. (2015). The order *Trypetheliales* accommodates primarily lichenized and less commonly non-lichenized taxa, characterized by perithecioid ascomata appearing solitary or aggregated in pseudostromata, branched and anastomosing paraphysoids forming a distinct network, and hyaline or rarely brown ascospores, transversely septate to muriform ascospores often with diamond-shaped lumina and angular wall thickenings (Aptroot et al. 2008; Hyde et al. 2013; Nelsen et al. 2014; Ertz et al. 2015). In a case study of divergence time estimates in Dothideomycetes (Liu et al. 2017), the order was diversified approximately 215 (140–298) MYA (crown age) and 309 (231–388) MYA (stem age).

***Polycoccaceae*** Ertz, Hafellner & Diederich, in Ertz et al., *Fungal Diversity* 74: 82 (2015).

*Index Fungorum number*: IF 814032; *Facesoffungi numbers*: FoF 08781, 50 species.

*Lichenicolous*. **Sexual morph**: *Ascomata* arising singly, often becoming grouped, sometimes united by a clypeus or enclosed in galls, immersed with only the ostiole visible to erumpent and the upper half exposed when mature, perithecioid, subglobose to obpyriform, dark brown to black, ostiolate, neck not extended and scarcely distinguishable from the ascomatal wall. *Peridium* thick or somewhat broader near the ostiole, comprises 3–6 layers of polyhedral pseudoparenchymatous cells, radially compressed in vertical

section and roughly isodiametric in surface view, forming a *textura angularis*, thick, brown to dark brown and continuing below the centrum in outer layers, less intensely pigmented to hyaline with thin-walled cells at inner layers. *Hamathecium* comprising branched, anastomosing net of thin, septate to remotely septate narrow hyphal filaments, probably trabeculate pseudoparaphyses (paraphysoids), paraphyses absent, hymenial gel I+ blue to violet or unchanged. *Asci* 2–8-spored, bitunicate, fissitunicate, broadly cylindrical to subclavate, shortly stalked, wall thicker in the upper part of mature asci, with a small internal apical beak. *Ascospores* irregularly distichously arranged in the asci, ellipsoid, brown to dark brown when mature, 1-septate (euseptate), somewhat constricted at the septum, normally equal in size or the upper cell larger and broader, generally rounded or rarely attenuated at apex, smooth or delicately verruculose, sometimes with a gelatinous sheath (adapted from Ertz et al. 2015).

*Type*: ***Polycoccum*** Saut. ex Körb.

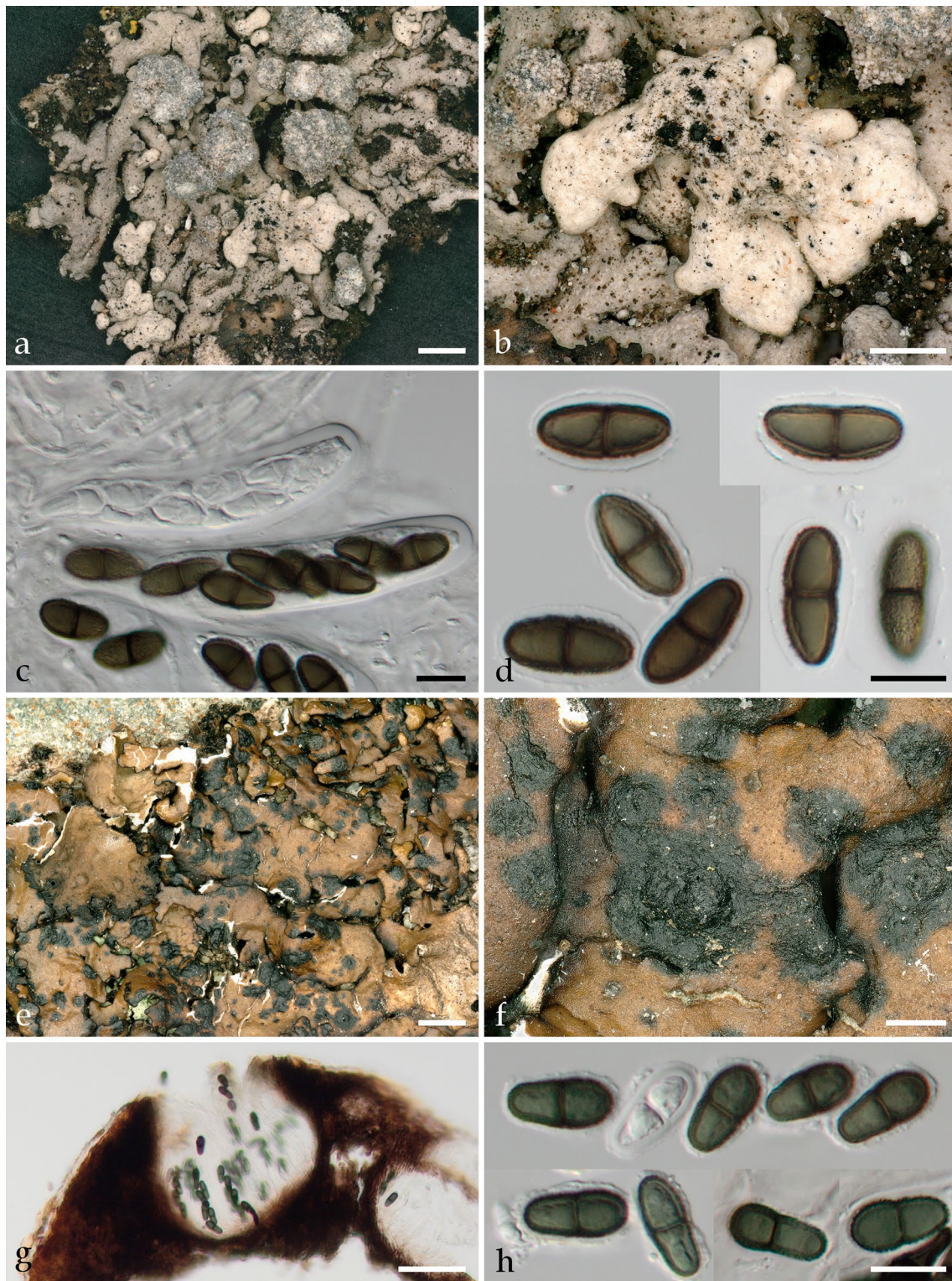
*Notes*: Ertz et al. (2015) included species of *Clypeococcum* and *Polycoccum* in phylogenetic analyses and found that members of the two genera formed a new lineage within Trypetheliales. Therefore, the sister family of *Trypetheliaceae* was introduced and named as *Polycoccaceae* to accommodate *Clypeococcum* and *Polycoccum* based on molecular and morphological data.

***Polycoccum*** Saut. ex Körb., *Parerga lichenol.* (Breslau) 5: 470 (1865).

*Index Fungorum number*: IF 4309; *Facesoffungi number*: FoF 08782; 41 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species*: ***Polycoccum sauteri*** Körb.

*Notes*: *Polycoccum* is considered as polyphyletic, with species being presented in two distantly related clades in Trypetheliales and Pleosporales (Ertz et al. 2015). *Polycoccum sensu stricto* and species of *Clypeococcum* form a lineage in Trypetheliales, thus Ertz et al. (2015) established *Polycoccaceae* to accommodate these genera. *Polycoccum sensu stricto* (in *Polycoccaceae*) is characterized by ascomata formed on the host thallus, induce the formation of galls, thick-walled with cells  $\pm$  isodiametric in longitudinal section, relatively thick paraphysoids, broadly cylindrical to subclavate asci, generally with irregularly distichously or irregularly uni-seriate arranged ascospores, often distinctly ornamented ascospores (Ertz et al. 2015). The genus has 57 species accepted by Lawrey and Diederich (2015) and new species are described almost every year (Ertz et al. 2015). It has become one of the most species-rich genera of lichenicolous fungi. The most complete key to species of *Polycoccum* so far was provided by Hawksworth and Diederich (1988). Other regional keys were established such as key for 13 species from Spain (Atienza et al. 2003), and key for 14



**Fig. 76** Morphology of genera in *Polycoccaceae* (a–d = *Polycoccum pulvinatum*, Belgium, Ertz 18114 (BR); e–h = *Clypeococcum cladonema*, Belgium, Ertz 15260 (BR)). a, b Galls with immersed ascromata on *Physcia caesia*. c Asci with ascospores in water. d Ascospores in water, the one in the lower right corner showing the

verruculose surface. e, f ascromata (= black areas) on *Xanthoparmelia* (= brownish host thallus). g Section of ascromata in water. h, ascospores in water. Scale bars: a, e = 1 mm, b = 500 μm, f = 250 μm, g = 50 μm, c, d, h = 10 μm

species from Sweden (Ihlen and Wedin 2008), and a key for 13 species from France (Gardiennet 2012) (Fig. 76).

#### Other genera included:

***Clypeococcum*** D. Hawksw., J. Linn. Soc., Bot. 75: 196 (1977).

*Index Fungorum number*: IF 1114; *Facesoffungi number*: FoF 08783; – 9 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Clypeococcum cladonema*** (Wedd.) D. Hawksw., Bot. J. Linn. Soc. 75(2): 197 (1977).

≡ *Lecidea cladonema* Wedd., Bull. Soc. bot. Fr. 21: 345 (1874).

*Notes*: According to Hawksworth and Diederich (1988), this genus shares some characters with *Polycoccum*, but differs by hyphal rather than pseudoparenchymatous ascomatal walls, thickened around the ostiole, and by the ascomata occurring in groups united by a common clypeus. In phylogenetic tree of Ertz et al. (2015), *Clypeococcum* represented by *C. placopsiophilum* and *C. psoromatis* is paraphyletic among *Polycoccum*. Ertz et al. (2015) noted that the long branches within *Polycoccaceae* clade showed the fast-evolving contrasting with low morphological variability, which results in few phenotypic characters useful for the recognition of different genera (Ertz et al. 2015). *Clypeococcum* is however included in *Polycoccaceae* but its placement will need to be confirmed by molecular data of type species. Fourteen epithets and 9 epithets of *Clypeococcum* are listed in Index Fungorum (2020) and Species Fungorum (2020), respectively, while sequence data are available for two species.

#### Economic and ecological significance

Species in this family are lichenicolous living on lichens as parasites.

***Trypetheliaceae*** Zenker in Goebel & Kunze, Pharmaceutische Waarenkunde: 123 (1827); Fée, Essai Crypt. Écorc. 1: xxxvi (1824), nom. inval.; Eschweiler, Syst. Lich.: 17 (1824), nom. inval.

*Mycobank number*: MB 81884; *Index Fungorum number*: IF 81884; *Facesoffungi number*: FoF 08784; approximately 440 species (Aptroot and Lücking 2016; Aptroot et al. 2016, 2019; Lücking et al. 2017; this paper).

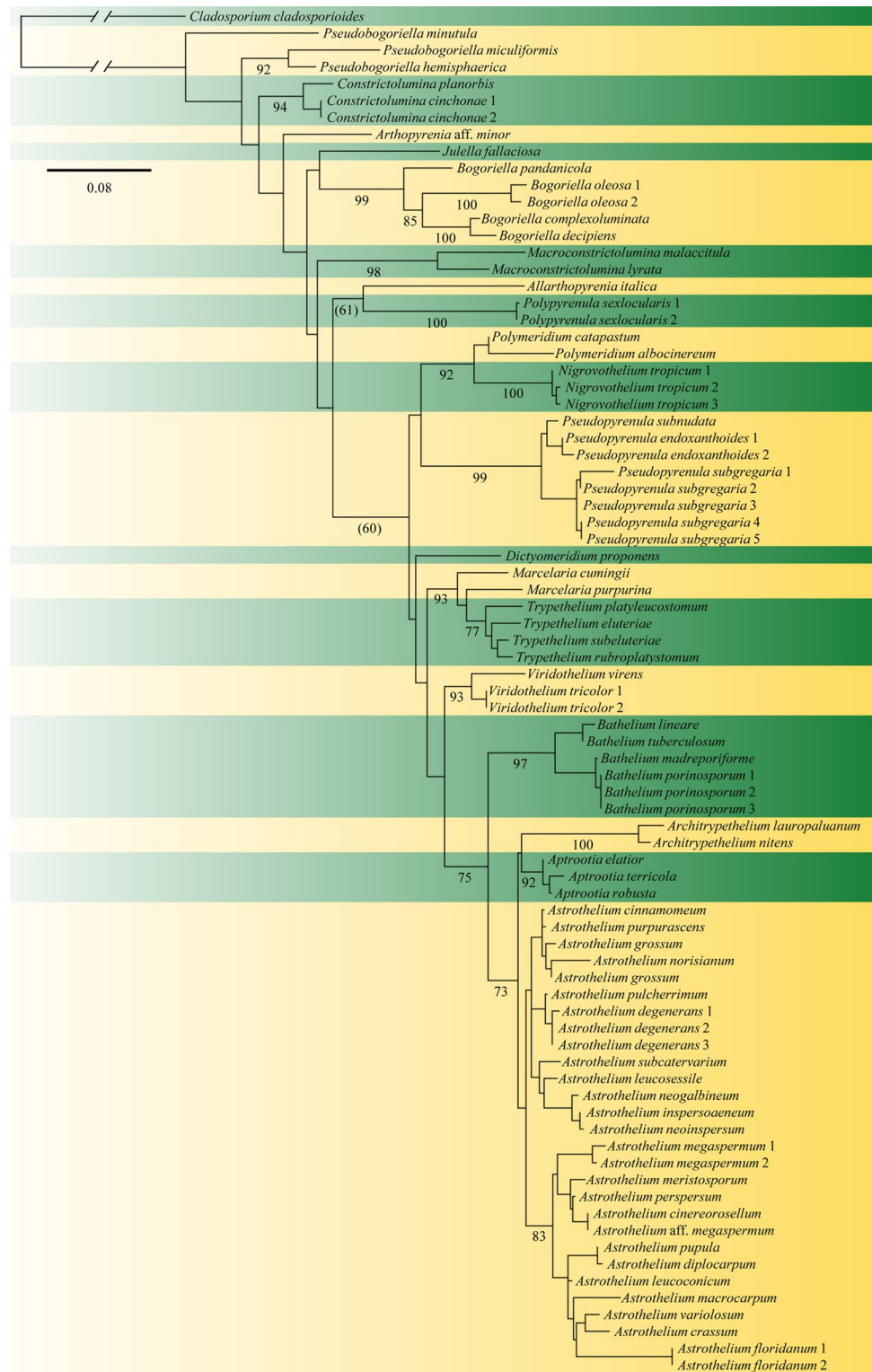
*Lichenized* or more rarely saprobic on bark or rarely on bryophytes over soil; in terrestrial, chiefly lowland to lower montane tropical habitats, with few species extending into temperate regions. *Thallus* reduced and ecorticate, white, to distinctly corticate, yellow-brown to olive-green, sometimes partly or completely bright yellow, orange or red due to superficial anthraquinone pigments. *Photobiont* *Trentepohlia*. *Ascomata* scattered, clustered, aggregated in

pseudostromata, or fused with common ostiole, immersed to sessile, brown-black but usually covered by thallus, globose to pear-shaped or conical, coriaceous to carbonaceous, ostiolate, ostiole round. *Excipulum* dense, consisting of compressed hyphae, appearing prosoplectenchymatous in thin, bleached sections but structure usually difficult to observe due to heavy carbonization, generally dark brown to brown-black. *Hamathecium* comprising 0.5–0.7(–1.5) µm wide paraphysoids, hyaline, straight or rarely flexuose, branched and usually anastomosing, usually embedded in a thick, gelatinous matrix, occasionally with hyaline or yellow oil inspersions. *Asci* 1–8-spored, bitunicate, fissitunicate, obclavate to cylindrical, short pedicellate, with refractive ring and very wide, non-amyloid ocular chamber comprising more than half of the width of the ascus. *Ascospores* irregularly arranged to biseriata, fusiform-ellipsoid to oblong, hyaline to dark brown, septate to muriform, with distosepta and sometimes additional eusepta and rectangular to diamond-shaped (generally six-angled) lumina, smooth-walled or rarely ornamented, not or slightly constricted at the septa, with evanescent mucilaginous material on the outside, either as polar pads or irregular median pads or a complete sheath enveloping the whole ascospore. *Pycnidia* known from a few species, immersed, visible as black dots in specific, often pseudostromatic areas on fertile thalli, or whole thalli only producing pycnidia; rarely old ascospores within asci transforming into pycnidia. *Conidia* acrogenous, hyaline, aseptate, bacillar. *Chemistry*: lichexanthone sometimes produced on thallus surface; yellow to orange or red anthraquinones and perylenequinones often produced in the medulla of the thalline layer covering the perithecia and sometimes in the thallus medulla or superficial on various parts of the thallus.

*Type*: ***Trypethelium*** Spreng.

*Notes*: *Trypetheliaceae* (Zenker in Goebel and Kunze 1827) is one of the oldest described families of lichenized *Ascomycota*. Its delimitation was obscure throughout the past nearly 200 years, but in general the family included pyrenocarpous, epiphytic lichens with crustose thalli containing a *Trentepohlia* photobiont, anastomosing paraphysoids forming a network embedded in a gelatinous matrix, bitunicate asci, and hyaline, distoseptate ascospores with diamond-shaped lumina (Aptroot 1991; Harris 1995; Aptroot et al. 2008; Sweetwood et al. 2012). Several genera that had been included at some point have subsequently been placed in other families, such as *Megalotremis*, *Ornatopyrenis*, and *Trypetheliopsis* (Aptroot 1991; Harris 1995; Lumbsch and Huhndorf 2010). Traditionally, the family included seven core genera: *Pseudopyrenula* (ecorticate; ascospores astrothelioid), *Polymeridium* (ecorticate; ascospores euseptate), *Trypethelium* (corticate; ascomata with apical ostiole; ascospores astrothelioid, transversely septate), *Laurera* (corticate; ascomata with apical ostiole; ascospores astrothelioid,

**Fig. 77** Best-scoring maximum-likelihood tree of *Trypetheliaceae*, showing all currently sequenced and recognized genera, based on the mtSSU marker, with a length of 962 bases. The tree was reconstructed in RAxML 8, using the universal GTR-Gamma model without site partitioning, and the final likelihood was  $-7368.672686$ . The currently accepted genera are highlighted



muriform), *Astrothelium* (corticate; ascomata with lateral or shared ostiole; ascospores astrothelioid, transversely septate), *Campylothelium* (corticate; ascomata with lateral ostiole; ascospores astrothelioid, muriform), and *Cryptothelium* (corticate; ascomata with shared ostiole; ascospores astrothelioid,

muriform). Four additional genera were included or recognized in more recent treatments (Aptroot 1991; Tucker and Harris 1980; Harris 1986, 1995; Lücking et al. 2007): *Exiliseptum* (corticate; ascomata with shared ostiole; ascospores euseptate), *Bathelium* (corticate; ascomata pseudostromatic,

with walls composed of brown, jigsaw-puzzle-shaped hyphal cells), *Architrypethelium* (corticate; ascomata with apical or lateral ostiole; ascospores transversely septate, very large, hyaline or brown), and *Aptrootia* (corticate; ascomata with apical ostiole; ascospores muriform, dark brown).

Molecular phylogenetic data (Fig. 77) have profoundly changed both the family circumscription of *Trypetheliaceae* and the delimitation of its genera (Del Prado et al. 2006; Nelsen et al. 2009, 2011a, 2014; Aptroot and Lücking 2016; Lücking et al. 2016; Miranda-González et al. 2020). Apart from the core *Trypetheliaceae*, the family now also contains a large number of species previously placed in the genera *Arthopyrenia* and *Mycomicrothelia*, for which the genera *Bogoriella*, *Constrictolumina* and *Novomicrothelia* have been established or reinstated (Aptroot and Lücking 2016; Lücking et al. 2016). In addition, *Polypyrenula* has been shown to be another member of *Trypetheliaceae* (Miranda-González et al. 2020). Other newly added elements are *Alloarthopyrenia* (Hyde et al. 2016b) and *Julella fallaciosa* (Nelsen et al. 2011a; Lücking et al. 2016). Based on molecular data, also the core *Trypetheliaceae* were reorganized, with most species now in a single genus, *Astrothelium*, and additional lineages with special characters allocated in the genera *Architrypethelium*, *Aptrootia*, *Bathelium*, *Dictyomeridium* (segregated from *Polymeridium*), *Marcelaria* (*Laurera purpurina* group), *Nigrovothelium* (*Trypethelium tropicum* group), *Polymeridium sensu stricto*, *Pseudopyrenula*, and *Trypethelium sensu stricto* (*T. eluteriae* group). The previously recognized genera *Campylothelium*, *Cryptothelium*, and *Laurera* are now considered synonyms of *Astrothelium* (Aptroot and Lücking 2016). As a whole, *Trypetheliaceae* forms a strongly supported, somewhat isolated clade within *Dothideomycetes*, and has therefore been assigned its own order, *Trypetheliales* (Aptroot et al. 2008). Recently, the mostly lichenicolous family *Polycoccaceae* was also assigned to this order (Ertz et al. 2015).

The hamathecial hyphae (physes) have variously been labeled paraphysoids or (trabeculate or trabecular) pseudoparaphyses (Henssen and Jahns 1973; Barr 1979a; Eriksson 1981; Liew et al. 2000). These terms were originally coined for hamathecium physes of presumably ascolocular fungi, to distinguish from true paraphyses. As per formal definition, the various types are clearly distinguished (Barr 1979a; Henssen and Jahns 1973; Eriksson 1981): true paraphyses develop from below and remain mostly unbranched; paraphysoids develop from stretching interascal plectenchyma; and pseudoparaphyses grow from top to bottom during ontogeny, attaching below and eventually becoming free above. However, the ontogeny of most Ascomycota regarding these features has not been studied and there are intermediate types. Furthermore, the terminology is confounded, e.g. by paraphysoids being named with ‘trabecular pseudoparaphyses’ (Eriksson 1981), thus combining

two supposedly different types into one. Also, according to Henssen and Jahns (1973), paraphysoids can either be precursors of true paraphyses or the only physes, which by extension means that paraphysoids can occur both in ascolohymenial and in ascolocular fungi. In addition, ascolohymenial and ascolocular fungi do not form phylogenetic entities and taxa thought to be closely related are now known to be unrelated and viceversa (Liew et al. 2000; Schoch et al. 2009a, b). For instance, Henssen and Jahns (1973) included *Trypethelium* in *Pyrenulaceae*, a family forming paraphyses (e.g. *Pyrenula*) or paraphysoids (e.g. *Trypethelium*), but whose elements actually belong to two different classes (Eurotiomycetes and Dothideomycetes). Eriksson (1981) also hypothesized a close relationship between these two lineages, using the term paraphyses for *Pyrenulaceae* and paraphysoids for *Trypetheliaceae*. We consider this terminology largely misleading and suggest to use only paraphysoids.

*Trypetheliaceae* now includes 18 genera plus some currently orphaned lineages (see key below) and well over 400 species, with about 800 predicted globally (Aptroot et al. 2016, 2019), mostly found in tropical lowland to lower montane, rain forest, dry forest, and savanna habitats.

***Trypethelium*** Spreng., Anleit. Kennt. Gew. 3: 350 (1804).

*Mycobank number*: MB 5628; *Index Fungorum number*: IF 5628; *Facesoffungi number*: FoF 08785; 16 morphologically defined species (Aptroot and Lücking 2016; Lücking et al. 2017); molecular data available for six species (Lücking et al. 2016).

*Lichenized* on bark in terrestrial, lowland to lower montane tropical habitats. *Thallus* corticate, yellow-brown to olive-green. *Photobiont* *Trentepohlia*. *Ascomata* aggregated in pseudostromata, sessile, brown-black or covered by algal-free, sterile tissue filled with crystalline, yellow to orange, KOH+ red to purple pigment, globose, coriaceous to carbonaceous, ostiolate, ostiole round. *Excipulum* prosoplectenchymatous, dark brown to brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a thick, gelatinous matrix. *Asci* 8-spored, bitunicate, fissitunicate, obclavate, short pedicellate, with refractive ring and non-amyloid ocular chamber. *Ascospores* irregularly arranged to biserial, fusiform, hyaline, multi-septate, with thin distosepta and more or less rectangular lumina, smooth-walled, not constricted at the septa, surrounded by an evanescent mucilaginous sheath. No asexual state known. *Chemistry*: Yellow to orange or red anthraquinones and perylenequinones produced in the pseudostromata.

*Type species*: ***Trypethelium eluteriae*** Spreng., Anleit. Kennt. Gew. 3: 350 (1804).

*Notes*: A tropical, lichenized genus found on bark of branches and trunks of trees, usually in (semi-)exposed situations. Traditionally, *Trypethelium* included all

*Trypetheliaceae* with thallus-dominated perithecia with separate, apical ostioles and transversely septate, astrotheleoid ascospores. In its current circumscription, the genus is limited to species with pseudostromatic perithecia, the pseudostromata typically containing yellow to orange, crystalline pigments, and multi-septate ascospores with more or less thin septa and walls and rectangular lumina (Aptroot and Lücking 2016).

#### Other genera included

*Alloarthopyrenia* Phukhams., Lücking & K.D. Hyde in Hyde et al., Fungal Diversity 80: 122, 131 (2016).

*Mycobank number*: MB 552236; *Index Fungorum number*: IF 552236; *Facesoffungi number*: FoF 02379; one phylogenetically and morphologically defined species (Hyde et al. 2016b).

*Saprobic* on tree branches in terrestrial, temperate forest habitats. *Thallus* and photobiont absent. *Ascomata* solitary, erumpent, carbonaceous, ostiolate, ostiole apical, periphysate. *Involucrellum* distinct, dark brown. *Excipulum* prosoplectenchymatous, brownish above, colorless below. *Hamathecium* comprising 0.5–1 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* 8-spored, bitunicate, fissionate, clavate, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to biserial, fusiform-ellipsoid to oblong, hyaline, 1-septate, euseptate, with secondary constrictions in each cell, rough-walled, constricted at the septum, with a gelatinous halo. *Pycnidia* unknown. *Chemistry*: no substances detected by TLC.

*Type species*: *Alloarthopyrenia italica* Phukhams., Camporesi, Ariyaw. & K.D. Hyde in Hyde et al., Fungal Diversity 80: 122, 135 (2016).

*Notes*: This monospecific genus was recently introduced for a previously undescribed species growing saprobially on tree branches in Italy. It represents one of now four separate clades in *Trypetheliaceae* that include members of the collective genus *Arthopyrenia*, besides *Constrictolumina*, *Macroconstrictolumina* (see below) and “*Arthopyrenia*” aff. *minor*. Three of these lineages feature ascospores with characteristic secondary constrictions in each of the cells. The discovery of this novel lineage further challenges the systematics of the families *Arthopyreniaceae* and *Naetrocymbeaceae* the genera *Arthopyrenia sensu stricto* and *Naetrocymbe*. Lücking and Nelsen (in Hyde et al. 2013) argued that the type of *Arthopyrenia*, *A. cerasi* (Schrad.) A. Massal. differs from the lineages now included in *Trypetheliaceae* in various anatomical characters, thus likely representing an unrelated lineage; the same argument was made for *Naetrocymbe*, with the type species *N. fuliginea* Körb. (Dai et al. in Hyde et al. 2013). However, almost every sequenced member of the collective genera *Arthopyrenia* and *Julella* has so far been found to represent a lineage of *Trypetheliaceae*, and

so the fate of *Arthopyrenia sensu stricto* and *Naetrocymbe*, whose type species have not yet been sequenced, remains uncertain.

*Aptrootia* Lücking & Sipman in Lücking et al., Lichenologist 39: 188 (2007).

*Mycobank number*: MB 29134; *Index Fungorum number*: IF 29134; *Facesoffungi number*: FoF 08786; three morphologically and phylogenetically defined species (Aptroot and Lücking 2016; Lücking et al. 2016, 2017).

*Lichenized* on bark or bryophytes or soil in terrestrial, chiefly montane tropical forest habitats. *Thallus* distinctly corticate, yellow-brown to mostly green, or ecorticate and greyish. *Photobiont Trentepohlia*. *Ascomata* solitary, immersed to erumpent, brown-black but usually covered by thick thallus layer except for ostiolar area, globose to pear-shaped or ovoid, coriaceous to carbonaceous, ostiolate, ostiole apical. *Involucrellum* reduced. *Excipulum* prosoplectenchymatous, colorless to brownish. *Hamathecium* comprising 0.5–1 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* 1(–2)-spored, bitunicate, fissionate, oblong-ellipsoid, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* oblong-ellipsoid, initially hyaline and I+ amyloid, but soon becoming dark brown, richly muriform, weakly distoseptate, wall smooth to granular ornamented, outer wall easily breaking under pressure, with gelatinous sheath. *Pycnidia* unknown. *Chemistry*: no substances detected by TLC.

*Type species*: *Aptrootia terricola* (Aptroot) Lücking, Umaña & Chaves in Lücking et al., Lichenologist 39: 188 (2007).

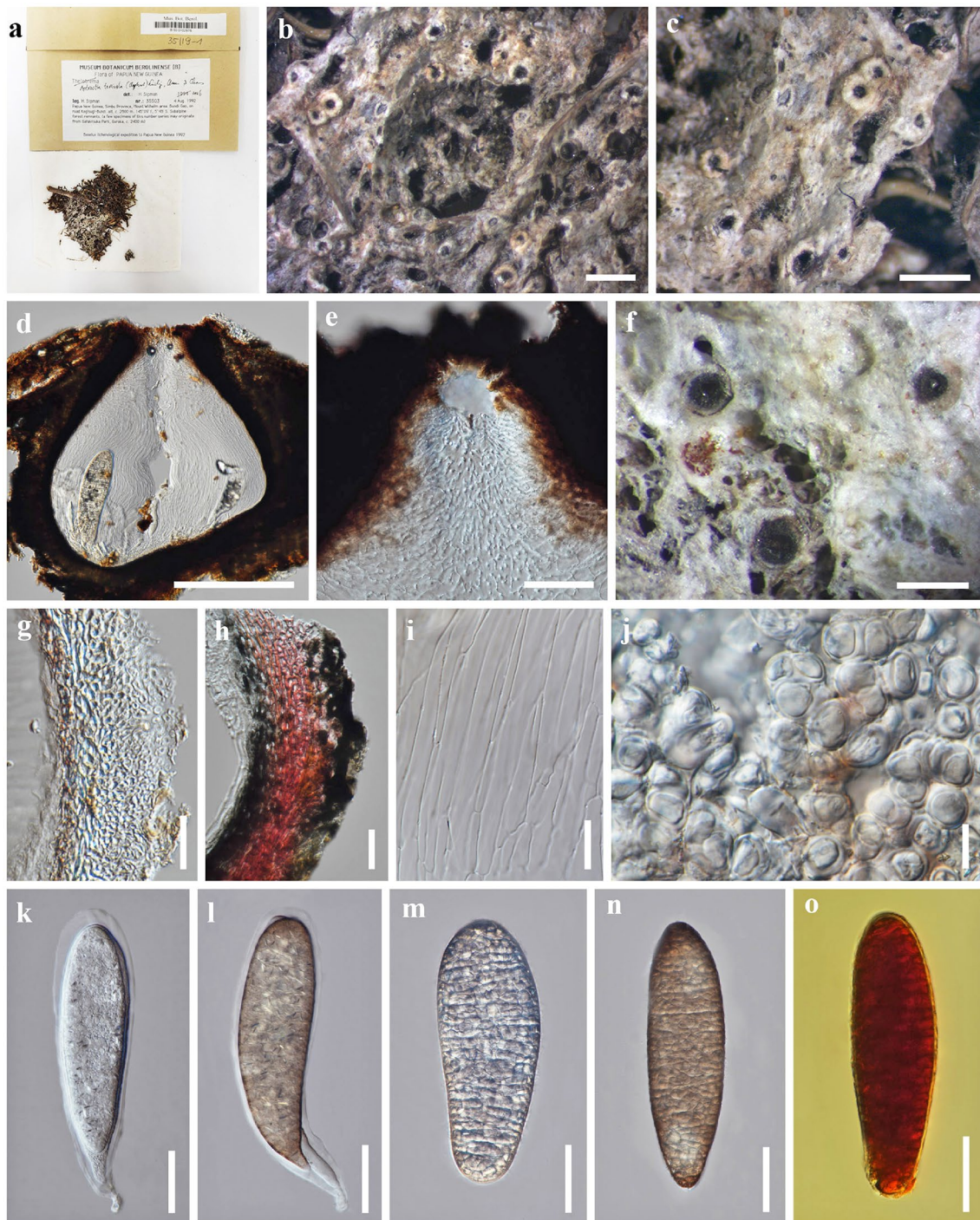
*Notes*: For key and discussion see Aptroot and Lücking (2016). The genus currently includes three species (Fig. 78).

*Architrypethelium* Aptroot, Biblioth. Lichenol. 44: 120 (1991).

*Mycobank number*: MB 26294; *Index Fungorum number*: IF 26294; *Facesoffungi number*: FoF 08787; eight morphologically defined species (Aptroot and Lücking 2016; Lücking et al. 2017; Luangsaphabool et al. 2018); molecular data available for four species (Lücking et al. 2016; Luangsaphabool et al. 2018).

*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical habitats. *Thallus* distinctly corticate, yellow-brown to olive-green. *Photobiont Trentepohlia*. *Ascomata* solitary to aggregated, erumpent to prominent, brown-black but usually covered by thallus layer except for ostiolar area, coriaceous to carbonaceous, ostiolate, ostiole apical or lateral. *Involucrellum* reduced, brown-black. *Excipulum* prosoplectenchymatous, brownish to colorless. *Hamathecium* comprising 0.5–1 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in





**Fig. 78** *Aptroothia terricola* (Sipman 35503; **f, j**: Sipman 51849). **a** Herbarium package and specimen. **b, c, f** Thallus with ascomata. **d** Vertical section through an ascoma. **e** Ostiolar region with periphyses. **g–h** Perithecial wall in thin section, and the outer layer become

reddish in 10% KOH. **i** Paraphysoids. **j** Trentepohlioid photobiont. **k, l** Asci. **m, n** Ascospores. **o** Ascospore in Lugol's iodine. Scale bars: **b, c** = 1 mm, **d** = 200  $\mu$ m, **e, k–n** = 50  $\mu$ m, **f** = 500  $\mu$ m, **g–i** = 20  $\mu$ m, **j** = 10  $\mu$ m

a gelatinous matrix, in some species interspersed with oil droplets. *Asci* 2–8-spored, bitunicate, fissitunicate, oblong-ellipsoid, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged, oblong-ellipsoid, hyaline to

mostly dark brown, 3–5-septate and very large (usually over 100  $\mu$ m) or rarely muriform and small, somewhat distoseptate but not astrothelioid, smooth-walled or with longitudinal wall folds or crystals, not or slightly constricted at the septa,

surrounded by a mucilaginous sheath. *Pycnidia* unknown. *Chemistry*: lichexanthone sometimes produced on thallus surface.

*Type species*: *Architrypethelium seminudum* (Mont.) Aptroot. [= *Architrypethelium nitens* (Fée) Aptroot in Aptroot et al., *Biblioth. Lichenol.* 97: 38 (2008)].

*Notes*: For discussion see Aptroot and Lücking (2016). The genus currently includes eight species. With the recent, surprising discovery of a species with rather small, muriform ascospores falling into this clade (Luangsuphabool et al. 2018), the generic boundaries towards *Astrothelium* have become more diffuse.

***Astrothelium*** Eschw., *Syst. Lich.*: 18, 26 (1824).

*Mycobank number*: MB 443; *Index Fungorum number*: IF 443; *Facesoffungi number*: FoF 08788; Over 250 morphologically defined species (Aptroot and Lücking 2016; Lücking et al. 2017); molecular data available for over 50 species (Lücking et al. 2016).

*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical habitats. *Thallus* distinctly corticate, yellow-brown to mostly green. *Photobiont* *Trentepohlia*. *Ascomata* scattered, clustered, aggregated in pseudostromata, or fused with common ostiole, immersed to sessile, brown-black but usually covered by thick thallus layer except for ostiolar area, globose to pear-shaped or conical, coriaceous to carbonaceous, ostiolate, ostiole round. *Excipulum* prosoplectenchymatous, dark brown to brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a thick, gelatinous matrix. *Asci* 1–8-spored, bitunicate, fissitunicate, obclavate, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to uni- or biseriate, fusiform-ellipsoid to oblong-cylindrical, hyaline, septate to muriform, with distinct distosepta and sometimes eusepta and diamond-shaped lumina (best visible in septate ascospores), smooth-walled, not or slightly constricted at the septa, often surrounded by an evanescent mucilaginous material on the outside, either as polar pads, or irregular median pads or a complete sheath enveloping the whole ascospore. *Pycnidia* known from a few species, immersed to erumpent, visible as black dots. *Conidia* acrogenous, rod-shaped, hyaline. *Chemistry*: lichexanthone sometimes produced on thallus surface; yellow to orange or red anthraquinones and perylenequinones often produced in the medulla of the thalline layer covering the perithecia and sometimes in the thallus medulla or superficial on various parts of the thallus.

*Type species*: *Astrothelium conicum* Eschw., *Syst. Lich.*: 26 (1824) [= *Astrothelium cinnamomeum* (Eschw.) Müll. Arg., *Flora* 67: 670 (1884)].

*Notes*: *Astrothelium* traditionally included species with thallus-dominated perithecia featuring lateral, fused ostioles

and transversely septate, astrothelioid ascospores. In its modern circumscription (Aptroot and Lücking 2016), practically all species with thickly corticate thalli, thallus-dominated perithecia, and astrothelioid ascospores are now included in this genus, regardless of the disposition of the perithecia and their ostioles or ascospore septation, with a total of over 250 taxa (Aptroot and Lücking 2016; Cáceres and Aptroot 2017; Aptroot and Weerakoon 2018; Aptroot et al. 2019). *Astrothelium* is essentially a fusion of the previously separated genera *Astrothelium*, *Bathelium* p.p., *Campylothelium*, *Cryptothelium*, *Laurera*, and *Trypethelium* p.p. Harris (1995) had already predicted the existence of this clade, suggesting the use of the name *Laurera*. However, *Laurera* postdates *Astrothelium*, a name Harris (1995) intended to reserve for a small group of species that have been shown to form part of a single, large clade including most species of the family (Lücking et al. 2016).

***Bathelium*** Ach., *Method. Lich.*: 111 (1803).

*Mycobank number*: MB 517; *Index Fungorum number*: IF 517; *Facesoffungi number*: FoF 08789; 16 morphologically defined species (Aptroot and Lücking 2016; Lücking et al. 2017); molecular data available for four species (Lücking et al. 2016).

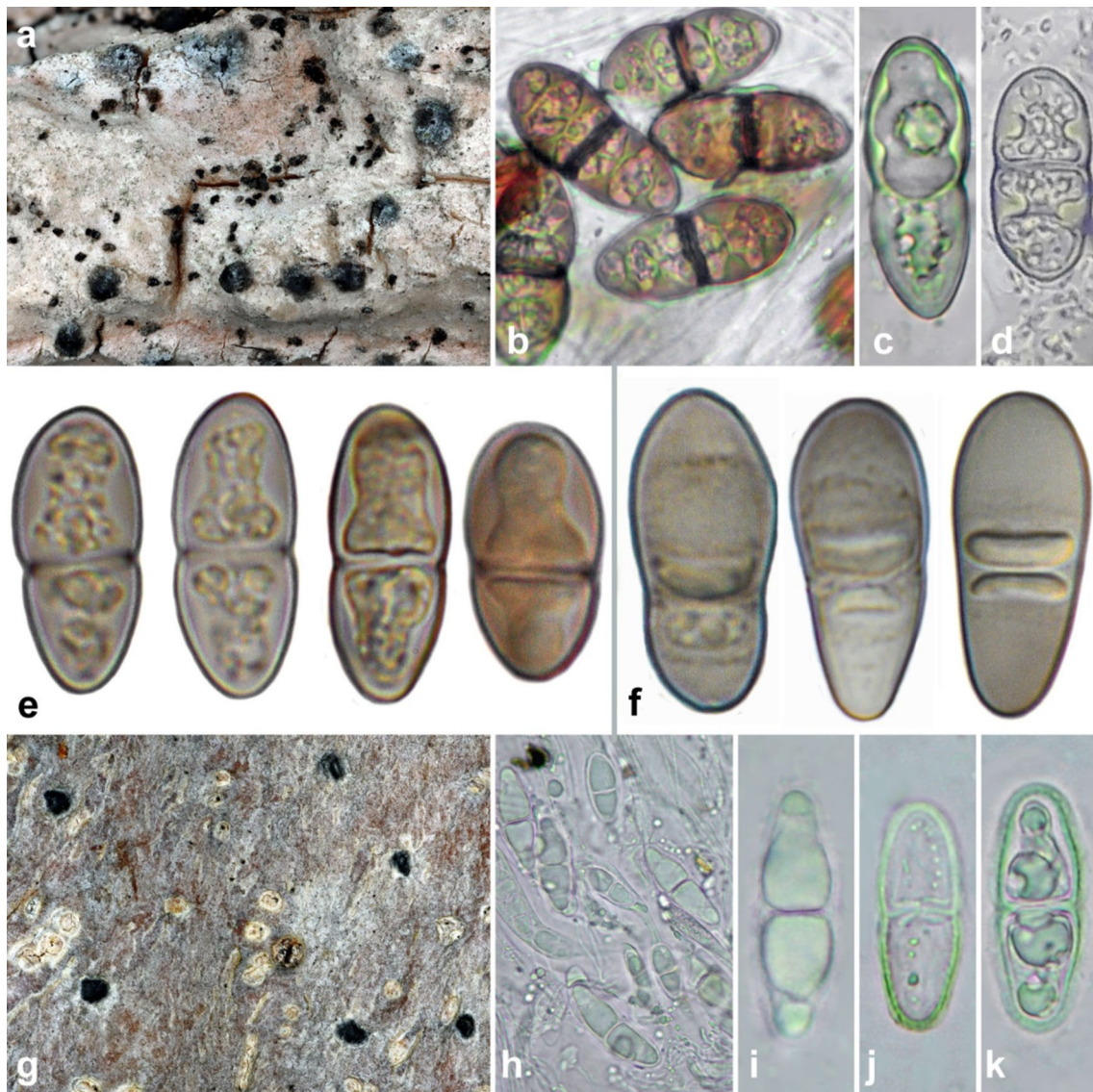
*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical habitats, often in drier situations. *Thallus* corticate, yellow-brown to olive-green. *Photobiont* *Trentepohlia*. *Ascomata* solitary to aggregated in distinct pseudostromata, prominent to sessile, brown-black and remaining fully exposed, rarely pruinose, coriaceous to carbonaceous, ostiolate, ostiole apical. *Involucrellum* reduced. *Excipulum* brown-black. *Hamathecium* comprising 0.5–0.7 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* 1–8-spored, bitunicate, fissitunicate, clavate to oblong, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to biseriate, fusiform-ellipsoid, hyaline, septate to mostly muriform, more or less euseptate, smooth-walled, not or slightly constricted at the septa (often at the middle septum only), surrounded by a gelatinous sheath. *Pycnidia* unknown. *Chemistry*: lichexanthone sometimes produced on thallus surface; yellow to orange anthraquinones often produced in the medulla of the pseudostromata.

*Type species*: *Bathelium mastoideum* Afz. ex Ach., *Method. Lich.*: 111 (1803).

*Notes*: For key and discussion see Aptroot and Lücking (2016).

***Bogoriella*** Zahlbr., *Annals Cryptog. Exot.* 1(2): 111 (1928).

*Mycobank number*: MB 608; *Index Fungorum number*: IF 608; *Facesoffungi number*: FoF 08790; 18 morphologically defined species (this paper); molecular data available



**Fig. 79** **a–d** *Bogoriella complexoluminata* (holotype). **a** Thallus with ascomata. **b–d** Ascospores in various stages of development. **e** *B. isthmospora* (Aptroot s.n.), ascospores in various stages of development. **f** *Schummiella angulata* (Aptroot 14061), ascospores in various stages of development. **g–k** *Macroconstrictolumina megalateralis*

(holotype). **g** Thallus with ascomata. **h** Hamatecium and ascospores. **i–k** Ascospores in various stages of development. Scale bars: **a, g** = 1 mm, **b–f, h–k** = 10  $\mu$ m. Photographs by André Aptroot except **e** and **f**, by Felix Schumm

for four species (Lücking et al. 2016; Zhang et al. 2017b; this paper).

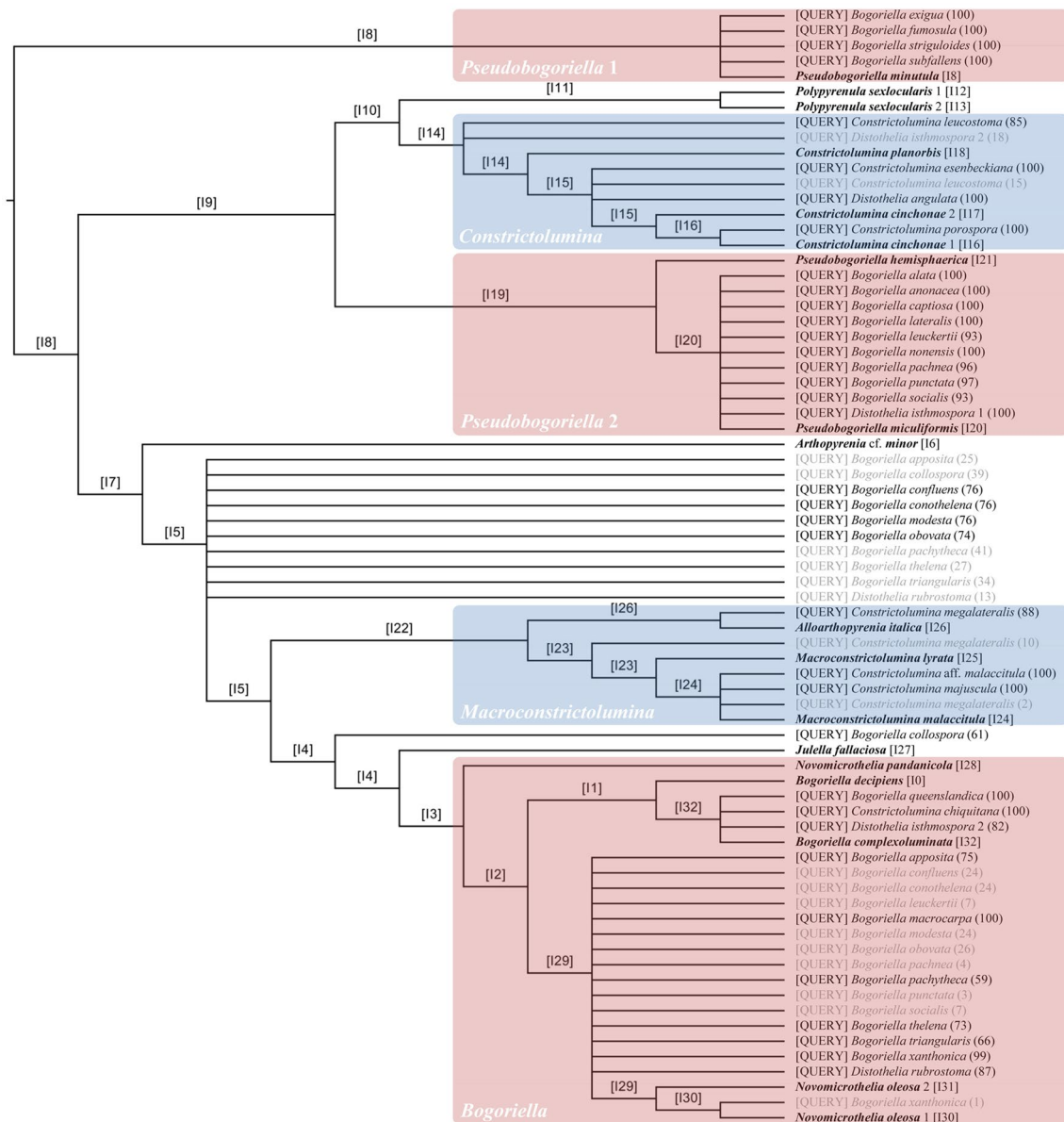
= *Ornatopyrenis* Aptroot, Biblioth. Lichenol. 44: 127 (1991). Type species: *Ornatopyrenis queenslandica* (Müll. Arg.) Aptroot [= *Bogoriella queenslandica* (Müll. Arg.) Aptroot & Lücking].

= *Distothelia* Aptroot in Seaward & Aptroot, Bryologist 108: 284 (2005). Type species: *Distothelia isthmospora* Aptroot in Seaward & Aptroot, Bryologist 108: 284 (2005).

= *Novomicrothelia* Aptroot, M.P. Nelsen & Lücking in Lücking et al., Lichenologist 48: 757 (2016). Type species:

*Novomicrothelia oleosa* (Aptroot) Aptroot, M.P. Nelsen & Lücking in Lücking et al., Lichenologist 48: 758 (2016).

*Lichenized* (sometimes barely so or apparently non-lichenized) on bark in terrestrial, chiefly lowland to lower montane tropical habitats. *Thallus* ecorticate, mostly whitish to pale brownish. *Photobiont* *Trentepohlia*. *Ascomata* solitary, erumpent to prominent, brown-black to carbonaceous, hemispherical to wart-shaped or conical, coriaceous to carbonaceous, ostiolate, ostiole apical to rarely lateral. *Involucrellum* usually well-developed, carbonaceous. *Excipulum* prosoplectenchymatous, usually brownish, in lateral and apical parts typically fused with the involucrellum.



**Fig. 80** Classification tree for non-sequenced species of *Bogoriella sensu lato* and *Constrictolumina sensu lato* [QUERY] based on phenotype-based phylogenetic binning into a molecular reference tree of sequenced species (in boldface). Numbers in parentheses behind each

query taxon represent bootstrap support for the corresponding placement. Queries with alternative placements supported with less than 70% are greyed out

*Hamathecium* comprising 1(–2)  $\mu\text{m}$  wide para-physoids, hyaline, straight to somewhat wavy, branched and anastomosing, embedded in a thin, gelatinous matrix. *Asci* 8-spored, bitunicate, fissitunicate, (ob-)clavate to fusiform, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to uni- or biseriata, fusiform-ellipsoid to oblong, grey-brown, 1–5-septate to small muriform, with eusepta and rectangular lumina or with thickened distosepta making the lumina appear halter-shaped, wall smooth to finely granular ornamented, not constricted at the septa or rarely with constrictions. *Pycnidia* known from

a few species, immersed to erumpent, visible as black dots. *Conidia* fusiform, aseptate, bacillar, hyaline,  $4\text{--}5 \times 0.8 \mu\text{m}$ . *Chemistry*: no substances detected by TLC.

*Type species*: *Bogoriella subpersicina* Zahlbr., *Annals Cryptog. Exot.* 1: 111 (1928) [= *Bogoriella decipiens* (Müll. Arg.) Aptroot & Lücking].

*Sequence data for Bogoriella decipiens*: mtSSU: MT968881.

*Notes*: Aptroot and Lücking (2016) adopted the name *Bogoriella* for more or less lichenized, tropical species previously classified in the genus *Mycomicrothelia* (Hawksworth

1985). The expanded molecular phylogeny now available shows that these taxa form several lineages (Fig. 77): two in a paraphyletic grade formed by the most basally diverging lineages, and three in a distant clade, forming several lineages on long branches. One of these had been named *Novomicrothelia* (Aptroot and Lücking 2016; Lücking et al. 2016), whereas a second clade of previously unpublished sequences includes the type species of *Bogoriella*, together with a new taxon, both with small muriform ascospores, one with eusepta and the other with peculiar distosepta (Fig. 79a–d). The third clade is formed by the recently described species *Novomicrothelia pandanicola* S.N. Zhang & K.D. Hyde (Zhang et al. 2017b). In the original analysis, nuLSU sequence data suggested a phylogenetic position of the latter close to *N. oleosa*, prompting inclusion in that genus. Our expanded phylogeny based on new mtSSU data showed that the genus *Bogoriella*, for which no data were originally available (Zhang et al. 2017b), is nested within *Novomicrothelia sensu lato*. *Novomicrothelia pandanicola* forms small, rather narrow (20–35 × 7–10 µm, about 3–3.5 times as long as broad), muriform ascospores with thin walls and septa and constrictions at the septa, whereas in the *Bogoriella sensu stricto* clade the ascospores are broadly ellipsoid (20–30 × 12–16 µm, about 1.5–2 times as long as broad) and muriform with either thin or conspicuously thickened walls and septa. *Novomicrothelia sensu stricto* has thin-walled, 1-septate ascospores without constrictions.

The species hitherto classified in *Bogoriella sensu lato* (including *Novomicrothelia*) thus represent a polyphyletic assembly. Given that most species of this morphodeme have not been sequenced yet, we employed morphology-based phylogenetic binning (Berger et al. 2011; Parnmen et al. 2012; Lücking and Kalb 2018) to assess the likely placement of the remaining species. As a result, 13 species clustered with support with the basal paraphyletic grade formed by *B. minutula*, *B. miculiformis*, and *B. hemisphaerica*, seven clustered with *Novomicrothelia sensu stricto*, none with *N. pandanicola*, four outside but close to *Novomicrothelia* in an unresolved position, and three with *Bogoriella sensu stricto* (Fig. 80). Given this result, the underlying topology, and the observation that taxa with different ascospore types (*B. complexoluminata* and *B. decipiens*) are closely related, we saw no alternative to merging *Bogoriella* and *Novomicrothelia* into a single genus, under the name *Bogoriella*. The basal grade is here recognized conservatively as a separate, single genus, under the name *Pseudobogoriella* (see below).

Based on the phylogenetic analysis and the binning exercise, *Bogoriella* in its revised sense includes three generic synonyms, since the type species of *Distothelia* (*D. isthmospora*) and *Ornatopyrenis* (*O. queenslandica*) are also assigned to this genus by the binning approach. Indeed, the ascospores of the type species of the latter two genera are

similar to those of *B. complexoluminata* (Fig. 79b–e) in development and endospore formation (Aptroot 1991; Harris 1995; Seaward and Aptroot 2005). One species previously placed in *Distothelia*, *D. angulata*, is here transferred to the new genus *Schummia*, as its ascospores are quite different (Fig. 79f; see below).

#### New species and new combinations in *Bogoriella*

***Bogoriella chiquitana*** (Flakus, Kukwa & Aptroot) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836785; *Index Fungorum number*: IF 836785; *Facesoffungi number*: FoF 08791

Bas.: *Constrictolumina chiquitana* Flakus, Kukwa & Aptroot, *Lichenologist* 48: 681 (2016).

***Bogoriella complexoluminata*** Aptroot & Lücking **sp. nov.** (Fig. 79a–d)

*Mycobank number*: MB 836786; *Index Fungorum number*: IF 836786; *Facesoffungi number*: FoF 08792

*Etymology*: Named for the complex lumina of the ascospores.

*Diagnosis*: Corticolous *Bogoriella* with thallus UV-negative; ostioles apical, ascospores 27–37 × 10–15 µm, initially hyaline and 1-septate with an euseptum, constricted at the septum, wall thickened in two open distosepta two places in each cell, so as to form three pseudoloculi per cell; mature ascospores brown with 1 dark brown median euseptum and a distoseptate wall that leaves six rows of 2–6 oval loculi of c. 5 µm diam.

*Holotype*: A. Aptroot 78050 (CGMS; isotype: ABL).

*GenBank accessions for type-based sequences*: mtSSU: MT968880.

*Thallus* inapparent, immersed in the soft, corky bark, covering up to 10 cm diam., apparently not lichenized; no algae observed. *Ascomata* erumpent to sessile, hemisphaerical with flattened top, black, 0.3–0.5 mm diam. and up to 0.4 mm high; ostiole black, minute, usually in a c. 0.1 mm wide and 0.05 mm deep depression; clypeus covering the top and the sides; wall c. 100 µm thick at the sides, only c. 20 µm thick below the hamathecium. *Hamathecium* clear, hyaline, of c. 1 µm wide filaments that are anastomosing above the asci. *Asci* broadly cylindrical, c. 100 × 25 µm, wall c. 2 µm thick all around; without ocular chamber. *Ascospores* 8/ascus, 27–37 × 10–15 µm, initially hyaline and 1-septate with an euseptum, constricted at the septum, wall thickened in two open distosepta two places in each cell, so as to form three pseudoloculi per cell; mature ascospores brown with 1 dark brown median euseptum and a distoseptate wall that leaves six rows of 2–6 oval loculi of c. 5 µm diam. *Pycnidia* not observed.

*Chemistry*: Thallus UV–, C–, P–, K–. TLC: nil.

**Ecology and distribution:** On tree bark in rural and urban areas; thus far only known from Brazil.

**Material examined:** Brazil. Mato Grosso do Sul, Campo Grande, UFMS campus; 20°30' S, 54°37' W, 550 m; on soft, corky bark of *Aspidosperma tomentosa* (*Apocynaceae*) tree (identified by Dr Angela Sartori); 22 November 2018, *A. Aptroot* 78050 (holotype: CGMS; isotype: ABL); Bonito, outskirts, near tower; 21°07'44" S, 56°30'41" W, 475 m; on bark of tree; 9 November 2018, *A. Aptroot* 78013 (paratype: CGMS).

**Notes:** This new species is phylogenetically closely related to the type species, *Bogoriella decipiens*, but the latter differs in having regularly muriform ascospores. The endospore development of *B. complexoluminata* appears to be unique, producing a peculiar shape of the lumina.

***Bogoriella isthmospora*** (*Aptroot*) Lücking, R. Miranda & *Aptroot* **comb. nov.** (Fig. 79e)

*Mycobank number:* MB 836787; *Index Fungorum number:* IF 836787; *Facesoffungi number:* FoF 08793

*Bas.:* *Distothelia isthmospora* *Aptroot* in *Seaward & Aptroot*, *Bryologist* 108: 284 (2005).

***Bogoriella pandanicola*** (S.N. Zhang & K.D. Hyde) S.N. Zhang, Lücking & *Aptroot* **comb. nov.**

*Mycobank number:* MB 836822; *Index Fungorum number:* IF 836822; *Facesoffungi number:* FoF 09232.

*Bas.:* *Novomicrothelia pandanicola* S.N. Zhang & K.D. Hyde in Zhang et al., *Phytotaxa* 321: 258 (2017).

*Sequence data:* mtSSU: MT967501.

***Bogoriella rubrostoma*** (*Aptroot*) Lücking, R. Miranda & *Aptroot* **comb. nov.**

*Mycobank number:* MB 836788; *Index Fungorum number:* IF 836788; *Facesoffungi number:* FoF 08794

*Bas.:* *Mycomicrothelia rubrostoma* *Aptroot*, *Biblioth. Lichenol.* 44: 135 (1991); *Distothelia rubrostoma* (*Aptroot*) *Aptroot* & Lücking, *Lichenologist* 48(6): 927 (2016).

### Key to species of *Bogoriella*:

1. Ascospores becoming distinctly muriform, with thin eusepta and rectangular lumina.....2
1. Ascospores 1-septate to rarely 3-septate or submuriform, with thin eusepta or with irregularly thickened endospore and distosepta.....4
2. Ascospores becoming thick-walled and with thickened median septum, 28–45 µm long.....*Bogoriella chiquitana*
2. Ascospores remaining thin-walled, 20–35 µm long.....3

3. Ascospores 20–30 × 12–16 µm, about 1.5–2 times as long as broad.....*Bogoriella decipiens*
3. Ascospores 20–35 × 7–10 µm, about 3–3.5 times as long as broad.....*Bogoriella pandanicola*
4. Ascospores with irregularly thickened endospore and distosepta, 1-septate or rarely 3-septate to submuriform; lumina irregular to halter-shaped.....5
4. Ascospores with thin eusepta, 1-septate or rarely 3-septate; lumina rectangular.....8
5. Ascospores (1–)3-septate to appearing submuriform, 27–45 × 10–17 µm.....6
5. Ascospores 1-septate but cells with irregular endospore invaginations, 15–29 × 6–14 µm.....7
6. Ascospores mostly distinctly 3-septate, occasionally 1-septate or with additional longitudinal septa.....*Bogoriella queenslandica*
6. Ascospores with one distinct, rather dark central septum and the two cells with irregular endospore invaginations giving them the appearance of a (sub-)muriform division.....*Bogoriella complexoluminata*
7. Ostiole with red pigment; ascospores 23–29 × 10–14 µm, secondary endospore invaginations developing late.....*Bogoriella isthmospora*
7. Ostiole lacking pigment; ascospores 15–18 × 6–8 µm, secondary endospore invaginations developing soon...*Bogoriella rubrostoma*
8. Ostiole lateral.....*Bogoriella triangularis*
8. Ostiole apical.....9
9. Hamathecium interspersed.....10
10. Hamathecium clear.....12
10. Ascospores 24–27 × 8–11 µm.....*Bogoriella oleosa*
10. Ascospores 30–45 × 10–15 µm.....11
11. Ascomata 0.5–0.7 mm diam.....*Bogoriella xanthonica*
11. Ascomata 0.7–1.1 mm diam.....*Bogoriella macrocarpa*
12. Ascospores becoming 3-septate.....*Bogoriella obovata*
12. Ascospores remaining 1-septate.....13
13. Ascospores 28–40 µm long.....*Bogoriella megaspora*
13. Ascospores 17–27 µm long.....14
14. Black prothallus line present.....15
14. Black prothallus line absent.....16
15. Asci 10–20 µm broad.....*Bogoriella conothelena*
15. Asci 20–30 µm broad.....*Bogoriella thelena*
16. Ascomata 0.8–1 mm diam., basally broadly expanded.....*Bogoriella confuens*
16. Ascomata 0.2–0.4 mm diam., basally barely or not expanded.....17
17. Ascomata conical.....*Bogoriella pachythea*
17. Ascomata flattened.....*Bogoriella modesta*

**Constrictolumina** Aptroot, M.P. Nelsen & Lücking in Lücking et al., *Lichenologist* 48: 756 (2016).

*Mycobank number*: MB 816872; *Index Fungorum number*: IF 816872; *Facesoffungi number*: FoF 08795; five morphologically defined species (this paper); molecular data available for two species (Lücking et al. 2016).

*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical habitats. *Thallus* ecorticate, usually whitish. *Photobiont* *Trentepohlia*. *Ascomata* solitary to rarely aggregate, erumpent to prominent, carbonaceous, ostiolate, ostiole apical to rarely lateral. *Involucrellum* carbonized. *Excipulum* prosoplectenchymatous, brownish to colorless below. *Hamathecium* comprising ca. 1 µm wide, hyaline, straight, branched and anastomosing, pseudoparaphyses, embedded in a gelatinous matrix. *Asci* 4–8-spored, bitunicate, fissitunicate, clavate, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to biseriate, fusiform-ellipsoid, hyaline, 1–3-septate, euseptate, with secondary constrictions in each cell and often with slightly thickened walls, smooth-walled, slightly constricted at the septum, with a gelatinous halo, rather small (15–30 × 5–11 µm). *Pycnidia* unknown. *Chemistry*: no substances detected by TLC.

*Type species*: **Constrictolumina cinchonae** (Ach.) Lücking, M.P. Nelsen & Aptroot in Lücking et al., *Lichenologist* 48(6): 756 (2016).

*Notes*: This genus was recently introduced for lichenized species of *Arthopyrenia sensu lato* with secondary cell wall constrictions clustering within *Trypetheliaceae* (Aptroot and Lücking 2016; Lücking et al. 2016). At the time, it was already noted that the species formed two lineages, *C. malaccitula* coming out separate. A phenotype-based phylogenetic binning approach of 11 species included in the genus demonstrated that about half of them each cluster with either with notable differences in the ascospores, those of the *C. malaccitula* group being mostly larger [(20–)30–50 × (7–)10–16 µm)], with more distinct secondary constrictions, and granular ornamented. We therefore introduce the genus *Macroconstrictolumina* for this group below. *Constrictolumina* in a strict sense then retains five species, which are keyed out below.

#### Key to species of *Constrictolumina sensu stricto*

1. Ascospores 17–23 × 5–8 µm, 1–3-septate.....2
1. Ascospores (20–)22–46 × 7–24 µm, 1-septate.....3
2. Perithecia aggregate...**Constrictolumina esenbeckiana**
2. Perithecia solitary.....**Constrictolumina cinchonae**
3. Ascospores 40–46 × 16–24 µm.....  
.....**Constrictolumina porospora**
3. Ascospores 20–30 × 7–16 µm.....4
4. Perithecia aggregate; ascospores 3-septate.....  
.....**Constrictolumina leucostoma**

4. Perithecia solitary; ascospores 1(–3)-septate.....  
.....**Constrictolumina planorbis**

**Dictyomeridium** Aptroot, M.P. Nelsen & Lücking in Lücking et al., *Lichenologist* 48: 756 (2016).

*Mycobank number*: MB 816873; *Index Fungorum number*: IF 816873; *Facesoffungi number*: FoF 08796; seven morphologically defined species (Aptroot and Lücking 2016); molecular data available for one species (Lücking et al. 2016).

*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical habitats, typically in drier situations. *Thallus* ecorticate, usually whitish. *Photobiont* *Trentepohlia*. *Ascomata* solitary to sometimes aggregated, erumpent to prominent, somewhat pyriform when seen from above, brown-black to grey-black, carbonaceous, ostiolate, ostiole lateral. *Involucrellum* carbonized. *Excipulum* prosoplectenchymatous, brownish. *Hamathecium* comprising 0.5–0.7 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* 2–8-spored, bitunicate, fissitunicate, clavate, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to biseriate, oblong-ellipsoid, hyaline, often I+ amyloid, muriform, euseptate, smooth-walled, not constricted at the septa, with a gelatinous sheath. *Pycnidia* known from a few species, immersed to erumpent, visible as black dots. *Conidia* aseptate, bacillar, hyaline. *Chemistry*: lichexanthone sometimes produced on thallus surface.

*Type species*: **Dictyomeridium proponens** (Nyl.) Aptroot, M.P. Nelsen & Lücking in Lücking et al., *Lichenologist* 48: 757 (2016)

*Notes*: For key and discussion see Aptroot and Lücking (2016).

**“Julella” fallaciosa** (Stizenb. ex Arnold) R.C. Harris, in Egan, *Bryologist* 90(2): 163 (1987)

*Mycobank number*: MB 132219; *Index Fungorum number*: IF 132219; *Facesoffungi number*: FoF 08797.

*Notes*: The genus *Julella* has usually been considered a muriform-spored counterpart of *Arthopyrenia sensu lato* (Barr 1985, 1987b; Harris 1995). Species assigned to this genus are typically non-lichenized and possibly saprobic, about some doubtful lichenization has been discussed (Aptroot 2002a). The few studies available about this genus seem to disagree widely about species taxonomy. Thus, while Harris (1995) distinguished at least 13 species, Aptroot and van den Boom (1995) only accepted three. The latter authors included all forms with 2–4(–6) ascospores in a single species, *J. lactea* (A. Massal.) M.E. Barr, whereas Harris (1995) keyed out six species in this group, separated by ascospore size and numbers of ascospores per ascus. Among taxa with 8-spored asci, Aptroot and van den Boom (1995)

distinguished two species: *J. vitrispora* (Cooke & Harkn.) M.E. Barr with longer ascospores and larger ascomata and *J. sericea* (A. Massal.) Coppins with shorter ascospores and smaller ascomata. In contrast, Harris (1995) accepted at least seven species in this group, distinguished by ascus shape and ascospore arrangement, size, and color, among other features. These differences are less the result of a disparate species concept (the theoretical approach of both treatments not being that much different) and more due to the fact that these authors studied a very different set of names and material and hence came to such different conclusions. Given the findings in other, similarly defined genera such as *Arthopyrenia sensu lato*, it is conceivable that *Julella* is also a highly heterogeneous assemblage not only including many species but also representing several, partly unrelated genera.

Only two species of *Julella* have been sequenced so far, viz. *J. avicenniae* (Borse) K.D. Hyde and *J. fallaciosa* (Nelsen et al. 2011a, 2014; Ariyawansa et al. 2013a; Lücking et al. 2016), thus not including the type species, *J. buxi*. *Julella avicenniae* was shown to be different from the type species in ascus type, the brownish ascospores, and the habitat on bark of mangrove trees in the genus *Avicennia*, a notion anticipated by Harris (1995), and consequently was placed in a separate, monospecific genus and family, *Halojulella* and *Halojulellaceae* (Ariyawansa et al. 2013a). The sequenced material of *J. fallaciosa*, which agrees well with the key provided by Harris (1995) and Wirth et al. (2013) clustered within *Trypetheliaceae* (Nelsen et al. 2011a, 2014; Lücking et al. 2016; Fig. 77), which is in line with the ascus featuring a broad ocular chamber and the hamathecial physes being thin and anastomosing. Notably, most species currently placed in *Julella* agree with *J. fallaciosa* in ascus and hamathecium type and are likely congeneric with *J. fallaciosa*, whereas the type, *J. buxi*, differs by the asci lacking a distinct tholus and ocular chamber and by the physes being flexuose and only sparsely branched (Barr 1987b; Ariyawansa et al. 2013a). This situation is thus comparable to that of *Arthopyrenia* (Lücking and Nelsen in Hyde et al. 2013).

Barr (1987b) was the first to propose synonymy of the genera *Polyblastiopsis*, based on *P. naegeli* (= *Julella lactea*), and *Peltosphaeria*, based on *P. vitrispora* (= *Julella vitrispora*), with *Julella*. Various workers pointed out the asci with broad ocular chamber and the thin, anastomosing physes of the type species of both genera (Riedl 1971; Barr 1987b; Mayrhofer 1987), which suggests that these taxa are not actually congeneric with *J. buxi* but would likely cover the clade falling in *Trypetheliaceae*. We have refrained from taking up either name for this clade, given that most species of this complex have not been sequenced and also considering the complex situation emerging with the taxa previously placed on *Arthopyrenia sensu lato* and *Mycocrothelia sensu lato*, which now form several clades each

within *Trypetheliaceae*. Indeed, the two types of *Polyblastiopsis* and *Peltosphaeria* differ in ascospore shape, being (ob-)clavate in *Polyblastiopsis naegeli* (*J. lactea* group) and cylindrical in *Peltosphaeria vitrispora* (*J. vitrispora* group). Thus, if the two generic names indeed correspond to two separate phylogenetic units, then *Polyblastiopsis* would be the name applicable to the *J. fallaciosa* clade, as the latter belongs in the *J. lactea* group (Harris 1995; Aptroot and van den Boom 1995). However, if both groups are congeneric, then the older name *Peltosphaeria* has priority.

*Index Fungorum* currently lists *Polyblastiopsis sericea* (= *Julella sericea*) as type of *Polyblastiopsis*. However, Clements and Shear (1931) had listed *P. naegeli* as lectotype, a selection adopted by Riedl (1971) and Barr (1987b). *Polyblastiopsis* was established as replacement name for *Polyblastia* (Müller 1882), an illegitimate later homonym of *Polyblastia* [nom. cons.]. Since Zahlbruckner (1907) did not cite a type, *Polyblastiopsis* is to be typified by the type of *Polyblastia*, which means the lectotypification by Clements and Shear (1931) must be in accordance with Müller's (1882) protologue. This fortunately is the case, as *P. naegeli* is explicitly listed in the protologue. While Aptroot and van den Boom (1995) synonymized *P. naegeli* under *J. lactea*, both Riedl (1971) and Barr (1987b) recognized the taxon as variety of the latter, according to Riedl (1971) differing in the complete (var. *lactea*) vs. cap-shaped (var. *naegeli*) gelatinous sheath of the ascospores and in substrate preferences (*Fraxinus* vs. conifers). Given that the two taxa have overlapping ranges, it seems appropriate to recognize them as separate species, in which case the type of *Polyblastiopsis* is to be cited as *P. naegeli* and not as *P. lactea* or *P. sericea*.

***Macroconstrictolumina* Lücking, R. Miranda & Aptroot gen. nov.**

*Mycobank number*: MB 836789; *Index Fungorum number*: IF 836789; *Facesoffungi number*: FoF 08798; Four morphologically defined species (this paper); molecular data available for two species (Lücking et al. 2016; this paper).

*Diagnosis*: Differing from *Constrictolumina* chiefly in the larger ascospores with granular ornamentation.

*Etymology*: The name refers to the relatively large ascospores.

*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical habitats. *Thallus* ecorticate, usually whitish. *Photobiont* *Trentepohlia*. *Ascomata* solitary to rarely aggregate, erumpent to prominent, carbonaceous, ostiolate, ostiole apical to rarely lateral. *Involucrellum* carbonized. *Excipulum* prosoplectenchymatous, brownish to colourless below. *Hamathecium* comprising ca. 1 µm wide pseudo-paraphyses, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* 2–8-spored, bitunicate, fissitunicate, clavate, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged



to biseriate, fusiform-ellipsoid, hyaline, 1(–3)-septate, euseptate, with secondary constrictions in each cell and often with slightly thickened walls, typically granular ornamented, slightly constricted at the septum, with a gelatinous halo, medium-sized [30–50 × 10–16(–24) µm], only in one species (*M. lyrata*) somewhat smaller. *Pycnidia* unknown. *Chemistry*: no substances detected by TLC.

*Type species: Macroconstrictolumina malaccitula* (Nyl.) Lücking, R. Miranda & Aptroot (see below).

*Notes*: This new genus accommodates the lineage phylogenetically separate from the *Constrictolumina cinchonae* group (Fig. 77), but which had so far been included in that genus (Aptroot and Lücking 2016; Lücking et al. 2016). The difference in ascospore size, in combination with the granular ornamented ascospore wall, appears to be consistent, but further species of both genera need to be sequenced to test this taxonomic hypothesis developed from the binning exercise (Fig. 80).

#### New species and new combinations in *Macroconstrictolumina*:

***Macroconstrictolumina lyrata*** (R.C. Harris) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836790; *Index Fungorum number*: IF 836790; *Facesoffungi number*: FoF 08799.

*Bas.*: *Arthopyrenia lyrata* R.C. Harris in Tucker & Harris, *Bryologist* 83: 6 (1980); *Constrictolumina lyrata* (R.C. Harris) Lücking, M.P. Nelsen & Aptroot in Aptroot & Lücking, *Lichenologist* 48: 921 (2016).

*Sequence data*: mtSSU: MT948052.

***Macroconstrictolumina majuscula*** (Nyl.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836791; *Index Fungorum number*: IF 836791; *Facesoffungi number*: FoF 08800.

*Bas.*: *Verrucaria majuscula* Nyl., *Ann. Sci. Nat., Bot., Sér. 4* 20: 253 (1863); *Arthopyrenia majuscula* (Nyl.) Zahlbr., *Cat. Lich. Univers. 1*: 332 (1922); *Ciferriolichen majusculus* (Nyl.) R.C. Harris, *Moscossa* 6: 215 (1990); *Constrictolumina majuscula* (Nyl.) Lücking, M.P. Nelsen & Aptroot in Aptroot & Lücking, *Lichenologist* 48: 921 (2016).

***Macroconstrictolumina malaccitula*** (Nyl.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836792; *Index Fungorum number*: IF 836792; *Facesoffungi number*: FoF 08801.

*Bas.*: *Verrucaria malaccitula* Nyl. in Nylander & Crombie, *J. Linn. Soc., Bot.* 20: 61 (1883); *Arthopyrenia malaccitula* (Nyl.) Zahlbr., *Cat. Lich. Univers. 1*: 284 (1921); *Constrictolumina malaccitula* (Nyl.) Lücking, M.P. Nelsen & Aptroot in Aptroot & Lücking, *Lichenologist* 48: 921 (2016).

= *Tomasellia dispersa* Müll. Arg., *Flora, Regensburg* 70: 427 (1887).

= *Arthopyrenia bifera* Zahlbr., *Annls mycol.* 33(1/2): 34 (1935).

= *Megalotremis biocellata* Aptroot, *Bibliothca Lichenol.* 44: 125 (1991).

*Notes*: This species is being discussed in detail in the *Monoblastiaceae* treatment of this issue (Lücking et al. in this paper), based on the finding that *Megalotremis biocellata*, previously classified in a genus belonging to *Monoblastiaceae*, was found to be conspecific with *M. malaccitula*.

***Macroconstrictolumina megalateralis*** Aptroot **sp. nov.** (Fig. 79 g–k)

*Mycobank number*: MB 836793; *Index Fungorum number*: IF 836793; *Facesoffungi number*: FoF 08802.

*Diagnosis*: Corticolous *Macroconstrictolumina* with thallus UV-negative; ostioles lateral, ascospores granular ornamented, 34–37 × 11–14 µm, with gelatinous sheath of c. 4 µm.

*Etymology*: The epithet refers to the large ascomata and ascospores and the lateral ostioles.

*Holotype*: A. Aptroot 77751 (CGMS).

*Thallus* crustose, endoperidermal, whitish to pinkish, opaque, not surrounded by a prothallus. *Ascomata* solitary, pyriform, 0.6–0.8 mm diam., black. *Ostioles* lateral, black. *Hamathecium* clear. *Ascospores* 8/ascus, hyaline, 1-septate, septum median, 34–37 × 11–14 µm, sole-shaped with upper cell wider than lower cell, with conspicuous granular wall ornamentation, more or less distinctly constricted but not thickened at the median septum, with secondary constriction or invagination in each cell, surrounded by a c. 4 µm thick gelatinous sheath. *Pycnidia* not observed.

*Chemistry*: Thallus UV–, C–, P–, K–; no substances detected by TLC.

*Ecology and distribution*: On tree bark in Atlantic Forest; thus far only known from Brazil.

*Material examined*: Brazil. Mato Grosso do Sul: Serra da Bodoquena, Bonito, Fazenda Marambaia; 20°58' S, 56°42' W, 650 m; Atlantic Forest, on tree bark in pasture close to forest; 30 October 2018, A. Aptroot 77751 (holotype: CGMS; isotype: ABL); Serra da Bodoquena, Fazenda Monte Negro; 20°54'25" S, 56°48'04" W, 530 m; Atlantic Forest, on tree bark in forest; 8 November 2018, A. Aptroot 77888, 77930, 77933, 77940, 77941, 77948, 77966 (paratypes: CGMS). Acre: Núcleo Cazumbá; 09°07' S, 68°57' W, 150 m; disturbed tropical rain forest; 2019, M. Cáceres & A. Aptroot (ABL, ISE 50171).

*Notes*: Four species of *Macroconstrictolumina* are so far recognized. The new species is unmistakable by the lateral ostioles.

**Key to species of *Macroconstrictolumina*:**

1. Ascospores  $18\text{--}30 \times 7\text{--}10\text{--}(12)$   $\mu\text{m}$ .....  
.....*Macroconstrictolumina lyrata*
1. Ascospores  $30\text{--}48 \times 10\text{--}16\text{--}(24)$   $\mu\text{m}$ .....2
2. Ostiole lateral; ascospores 1-septate.....  
.....*Macroconstrictolumina megalateralis*
2. Ostiole apical; ascospores 1(–3)-septate.....3
3. Ascospores  $27\text{--}37 \times 10\text{--}12$   $\mu\text{m}$ , often 3-septate.....  
.....*Macroconstrictolumina majuscula*
3. Ascospores  $40\text{--}50 \times 15\text{--}20$   $\mu\text{m}$ , mostly 1-septate.....  
.....*Macroconstrictolumina malaccitula*

**Marcelaria** Aptroot, M.P. Nelsen & Parnmen, *Glia* 5(2): 3 (2013), nom. cons. prop.

*Mycobank number*: MB 805450; *Index Fungorum number*: IF 805450; *Facesoffungi number*: FoF 08803; three morphologically defined species (Aptroot and Lücking 2016); molecular data available for two species (Lücking et al. 2016).

= *Buscalionia* Sambo nom. cons. prop., *Ann. Bot.*, Roma 22: 27 (1940). Type species: *Buscalionia rubra* Sambo, *Ann. Bot.*, Roma 22: 27 (1940) [= *Marcelaria purpurina* (Nyl.) Aptroot, Nelsen & Parnmen].

*Lichenized* on bark in terrestrial, chiefly lowland tropical wet forest habitats. *Thallus* distinctly corticate, yellow-brown to olive-green. *Photobiont Trentepohlia*. *Ascomata* solitary to often crowded or loosely aggregate, prominent to sessile, brown-black but covered by thick thallus and a thick layer of yellow-orange to red pigment crystals, hemispherical to wart-shaped, coriaceous, ostiolate, ostiole apical. *Excipulum* prosoplecten-chymatous, dark brown to carbonized. *Hamathecium* comprising 0.5–0.7  $\mu\text{m}$  wide para-physoids, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* 2–8-spored, bitunicate, fissitunicate, oblong-clavate, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to biseriate, fusiform-ellipsoid, hyaline, richly muriform, with somewhat thickened distosepta and rounded lumina, smooth-walled, not or slightly constricted at the septa, often with a gelatinous sheath. *Pycnidia* unknown. *Chemistry*: lichexanthone sometimes produced on thallus surface; yellow to orange or red anthraquinones present on the ascomata.

*Type species*: *Marcelaria purpurina* (Nyl.) Aptroot, Nelsen & Parnmen, *Glia* 5(2): 9 (2013) [= *Buscalionia rubra* Sambo, *Ann. Bot.*, Roma 22: 27 (1940)].

*Notes*: For key and discussion see Aptroot and Lücking (2016). The older name *Buscalionia* has recently been discovered to be congeneric with *Marcelaria* and has been proposed for conservation (Aptroot and Nepi 2017), with the decision pending.

**Nigrothelium** Lücking, M.P. Nelsen & Aptroot in Lücking et al., *Lichenologist* 48: 757 (2016).

*Mycobank number*: MB 816875; *Index Fungorum number*: IF 816875; *Facesoffungi number*: FoF 08804; three morphologically and partly phylogenetically defined species (Aptroot and Lücking 2016); molecular data available for two species (Lücking et al. 2016).

*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical habitats, often in drier situations. *Thallus* distinctly corticate, olive-green to yellowish brown. *Photobiont Trentepohlia*. *Ascomata* solitary, prominent to sessile, black, subglobose to egg-shaped, carbonaceous, ostiolate, ostiole apical. *Involucrellum* carbonized. *Excipulum* prosoplectenchymatous, brownish to carbonized. *Hamathecium* comprising 0.5–0.7  $\mu\text{m}$  wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* 8-spored, bitunicate, fissitunicate, clavate, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to biseriate, fusiform-ellipsoid, hyaline, 3-septate, astrothelioid with distinct distosepta and diamond-shaped lumina, smooth-walled, not constricted at the septa, often with a gelatinous sheath. *Pycnidia* rare, immersed to erumpent, visible as black dots. *Conidia* aseptate, bacillar, hyaline. *Chemistry*: no substances detected by TLC.

*Type species*: *Nigrothelium tropicum* (Ach.) Lücking, M.P. Nelsen & Aptroot in Lücking et al., *Lichenologist* 48: 757 (2016).

*Notes*: For key and discussion see Aptroot and Lücking (2016).

**Polymeridium** (Müll. Arg.) R.C. Harris in Tucker & Harris, *Bryologist* 83: 12 (1980).

*Mycobank number*: MB 4316; *Index Fungorum number*: IF 4316; *Facesoffungi number*: FoF 08805; Approximately 50 morphologically defined species (Aptroot and Lücking 2016; Aptroot and Weerakoon 2018); molecular data available for three species (Lücking et al. 2016).

*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical habitats, often in drier situations. *Thallus* usually ecorticate, rarely indistinctly corticate, whitish. *Photobiont Trentepohlia*. *Ascomata* solitary to aggregate, erumpent to prominent, black, hemispherical to wart-shaped or conical, carbonaceous, ostiolate, ostiole apical, rarely lateral or fused. *Involucrellum* carbonized. *Excipulum* prosoplectenchymatous, brownish to carbonized. *Hamathecium* comprising 0.5–0.7  $\mu\text{m}$  wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* 4–8-spored, bitunicate, fissitunicate, clavate, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to biseriate, fusiform-ellipsoid, hyaline, multi-septate to rarely (sub-)muriform, with thin eusepta and rectangular lumina, smooth-walled, not or slightly constricted at the septa, often with a gelatinous sheath. *Pycnidia* rare, immersed to erumpent, visible as black dots. *Conidia* aseptate, bacillar, hyaline. *Chemistry*:

lichexanthone sometimes produced on thallus surface; ostiolar area or hamathecium rarely with anthraquinones.

*Type species: Polymeridium contendens* (Nyl.) R.C. Harris in Tucker & Harris, Bryologist 83: 12 (1980).

*Notes:* For key and discussion see Aptroot and Lücking (2016).

**Polypyrenula** D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 165 (1985).

*Mycobank number:* MB 25730; *Index Fungorum number:* IF 25730; *Facesoffungi number:* FoF 08806; one morphologically and phylogenetically defined species (Miranda-González et al. 2020).

*Lichenized* (sometimes indistinctly or photobiont apparently absent) on bark in terrestrial, lowland tropical, seasonally dry forest habitats. *Thallus* ecorticate, whitish to pale greyish or brownish. *Photobiont* (when present) *Trentepohlia*. *Ascomata* dispersed, solitary, erumpent to prominent, black but basally covered by thin thallus layer, hemispherical to wart-shaped, carbonaceous, ostiolate, ostiole apical. *Involucrellum* well-developed, carbonaceous. *Excipulum* prosoplectenchymatous, basally reddish brown, laterally and apically thin and fused with involucrellum. *Hamathecium* comprising 0.5–1 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* (6–)8-spored, bitunicate, clavate, shortly pedicellate, with a non-amyloid ocular chamber. *Ascospores* biseriate, fusiform-ellipsoid and tapering towards the distal end, reddish brown but with basal cell paler, 5(-6)-septate, with distinct distosepta and rounded lumina except for the lowermost cell which is separated by a thin euseptum and has a triangular lumen, smooth-walled, not constricted at the septa, lacking a gelatinous sheath. *Pycnidia* unknown. *Chemistry:* no substances detected by TLC.

*Type species: Polypyrenula sexocularis* (Müll. Arg.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 165 (1985) [= *Polypyrenula albissima* Aptroot, Biblioth. Lichenol. 44: 102 (1991); nom. illeg., ICN Art. 52.1].

*Notes:* This monospecific genus is characterized by highly unique ascospores, which coincides with its position on a very long branch but with unresolved affinities among the basally diverging clades of the family (Fig. 77). For a long time, *Polypyrenula* was classified in the families *Pyrenulaceae* and *Requienellaceae* (Aptroot 1991; Lumbsch and Huhndorf 2007, 2010; Jaklitsch et al. 2016). However, the paraphysoids are more in line with those of *Trypetheliaceae* and molecular data recently demonstrated placement of the genus in that family (Miranda-González et al. 2020), a result anticipated in two recent classification papers (Lücking et al. 2017; Wijayawardene et al. 2017a). Miranda-González et al. (2020) also showed that *P. sexocularis* is the correct name for the only species, *P. albissima* Aptroot being an illegitimate, homotypic synonym. The species appears to be found

mostly in dry forests across the Neotropics (known from the Caribbean, Mexico and Bolivia) and has likely been overlooked due to the nondescript thallus and ascomata.

**Pseudobogoriella** Lücking, R. Miranda & Aptroot **gen. nov.**

*Mycobank number:* MB 836794; *Index Fungorum number:* IF 836794; *Facesoffungi number:* FoF 08807; 15 morphologically defined species (this paper); molecular data available for three species (Lücking et al. 2016; this paper).

*Diagnosis:* Differing from *Bogoriella* chiefly in the smaller ascospores always lacking endospore thickenings.

*Etymology:* The name refers to the notion as a “false” *Bogoriella*, i.e. similar but not closely related to the latter.

*Lichenized* (sometimes barely so or apparently non-lichenized) on bark in terrestrial, chiefly lowland to lower montane tropical habitats. *Thallus* ecorticate, mostly whitish to pale brownish or pinkish. *Photobiont* *Trentepohlia*. *Ascomata* solitary, erumpent to prominent, brown-black to carbonaceous, hemispherical to wart-shaped, coriaceous to carbonaceous, ostiolate, ostiole apical to rarely lateral. *Involucrellum* usually well-developed, carbonaceous. *Excipulum* prosoplectenchymatous, usually brownish, in lateral and apical parts typically fused with the involucrellum. *Hamathecium* comprising 1 µm wide para-physoids, hyaline, straight to somewhat wavy, branched and anastomosing, embedded in a thin, gelatinous matrix. *Asci* 8-spored, bitunicate, fissitunicate, clavate to fusiform, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to uni- or biseriate, fusiform-ellipsoid, grey-brown, 1-septate, with eusepta and rectangular lumina, wall finely granular ornamented, not or slightly constricted at the septa, typically rather small (mostly around 15–20 × 6–8 µm), only in the type species somewhat larger. *Pycnidia* known from a few species, immersed to erumpent, visible as black dots. *Conidia* aseptate, bacillar, hyaline. *Chemistry:* no substances detected by TLC.

*Type species: Pseudobogoriella hemisphaerica* (Müll. Arg.) Lücking, R. Miranda & Aptroot (see below).

*Notes:* The establishment of this new genus follows the topology of the phylogenetic tree, in which former members of *Mycomicrothelia sensu lato* emerge on three separate clades (Fig. 77). The systematics of these taxa is not settled, given that only few species have been sequenced. *Pseudobogoriella* currently represents a paraphyletic grade of two clades, but we have adopted the conservative solution of merging the two clades into a single genus for the time being. This reflects the fact that these species cannot be classified in *Bogoriella sensu stricto* for topological reasons, but at the same time too few data are available to further resolve this basally emerging grade. The main difference when compared to *Bogoriella* are the small, 1-septate ascospores lacking endospore thickenings.

**New combinations in *Pseudobogoriella*:**

***Pseudobogoriella alata*** (Groenh. ex Aptroot) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836795; *Index Fungorum number*: IF 836795; *Facesoffungi number*: FoF 08808.

Bas.: *Mycomicrothelia alata* Groenh. ex Aptroot, Biblioth. Lichenol. 44: 130 (1991); *Bogoriella alata* (Groenh. ex Aptroot) Aptroot & Lücking, Lichenologist 48: 905 (2016).

***Pseudobogoriella annonacea*** (Müll. Arg.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836796; *Index Fungorum number*: IF 836796; *Facesoffungi number*: FoF 08809.

Bas.: *Microthelia annonacea* Müll. Arg., [as ‘anonacea’], Hedwigia 34: 145 (1895); *Mycomicrothelia annonacea* (Müll. Arg.) D. Hawksw., [as ‘anonacea’] Bull. Br. Mus. Nat. Hist., Bot. 14(2): 67 (1985); *Bogoriella annonacea* (Müll. Arg.) Aptroot & Lücking, Lichenologist 48: 907 (2016).

***Pseudobogoriella captiosa*** (Kremp.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836797; *Index Fungorum number*: IF 836797; *Facesoffungi number*: FoF 08810.

Bas.: *Verrucaria captiosa* Kremp., Flora 59: 524 (1876); *Microthelia captiosa* (Kremp.) Müll. Arg., Flora 66: 272 (1883); *Mycomicrothelia captiosa* (Kremp.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 73 (1985); *Bogoriella captiosa* (Kremp.) Aptroot & Lücking, Lichenologist 48: 908 (2016).

***Pseudobogoriella exigua*** (Müll. Arg.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836798; *Index Fungorum number*: IF 836798; *Facesoffungi number*: FoF 08811.

Bas.: *Microthelia exigua* Müll. Arg., Bot. Jahrb. 6: 416 (1885); *Mycomicrothelia exigua* (Müll. Arg.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 84 (1985); *Bogoriella exigua* (Müll. Arg.) Aptroot & Lücking, Lichenologist 48: 910 (2016).

***Pseudobogoriella fumosula*** (Zahlbr.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836799; *Index Fungorum number*: IF 836799; *Facesoffungi number*: FoF 08812.

Bas.: *Microthelia fumosula* Zahlbr. in Handel-Mazzetti, Symb. Sinic. 3: 18 (1930); *Mycomicrothelia fumosula* (Zahlbr.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 86 (1985); *Bogoriella fumosula* (Zahlbr.) Aptroot & Lücking, Lichenologist 48: 910 (2016).

***Pseudobogoriella hemisphaerica*** (Müll. Arg.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836800; *Index Fungorum number*: IF 836800; *Facesoffungi number*: FoF 08813.

Bas.: *Microthelia hemisphaerica* Müll. Arg., Bot. Jahrb. 6: 417 (1885); *Mycomicrothelia hemisphaerica* (Müll. Arg.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 86 (1985); *Bogoriella hemisphaerica* (Müll. Arg.) Aptroot & Lücking, Lichenologist 48: 910 (2016).

***Pseudobogoriella lateralis*** (Sipman) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836801; *Index Fungorum number*: IF 836801; *Facesoffungi number*: FoF 08814.

Bas.: *Mycomicrothelia lateralis* Sipman, Lichenologist 37: 309 (2005); *Bogoriella lateralis* (Sipman) Aptroot & Lücking, Lichenologist 48: 911 (2016).

***Pseudobogoriella leuckertii*** (D. Hawksw. & J.C. David) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836802; *Index Fungorum number*: IF 836802; *Facesoffungi number*: FoF 08815.

Bas.: *Mycomicrothelia leuckertii* D. Hawksw. & J.C. David in David & Hawksworth, Biblioth. Lichenol. 57: 98 (1995); *Bogoriella leuckertii* (D. Hawksw. & J.C. David) Aptroot & Lücking, Lichenologist 48: 911 (2016).

***Pseudobogoriella minutula*** (Zahlbr.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836803; *Index Fungorum number*: IF 836803; *Facesoffungi number*: FoF 08816.

Bas.: *Microthelia minutula* Zahlbr. in Handel-Mazzetti, Symb. Sinic. 3: 18 (1930); *Mycomicrothelia minutula* (Zahlbr.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14(2): 102 (1985); *Bogoriella minutula* (Zahlbr.) Aptroot & Lücking, Lichenologist 48: 912 (2016).

***Pseudobogoriella nonensis*** (Stirt.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836804; *Index Fungorum number*: IF 836804; *Facesoffungi number*: FoF 08817.

Bas.: *Verrucaria nonensis* Stirt., Proc. Roy. Phil. Soc. Glasgow 11: 320 (1879); *Microthelia nonensis* (Stirt.) Zahlbr., Cat. Lich. Univers. 1: 264 (1921); *Mycomicrothelia nonensis* (Stirt.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 105 (1985); *Bogoriella nonensis* (Stirt.) Aptroot & Lücking, Lichenologist 48: 913 (2016).

***Pseudobogoriella pachnea*** (Körb.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836805; *Index Fungorum number*: IF 836805; *Facesoffungi number*: FoF 08818.

Bas.: *Microthelia pachnea* Körb., Parerga Lichenol. 5: 398 (1865); *Amphisphaeria pachnea* (Körb.) Rehm, Ann.

Mycol. 4: 264 (1906); *Mycomicrothelia pachnea* (Körb.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 108 (1985).

***Pseudobogoriella punctata*** (Aptroot) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836806; *Index Fungorum number*: IF 836806; *Facesoffungi number*: FoF 08819

Bas.: *Mycomicrothelia punctata* Aptroot, Biblioth. Lichenol. 44: 134 (1991); *Bogoriella punctata* (Aptroot) Aptroot & Lücking, Lichenologist 48: 914 (2016).

***Pseudobogoriella socialis*** (Zahlbr.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836807; *Index Fungorum number*: IF 836807; *Facesoffungi number*: FoF 08820.

Bas.: *Microthelia socialis* Zahlbr., Mycologia 22: 69 (1930); *Mycomicrothelia socialis* (Zahlbr.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 110 (1985); *Bogoriella socialis* (Zahlbr.) Aptroot & Lücking, Lichenologist 48: 915 (2016).

***Pseudobogoriella striguloides*** (Sérus. & Aptroot) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836808; *Index Fungorum number*: IF 836808; *Facesoffungi number*: FoF 08821.

Bas.: *Mycomicrothelia striguloides* Sérus. & Aptroot, Bryologist 101: 145 (1998); *Bogoriella striguloides* (Sérus. & Aptroot) Aptroot & Lücking, Lichenologist 48: 915 (2016).

*Notes*: This species is highly unusual among the genus due to its foliicolous, *Strigula*-like, subcuticular thallus. Sérusiaux and Aptroot (1998) already discussed the possibility of this being a lichenicolous fungus on a *Strigula* thallus, but found no support for this hypothesis. The anatomical characters of the ascomata and asci are reminiscent of the lichenicolous genus *Polycoccum* Saut. ex Körb. (Matzer 1996; Diederich et al. 2018), which has recently been identified as a close relative of *Trypetheliaceae* (Ertz et al. 2015). We refrain from proposing any taxonomic changes at this point but we predict that this taxon is not a genuine *Trypetheliaceae*.

***Pseudobogoriella subfallens*** (Müll. Arg.) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836809; *Index Fungorum number*: IF 836809; *Facesoffungi number*: FoF 08822

Bas.: *Microthelia subfallens* Müll. Arg., Bot. Jahrb. 6: 416 (1885); *Mycomicrothelia subfallens* (Müll. Arg.) D. Hawksw., Bull. Br. Mus. Nat. Hist., Bot. 14: 111 (1985); *Bogoriella subfallens* (Müll. Arg.) Aptroot & Lücking, Lichenologist 48: 915 (2016).

#### Key to species of *Pseudobogoriella*:

1. Ostiole lateral.....***Pseudobogoriella lateralis***
1. Ostiole apical.....2
2. Ascospores 24–28 µm long.....***Pseudobogoriella hemisphaerica***
2. Ascospores 12–22 µm long.....3
3. Thallus foliicolous, subcuticular, distinctly lobed.....***Pseudobogoriella striguloides***
3. Thallus corticolous, not lobed.....4
4. Excipulum with K+ red, dissolving pigment.....***Pseudobogoriella leuckertii***
4. Excipulum lacking pigment.....5
5. Black prothallus line with numerous pycnidia.....***Pseudobogoriella punctata***
5. Black prothallus line lacking pycnidia or absent.....6
6. Thallus besides ascomata with numerous black dots representing pycnidia.....7
6. Thallus lacking pycnidia.....8
7. Ascomata aggregate; ascospores 15–20 × 6–9 µm.....***Pseudobogoriella socialis***
7. Ascomata solitary; ascospores 11–17 × 5–7 µm.....***Pseudobogoriella fumosula***
8. Involucrellum broadly expanding basally to over 0.5 mm diam.....***Pseudobogoriella alata***
8. Ascomata including basally slightly expanding involucrellum 0.2–0.5 mm diam.....9
9. Ascospores 12–16 µm long.....10
9. Ascospores 16–22 µm long.....12
10. Ascomata 0.3–0.5 mm diam.....***Pseudobogoriella subfallens***
10. Ascomata 0.2–0.3 mm diam.....11
11. Ascospores 4–5.5 µm broad, 2.5–3 times as long as broad; involucrellum basally not expanding.....***Pseudobogoriella exigua***
11. Ascospores 5.5–7 µm broad, 2–2.5 times as long as broad; involucrellum basally expanding.....***Pseudobogoriella minutula***
12. Black prothallus line present.....13
12. Black prothallus line absent.....14
13. Ascomata conical, basally not expanded.....***Pseudobogoriella captiosa***
13. Ascomata flattened, basally expanded.....***Pseudobogoriella miculiformis***
14. Ascomata basally broadly expanded, fringe 50–100 µm broad.....***Pseudobogoriella annonacea***
14. Ascomata basally narrowly expanded, fringe 20–50 µm broad.....***Pseudobogoriella nonensis***

***Pseudopyrenula*** Müll. Arg., Flora 66: 247 (1883).

*Mycobank number*: MB 4481; *Index Fungorum number*: IF 4481; *Facesoffungi number*: FoF 08823; Approximately 20 morphologically defined species (Aptroot and Lücking

2016; Aptroot et al. 2019); molecular data available for four species (Lücking et al. 2016).

*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical habitats, often in drier situations. *Thallus* ecorporate, whitish. *Photobiont* *Trentepohlia*. *Ascomata* solitary, erumpent to prominent, black, hemispherical to wart-shaped or conical, carbonaceous, ostiolate, ostiole apical, rarely lateral. *Involucrellum* carbonized. *Excipulum* prosoplectenchymatous, brownish to carbonized. *Hamathecium* comprising 0.5–0.7 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a gelatinous matrix. *Asci* 8-spored, bitunicate, fissitunicate, clavate, short pedicellate, with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to biseriate, fusiform-ellipsoid, hyaline, 3(–5)-septate, astrothelioid with distinct distosepta and diamond-shaped lumina, smooth-walled, not constricted at the septa, often with a gelatinous sheath. *Pycnidia* rare, immersed to erumpent, visible as black dots. *Conidia* aseptate, bacillar, hyaline. *Chemistry*: lichexanthone sometimes produced on thallus surface; hamathecium and/or ascospores sometimes with yellow anthraquinones.

*Type species: Pseudopyrenula diluta* (Fée) Müll. Arg., *Flora* 66: 249 (1883)

*Notes*: For key and discussion see Aptroot and Lücking (2016).

***Schummia*** Lücking, R. Miranda & Aptroot **gen. nov.**

*Mycobank number*: MB 836810; *Index Fungorum number*: IF 836810; *Facesoffungi number*: FoF 08824; one morphologically defined species (this paper); molecular data thus far unavailable.

*Diagnosis*: Differing from *Bogoriella* in the ascospores with lens-shaped lumina and very thick terminal walls.

*Etymology*: Named after our colleague and friend, Felix Schumm, for his excellent contributions to our knowledge of the morphology and anatomy of lichen fungi.

*Lichenized* (weakly so) on bark in terrestrial, lowland to lower montane subtropical habitats (Azores). *Thallus* ecorporate, pale brownish (to pinkish). *Photobiont* *Trentepohlia*. *Ascomata* solitary, erumpent, brown-black to carbonaceous, appanately wart-shaped to irregular in outline, ostiolate, ostiole apical. *Involucrellum* weakly developed, with periderm layers, carbonaceous. *Excipulum* prosoplectenchymatous, brown-black, in apical parts fused with involucrellum. *Hamathecium* comprising 1.5 µm wide paraphysoids, hyaline, straight to somewhat wavy, slightly branched. *Asci* 8-spored, bitunicate, fissitunicate, clavate, short pedicellate, with a non-amyloid, rather long ocular chamber. *Ascospores* irregularly arranged to biseriate, ellipsoid to drop-shaped, grey-brown, 1-septate, with a central euseptum and rectangular lumina, the terminal walls much thickened and inflated, not or slightly constricted at the septa. *Pycnidia* unknown. *Chemistry*: no substances detected by TLC.

*Type species: Schummia angulata* (Aptroot & Schumm) Lücking, R. Miranda & Aptroot (see below).

*Notes*: This new genus is introduced for a single species with highly unusual ascospores that in their mature stage are reminiscent of *Arthoniaceae* and *Graphidaceae* rather than *Trypetheliaceae*. The species was originally described in the genus *Distothelia* (Schumm and Aptroot 2013), but the ascospores differ clearly in shape and endospore development, resulting in two strongly thickened terminal walls. Immature ascospores appear 3-septate with three eusepta, somewhat similar to ascospores in *Novomicrothelia* and *Pseudobogoriella* except for the more numerous septa. However, the two terminal lumina eventually become filled entirely with endospore material and simultaneously inflated, so that the two-remaining central lumina appear much smaller than the thickened terminal walls (Fig. 79f). Given the current distribution of ascospore types among basally diverging lineages in the family, we predict that this taxon represents its own lineage, and placement in *Bogoriella*, together with the other two species previously placed in *Distothelia*, would be misleading.

***Schummia angulata*** (Aptroot & Schumm) Lücking, R. Miranda & Aptroot **comb. nov.**

*Mycobank number*: MB 836811; *Index Fungorum number*: IF 836811; *Facesoffungi number*: FoF 08825.

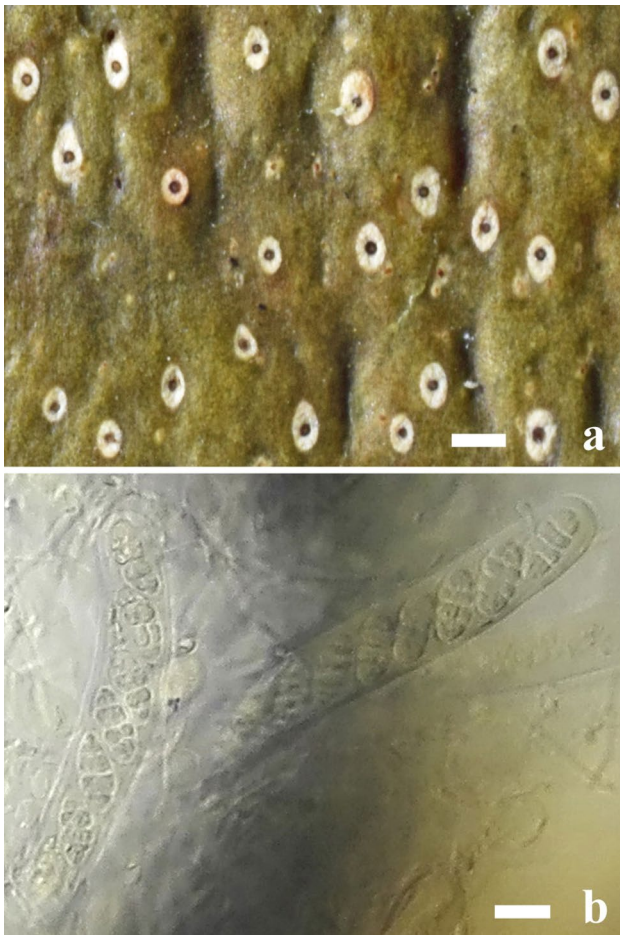
*Bas.:* *Distothelia angulata* Aptroot & Schumm in Schumm & Aptroot, *Flechten Madeiras, der Kanaren und Azoren* 2: 200 (2013).

***Viridothelium*** Lücking, M.P. Nelsen & Aptroot in Lücking et al., *Lichenologist* 48: 758 (2016).

*Mycobank number*: MB 816877; *Index Fungorum number*: IF 816877; *Facesoffungi number*: FoF 08826; 11 morphologically defined species (Aptroot and Lücking 2016; Cáceres and Aptroot 2017); molecular data available for three species (Lücking et al. 2016).

= ?*Exiliseptum* R.C. Harris, *Acta Amazonica* 14(1–2, Suppl.): 65 (1986) [1984]. *Type species: Exiliseptum ocellatum* (Müll. Arg.) R.C. Harris, *Acta Amazonica* 14(1–2, Suppl.): 66 (1986) [1984].

*Lichenized* on bark in terrestrial, chiefly lowland to lower montane tropical to temperate forest habitats. *Thallus* distinctly corticate, yellow-brown to olive-green. *Photobiont* *Trentepohlia*. *Ascomata* solitary to aggregated or diffusely pseudostromatic, immersed to erumpent, brown-black but usually covered by thallus layer except for ostiolar area, coriaceous to carbonaceous, ostiolate, ostiole apical to lateral, sometimes fused. *Excipulum* prosoplectenchymatous, brownish. *Hamathecium* comprising 0.5–0.7 µm wide paraphysoids, hyaline, straight, branched and anastomosing, embedded in a thick, gelatinous matrix. *Asci* 4–8-spored, bitunicate, fissitunicate, clavate to oblong, short pedicellate,



**Fig. 81** *Exiliseptum ocellatum* (holotype). **a**, **b** habitus and asci with ascospores. Scale bars: **a** = 1 mm, **b** = 10  $\mu$ m

with a non-amyloid ocular chamber. *Ascospores* irregularly arranged to biserial, oblong-fusiform, hyaline, septate to rarely muriform, with slightly thickened distosepta and more or less rectangular lumina, smooth-walled, not constricted at the septa, often with a gelatinous sheath. *Pycnidia* rare, immersed to erumpent, visible as black dots. *Conidia* aseptate, bacillar, hyaline. *Chemistry*: orange anthraquinone known from one species

*Type species*: *Viridothelium virens* (Tuck. ex Michener) Lücking, M.P. Nelsen & Aptroot in Lücking et al., *Lichenologist* 48: 759 (2016).

*Notes*: For key and discussion see Aptroot and Lücking (2016). The genus currently includes 11 species (Cáceres and Aptroot 2017). The genus *Exiliseptum*, described by Harris (1986), was later considered a member of *Polymeridium* with a corticate thallus (Aptroot and Cáceres 2014), and this view was followed in the recent synopsis on *Trypetheliaceae* (Aptroot and Lücking 2016). However, upon re-examination of the type material (Fig. 81), we believe that this taxon may be congeneric with *Viridothelium*, in

which case it would provide an earlier name for that genus. We have refrained from formal implementation of this finding, as the phylogenetic placement of odd lineages in *Trypetheliaceae* is somewhat unpredictable and we anticipate collecting authentic material for sequencing.

#### Key to genera of *Trypetheliaceae*:

1. Ascospores remaining hyaline.....2
1. Ascospores becoming brown.....23
2. Ascospores 1-septate.....3
2. Ascospores 3-septate to muriform.....6
3. Ascospores up to  $15 \times 5 \mu\text{m}$ , lacking secondary constrictions.....“*Arthopyrenia*” (aff. *minor*)
3. Ascospores larger than  $15 \times 5 \mu\text{m}$ , usually with secondary constrictions.....4
4. Non-lichenized; saprobic on branches in southern Europe.....*Alloarthopyrenia* (*italica*)
4. Lichenized (often barely so); (sub-)tropical.....5
5. Ascospores smooth-walled, up to  $30 \times 11 \mu\text{m}$  (in one species up to  $46 \times 24 \mu\text{m}$ ) .....*Constrictolumina* p.p.
5. Ascospores granular ornamented, mostly larger than  $30 \times 11 \mu\text{m}$  (in one species  $20\text{--}30 \times 7\text{--}12 \mu\text{m}$ ).....*Macroconstrictolumina* p.p.
6. Thallus ecorticate or indistinctly corticate, usually whitish or greyish, contrasting with the black ascospores.....7
6. Thallus distinctly corticate, olive-green to yellowish brown.....13
7. Hamathecium physes basally somewhat thickened, somewhat flexuose, branched but usually not anastomosing; ascospores (1–)3-septate.....8
7. Hamathecium physes thin, straight, branched and anastomosing to form a net-like structure.....9
8. Ascospores up to  $23 \times 8 \mu\text{m}$ , smooth-walled.....*Constrictolumina* p.p.
8. Ascospores mostly larger than  $30 \times 11 \mu\text{m}$  (in one species  $20\text{--}30 \times 7\text{--}12 \mu\text{m}$ ), granular ornamented.....*Macroconstrictolumina* p.p.
9. Ascospores astrothelioid, with diamond-shaped lumina.....*Pseudopyrenula*
9. Ascospores euseptate, with thin septa and rectangular lumina.....10
10. Ascospores transversely septate...*Polymeridium* p.p.
10. Ascospores muriform.....11
11. Ostioles lateral.....*Dictyomeridium*
11. Ostioles apical.....12
12. Non-lichenized; temperate.....“*Julella*” (*fallaciosa*)
12. Lichenized; (sub-)tropical.....*Polymeridium* p.p.
13. Ascospores transversely septate.....14
13. Ascospores muriform.....19
14. Ascospores very large with few (3–5) septa, typically over  $100 \times 30 \mu\text{m}$  and up to  $190 \times 60 \mu\text{m}$ ; septa and

- walls somewhat thickened but lumina not astrothelioid.....**Architrypethelium** p.p.
14. Ascospores when 3–5-septate very rarely exceeding 100 × 30 μm and if so, ascospores distinctly astrothelioid, with diamond-shaped lumina.....15
15. Ascospores astrothelioid, with diamond-shaped lumina.....16
15. Ascospores euseptate, with rather thin septa and more or less rectangular lumina.....17
16. Perithecia strongly prominent to sessile, completely exposed, pure black, somewhat egg-shaped.....**Nigrothelium**
16. Perithecia immersed to erumpent or aggregate in erumpent to sessile pseudostromata.....**Astrothelium** p.p.
17. Perithecia aggregate in prominent to sessile, brown-black pseudostromata; ascospores with thin septa and walls.....**Bathelium** p.p.
17. Perithecia solitary to pseudostromatic but pseudostromata not as above; ascospores with slightly thickened septa.....18
18. Perithecia immersed to erumpent or rarely indistinctly pseudostromatic; pigments mostly absent.....**Viridothelium** p.p.
18. Perithecia aggregate in distinct, prominent to sessile pseudostromata; internal and/or external pigments usually present.....**Trypethelium**
19. Ascospores with thin (eu-)septate and thin walls.....20
19. Ascospores with thickened (disto-)septate, in young stages often astrothelioid.....21
20. Perithecia aggregate in prominent to sessile, brown-black pseudostromata.....**Bathelium** p.p.
20. Perithecia dispersed and with whitish rim or in erumpent, whitish pseudostromata strongly contrasting with the blackish perithecia and the olive-brown thallus.....**Viridothelium** (incl. *Exsiliseptum*)
21. Perithecia in prominent to sessile warts covered by a thick layer of yellow-orange or red pigment.....**Marcelaria**
21. Perithecia immersed to erumpent, rarely prominent, usually covered by thallus, rarely with a thin layer of pigment pruina.....22
22. Perithecia aggregate in irregular, blackish pseudostromata; ascospores about 50 × 15 μm.....**Architrypethelium** (*murisporum*)
22. Perithecia and ascospores not in the above combination.....**Astrothelium** p.p.
23. Ascospores transversely septate.....24
23. Ascospores (sub-)muriform.....30
24. Ascospores with a basal euseptum and the basal cell pale, otherwise distoseptate and brown.....**Polyphyrenula** (*sexocularis*)
24. Ascospores with either eu- or distosepta.....25
25. Ascospores large, usually over 100 μm long.....26
25. Ascospores small, under 50 μm long.....27
26. Ascospores 3-septate, 25–50 μm broad, about 3–4 times as long as broad.....**Architrypethelium** p.p.
26. Ascospores 11–15-septate, 25–30 μm broad, about 4–5 times as long as broad...**Astrothelium** (*fuscosporum*)
27. Ascospores with strongly thickened distosepta.....28
27. Ascospores with thin eusepta.....29
28. Ascospores drop-shaped, macrocephalic, with strongly thickened terminal walls and two narrow, rectangular lumina near the center.....**Schummia** (*angulata*)
28. Ascospores ellipsoid, with irregular wall thickenings and halter-shaped to irregular lumina.....**Bogoriella** p.p.
29. Ascospores up to 20 × 8 μm, only in one species larger (up to 30 × 10 μm).....**Pseudobogoriella**
29. Ascospores 20–50 × 8–15 μm.....**Bogoriella** p.p.
30. Ascospores small, under 50 × 20 μm, often with irregularly thickened endospore and halter-shaped lumina...**Bogoriella** p.p.
30. Ascospores very large, 150–400 × 50–140 μm, with outer wall often breaking under pressure.....**Aptrophia**

#### Corrections for errors detected in previous synopsis of *Trypetheliaceae*

Given the large size of the previous synopsis of the *Trypetheliaceae* (Aptroot and Lücking 2016), unfortunate errors and omissions were almost inevitable. Corrections to most of these were already listed in Aptroot et al. (2019). A few more are reported and corrected below. When using the key, it should also be noted that additional species have been described in the meanwhile, particularly in *Astrothelium* but also in other genera.

Page 783, Table 1: for (*Astrothelium*) *subinterjectum*, replace +/+ with -/+ (lichexanthone on ascomata only).

Page 802, key couplet 24, first alternative, add: ascospores 48–65 × 17–20 μm.

Page 802, key couplet 24, second alternative, add: ascospores 62–80 × 20–25 μm.

Page 806, key couplet 21, first alternative: replace “Hamathecium interspersed” with “Lichexanthone on thallus only”.

Page 806, key couplet 21, second alternative: replace “Hamathecium clear” with “Lichexanthone on thallus and ascomata or on ascomata only”.

Page 808, key couplet 39, first alternative: replace “Thallus cracked” with “Thallus covered with yellow to orange pigment”.

Page 808, key couplet 39, second alternative: replace “Thallus not cracked” with “Thallus olive-green to brownish



yellow, lacking pigment, only pseudostromata covered with yellow to orange pigment”.

Page 857, left column, description of *Astrothelium defossum*: replace “8 per ascus” with “4 per ascus”.

Page 911, left column, description of *Bogoriella lateralis* (Sipman) Aptroot & Lücking comb. nov.: replace “Ascomata with apical ostioles” with “Ascomata with lateral ostioles”.

Page 916, right column, description of *Bogoriella triangularis* (Aptroot) Aptroot & Lücking comb. nov.: replace “Ascomata with apical ostioles” with “Ascomata with lateral ostioles”.

Page 961, right column, description of *Pseudopyrenula superans*: replace “Hamathecium inspersed” with “Hamathecium clear.”, “UV–” by “UV+ yellow”, and “no substances found” by “lichexanthone”.

### Economic and ecological significance

*Trypetheliaceae* is the second most diverse family of tropical crustose lichens, with over 400 species known and about 800 predicted (Aptroot et al. 2016). It is an important component of lichen communities particularly in wet and dry tropical forest and savanna ecosystems (Komposch and Hafellner 2000, 2003; Rivas Plata et al. 2008; Aptroot 2013; Menezes et al. 2018). There are no currently known uses of economic importance of *Trypetheliaceae*; the family is chemically comparatively simple, but with diverse anthraquinone and other pigments (Mathey 1979; Mathey et al. 1980; Aptroot and Lücking 2016). Some of these pigments appear to have potential pharmaceutical properties (Manojlovic et al. 2010; Sun et al. 2010; Takenaka et al. 2013; Elsebai et al. 2014; Basnet et al. 2019; Srinivasan et al. 2019). The copious red pigment of the ascomata of *Marcelaria purpurina*, collected during the 1899 expedition of Luigi Buscalioni (Sambo 1940; Daly and Millozza 2007), has apparently been used as dye by Amazonian indigenous tribes. Harris (1986) reported the use of the same species by the Bolivian Chácobo people as a treatment against headaches. Prance (1972) described the use of a pyrenocarpous lichen by the Denis tribe in Amazonian Brazil as ‘Badhu’, sniffed through the nose; this lichen may well represent a *Trypetheliaceae* but its exact affinity is unknown. *Trypetheliaceae* is one of four families that has been studied in detail regarding the latitudinal diversity gradient in lichens and the potential impact of climate change on lichen distribution ranges (Menezes et al. 2018).

### Tubeufiales Boonmee & K.D. Hyde.

*Index Fungorum number*: IF 550704; *Facesoffungi number*: FoF 00203.

Tubeufiales was established by Boonmee et al. (2014b) based on phylogenetic analyses and morphology. Liu et al.

(2017) treated *Bezerromycetaceae* and *Wiesneriomycetaceae* as families of Tubeufiales on the basis of divergence time estimates. The latest comprehensive revision on Tubeufiales was carried out by Lu et al. (2018b), who expanded the circumscription of the type family *Tubeufiaceae*, accepted 42 genera in this family, and revised the taxonomy of tubeufiaceous species. This revision, in particular, helped to highlight fungi which were misidentified and resolved which morphs are important in classifying species. Tubeufiaceous fungi have the potential to produce bioactive compounds (Ohtsu et al. 2003; Lu et al. 2018b; Fan et al. 2019). Fan et al. (2019) tested the antifungal and anticancer effects of 19 tubeufiaceous strains, and found that most of them showed obvious bioactivities. We introduce a new morphological record of *Tubeufia longiseta*. The divergence time for Tubeufiales is estimated as 234 MYA (stem age, Hongsanan et al. 2020).

*Accepted families*: *Bezerromycetaceae*, *Tubeufiaceae*, and *Wiesneriomycetaceae* (Fig. 82).

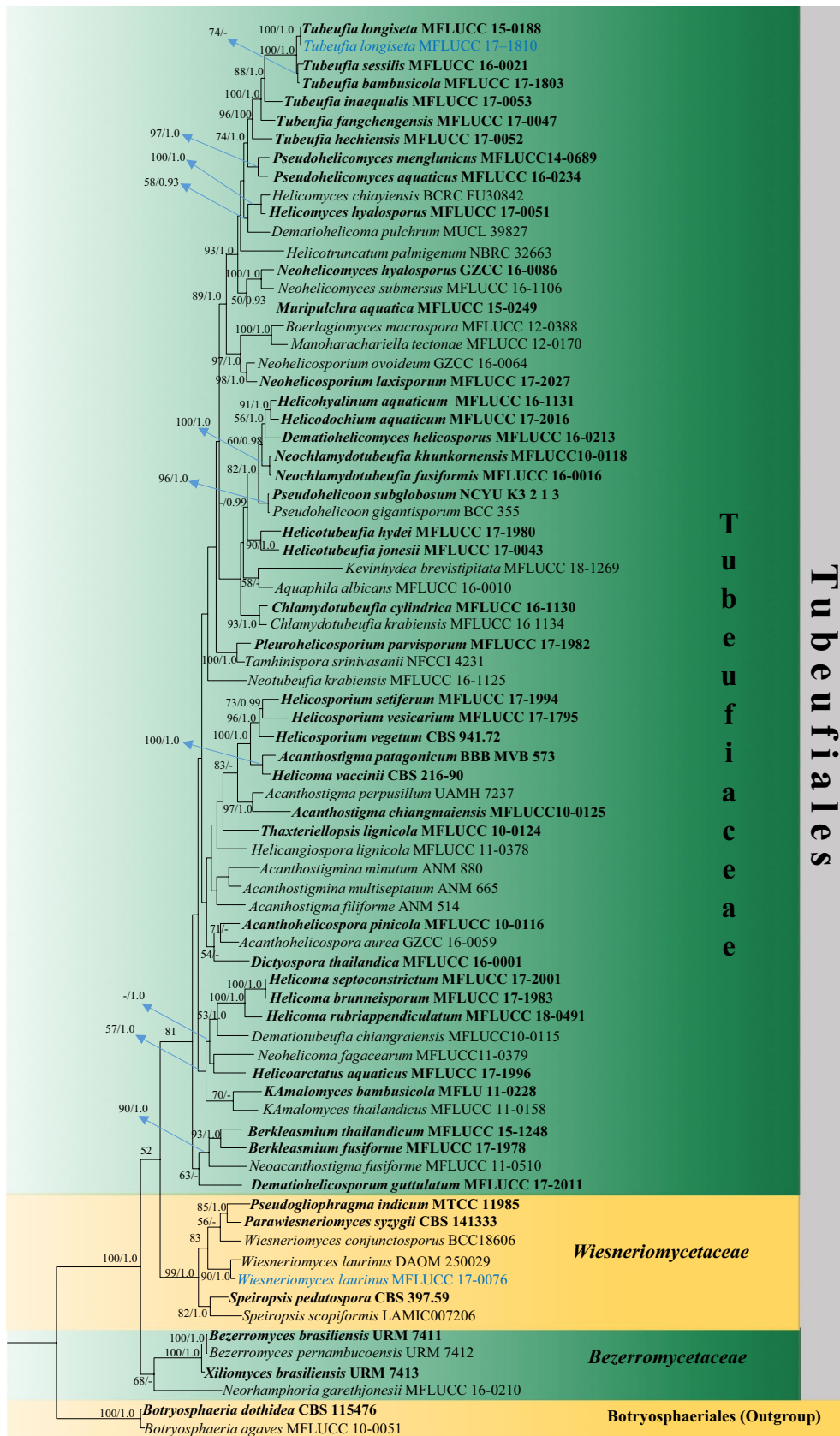
***Bezerromycetaceae*** J.D.P. Bezerra, Souza-Motta & Crous, Mycol. Progr. 16: 301 (2017).

*Index Fungorum*: IF 817521; *Facesoffungi number*: FoF 06809, 4 species.

*Saprobic* on dead wood in terrestrial habitats, or as endophytic fungi associated with cactus species in tropical dry forests. **Sexual morph**: *Ascomata* superficial or immersed in culture media, pseudothecial, unilocular, globose to subglobose, gregarious or solitary, pale brown to brown at maturity, minutely papillate with ostiole, collapsing cupulate or laterally, smooth or hairy. *Peridium* comprising pale brown cells of *textura angularis*, and small cells of *textura prismatica*. *Hamathecium* comprising numerous, filiform, septate, branched, hyaline pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical to cylindrical-clavate, short pedicellate, with or without a minute ocular chamber. *Ascospores* 1–2-seriate, ellipsoidal, hyaline when young, becoming pale brown to brown at maturity, muriformly septate, smooth or minutely verrucose. *Chlamydospores* sometimes linked to ascomata by hyphae, multi-septate, brown, dictyochlamydospore-like, globose to subglobose or ellipsoid to cylindrical. **Asexual morph**: Undetermined.

*Type*: ***Bezerromyces*** J.D.P. Bezerra, Souza-Motta & Crous

*Notes*: *Bezerromycetaceae* was introduced based on multi-gene phylogenetic analyses and morphological characteristics to accommodate the genera *Bezerromyces* and *Xiliomyces*. Liu et al. (2017) treated *Bezerromycetaceae* as a family of Tubeufiales by divergence time estimates. Lu et al.



◀**Fig. 82** Phylogram generated from maximum likelihood analysis (RAxML) of genera in Tubeufiales based on ITS, LSU, rpb-2 and tef1 sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Botryosphaeria agaves* (MFLUCC 10-0051) and *B. dothidea* (CBS 115476). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP

(2018b) transferred *Neorhamphoria* to *Bezerromycetaceae* based on phylogenetic and morphological evidence. Four species of *Bezerromycetaceae* are reported, *Bezerromyces brasiliensis*, *B. pernambucoensis*, *Neorhamphoria garethjonesii*, and *Xiliomyces rasiliensis*, and all have both morphology and DNA molecular data (Boonmee et al. 2016; Bezerra et al. 2017).

***Bezerromyces*** J.D.P. Bezerra, Souza-Motta & Crous, Mycol. Progr. 16: 301 (2017).

*Index Fungorum number*: IF 817522; *Facesoffungi number*: FoF 06810; 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Bezerromyces brasiliensis*** J.D.P. Bezerra, Souza-Motta & Crous, Mycol. Progr. 16: 302 (2017).

*Notes*: *Bezerromyces* was established based on the type species *B. brasiliensis* and a second species *B. pernambucoensis*. They are known only as endophytes associated with cactus species in tropical dry forests (Bezerra et al. 2017). Their ascomata are superficial or immersed in culture media, and sometimes there have multi-septate, brown chlamydo-spores linked to ascomata by hyphae (Bezerra et al. 2017).

***Bezerromyces brasiliensis*** J.D.P. Bezerra, Souza-Motta & Crous, in Bezerra et al., Mycol. Progr. 16(4): 302 (2016) [2017].

*Index Fungorum number*: IF 817523; *Facesoffungi number*: FoF 06810; Fig. 83

*Description*: see Bezerra et al. (2017).

*Material examined*: Brazil, Pernambuco, Catimbau National Park (8°36'35"S, 37°14'40"W), as endophyte from cactus *Tacinga inamoena*, September 2013, J.D.P. Bezerra (URM 89943, **holotype**).

#### Other genera included

***Neorhamphoria*** Boonmee, Hüseyin & Selçuk, Mycosphere 7(9): 1450 (2016).

*Index Fungorum number*: IF 552704; *Facesoffungi number*: FoF 02823; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Neorhamphoria garethjonesii*** Boonmee, Hüseyin & Selçuk, Mycosphere 7(9): 1451 (2016).

*Notes*: *Neorhamphoria* was introduced as a genus *incertae sedis* in Tubeufiales. Lu et al. (2018b) accepted it as a

member of *Bezerromycetaceae* based on phylogenetic and morphological evidence. *Neorhamphoria* is characterized by dark apothecial ascomata, broad cellular pseudoparaphyses, with bitunicate, broad-clavate asci, and hyaline, muriform ascospores.

***Xiliomyces*** J.D.P. Bezerra, Souza-Motta & Crous, Mycol. Progr. 16: 304 (2017).

*Index Fungorum number*: IF 817525; *Facesoffungi number*: FoF 06811; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Xiliomyces brasiliensis*** J.D.P. Bezerra, Souza-Motta & Crous, Mycol. Progr. 16: 304 (2017).

*Notes*: *Xiliomyces* was established mainly based on phylogenetic analyses. *Xiliomyces brasiliensis* was reported as an endophyte from cactus *Tacinga inamoena*, and its morphology is incomplete because it lacks well-defined sexual or asexual structures (Bezerra et al. 2017).

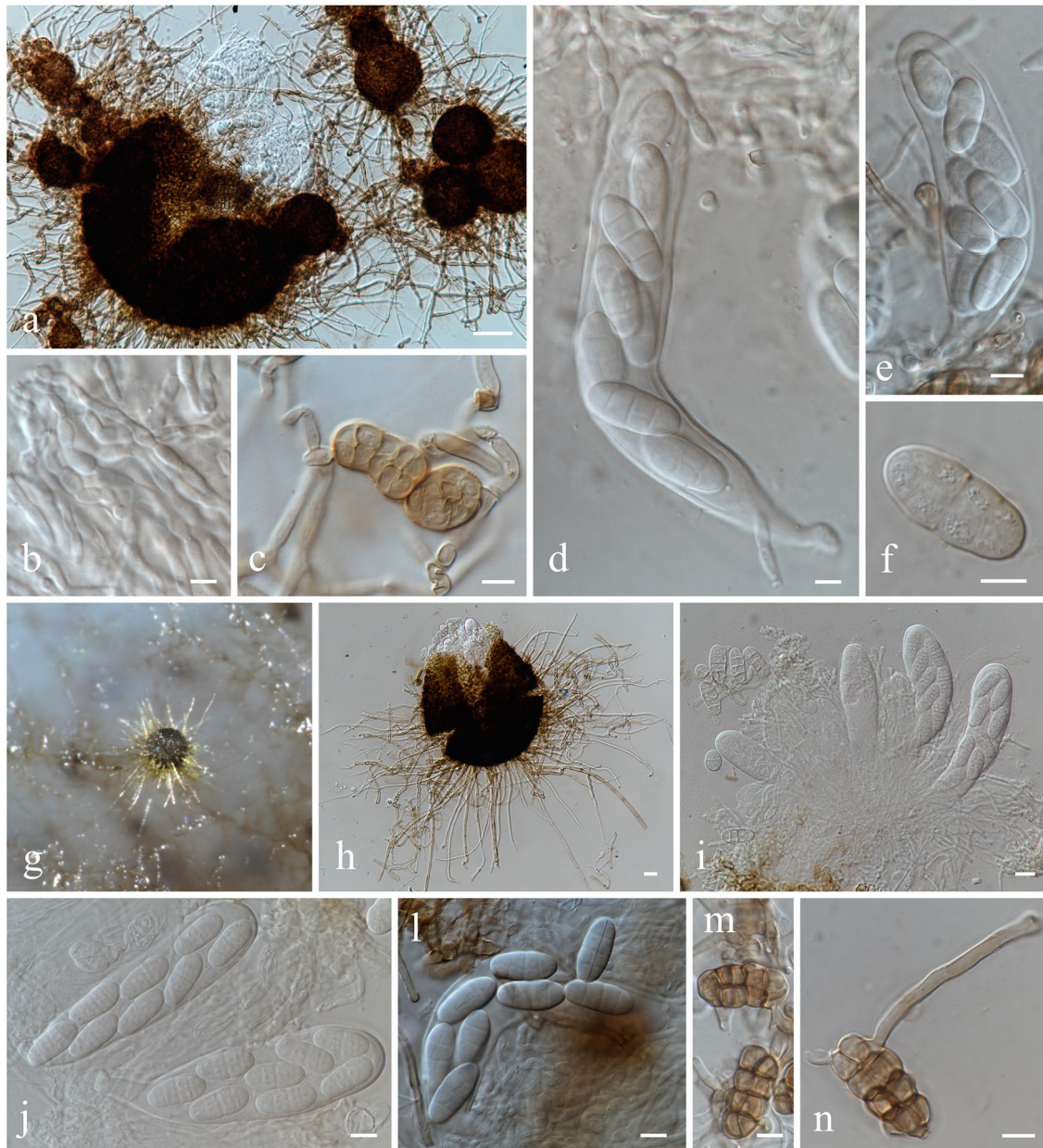
#### Economic and ecological significance

There is no report on their economic significance but they play roles in recycling organic matter.

***Tubeufiaceae*** M.E. Barr, Mycologia 71(5): 948 (1979).

*Index Fungorum*: IF 81599; *Facesoffungi number*: FoF 00204, 377 species.

*Saprobic* on decaying wood and leaves in terrestrial and/or aquatic habitats. **Sexual morph**: *Ascomata* superficial, seated on a subiculum, unilocular, globose-subglobose to obovate, solitary to gregarious, cream-white, yellow, pale brown, brown to black, ostiolate, with or without setae. *Peridium* composed of cells of *textura angularis*, thick-walled cells, yellow, pale brown, dark brown to black externally, with thin layers of *textura prismatica* inwardly, hyaline, yellow, pale brown to brown. *Hamathecium* comprising numerous filiform, septate, branched, sometimes anastomosing, hyaline pseudoparaphyses, embedded in a gelatinous matrix. *Asci* 8-spored, bitunicate, fissitunicate, saccate, cylindrical to clavate, sometimes broadly oblong-subclavate, with or without an apically rounded, distinct ocular chamber, with or without pedicel, smooth-walled. *Ascospores* 2–3-seriate to fasciculate, elongate, cylindrical, fusiform to filiform, tapering towards narrow ends, hyaline to pale brown, sometimes yellow, multi-septate, smooth-walled. **Asexual morph**: Hyphomycetous, 1) helicosporeous. *Colonies* on the substratum superficial, effuse, gregarious, white to pink, pale yellow to yellow green, pale brown to brown. *Mycelium* mostly immersed, partly superficial, composed of branched, septate hyphae, hyaline, pale brown to brown, with masses of crowded conidia. *Conidiophores* macronematous, mononematous, erect, cylindrical, branched or unbranched, hyaline, pale brown to dark brown, smooth-walled. *Conidiogenous cells* holoblastic, mono- to polyblastic, discrete



**Fig. 83** *Bezerromyces brasiliensis* (URM 89943, **holotype**). **a** Ascomata. **b** Pseudoparaphyses. **c** Chlamydospores. **d, e** Asci and ascospores. **f** Ascospore. *Bezerromyces pernambucoensis*. **g** Asco-

mata on culture medium. **h** Ascoma and ascospores. **i–l** Asci and ascospores. **m, n** Germinating ascospores. Scale bars: **a, h** = 25  $\mu\text{m}$ , **b–f, i–n** = 10  $\mu\text{m}$

or integrated, determinate or sympodial, terminal or intercalary, denticulate, arising laterally from the lower parts of conidiophores as tiny tooth-like protrusions or bladder-like protrusions, sometimes truncate at apex after conidial secession, hyaline to pale brown, smooth-walled. *Conidia* solitary, acrogenous, or pleurogenous, or acropleurogenous, helicoid, rounded at tip, hyaline to yellow green, yellow, pale brown to brown, multi-septate, guttulate, smooth-walled; 2) chlamydosporous. *Conidiophores* lacking. *Chlamydospores* holoblastic, broadly oval to ellipsoid, dictyoseptate, pale

brown when immature, darkened to black when matured, with terminal cells round and subhyaline; 3) phragmosporous. *Conidiophores* macronematous, mononematous, erect, arising as lateral branches from creeping hyphae, branched or unbranched, thin-walled and smooth, indistinctly septate, flexuous, hyaline. *Conidiogenous cells* holoblastic, mono- to polyblastic, sympodial, terminal or intercalary, cylindrical, with denticles, hyaline. *Conidia* solitary, acrogenous, fusiform to obclavate, slightly curved and acute at both ends,

hyaline, multi-septate, slightly constricted at the septa, guttulate, smooth-walled.

*Type: Tubeufia* Penz. & Sacc., *Malpighia* 11(11–12): 517 (1898) [1897].

*Notes: Tubeufiaceae* was introduced based on the generic type *Tubeufia* to accommodate bitunicate ascomycetes occurring as saprobes on decaying wood. Barr (1979a) accepted six genera in the family, while Rossman (1987) accepted 12 genera, Kirk et al. (2001) accepted 21 genera, Lumbsch and Huhndorf (2010) accepted 23 genera, and Boonmee et al. (2014b) accepted 19 genera. Brahamanage et al. (2017) introduced *Dictyospora*, Chaiwan et al. (2017) introduced *Neotubeufia*, Luo et al. (2017) introduced *Muripulchra* and *Neohelicomyces*, Liu et al. (2018) introduced *Helicotubeufia* and *Neohelicosporium* to this family based on morphology and phylogeny (Lu et al. (2018b) reappraised *Tubeufiaceae* and introduced 13 genera, and accepted 43 genera in this family based on phylogenetic analyses and morphological evidence. Liu et al. (2019) introduced *Kevinhydea* and Jayasiri et al. (2019) introduced *Discotubeufia* and Hyde et al. (2020b) introduced *Camporesiomyces*. Currently, *Tubeufiaceae* contains 46 genera (Lu et al. 2018b; Jayasiri et al. 2019; Liu et al. 2019).

Tubeufiaceous fungi are widespread distributed in tropical and temperate regions (Rossman 1987; Kirk et al. 2001; Lumbsch and Huhndorf 2010; Boonmee et al. 2014b; Luo et al. 2017; Lu et al. 2018a, b). Most species in this family are saprobic on terrestrial woody substrates and some are found on aquatic habitats (Barr 1979a, 1980; Rossman 1987; Kirk et al. 2001; Zhao et al. 2007; Lumbsch and Huhndorf 2010; Boonmee et al. 2011, 2014b; Hyde et al. 2016b; Doilom et al. 2017; Luo et al. 2017; Phookamsak et al. 2018). Interestingly, most asexual morphs of *Tubeufiaceae* were collected from freshwater habitats (Hyde et al. 2016b, 2017; Brahamanage et al. 2017; Chaiwan et al. 2017; Lu et al. 2017a, b, c, 2018a, b; Luo et al. 2017; Liu et al. 2018).

*Tubeufia* Penz. & Sacc., *Malpighia* 11(11–12): 517 (1898) [1897].

*Index Fungorum number:* IF 5635; *Facesoffungi number:* FoF 00063; 57 morphological species (Species Fungorum 2020), 38 species with molecular data.

*Notes: Tubeufia* is the type genus of *Tubeufiaceae*, established by Penzig and Saccardo (1897) based on the type species *T. javanica*. Boonmee et al. (2014b) designated the epitype of *T. javanica* with phylogenetic analyses. Lu et al. (2018b) reappraised the taxonomy of *Tubeufia* and introduced 18 species and six combinations in this genus based on phylogeny and morphology.

*Tubeufia longiseta* D.Q. Dai & K.D. Hyde, *Fungal Diversity* 82: 42 (2016).

*Index Fungorum:* IF 552029; *Facesoffungi number:* FoF 01985; Fig. 84

*Saprobic* on dead culms of bamboo in a forest. **Sexual morph:** *Ascomata* 230–350  $\mu\text{m}$  high  $\times$  170–220  $\mu\text{m}$  diam. superficial, gregarious, ellipsoidal, subglobose, setose, coriaceous, with a central ostiole, dark brown to black. *Ostiole* single, central. *Setae* 320–410  $\times$  3.5–4.5  $\mu\text{m}$ , dense, flexuous, covering the whole ascoma, unbranched, rounded at apical end, septate, dark brown. *Peridium* 25–45  $\mu\text{m}$  wide, composed cells of *textura angularis*, dark, with innermost part comprising thin layers of hyaline to pale brown cells of *textura subprismatica*. *Hamathecium* comprising numerous filiform, septate, branched, cellular pseudoparaphyses. *Asci* 130–160  $\times$  13–18  $\mu\text{m}$  ( $\bar{x}$  = 150  $\times$  15  $\mu\text{m}$ ,  $n$  = 20), 8-spored, bitunicate, cylindrical, rounded at apex, with an ocular chamber, thick-walled, short-pedicellate. *Ascospores* 55–75  $\times$  4.5–6  $\mu\text{m}$  ( $\bar{x}$  = 65  $\times$  5.3  $\mu\text{m}$ ,  $n$  = 50), 2–3-seriate, broad fusiform, cylindrical to long subfusiform, elongate, slightly curved, tapering towards rounded ends, hyaline, 13–17-septate, guttulate. **Asexual morph:** undetermined.

*Culture characteristics:* *Ascospores* germinating on water agar and germ tubes produced from ascospores within 12 hours. *Colonies* growing on PDA, circular, with flat surface, edge undulate, reaching 11 mm in two weeks at 28 °C, brown to dark brown. *Mycelium* superficial and partially immersed, branched, septate, hyaline to pale brown, smooth.

*Material examined:* Thailand, Chiang Rai, Mae Fah Luang University, on dead culms of bamboo, 19 February 2017, Yong-Zhong Lu, MFU01 (MFLU 17-1119, HKAS 100789); living culture, MFLUCC 17-1810.

*GenBank numbers:* ITS: MW136949, TEF1: MW147764, RPB2:MW147765.

*Notes:* Morphologically, our new collection resembles *Tubeufia longiseta* in ascomata, asci, and ascospores (Dai et al. 2017). Although the ascospores of our new collection are longer than the holotype of *T. longiseta* (55–75 vs. 38.5–55.5  $\mu\text{m}$ ), we identify them as the same species as there is only a single base pair difference in the ITS sequence data. We provide LSU, rpb-2 and tef1- $\alpha$  sequence data in this study, but we could not compare them to the holotype of *T. longiseta* as it has only ITS sequence data available (Dai et al. 2017).

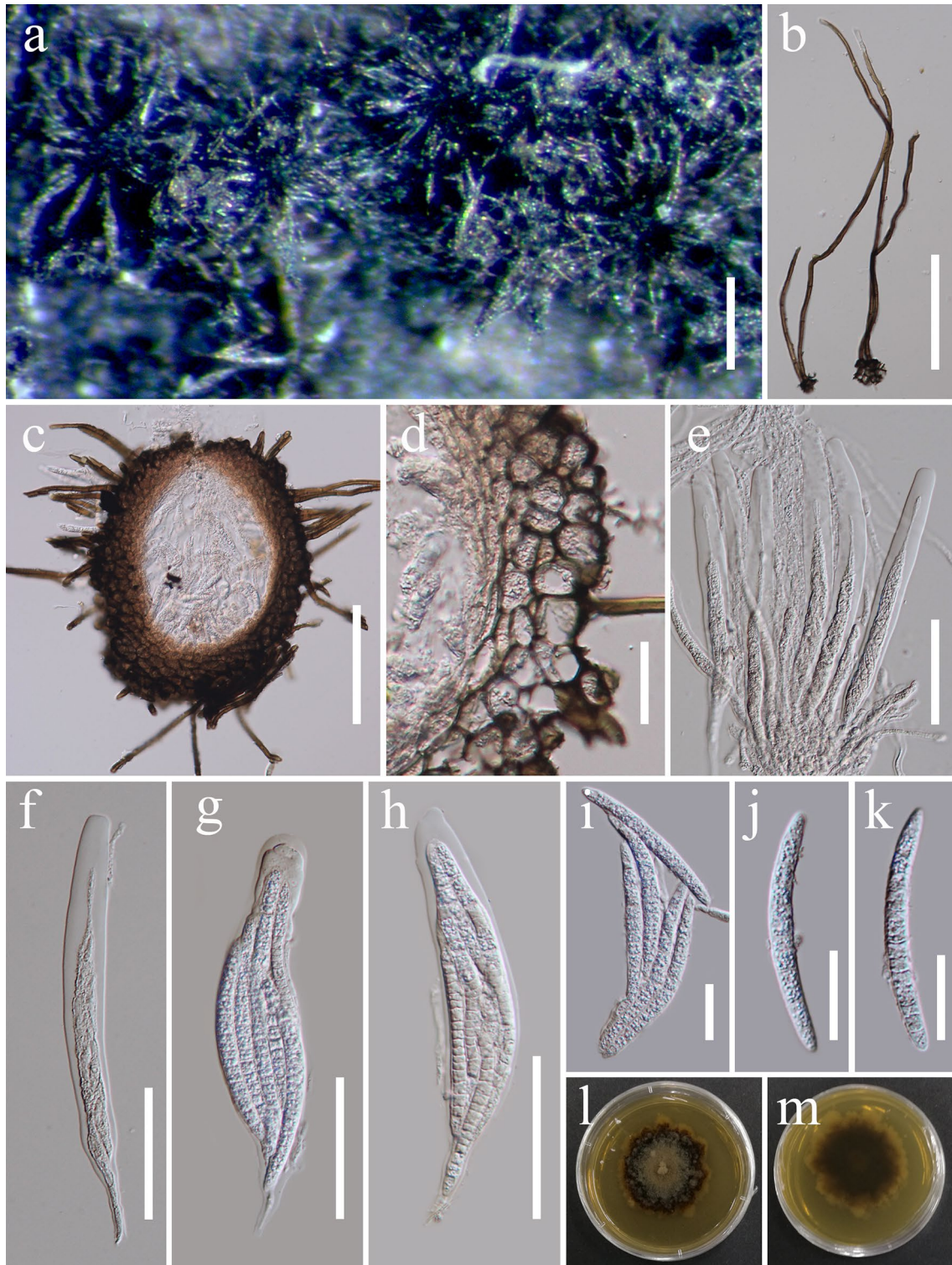
#### Other genera included

*Acanthohelicospora* Boonmee & K.D. Hyde, *Fungal Diversity* 68(1): 251 (2014).

*Index Fungorum number:* IF 550572; *Facesoffungi number:* FoF 00206; – 4 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species: Acanthohelicospora pinicola* Boonmee & K.D. Hyde, *Fungal Diversity* 68(1): 251 (2014).

*Notes: Acanthohelicospora* was introduced based on morphological and phylogenetic evidence. Its sexual morph



**Fig. 84** *Tubeufia longiseta* (MFLU 17-1119). **a** Superficial ascomata on substrate. Note ascomata surrounded by black setae. **b** Setae. **c** Ascoma. **d** Peridium. **e–h** Asci. **i–k** Ascospores. **l, m** Colonies on

PDA from above and below. Scale bars: **a, d, i–k** = 200  $\mu\text{m}$ , **b, c** = 100  $\mu\text{m}$ , **e–h** = 50  $\mu\text{m}$

is characterized by superficial ascomata covered by setae which taper to an acute apex, 8-spored, bitunicate asci and slightly curved, fusiform ascospores, which taper towards rounded ends (Boonmee et al. 2014b; Lu et al. 2018b). Its asexual morph is characterized by helicosporous hyphomycetous, which are similar to *Helicosporium* in conidiophores, conidiogenous cells and conidial morphology (Lu et al. 2017a, 2018b). Four species are accommodated in this genus, *A. aurea*, *A. guianensis*, *A. pinicola*, and *A. scopula* (Lu et al. 2018b).

***Acanthophiobolus*** Berl., Atti Congr. Bot. Intern. di Genova, 1892: 571 (1893).

*Index Fungorum number*: IF 13; *Facesoffungi number*: FoF 06812; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Acanthophiobolus helicosporus*** (Berk. & Broome) J. Walker, Trans. Br. mycol. Soc. 58(3): 445 (1972).

≡ *Sphaeria helicospora* Berk. & Broome, Ann. Mag. nat. Hist., Ser. 2 9: 383 (1852).

*Notes*: *Acanthophiobolus* was introduced with *A. helicosporus* as the type species (Berlese 1893, as *A. helminthosporus*). Boonmee et al. (2011) reexamined the holotype of *A. helicosporus* and accepted *Acanthophiobolus* as a member of *Tubeufiaceae*. The ascomata of *Acanthophiobolus* are globose to subglobose, reddish brown to dark brown, with much longer red brown to dark brown setae, and asci are elongate-cylindrical with long filiform ascospores (Boonmee et al. 2011, 2014). Lu et al. (2018b) listed three species, *A. anogeissi*, *A. helicosporus*, and *A. indicus*.

***Acanthostigma*** De Not., Hedwigia 4: 28 [1865].

*Index Fungorum number*: IF 16; *Facesoffungi number*: FoF 06813; – 41 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Acanthostigma perpusillum*** De Not., Hedwigia 4: 28 [1865].

*Notes*: Réblová and Barr (2000) reviewed *Acanthostigma* and six species were accepted. Boonmee et al. (2011) introduced *A. Chiangmaiensis* based on phylogenetic analyses and morphology. Boonmee et al. (2014b) accepted only *A. perpusillum*, *A. Chiangmaiensis*, and *A. minutum* within *Acanthostigma*, but did not change the status of other *Acanthostigma* species. The ascomata of *Acanthostigma* are globose to subglobose, dark brown to black and covered by dark setae, asci are clavate with a short pedicel, and ascospores are broadly fusiform to clavate, with one of the middle cells often broader than others (Boonmee et al. 2011, 2014). Lu et al. (2018b) accepted seven species, *A. Chiangmaiensis*, *A. ellisii*, *A. longisporum*, *A. minutum*, *A. Patagonicum*, *A. perpusillum*, and *A. revocatum*.

***Acanthostigmia*** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1499 (1909).

*Index Fungorum number*: IF 19; *Facesoffungi number*: FoF 06814; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Acanthostigmia minuta*** (Fuckel) Clem. & Shear, Gen. fung., Edn 2 (Minneapolis): 270 (1931).

≡ *Lasiosphaeria minuta* Fuckel, Jb. Nassau. Ver. Naturk. 23–24: 148 (1870) [1869–70].

*Notes*: Boonmee et al. (2014b) reported that *A. minuta* (ANM810, ANM818 and ANM238) is related to two strains of *A. multiseptatum* (ANM475 and ANM665) which represented *Acanthostigmia*. The ascomata of *Acanthostigmia* are globose to subglobose, dark brown, and covered by sparse dark brown to black setae, and asci are broadly cylindrical-subclavate with curved fusiform ascospores (Boonmee et al. 2014b). Lu et al. (2018b) accepted two species, *A. minuta* and *A. multiseptatum*.

***Acanthotubeufia*** Y.Z. Lu & K.D. Hyde, Fungal Diversity 92: 146 (2018).

*Index Fungorum number*: IF 554812; *Facesoffungi number*: FoF 04696; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Acanthotubeufia filiforme*** (Promp. & A.N. Mill.) Y.Z. Lu & K.D. Hyde, Fungal Diversity 92: 146 (2018).

≡ *Acanthostigma filiforme* Promp. & A.N. Mill., Mycologia 102(3): 575 (2010).

*Notes*: *Acanthotubeufia* was introduced based on morphological and phylogenetic analyses. Its morphology is similar to *Neoacanthostigma* and *Acanthostigma* with one-celled or rarely one-septate setae covering the globose to subglobose ascomata, but differs by its longer, narrower and symmetrical filiform ascospores (Promputtha and Miller 2010, as *Acanthostigma filiforme*; Lu et al. 2018b).

***Aquaphila*** Goh, K.D. Hyde & W.H. Ho, Mycol. Res. 102(5): 588 (1998).

*Index Fungorum number*: IF 27791; *Facesoffungi number*: FoF 02356; – 2 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Aquaphila albicans*** Goh, K.D. Hyde & W.H. Ho, Mycol. Res. 102(5): 588 (1998).

*Notes*: Castañeda-Ruiz et al. (2000) introduced *A. edentata* based on morphology. Tsui et al. (2007) accepted *Aquaphila* as a member of *Tubeufiaceae* based on phylogenetic analyses. Boonmee et al. (2014b) linked its sexual-asexual morphs based on phylogenetic evidence. The sexual morph of *Aquaphila* is characterized by dark globose to subglobose ascomata covered by brown setae, and cylindrical-clavate asci with fusiform ascospores (Boonmee et al. 2014b). Its asexual morphs are hyaline flexuous to geniculate

conidiophores with hyaline fusoid to falcate or sigmoid conidia (Goh et al. 1998a; Boonmee et al. 2014b; Hyde et al. 2016b). Hyde et al. (2016b) reported a new record of *A. albicans* associated with submerged wood in southern Thailand.

**Artocarpomyces** Subram., Kavaka 22/23: 52 (1996) [1994].

*Index Fungorum number*: IF 28736; *Facesoffungi number*: FoF 06815; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: **Artocarpomyces paradoxus** Subram. [as ‘paradoxa’], Kavaka 22/23: 52 (1996) [1994].

*Notes*: *Artocarpomyces* is characterized by macronematous conidiophores arising from a brown pseudoparenchymatous stroma, and conidia are muriform, irregular and resembling the fruit of *Artocarpus* (Subramanian 1994). Lu et al. (2018b) accepted *Artocarpomyces* as a genus of *Tubeufiaceae* based on morphological evidence.

**Berkleasium** Zobel, Icon. fung. (Prague) 6: 4 (1854).

*Index Fungorum number*: IF 7362; *Facesoffungi number*: FoF 01879; – 44 morphological species (Species Fungorum 2020), 7 species with molecular data.

*Type species*: **Berkleasium concinnum** (Berk.) S. Hughes, Canad. J. Bot. 36: 740 (1958).

≡ *Sporidesmium concinnum* Berk., London J. Bot. 4: 309 (1845).

*Notes*: Tanney and Miller (2017) accepted *Berkleasium* within *Tubeufiaceae*, and reported that the type species *B. concinnum*, is the asexual morph of *Neoacanthostigma septoconstrictum* based on phylogenetic analyses. Lu et al. (2018b) accepted seven *Berkleasium* species within *Tubeufiaceae* based on phylogenetic and morphological evidence. *Berkleasium* is characterized by superficial ascomata with dark brown to black multi-celled setae, and cylindrical asci with slightly curved fusiform ascospores (Tanney and Miller 2017; Lu et al. 2018b). Its asexual morphs comprise dictyosporous and helicosporous hyphomycetes (Tanney and Miller 2017; Lu et al. 2018b).

**Bifrontia** Norman, Bot. Notiser: 18 (1872).

*Index Fungorum number*: IF 569; *Facesoffungi number*: FoF 00175; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Bifrontia compactior** Norman, Bot. Notiser: 19 (1872).

*Notes*: Boonmee et al. (2014b) reexamined the holotype of *B. compactior* and accepted *Bifrontia* as a genus of *Tubeufiaceae*. The ascomata of *Bifrontia* are globose to subglobose, collapsing when mature or dried, and asci are fusiform with straight to slightly curved fusiform ascospores (Boonmee et al. 2014b).

**Boerlagiomyces** Butzin, Willdenowia 8(1): 39 (1977).

*Index Fungorum number*: IF 607; *Facesoffungi number*: FoF 00176; – 8 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Boerlagiomyces velutinus** (Penz. & Sacc.) Butzin, Willdenowia 8(1): 39 (1977).

≡ *Boerlagella velutina* Penz. & Sacc., Malpighia 11(9–10): 404 (1897).

*Notes*: Crane et al. (1998) reviewed and accepted six *Boerlagiomyces* species in *Tubeufiaceae*. The ascomata of *Boerlagiomyces* are globose and covered with flexuous and hairy black velvety setae, and asci are cylindrical-clavate with hyaline muriform ascospores (Boonmee et al. 2014b). Lu et al. (2018b) listed eight species in this genus.

**Camporesiomyces** D.P. Wanas. & K.D. Hyde, Fungal Diversity 100: 139 (2020).

*Index Fungorum number*: IF 557070; *Facesoffungi number*: FoF 07074; – 3 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: **Camporesiomyces mali** D.P. Wei & K.D. Hyde, Fungal Diversity 100: 139 (2020).

*Notes*: *Camporesiomyces* was introduced based on morphological and phylogenetic analyses. The type species of *Camporesiomyces* is distinguished from other members in *Tubeufiaceae* by multi-loculate ascomata (Hyde et al. 2020b). *Acanthostigma patagonicum* and *Helicoma vaccinii* were transferred to *Camporesiomyces patagonicus* and *C. vaccinii* based on phylogenetic evidence, respectively (Hyde et al. 2020b).

**Chaetosphaerulina** I. Hino, Bull. Miyazaki Coll. Agric. Forest. 10: 62 (1938).

*Index Fungorum number*: IF 971; *Facesoffungi number*: FoF 06816; – 6 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Chaetosphaerulina yasudae** I. Hino, Canad. J. Plant Sci. 10: 62 (1938).

*Notes*: Pirozynski (1972) transferred *C. yasudae* and *C. vermicularispora* to *Herpotrichia*. Sivanesan (1984) transferred these two species to *Tubeufia*. Crane (1998) transferred *Thaxteriellopsis bambusicola* and *T. lignicola* to *Chaetosphaerulina*. Boonmee et al. (2011) accepted Crane’s evaluation for *Thaxteriellopsis bambusicola* but reinstated *T. lignicola* as the type species of *Thaxteriellopsis*. Boonmee et al. (2014b) excluded *Chaetosphaerulina* from *Tubeufiaceae*. Lu et al. (2018b) accepted *Chaetosphaerulina* as a member of *Tubeufiaceae* based on morphological evidence. The ascomata of *Chaetosphaerulina* are ovoid to ellipsoid and covered with hairy setae, asci are cylindrical and slightly truncate at apex, with curved hyaline fusiform ascospores which are constricted at the median (Boonmee et al. 2011).



***Chlamydotubeufia*** Boonmee & K.D. Hyde, Fungal Diversity 51(1): 78 (2011).

*Index Fungorum number*: IF 563500; *Facesoffungi number*: FoF 02357; – 5 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species*: ***Chlamydotubeufia huaikangplaensis*** Boonmee & K.D. Hyde, Fungal Diversity 51(1): 78 (2020).

*Notes*: Lu et al. (2018b) accepted five species in *Chlamydotubeufia* and excluded three species from this genus based on phylogenetic inference. The sexual morph of *Chlamydotubeufia* is characterized by globose to subglobose ascomata covered with dark brown to black setae, and cylindrical to clavate asci with straight to slightly curved fusiform ascospores (Boonmee et al. 2011; Lu et al. 2018b). Its asexual morphs are mostly chlamydosporous and rarely helicosporous hyphomycetous (Lu et al. 2018b).

***Dematiohellicoma*** Y.Z. Lu, J.C. Kang & K.D. Hyde, Fungal Diversity 92: 157 (2018).

*Index Fungorum number*: IF 554821; *Facesoffungi number*: FoF 04700; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Dematiohellicoma pulchrum*** (R.F. Castañeda & Guarro) Y.Z. Lu & K.D. Hyde, Fungal Diversity 92: 158 (2018).

≡ *Helicoma pulchrum* R.F. Castañeda & Guarro [as ‘pulchra’], in Castañeda Ruíz, Kendrick, Guarro & Mayayo, Mycol. Res. 102(1): 58 (1998).

*Notes*: *Dematiohellicoma* was introduced based on morphological and phylogenetic analyses. The conidia of *Dematiohellicoma* are characterized by hyaline or subhyaline basal cells, tapering gradually towards a truncated base, while the remaining cells are reddish brown, and their conidial septa are dark brown and obviously darker than the adjacent parts (Lu et al. 2018b).

***Dematiohellicomyces*** Y.Z. Lu, Boonmee & K.D. Hyde, Fungal Diversity 92: 159 (2018).

*Index Fungorum number*: IF 554824; *Facesoffungi number*: FoF 04701; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Dematiohellicomyces helicosporus*** (Boonmee, Y.Z. Lu & K.D. Hyde) Y.Z. Lu, Fungal Diversity 92: 159 (2018).

≡ *Chlamydotubeufia helicospora* Boonmee, Y.Z. Lu & K.D. Hyde, in Hyde et al., Fungal Diversity 80:123 (2016).

*Notes*: *Dematiohellicomyces* was introduced based on morphological and phylogenetic analyses. *Dematiohellicomyces* resembles *Helicomyces* in having short conidiophores that are 0–3-septate, and helicoid conidia, having a spatulate basal end cell, but can be distinguished by its brown conidiophores (Lu et al. 2018b).

***Dematiohelicosporum*** Y.Z. Lu, J.K. Liu & K.D. Hyde, Fungal Diversity 92: 159 (2018).

*Index Fungorum number*: IF 554826; *Facesoffungi number*: FoF 04703; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Dematiohelicosporum guttulatatum*** Y.Z. Lu, J.K. Liu & K.D. Hyde, Fungal Diversity 92: 160 (2018).

*Notes*: *Dematiohelicosporum* was introduced based on morphological and phylogenetic analyses. Conidia of *Dematiohelicosporum* are slightly circinate in three dimensions, clearly verrucose and guttulate, olivaceous to brown (Lu et al. 2018b).

***Dematiotubeufia*** Y.Z. Lu, Boonmee & K.D. Hyde, Fungal Diversity 92: 160 (2018).

*Index Fungorum number*: IF 554828; *Facesoffungi number*: FoF 04705; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Dematiotubeufia chiangraiensis*** (Boonmee & K.D. Hyde) Y.Z. Lu, Fungal Diversity 92: 162 (2018).

≡ *Helicoma chiangraiense* Boonmee & K.D. Hyde, in Boonmee, Rossman, Liu, Crous, Bhat, Chukeatirote, Jones & Hyde, Fungal Diversity 68: 271 (2014).

*Notes*: *Dematiotubeufia* was introduced based on morphology and phylogenetic analysis. It is characterized by dark brown to black, shiny ascomata with distinct ostioles, and cylindrical asci with straight to slightly curved fusiform ascospores (Boonmee et al. 2014b, as *Helicoma chiangraiense*; Lu et al. 2018b).

***Dictyospora*** Brahaman., Y.Z. Lu, Boonmee & K.D. Hyde, Mycosphere 8(7): 924 (2017).

*Index Fungorum number*: IF 553178; *Facesoffungi number*: FoF 03262; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Dictyospora thailandica*** Brahaman., Y.Z. Lu, Boonmee & K.D. Hyde, Mycosphere 8(7): 924 (2017).

*Notes*: Lu et al. (2018b) described a new record of *D. thailandica* bearing some peculiar morphological characteristics, and pointed out that *Dictyospora* resembles *Chlamydotubeufia* in both asexual and sexual morphs, but phylogenetic analyses indicated that they are distinct genera.

***Discotubeufia*** Jayasiri, E.B.G. Jones & K.D. Hyde, Mycosphere 10(1): 156 (2019).

*Index Fungorum number*: IF 555585; *Facesoffungi number*: FoF 05300; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Discotubeufia browneae*** Jayasiri, E.B.G. Jones & K.D. Hyde, Mycosphere 10(1): 158 (2019).

*Notes*: *Discotubeufia* is characterized by cup-shaped, erumpent to superficial, light brown to dark, setiferous

ascomata and cylindrical to sub cylindrical asci (Jayasiri et al. 2019).

***Helicangiospora*** Boonmee, Bhat & K.D. Hyde, Fungal Diversity 68(1): 259 (2014).

*Index Fungorum number*: IF 550574; *Facesoffungi number*: FoF 00210; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Helicangiospora lignicola*** Boonmee, Bhat & K.D. Hyde, Fungal Diversity 68(1): 262 (2014).

*Notes*: *Helicangiospora* helicoma-like asexual morph was found from the culture of sexual morph specimen (Boonmee et al. 2014b).

***Helicoarctatus*** Y.Z. Lu, J.C. Kang & K.D. Hyde, Fungal Diversity 92: 165 (2018).

*Index Fungorum number*: IF 554830; *Facesoffungi number*: FoF 04707; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Helicoarctatus aquaticus*** Y.Z. Lu, J.C. Kang & K.D. Hyde, Fungal Diversity 92: 166 (2018).

*Notes*: *Helicoarctatus* shares similar morphology with *Helicosporium* by setiform conidiophores, and discrete, tooth-like protrusions conidiogenous cells arising laterally from lower portion of the conidiophores, with each bearing 1–2 tiny sporogenous conidiogenous loci (Lu et al. 2018b).

***Helicodochium*** J.S. Monteiro, R.F. Castañeda, A.C. Cruz & Gusmão, Mycotaxon 127: 6 (2014).

*Index Fungorum number*: IF 804995; *Facesoffungi number*: FoF 04709; – 2 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Helicodochium amazonicum*** J.S. Monteiro, R.F. Castañeda, A.C. Cruz & Gusmão, Mycotaxon 127: 6 (2014).

*Notes*: Lu et al. (2018b) accepted *Helicodochium* as a genus of *Tubeufiaceae* based on morphological and phylogenetic evidence. *Helicodochium* is characterized by sporodochial conidiomata, macronematous branched conidiophores, and conidiogenous cells that produce helicoids, multi-septate, smooth and hyaline conidia (Monteiro et al. 2014; Lu et al. 2018b).

***Helicohyalinum*** Y.Z. Lu, J.K. Liu & K.D. Hyde, Fungal Diversity 92: 168 (2018).

*Index Fungorum number*: IF 554833; *Facesoffungi number*: FoF 04710; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Helicohyalinum infundibulum*** Y.Z. Lu, J.K. Liu & K.D. Hyde, Fungal Diversity 92: 170 (2018).

*Notes*: *Helicohyalinum* is characterized by flexuous, cylindrical, 0–3-septate, hyaline conidiophores with the

terminal conidiogenous cells tapering towards apex, having an inverted funnel shape at apex (Lu et al. 2018b).

***Helicoma*** Corda, Icon. fung. (Prague) 1: 15 (1837).

*Index Fungorum number*: IF 8473; *Facesoffungi number*: FoF 00211; – 64 morphological species (Species Fungorum 2020), 22 species with molecular data.

*Type species*: ***Helicoma muelleri*** Corda, Icon. fung. (Prague) 1: 15 (1837).

*Notes*: Goos (1986) reviewed the status of *Helicoma* species. Lu et al. (2018b) introduced ten new *Helicoma* species, and redefined the morphological concept of *Helicoma* to include two additional asexual morphs, one is the typical-helicoma morphology with conidia that are acrogenous or acropleurogenous, helicoid, circinate, dry, tapering towards apex, truncate at the base, coiled 1¼–1¾ times, not becoming loose in water. Another one is characterized by conidiogenous cells that are intercalary, cylindrical, with denticles, arising laterally from the lower portion of conidiophores as tooth-like protrusions, and conidia are pleurogenous, helicoid, hygroscopic, tapering towards apex and rounded at tip, coiled 1½–5 times, becoming loosely coiled in water (Lu et al. 2018b). Lu et al. (2018b) accepted 57 species within *Helicoma*, and excluded twelve species from this genus. Liu et al. (2019) reported a new species, *H. hydei*, from decaying wood in Thailand.

***Helicomycetes*** Link, Mag. Gesell. naturf. Freunde, Berlin 3(1–2): 21 (1809).

*Index Fungorum number*: IF 8476; *Facesoffungi number*: FoF 00212; – 17 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species*: ***Helicomycetes roseus*** Link, Mag. Gesell. naturf. Freunde, Berlin. 3: 21 (1809).

*Notes*: Linder (1929) redefined this genus, and many of the species originally assigned to *Helicomycetes* were reassigned to *Helicosporium* or *Helicoma*. Moore (1955) provided a key for all known *Helicomycetes* species. Goos (1985) reviewed the taxonomic status of *Helicomycetes*, provided updated descriptions and a key to accepted species. Lu et al. (2018b) pointed out the confusion of *Helicomycetes* and reappraised its taxonomy and phylogeny. Twelve species were accepted in *Helicomycetes* and four species were excluded (Lu et al. 2018b). *Helicomycetes* is characterized by conidiophores that are 0–3-septate, arising as lateral branches from creeping hyphae, conidiogenous cells are integrated, sympodial and truncate at apex after conidial secession, and conidia are acrogenous or acropleurogenous, helicoid and rounded at tip (Link 1809; Linder 1929; Moore 1955; Goos 1985; Lu et al. 2018b).

***Helicosporium*** Nees, Syst. Pilze (Würzburg): 68 (1817) – 13 species (Lu et al. 2018b).

*Index Fungorum number*: IF 8484; *Facesoffungi number*: FoF 00213; – 20 morphological species (Species Fungorum 2020), 8 species with molecular data.

*Type species*: *Helicosporium vegetum* Nees, Syst. Pilze (Würzburg): 68 (1817).

*Notes*: Linder (1929) redefined the generic concept of *Helicosporium*. Goos (1989) reviewed the status of *Helicosporium* species and redefined the generic concept including species with hyaline conidia whose filaments do not exceed 3 µm diam. Lu et al. (2018b) reviewed all *Helicosporium* species, redefined the generic concept, and accepted 13 species and excluded 25 species from this genus.

***Helicotruncatum*** Y.Z. Lu, J.C. Kang & K.D. Hyde, Fungal Diversity 92: 220 (2018).

*Index Fungorum number*: IF 554859; *Facesoffungi number*: FoF 04730; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: *Helicotruncatum palmigenum* (Penz. & Sacc.) Y.Z. Lu & K.D. Hyde, Fungal Diversity 92: 220 (2018).

≡ *Helicosporium intermedium* var. *palmigenum* Penz. & Sacc., Malpighia 15(7–9): 249 (1902) [1901].

*Notes*: *Helicotruncatum* was established based on morphological and phylogenetic evidence. *Helicotruncatum* is characterized by the lateral cell wall of the conidiophore and by the basal cells of conidia distinctively thickened (Lu et al. 2018b).

***Helicotubeufia*** Y.Z. Lu & J.K. Liu, Mycosphere 9(3): 500 (2018).

*Index Fungorum number*: IF 554759; *Facesoffungi number*: FoF 04385; – 3 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: *Helicotubeufia guangxiensis* Y.Z. Lu & J.K. Liu, Mycosphere 9(3): 500 (2018).

*Notes*: *Helicotubeufia* was introduced based on phylogenetic and morphological evidence to accommodate three species, the type species *H. guangxiensis*, *H. hydei*, and *H. jonesii*. *Helicotubeufia* is characterized by subglobose to ellipsoidal-ovate, dark brown to black ascospores, and cylindrical asci with hyaline fusiform, slightly curved ascospores, and hyphomycetous helicosporous asexual morphs (Liu et al. 2018).

***Kamalomyces*** R.K. Verma, N. Sharma & Soni, Forest Fungi of Central India: 196 (2008).

*Index Fungorum number*: IF 512509; *Facesoffungi number*: FoF 06817; – 6 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: *Kamalomyces indicus* R.K. Verma, N. Sharma & Soni, Forest Fungi of Central India: 196 (2008).

*Notes*: Phookamsak et al. (2018) reported the phylogenetic relationship of *Kamalomyces* and first described its asexual morph. *Kamalomyces* is characterized by subglobose to lemoniform ascospores with short stalks on a subiculum of black hyphae, and broadly cylindrical to clavate asci with crowded, hyaline vermiform and septate ascospores (Verma et al. 2008; Phookamsak et al. 2018). Six *Kamalomyces* species are accepted, *K. bambusicola*, *K. indicus*, *K. mahabaleshwariensis*, *K. mangrovei*, *K. polyseptatus* and *K. thailandicus* (Lu et al. 2018b, Hyde et al. 2019).

***Kevinhydea*** N.G. Liu, Y.Z. Lu & J.K. Liu, Mycol. Prog. 18: 675 (2019).

*Index Fungorum number*: IF 555352; *Facesoffungi number*: FoF 04875; – 1 morphological species (Liu et al. 2019), 1 species with molecular data.

*Type species*: *Kevinhydea brevistipitata* N.G. Liu, Y.Z. Lu & J.K. Liu, Mycol. Prog. 18: 677 (2019).

*Notes*: *Kevinhydea* was introduced based on phylogenetic and morphological evidence. *Kevinhydea* is characterized by dictyosporous asexual morph and has short conidiophores which differentiate it from *Chlamydotubeufia*, *Dictyospora*, *Tamhinispora*, and *Tubeufia*, genera that lack conidiophores (Liu et al. 2019).

***Manoharachiella*** Bagyan., N.K. Rao & Kunwar, Mycotaxon 109: 301 (2009).

*Index Fungorum number*: IF 512919; *Facesoffungi number*: FoF 07530; – 4 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: *Manoharachiella lignicola* Bagyan., N.K. Rao & Kunwar, Mycotaxon 109: 302 (2009).

*Notes*: Rajeshkumar and Singh (2012) introduced *Manoharachiella indica* and Selcuk and Ekici (2014) introduced *M. elsadii* based on morphological evidence. Doilom et al. (2017) introduced the fourth species, *M. tectonae*, and accepted this genus as a member of *Tubeufiaceae* based on phylogenetic analysis and morphological evidence. *Manoharachiella* is characterized by macronematous, mononematous conidiophores with integrated monoblastic conidiogenous cells producing solitary, doliiform, obpyriform dictyoseptate and apiculate conidia (Bagyanarayana et al. 2009; Rajeshkumar and Singh 2012; Selcuk and Ekici 2014; Doilom et al. 2017).

***Muripulchra*** Z.L. Luo, Hong Y. Su & K.D. Hyde, Cryptog. Mycol. 38(1): 36 (2017).

*Index Fungorum number*: IF 818825; *Facesoffungi number*: FoF 02647; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: *Muripulchra aquatica* Z.L. Luo, Hong Y. Su & K.D. Hyde, Cryptog. Mycol. 38(1): 39 (2017).

*Notes:* *Muripulchra* was introduced based on phylogenetic and morphological analyses. *Muripulchra* is characterized by its obpyriform conidia often carrying part of conidiogenous cells at the base as a broken frill (Luo et al. 2017).

***Neoacanthostigma*** Boonmee, Bhat & K.D. Hyde, Fungal Diversity 68(1): 278 (2014).

*Index Fungorum number:* IF 550576; *Facesoffungi number:* FoF 00214; – 3 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species:* ***Neoacanthostigma fusiforme*** Boonmee, Bhat & K.D. Hyde, Fungal Diversity 68(1): 279 (2014).

*Notes:* *Neoacanthostigma* was introduced based on phylogenetic and morphological evidence. Lu et al. (2017c) introduced four new *Neoacanthostigma* species. Lu et al. (2018b) accepted only the type species *N. fusiforme* based on phylogenetic and morphological analyses. The ascomata of *Neoacanthostigma* are globose to subglobose, reddish brown to dark brown, to black, and are covered by black setae. Asci are cylindrical-clavate with a short rounded pedicel, ascospores are narrowly fusiform and tapering towards the rounded ends. The asexual morph of *Neoacanthostigma* is characterized by helicosporous hyphomycetous, which lack conidiophores, and conidia are acrogenous with loosely coiled conidial filaments (Boonmee et al. 2014b; Lu et al. 2018b).

***Neochlamydotubeufia*** Y.Z. Lu, Boonmee & K.D. Hyde, Fungal Diversity 92: 221 (2018).

*Index Fungorum number:* IF 554861; *Facesoffungi number:* FoF 04731; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species:* ***Neochlamydotubeufia fusiformis*** Y.Z. Lu, Boonmee & K.D. Hyde, Fungal Diversity 92: 221 (2018).

*Notes:* *Neochlamydotubeufia* was introduced based on phylogenetic evidence. *Neochlamydotubeufia* shares similar sexual and asexual morphs with *Chlamydotubeufia* and *Dictyospora*, but phylogenetic analyses support *Neochlamydotubeufia* as a distinct genus (Lu et al. 2018b).

***Neohelicoma*** Y.Z. Lu, Boonmee & K.D. Hyde, Fungal Diversity 92: 224 (2018).

*Index Fungorum number:* IF 554864; *Facesoffungi number:* FoF 04734; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species:* ***Neohelicoma fagacearum*** (Boonmee & K.D. Hyde) Y.Z. Lu, Fungal Diversity 92: 224 (2018).

≡ *Helicoma fagacearum* Boonmee & K.D. Hyde, in Boonmee et al., Fungal Diversity 68: 271 (2014).

*Notes:* *Neohelicoma* was introduced based on phylogenetic evidence. *Neohelicoma* shares similar sexual morph with *Helicoma* in ascomata, asci and ascospores, but phylogenetic analyses supported it as a distinct genus (Lu et al.

2018b). The type species *Neohelicoma fagacearum* is the only accepted species within this genus.

***Neohelicomyces*** Z.L. Luo, Bhat & K.D. Hyde, Cryptog. Mycol. 38(1): 39 (2017).

*Index Fungorum number:* IF 818820; *Facesoffungi number:* FoF 02643; – 8 morphological species (Species Fungorum 2020), 8 species with molecular data.

*Type species:* ***Neohelicomyces aquaticus*** Z.L. Luo, Bhat & K.D. Hyde, Cryptog. Mycol. 38(1): 40 (2017).

*Notes:* *Neohelicomyces* was introduced to accommodate *N. aquaticus*, *N. grandisporus*, and *N. submersus*. Lu et al. (2018b) introduced *Neohelicomyces hyalosporus*, and synonymized *Helicosporium pallidum* under *Neohelicomyces* based on phylogenetic and morphological evidence. Tibpromma et al. (2018b) reported *Neohelicomyces pandanicola* from dead roots of *Pandanus*. Crous et al. (2019a) introduced *N. deschampsiae* from the culm base of dead leaf sheath of *Deschampsia cespitosa*. *Neohelicomyces* can be recognized from other helicosporous hyphomycetous by its hyaline conidiophores and conidia (Luo et al. 2017; Lu et al. 2018b; Crous et al. 2019a).

***Neohelicosporium*** Y.Z. Lu, J.C. Kang & K.D. Hyde, Mycol. Progr. 17 (5): 637 (2017).

*Index Fungorum number:* IF 822045; *Facesoffungi number:* FoF 03570; – 22 morphological species (Species Fungorum 2020), 18 species with molecular data.

*Type species:* ***Neohelicosporium parvisporum*** Y.Z. Lu, J.C. Kang & K.D. Hyde, Mycol. Progr. 17 (5): 637 (2017).

*Notes:* *Neohelicosporium* was established based on phylogenetic and morphological evidence. Lu et al. (2018b) accepted 22 species in this genus. *Neohelicosporium* differs from *Helicosporium* in having acrogenous and/or acropleurogenous conidia developing from an integrated, sympodial conidiogenous cells while *Helicosporium* species have pleurogenous conidia and discrete, determinate conidiogenous cells (Lu et al. 2018a, b).

***Neotubeufia*** Chaiwan, Boonmee, Y.Z. Lu & K.D. Hyde, Mycosphere 8(9): 1149 (2017).

*Index Fungorum number:* IF 553871; *Facesoffungi number:* FoF 03777; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species:* ***Neotubeufia krabiensis*** Chaiwan, Boonmee, Y.Z. Lu & K.D. Hyde, Mycosphere 8(9): 1149 (2017).

*Notes:* *Neotubeufia* was introduced based on phylogenetic and morphological evidence. The type species *N. krabiensis* is the only accepted species in this genus. The ascomata of *Neotubeufia* are dark brown to black subglobose without setae, and asci are broadly cylindrical with slightly curved cylindrical-fusiform ascospores (Chaiwan et al. 2017).

***Pleurohelicosporium*** Y.Z. Lu, J.C. Kang & K.D. Hyde, Fungal Diversity 92: 247 (2018).

*Index Fungorum number*: IF 554884; *Facesoffungi number*: FoF 04743; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Pleurohelicosporium parvisporum*** Y.Z. Lu, J.C. Kang & K.D. Hyde, Fungal Diversity 92: 248 (2018).

*Notes*: *Pleurohelicosporium* was introduced based on phylogenetic and morphological evidence. *Pleurohelicosporium* shares similar asexual morphs with *Neohelicosporium* but can be distinguished by its pleurogenous conidia, while the conidia of *Neohelicosporium* are acrogenous or acropleurogenous (Lu et al. 2018b). The type species *P. parvisporum* is the only accepted species in this genus.

***Podonectria*** Petch, Trans. Br. mycol. Soc. 7(3): 146 (1921).

*Index Fungorum number*: IF 4280; *Facesoffungi number*: FoF 06818; – 9 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Podonectria coccicola*** (Ellis & Everh.) Petch, Trans. Br. mycol. Soc. 7(3): 146 (1921).

≡ *Nectria coccicola* Ellis & Everh., J. Mycol. 2(4): 39 (1886).

*Notes*: Rossman (1978) reviewed this genus and accepted eight species. The ascomata of *Podonectria* are subglobose-globose, light yellow reddish and covered with light brown mycelium, asci are cylindric-clavate with short pedicel, and ascospores are clavate to fusiform. Its asexual morph is characterized by phragmosporous hyphomycetous, and conidia are produced on sympodial conidiophores (Petch 1921; Rossman 1978; Boonmee et al. 2011). Boonmee et al. (2014b) accepted *Podonectria* in *Tubeufiaceae* and pointed out that its sexual morphs were compatible with *Tubeufiaceae*.

***Pseudohelicomyces*** Y.Z. Lu, J.K. Liu & K.D. Hyde, Fungal Diversity 92: 248 (2018), nom. illegit., non Garnica & E. Valenz. (2000).

*Index Fungorum number*: IF 554886; *Facesoffungi number*: FoF 04745; – 8 morphological species (Species Fungorum 2020), 7 species with molecular data.

*Type species*: ***Pseudohelicomyces talbotii*** (Goos) Y.Z. Lu & K.D. Hyde, Fungal Diversity 92: 252 (2018).

≡ *Helicosporium talbotii* Goos, Mycologia 81(3): 368 (1989).

*Notes*: *Pseudohelicomyces* was introduced to accommodate five species, *P. aquaticus*, *P. hyalosporus*, *P. indicus*, *P. paludosus*, and *P. talbotii* based on phylogenetic and morphological evidence (Lu et al. 2018b). Phookamsak et al. (2019) reported *Pseudohelicomyces menglunicus* from an unidentified seed in China. Jayasiri et al. (2019) introduced a new *Pseudohelicomyces* species and two new records. Hyde

et al. (2019) described a new member, *Pseudohelicomyces menglunicus*, from an unidentified seed coat. Recently, Lu et al. (2020) submitted a proposal to conserve *Pseudohelicomyces (Tubeufiaceae)* against *Pseudohelicomyces (Hymenogastraceae)*. *Pseudohelicomyces* shares similar conidial characters with *Helicomyces* but can be distinguished by its erect and branched cylindrical conidiophores (Lu et al. 2018b; Jayasiri et al. 2019).

***Pseudohelicoon*** Y.Z. Lu & K.D. Hyde, Fungal Diversity 92: 254 (2018).

*Index Fungorum number*: IF 554919; *Facesoffungi number*: FoF 04748; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Pseudohelicoon subglobosum*** (Goh & C.H. Kuo) Y.Z. Lu & Hyde, Fungal Diversity 92: 255 (2018).

≡ *Helicoon subglobosum* Goh & C.H. Kuo [as ‘*Helicoön*’], Phytotaxa 346(2): 145 (2018).

*Notes*: *Pseudohelicoon* shares similar asexual morph with *Helicoön* in non-proliferating and ellipsoidal to doliiform conidia but phylogenetic analyses indicated that they are different genera (Lu et al. 2018b).

***Tamhinispora*** Rajeshk. & Rah. Sharma, Mycosphere 4(2): 166 (2013).

*Index Fungorum number*: IF 803105; *Facesoffungi number*: FoF 00215; – 3 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: ***Tamhinispora indica*** Rajeshk. & Rah. Sharma, Mycosphere 4(2): 167 (2013).

*Notes*: *Tamhinispora* was established based on phylogenetic and morphological evidence. Rajeshkumar et al. (2018) introduced *Tamhinispora srinivasanii* and Sommai et al. (2019) introduced *T. saraburiensis*. The conidia of *Tamhinispora* are irregular, dictyoseptate, dark brown and adorned with brown to blackish apical appendages, which are unique in *Tubeufiaceae* (Rajeshkumar and Sharma 2013; Rajeshkumar et al. 2018; Sommai et al. 2019).

***Thaxteriella*** Petr., Annl. mycol. 22(1/2): 63 (1924).

*Index Fungorum number*: IF 5408; *Facesoffungi number*: FoF 00189; – 10 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Thaxteriella corticola*** Petr., Annl. mycol. 22(1/2): 63 (1924).

*Notes*: Boonmee et al. (2011) reexamined the type material of *T. corticola* and accepted *Thaxteriella* as a genus of *Tubeufiaceae*. The ascomata of *Thaxteriella* are globose or subglobose, shiny, and collapsing in the middle when dried, asci are broadly clavate or subclavate with a short pedicel, and ascospores are cylindrical to long fusiform (Boonmee et al. 2011, 2014).

**Thaxteriellopsis** Sivan., Panwar & S.J. Kaur, Kavaka 4: 39 (1977) [1976].

*Index Fungorum number*: IF 5409; *Facesoffungi number*: FoF 01866; – 1 morphological species (Lu et al. 2018b), 1 species with molecular data.

*Type species*: **Thaxteriellopsis lignicola** Sivan., Panwar & S.J. Kaur, Kavaka 4: 39 (1977) [1976].

*Notes*: Crane et al. (1998) transferred *T. lignicola* to *Chaetosphaerulina*. Boonmee et al. (2011) reexamined the holotype of *T. lignicola* (IMI 197065), designated an epitype (MFLU 10-0057), and retained *Thaxteriellopsis* as a distinct genus within *Tubeufiaceae*. Doilom et al. (2017) introduced an asexual record of *T. lignicola* based on phylogenetic evidence. Lu et al. (2018b) reported new records of *T. lignicola* with new morphological characteristics. *Thaxteriellopsis* is characterized by globose to subglobose ascospores are reddish brown to dark brown, collapsed when dry, and covered with brown to black setae, cylindrical asci with a long pedicel, and straight or slightly curved ascospores are fusiform to clavate with 5 septa. The conidia of *Thaxteriellopsis* are typical helicoma-like but conidiophores are distinct from *Helicoma* species (Boonmee et al. 2011; Doilom et al. 2017; Lu et al. 2018b).

### Economic and ecological significance

*Tubeufiaceae* fungi have the potential to produce a number of bioactive compounds. Hanada et al. (1996) reported a novel protein produced by a species of *Helicosporium*, which had effects on neurite outgrowth via cultured cortical neurons and NGF-treated PC12 cells. Ohtsu et al. (2003) obtained five compounds from *Helicomycetes* sp. No. 19353, and found that one compound had a significant anti-diabetic activity (Ohtsu et al. 2003; Yoshimura et al. 2003; Zenkoh et al. 2003). Dong et al. (2004) reported that mobility of nematodes was inhibited by 98.95% by the mycelial extracts from *Helicomycetes roseus*. Jiao et al. (2006) reported that seven compounds were isolated from *Tubeufiaceae* sp. A-00471 and exhibited antibiotic activity against Gram-positive bacteria (Jiao et al. 2006). Hu et al. (2006) obtained one Diepoxin and five Decaspiroones compounds from *Helicoma viridis*. Jung et al. (2012) reported that 2-methylresorcinol from *Helicosporium* sp. KCTC 0635BP exhibited antimicrobial activity against various types of bacteria and fungi, and also exhibited considerable cytotoxicity activity against human cancer cells. Lee et al. (2013) found that *Helicosporium* sp. 0635BP was effective against *Fusarium oxysporum*, *Phytophthora drechsleri*, and *Rhizoctonia solani*.

**Wiesneriomycetaceae** Suetrong, Rungjindamai, Somrithipol. & E.B.G. Jones, Phytotaxa 176: 288 (2014).

*Index Fungorum*: IF 550306; *Facesoffungi number*: FoF 06311, 20 species.

*Saprobic* on different substrates, colonies effuse, consisting of scattered conidiomata. *Mycelium* immersed. **Asexual morph**: *Conidiomata* sporodochial or synnematal, solitary to gregarious, with or without setae. *Setae* subulate, septate, pigmented, thick-walled, erect, flexuous, arising from basal pseudoparenchymatous stalk or mycelium immersed in the substrate. *Conidiophores* macronematous, mononematous, penicillate, septate, branched, straight or flexuous, solitary or gregarious. *Conidiogenous cells* holoblastic, monoblastic, polyblastic, discrete, determinate, terminate, clavate, cylindrical, slightly ampulliform. *Conidia* solitary to gregarious, catenate, connected by narrow isthmi, fusiform to falcate, cylindrical, subcylindrical, cuneiform, branched, hyaline to slightly pigmented, aseptate. **Sexual morph**: undetermined.

*Type*: **Wiesneriomyces** Koord.

*Notes*: Suetrong et al. (2014) introduced *Wiesneriomycetaceae* as order *incertae sedis*, based on morphology and molecular phylogenetic inference. Pratibha et al. (2015) placed *Wiesneriomycetaceae* in *Tubeufiales*, and included *Pseudogliophragma* in this family. Santos (2015) included *Speiroopsis* in this family and suggested *Pseudogliophragma* as a synonym of *Wiesneriomyces*. *Parawiesneriomyces* was included in this family by Crous et al. (2016b). Bezerra et al. (2017) introduced *Wiesneriomycetales* to accommodate *Wiesneriomycetaceae* based on morphological characteristics and phylogenetic analyses. Liu et al. (2017) assigned *Wiesneriomycetales* as a synonym of *Tubeufiales* based on phylogenetic inference and divergence times estimates which estimated as 40 MYA (crown age).

**Wiesneriomyces** Koord., Verh. K. Akad. Wet., tweede sect. 13(4): 246 (1907).

*Index Fungorum number*: IF 10438; *Facesoffungi number*: FoF 06312; 3 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: **Wiesneriomyces laurinus** (Tassi) P.M. Kirk, Trans. Br. mycol. Soc. 82(4): 748 (1984).

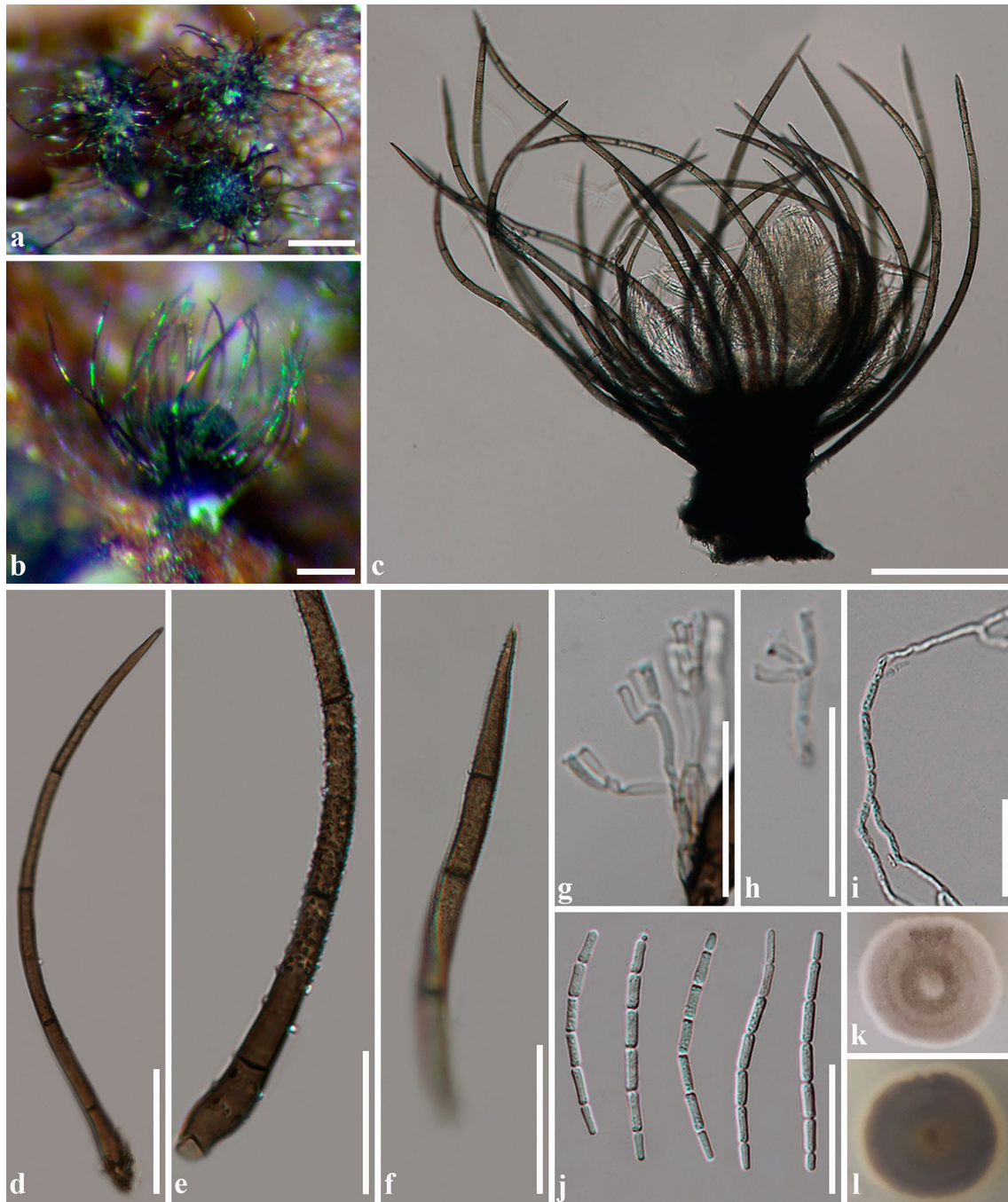
≡ *Volutellaria laurina* Tassi, Atti R. Accad. Fisiocrit. Siena, Sér. 4 8: 5 (1897).

*Notes*: Kirk (1984) proposed the new combination, *Wiesneriomyces laurinus*, based on the holotype of *Volutellaria laurina* and showed that it was an earlier name for *Wiesneriomyces javanicus*. No sexual morph has been reported for this genus (Suetrong et al. 2014; Bezerra et al. 2017; Lu et al. 2018b).

**Wiesneriomyces laurinus** (Tassi) P.M. Kirk, Trans. Br. mycol. Soc. 82(4): 748 (1984).

*Index Fungorum number*: IF 107371; *Facesoffungi number*: FoF 06313; Fig. 85

*Saprobe*, on bark of *Hevea brasiliensis*; **Sexual morph**: Undetermined. **Asexual morph**: Colonies 385–440 µm diam., on the substrate inconspicuous. *Conidiomata*



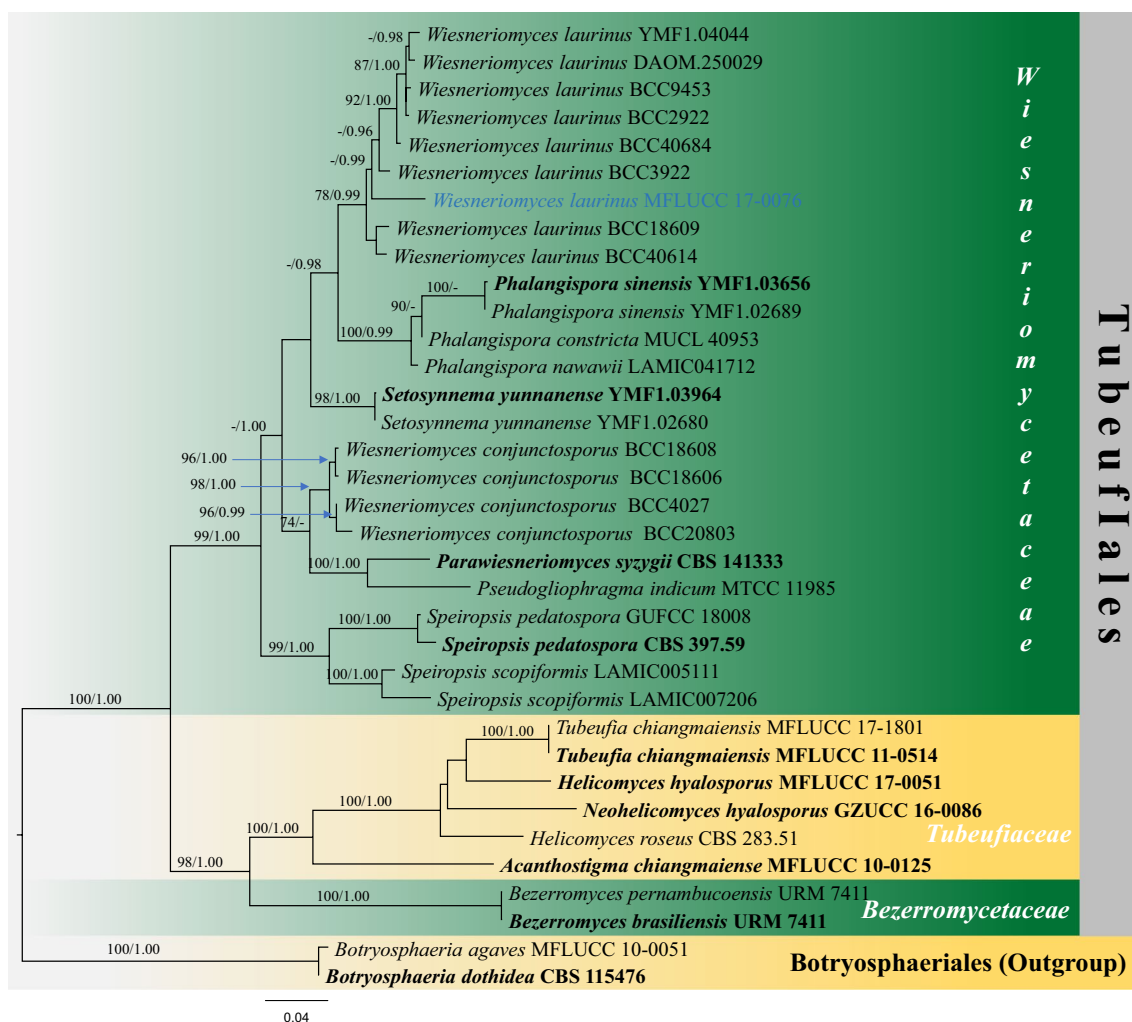
**Fig. 85** *Wiesneriomyces laurinus* (MFLU 18-1384, **new host record**). **a, b** Habit on substrate. **c** Conidioma. **d** Seta. **e** Base of seta. **f** Tip of seta. **g, h** Conidiophores. **i** Germinated spores. **j** Conidia. **k**

Culture characteristic on PDA after 21 days (**k** = colony from above, **l** = colony from below). Scale bars: **a–c** = 100  $\mu\text{m}$ , **d–j** = 30  $\mu\text{m}$

sporodochial, superficial, solitary to gregarious, scattered. *Setae* 130–430  $\times$  3–12  $\mu\text{m}$ , arising from basal pseudostromatal stalk, straight or  $\pm$  bent, abundant, dark brown to black, verruculose, 5–10-septate, tapering to subulate apex. *Conidiophores* 18–38  $\times$  2–3  $\mu\text{m}$ , macronematous, hyaline to subhyaline, smooth-walled, branched. *Conidiogenous cells* terminal, clavate to slightly inflated, hyaline, smooth-walled,

5.5–8.5  $\times$  1.5–2.5  $\mu\text{m}$ . *Conidia* [(4)5–7 cells], 46–67  $\times$  2–4  $\mu\text{m}$ , in chains, straight, long cylindrical, hyaline to subhyaline, aseptate, smooth-walled.

*Culture characteristics*: Conidia germinated on MEA within 12 hours and germ tube produced from one or both end or several cell of the conidia. Colonies on PDA reaching 4.5–5 cm diam. after 21 days at room temperature (20–25



**Fig. 86** Phylogram generated from maximum likelihood analysis (RAxML) of genera in *Wiesneriomycetaceae* based on ITS, LSU, rpb-2, SSU and tef1 sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original iso-

late number is noted after the species name. The tree is rooted to *Botryosphaeria agaves* (MFLUCC 10-0051) and *B. dothidea* (CBS 115476). The ex-type strains are indicated in bold. The new sequence is in blue. Hyphen (-) represents support values below 70% MLBS and 0.90 PP

°C), circular, effuse, velvety to hairy, initially white, becoming slightly radiating with greyish-brown concentric ring, white at the margin from above, dark grey to blackish at the center from below, with white circular edge.

**Material examined:** Thailand, Phayao Province, Muang, inner bark of *Hevea brasiliensis* (*Euphorbiaceae*), 5 December 2016, Senwannan C., RBPY019 (MFLU 18-1384; living culture MFLUCC 17-0076)

**Sequence data:** ITS: MN168764, LSU: MN168761, rpb-2: MN174863, SSU: MN168759, tef1: MT050455.

**Notes:** During our study of microfungi on Para rubber in Thailand, a fresh specimen was obtained from inner bark of *Hevea brasiliensis*. The morphological characters of our fresh collection fit well with the description of *W. laurinus* (Suetrong et al. 2014, Chen and Tzean 2015). Based on our

phylogenetic analysis of combined LSU and SSU sequence data, our strain groups with other *W. laurinus* strains with moderate bootstrap support (Fig. 86). Thus, this fresh collection is identified as *W. laurinus*.

#### Other genera included

*Parawiesneriomyces* Crous & M.J. Wingf., in Crous et al., Persoonia 36: 389 (2016).

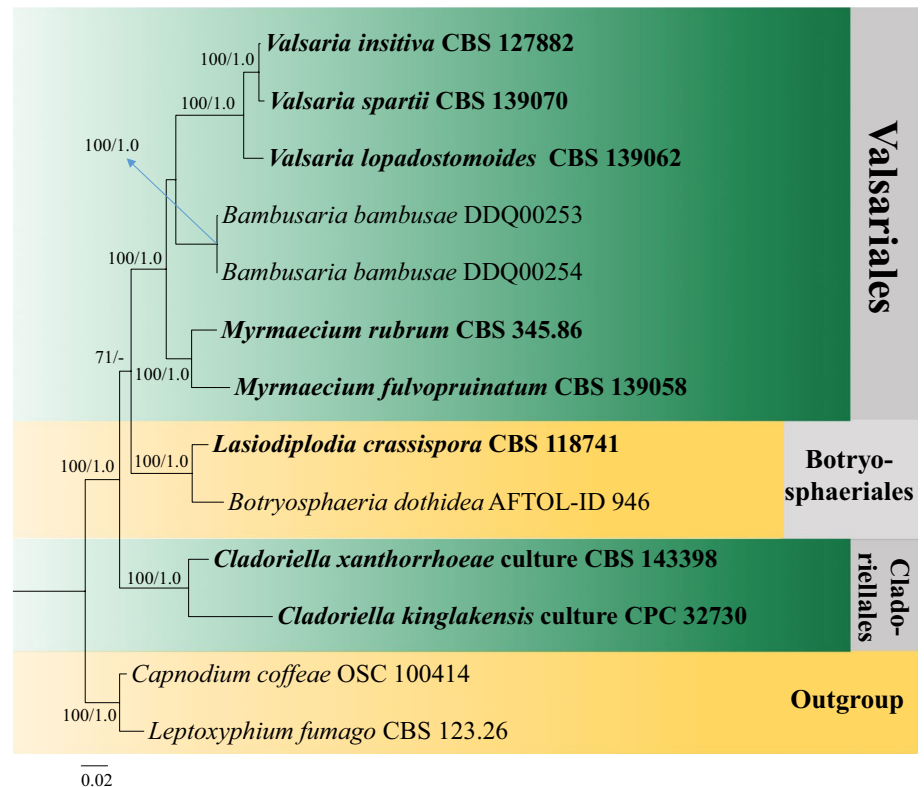
**Index Fungorum number:** IF 817060; **Facesoffungi number:** FoF 06556; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

**Type species:** *Parawiesneriomyces syzygii* Crous & M.J. Wingf., in Crous et al., Persoonia 36: 389 (2016).

**Notes:** *Parawiesneriomyces* was introduced based on phylogeny and morphology (Crous et al. 2016b).



**Fig. 87** Phylogram generated from maximum likelihood analysis (RAxML) of genera in Valsariales based on ITS, LSU, SSU and tef1 sequence data. Maximum likelihood bootstrap values equal or above 70%. Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Capnodium coffeae* (OSC 100414) and *Leptoxyphium fumago* (CBS 123.26). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



*Parawiesneriomyces* is similar to *Wiesneriomyces* in its conidial characters, however they differ in conidiomata and setae characters (Crous et al. 2016b). Thus, further collections and sequence data are necessary to resolve and to confirm the validity of the new genus.

***Phalangispora*** Nawawi & J. Webster, Trans. Br. mycol. Soc. 79(1): 65 (1982).

*Index Fungorum number*: IF 9328; *Facesoffungi number*: FoF 07568; – 4 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: ***Phalangispora constricta*** Nawawi & J. Webster, Trans. Br. mycol. Soc. 79(1): 65 (1982).

*Notes*: *Phalangispora* is characterized by setose, sporodochial conidiomata and branched, tetra- or radiate conidia (Nawawi and Webster 1982). A combined dataset of ITS, LSU, tub1 and tub2 sequence data placed *Phalangispora* within *Wiesneriomyces* (Santos 2015). Recent molecular phylogenetic data showed that *Phalangispora* is a distinct group within *Wiesneriomycetaceae* (Guo et al. 2019).

***Pseudogliophragma*** Phadke & V.G. Rao, Norw. J Bot. 27: 127 (1980).

*Index Fungorum number*: IF 9579; *Facesoffungi number*: FoF 06557; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Pseudogliophragma indica*** Phadke & V.G. Rao, Norw. J Bot. 27(2): 127 (1980).

*Notes*: *Pseudogliophragma* was introduced to accommodate a single species characterized by synnematous conidiomata, 4–8-celled, fusiform to falcate conidia. Recent molecular phylogenetic data showed that *Pseudogliophragma* is a distinct genus within *Wiesneriomycetaceae* (Pratibha et al. 2015).

***Setosynnema*** D.E. Shaw & B. Sutton, J. Linn. Soc., Bot. 91: 33 (1985).

*Index Fungorum number*: IF 9328; *Facesoffungi number*: FoF 07569; – 3 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Setosynnema isthmosporum*** D.E. Shaw & B. Sutton, Bot. J. Linn. Soc. 91(1–2): 34 (1985).

*Notes*: *Setosynnema* is characterized by synnematous conidiomata, filiform conidia with an isthmus at the central septum (Shaw and Sutton 1985). The genus was introduced as a genus *incertae sedis* and reported as aquatic fungi (Bai et al. 2013; Rajeshkumar 2014; Guo et al. 2019). Guo et al. (2019) accepted *Setosynnema* as a member of *Wiesneriomycetaceae* based on phylogenetic and morphological evidence.

***Speiropsis*** Tubaki, J. Hattoribot. Lab. 20: 171 (1958).



**Fig. 88** *Valsaria ostryae* (MFLU 17-0837, holotype). **a, b** Habit and appearance of ectostromata on host surface. **c** Vertical section of stroma. **d** Peridium wall. **e** Apically free pseudoparaphyses. **f, g** Immature asci **h** Mature asci. **i–k** Immature ascospores **l, m** Mature ascospore. **q** Hyphae with denticles and conidia (partly budding). **n–p** Phialides. **r–w** Conidia. Scale bars: **a** = 500  $\mu\text{m}$ , **b, c** = 200  $\mu\text{m}$ , **f–h** = 50  $\mu\text{m}$ , **d, n–q** = 10  $\mu\text{m}$ , **e, i–m, r–w** = 5  $\mu\text{m}$

*Index Fungorum number*: IF 9965; *Facesoffungi number*: FoF 06558; – 8 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: *Speiropsis pedatospora* Tubaki, J. Hattori bot. Lab 20: 171 (1958).

*Notes*: *Speiropsis* is characterized by erect, simple, straight, mostly mononematous conidiophores, polyblastic conidiogenous cells and catenate conidia in branched or unbranched chains connected by narrow isthmi (Barbosa and Gusmao 2005; Pratibha et al. 2016). Based on morphology and molecular analyses, Pratibha et al. (2016) referred *Speiropsis* to *Wiesneriomycetaceae*. There are 28 DNA sequence data available in GenBank, comprising *S. pedatospora* and *S. scopiformis*.

### Economic and ecological significance

Genera included in *Wiesneriomycetaceae* play a role as saprobes, occurring on different substrates with a worldwide distribution (Suetrong et al. 2014; Pratibha et al. 2015; 2016; Crous et al. 2016b). In addition, *Speiropsis* has been reported as an aquatic hyphomycete (Barbosa and Gusmao 2005; Santos 2015).

### Valsariales Jaklitsch, K.D. Hyde & Voglmayr.

*Index Fungorum number*: IF 811900; *Facesoffungi number*: FoF 08827.

Valsariales was introduced by Jaklitsch et al. (2015) based on multi-gene phylogeny analyses to accommodate the single family *Valsariaceae*. Valsariales species have perithecioid ascomata, immersed in eu- or pseudostromata, bitunicate asci, without obvious fissitunicate dehiscence and dark brown, bicelled ascospores. Member of Valsariales have a worldwide distribution on various substrates as saprobes, plant pathogens or necrotrophs (Ju et al. 1996; Jaklitsch et al. 2015). There are only three genera with molecular data. Our phylogenetic analyses generated from ITS, LSU, SSU and *tef1* sequence data (Fig. 87) indicate that the three genera cluster with high bootstrap support (100% ML, 1.0 PP), and each genus is well-resolved. The divergence time for Valsariales is estimated as 224 MYA (stem age, Hongsanan et al. 2020).

*Accepted families*: *Valsariaceae*.

*Valsariaceae* Jaklitsch, K.D. Hyde & Voglmayr, in Jaklitsch et al., Fungal Diversity 73: 167 (2015).

*Index Fungorum number*: IF 811901; *Facesoffungi number*: FoF 06561, 41 species.

*Saprobic* and *pathogens* in bark of dicotyledons in terrestrial habitats or on culms of bamboo. **Sexual morph**: *Stromata* eu- or pseudostromatic, immersed, erumpent to superficial on bark, enclosed on top and/or at the sides by a black pseudoparenchymatous. *Ascomata* perithecial, immersed in the stromata, usually monostichous in valloid or diatrypoid configuration, upright or oblique, with several ostiolar necks fusing into one. *Ostiole* periphysate. *Peridium* composed of several cell layers of brown to black cells. *Hamathecium* comprising numerous paraphyses. *Asci* 4–8-spored, bitunicate, with or without obvious fissitunicate, cylindrical, with short pedicel, an ocular chamber apex, and a pulvinate ring staining in Congo Red. *Ascospores* (often obliquely) uni-seriate, ellipsoid to subfusiform, dark brown, 1-septate, with a dark, usually not or slightly constricted at the septum, budding in artificial culture, with surface ornamentation. **Asexual morph**: in nature coelomycetous, in culture hyphomycetous or coelomycetous. *Conidia* produced on phialides, minute pegs or by budding of ascospores and conidia, oblong or bullet-shaped, hyaline, 1-celled, smooth-walled, with inconspicuous guttules.

*Type*: *Valsaria* Ces. & De Not.

*Notes*: Based on bitunicate asci without obvious fissitunicate dehiscence, Ju et al. (1996) placed *Valsaria* in Dothideomycetes (as Loculoascomycetes). However, Kirk et al. (2008) referred *Valsaria* to Diaporthales (Sordariomycetes), based on the hamathecium consisting of true, apically free paraphyses, a true ascomatal wall distinct from the surrounding pseudostroma and unitunicate asci (Barr 1978, 1990; Glawe 1985; Huhndorf 1992). Recent phylogenetic analyses have shown *Valsariaceae* to be a distinct family within Dothideomycetes (Jaklitsch et al. 2015; Pem et al. 2019b). *Valsariaceae* was introduced by Jaklitsch et al. (2015) to accommodate *Bambusaria*, *Myrmaecium* and *Valsaria*, based on multi-gene phylogeny analyses of ITS, LSU, SSU, *rpb-2* and *tef1* sequence data.

*Valsaria* Ces. & De Not., Comm. Soc. crittog. Ital. 1(fasc. 4): 205 (1863).

*Index Fungorum number*: IF 5704; *Facesoffungi number*: 33 morphological species (Species Fungorum 2020), 6 species with molecular data.

*Type species*: *Valsaria insitiva* (Tode) Ces. & De Not.

≡ *Sphaeria insitiva* Tode, Fung. mecklenb. sel. (Lüneburg) 2: 36 (1791).

*Notes*: *Valsaria* contains plant pathogens and saprobes on various hosts (Phillips 2000; Jaklitsch et al. 2015; Žežlina et al. 2016). Morphological characteristic of *Valsaria* are overlapping and hence DNA sequence analyses are needed to classify and delineate them. There are six epithets accommodated in *Valsaria* based on molecular data coupled with

morphological characteristics (Jaklitsch et al. 2015; Wijayawardene et al. 2017a; Index Fungorum 2020).

***Valsaria ostryae*** D. Pem, R. Jeewon, Camporesi & K.D. Hyde, in Pem et al., PLoS ONE 14(6): e0217982, 5 (2019).

*Index Fungorum number*: IF 554758; *Facesoffungi number*: FoF 04614, Fig. 88

*Description*: see Pem et al. (2019b).

*Material examined*: Italy, Province of Forlì-Cesena [FC], Santa Sofia, Camposonardo, on dead branches of *Ostrya carpinifolia* (*Betulaceae*), 18 March 2017, E. Camporesi, IT 3290 (MFLU 17-0837, **holotype**).

### Other genera included

***Bambusaria*** Jaklitsch, D.Q. Dai, K.D. Hyde & Voglmayr, in Jaklitsch et al., Fungal Diversity 73: 196 (2015).

*Index Fungorum number*: IF 811906; *Facesoffungi number*: FoF 06559; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: ***Bambusaria bambusae*** (J.N. Kapoor & H.S. Gill) Jaklitsch, D.Q. Dai, K.D. Hyde & Voglmayr, in Jaklitsch et al., Fungal Diversity 73: 196 (2015).

≡ *Valsaria bambusae* J.N. Kapoor & H.S. Gill, Indian Phytopath. 14(2): 152 (1962) [1961].

*Notes*: Based on a multi-locus phylogeny and morphological features, Jaklitsch et al. (2015) established a new genus *Bambusaria* with a single species *B. bambusae* (synonym: *Valsaria bambusae*) as the type species, which is host-specific for Bambusoideae. The genus is characterized by eustromatic stromata, ascumata immersed in a stromata in valsoid configuration, bitunicate asci without obvious fisitunicate dehiscence, ellipsoid to broadly fusiform or biconoid, brown, 1-septate ascospores with longitudinally ribbed and produces asexual morph in culture.

***Myrmaecium*** Nitschke ex Fuckel, Jb. nassau. Ver. Naturk. 23–24: 227 (1870) [1869–70].

*Index Fungorum number*: IF 3385; *Facesoffungi number*: FoF 06560; – 7 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species*: ***Myrmaecium rubricosum*** (Fr.) Fuckel, Jb. nassau. Ver. Naturk. 23–24: 227 (1870) [1869–70].

≡ *Sphaeria rubricosa* Fr., Elench. fung. (Greifswald) 2: 63 (1828).

*Notes*: Previously *Myrmaecium* was treated as a synonym of *Valsaria* (Ju et al. 1996, Jaklitsch et al. 2015). However, a multi-gene molecular study established the monophyly of *Myrmaecium* species, and their inclusion in *Valsariaceae* (Jaklitsch et al. 2015). *Myrmaecium* can be distinguished from other genera in *Valsariaceae* by the eu- or pseudostromata, showing ionomidotic reaction (KOH-extractable pigments). *Myrmaecium* has a worldwide distribution occurring on sun-exposed, corticated logs and branches of coniferous

and broadleaf trees. In addition, *Myrmaecium fulvopruinatum* and *M. rubrum* are sources of secondary metabolites (Aptroot 1995; Jaklitsch et al. 2015).

### Economic and ecological significance

Species of *Valsariaceae* occur on a wide range of hosts as saprobes, only *Myrmaecium fulvopruinatum* and *Valsaria insitiva* were reported as pathogenic and play a negative role in causing canker disease of Chinese chestnut (*Castanea mollissima*) and stone fruit (Žežlina et al. 2016, Jiang et al. 2018a).

**Venturiales** Y. Zhang ter, C.L. Schoch & K.D. Hyde.

*Index Fungorum number*: IF 513386; *Facesoffungi number*: FoF 06345.

Venturiales was introduced by Zhang et al. (2011) using morphological and ecological characteristics, as well as strong support in multi-gene phylogenetic analyses. This order presently contains *Sympoventuriaceae* and *Venturiaceae* (Zhang et al. 2011; Hyde et al. 2013). Some species of this order are plant pathogens or saprobes, mostly on leaves or stems of dicotyledons. Important characters of this order are small to medium-sized ascumata, with or without setae, a mostly evanescent hamathecium, 8-spored, broadly or usually obclavate asci, usually lacking a pedicel, hyaline, light greenish olivaceous to brown, 1-septate, symmetrical, asymmetrical or apiosporous ascospores and hyphomycetous asexual morphs (Zhang et al. 2011). The divergence time for Venturiales is estimated as 184 MYA (stem age, Hongsanan et al. 2020).

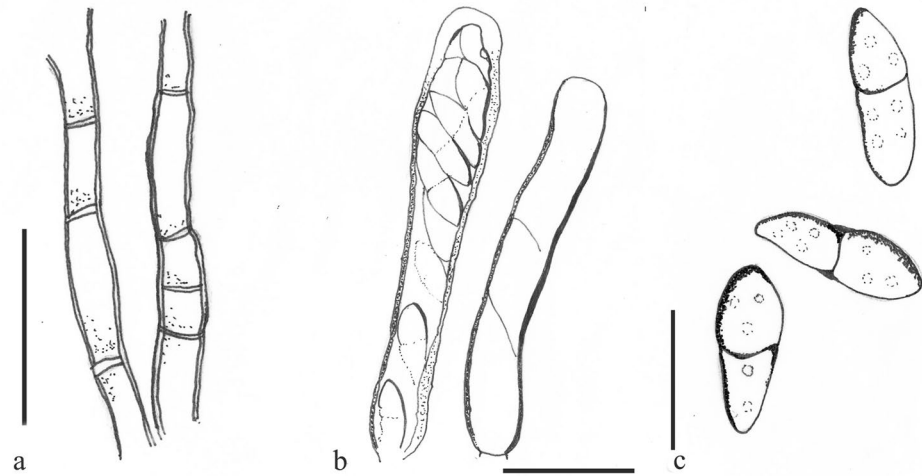
*Accepted families*: *Sympoventuriaceae*, *Venturiaceae*.

***Sympoventuriaceae*** Y. Zhang ter, C.L. Schoch & K.D. Hyde, Fungal Diversity 51: 255 (2011).

*Index Fungorum number*: IF 563117; *Facesoffungi number*: FoF 06346, 130 species.

*Pathogenic or saprobic* on plants. **Sexual morph**: *Ascumata* pseudothecia, solitary or aggregated, immersed in host tissue, erumpent when mature, subglobose to globose, substomatal, subepidermal, inconspicuous; walls pigmented; papillate, ostiolate. *Peridium* thick-walled, comprising of 2–3 layers of brown to dark brown cells of *textura angularis*. *Hamathecium* comprising 2 µm wide, septate, hyaline, cellular pseudoparaphyses, anastomosing between and above the asci, constricted at the septa. *Asci* 8-spored, bitunicate, fisitunicate, subcylindrical, pedicellate. *Ascospores* crowded or partially overlapping in asci, symmetrical, fusoid-ellipsoidal, hyaline, medianly 1-septate, constricted at the septum, widest in the middle of each cell, guttulate, smooth-walled with slightly rough ends. **Asexual morph**: Hyphomycetous. “sympodiella”-like, “fusicladium”-like, *Veronaopsis*. *Mycelium* forming a superficial network with pigmented, thin- to thick-walled, smooth, septate, anastomosing hyphae.

**Fig. 89** *Sympoventuria capensis* (redrawn from Crous et al. 2007b) **a** Pseudoparaphyses. **b** Asci. **c** Ascospores. Scale bars: **a–c** = 10  $\mu$ m



*Conidiogenous cells* integrated, mono-blastic, holoblastic or polyblastic, sympodial, with inconspicuous scars. *Conidiophores* septate, solitary, slightly thickened and darkened, producing conidial chains with up to 20 conidia. *Conidia* thin-walled, cylindrical, sometimes globose to broadly oval at maturity, with truncate ends, hyaline to yellow brown, 1–5 septate to muriform, in unbranched chains on terminal portion of the conidiophores, smooth-walled, guttulate or not.

*Type: Sympoventuria* Crous & Seifert.

*Notes:* Species of *Sympoventuriaceae* have parasitic or saprobic lifestyles and can be found on leaves or stems of dicotyledons (Zhang et al. 2011). Species of *Sympoventuriaceae* are hyphomycetous and sexual morphs for most of the species are not determined (Huanraluek et al. 2019b). According to the outline of Ascomycota 2017, *Acroconidiellina* and *Sympoventuria* are included in this family (Wijayawardene et al. 2018).

***Sympoventuria*** Crous & Seifert, Fungal Divers 25: 31 (2007).

*Index Fungorum number:* IF 501002; *Facesoffungi number:* FoF 06347; 3 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species: Sympoventuria capensis* Crous & Seifert.

*Notes:* *Sympoventuria* is the type genus in the *Sympoventuriaceae*, distinguished from *Venturiaceae* by its saprobic habitat, pseudoparaphyses, and hyaline, symmetrical ascospores (Fig. 89). The asexual morph of *Sympoventuria* was described as “sympodiella”-like by Crous et al. (2007b).

#### Other genera included

***Acroconidiellina*** M.B. Ellis, Mycol. Pap. 125: 22 (1971).

*Index Fungorum number:* IF 7031; *Facesoffungi number:* FoF 08828; – 4 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Acroconidiellina loudetiae* M.B. Ellis, Mycol. Pap. 125: 23 (1971).

*Notes:* Species of *Acroconidiellina* can be distinguished by having dark brown to blackish brown hairy colonies, superficial hyphae arising setae, sclerotia, macronematous conidiophores, polytretic conidiogenous cells, and broadly ellipsoidal, brown, echinulate, 1- septate conidia (Ellis 1960).

***Clavatispora*** Boonmee & K.D. Hyde, Phytotaxa 176(1): 95 (2014).

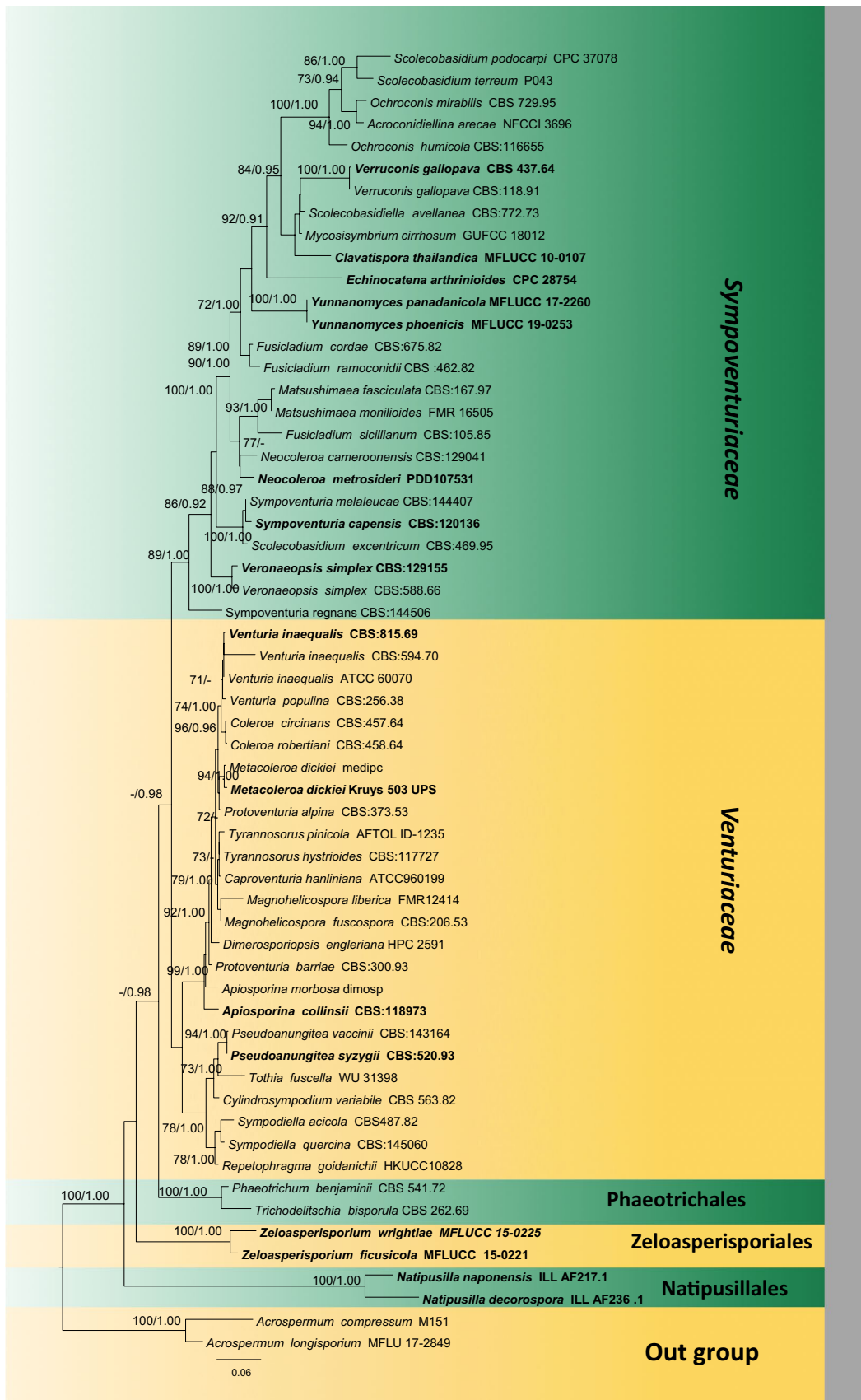
*Index Fungorum number:* IF 805923; *Facesoffungi number:* FoF 08829; –1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Clavatispora thailandica* Boonmee & K.D. Hyde, Phytotaxa 176(1): 96 (2014).

*Notes:* The genus is characterized by solitary, superficial ascomata, covered by dark setae, with an ostiole, clavate, multi-septate, yellowish to reddish brown ascospores (Boonmee et al. 2014a). It does not resemble other genera in *Sympoventuriaceae*. However, the LSU sequence data showed that *Clavatispora* clusters with the hyphomycete genus *Scolecobasidiella* in *Sympoventuriaceae* along with *Ochroconis*, *Scolecobasidium*, *Fusicladium* and *Veronaeopsis* (Boonmee et al. 2014a). The asexual morph of *Clavatispora* are unique in having 1–3-phragmoseptate, smooth-walled, guttulate conidia, deeply constricted at septa, while other genera have conidia and conidiogenous apparatus which are mostly verrucose to denticulate (Boonmee et al. 2014a).

***Echinocatena*** R. Campb. & B. Sutton, Trans. Br. mycol. Soc. 69(1): 126 (1977).

*Index Fungorum number:* IF 8121; *Facesoffungi number:* FoF 09212; –1 morphological species (Species Fungorum 2020), 1 species with molecular data.



**Fig. 90** Phylogram generated from maximum likelihood analysis (RAxML) of genera in Venturiales based on LSU, SSU and RPB2 sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Acrospermum compressum* (M151) and *Acrospermum longisporium* (MFLU 17-2849). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP

*Type species: Echinocatena arthrinooides* R. Campb. & B. Sutton, Trans. Br. mycol. Soc. 69(1): 130 (1977).

*Notes:* The genus is characterized by micronematous and mononematous conidiophores, consisting of branched, acropetal chains of polyblastic conidiogenous cells, with solitary, spherical, brown, aseptate, echinulate conidia (Campbell and Sutton 1977). Crous et al. (2018b) included this genus in *Sympoventuriaceae* based on the sequence data of type species (*Echinocatena arthrinooides*). Its polyblastic conidiogenous cells and straight and flexuous conidiophores are reminiscent of the Venturiales (Shen et al. 2020). Therefore, we accept this genus in *Sympoventuriaceae* and note that more sequence data is needed to resolve its taxonomic placement.

***Fusicladium*** Bonord., Handb. Allgem. mykol. (Stuttgart): 80 (1851).

*Index Fungorum number:* IF 8292; *Facesoffungi number:* FoF 08830; – 81 morphological species (Species Fungorum 2020), 31 species with molecular data.

*Type species: Fusicladium virescens* Bonord., Handb. Allgem. mykol. (Stuttgart): 80 (1851).

*Note:* Species of *Fusicladium* are characterised by having immersed, subcuticular to intra-epidermal mycelia, often forming radiating strands or loose to dense stromatic aggregations, which give rise to conidiogenous cells or conidiophores penetrating the cuticle (Schubert et al. 2003).

***Matsushimaea*** Subram., Kavaka 5: 96 (1978) [1977].

*Index Fungorum number:* IF 8865; *Facesoffungi number:* FoF 08831; – 4 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species: Matsushimaea fasciculata* Subram., Kavaka 5: 96 (1978) [1977].

*Note:* Species of *Matsushimaea* are characterised by having branched, septate, olive mycelium with hyphal coils, by the production of sessile branched conidia arising directly from vegetative hyphae and integrated, mono- or polyblastic, intercalary or terminal, elongated conidiogenous cells, with irregular-shaped, septate, often branched filaments and brown conidia. The production of sessile branched conidia arising directly from vegetative hyphae is an important character of this genus (Crous et al. 2018b).

***Mycosisymbrium*** Carris, Mycologia 86(1): 132 (1994).

*Index Fungorum number:* IF 27274; *Facesoffungi number:* FoF 06348; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Mycosisymbrium cirrhosum* Carris, Mycologia 86(1): 132 (1994).

*Note:* According to Prathiba and Prabhugaonkar (2016), *Mycosisymbrium* is well-supported as a genus in *Sympoventuriaceae* and is sister to *Ochroconis* and *Verruconis* (Samerpitak et al. 2014; Machouart et al. 2014; Hyde et al. 2013; Zhang et al. 2011). This genus is similar to *Ochroconis* in having 2-celled conidia, slightly constricted at the septa and polyblastic conidiogenous cells (Prathiba and Prabhugaonkar 2016).

***Ochroconis*** de Hoog & Arx, Kavaka 1: 57 (1974).

*Index Fungorum number:* IF 9136; *Facesoffungi number:* FoF 06349; – 24 morphological species (Species Fungorum 2020), 14 species with molecular data.

*Type species: Ochroconis constricta* (E.V. Abbott) de Hoog & Arx, Kavaka 1: 57 (1974) [1973].

≡ *Scolecobasidium constrictum* E.V. Abbott, Mycologia 19(1): 30 (1927).

*Notes:* *Ochroconis* species can be distinguished in their slow to moderate growth, colonies of brown to olivaceous, brownish, septate conidiophores and dark pigmented, and rough-walled conidia produced by sympodial conidiogenesis and liberated rhexolytically (Giraldo et al. 2014). Machouart et al. (2014) included *Ochroconis* in *Sympoventuriaceae* based on phylogeny. Pseudoparaphyses and hyaline, symmetrical ascospores and a saprobic nutritional mode are considered to confirm its placement in *Sympoventuriaceae*.

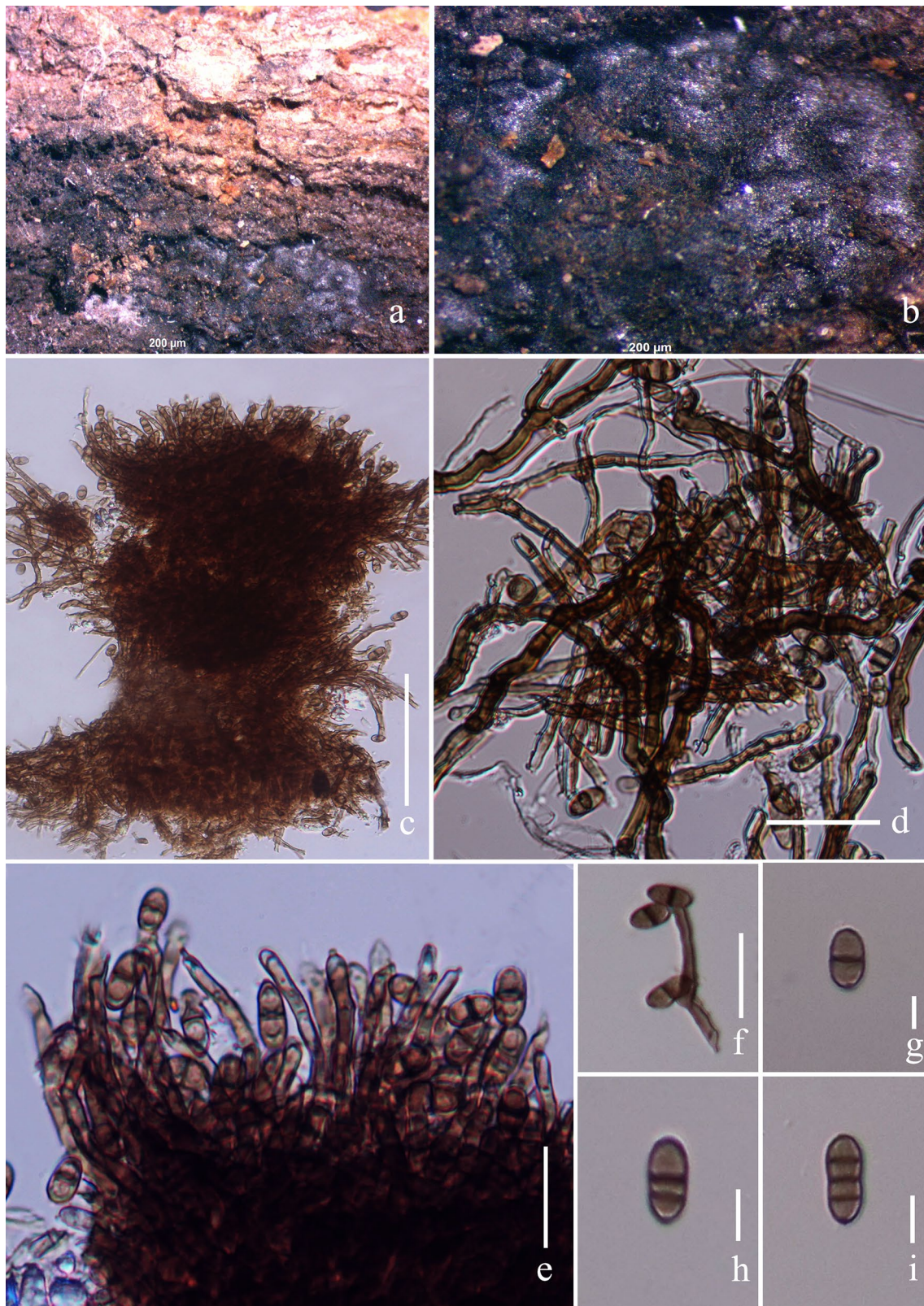
***Scolecobasidiella*** M.B. Ellis, Mycol. Pap. 125: 12 (1971).

*Index Fungorum number:* IF9839; *Facesoffungi number:* FoF 09213; – 2 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Scolecobasidiella avellanea* (Sappa & Mosca) M.B. Ellis, Mycol. Pap. 125: 10 (1971).

*Notes:* Species of *Scolecobasidiella* are characterized by superficial straw coloured to pale brown hyphae, septate, pale brown, smooth conidiophores, 1–3 septate ramo-conidia and broadly ellipsoidal or clavate, 1-septate, pale brown, smooth conidia (Ellis 1971). This genus is closely related to *Clavatispora* based on phylogenetic analyses (Boonmee et al. 2014a). However, the type species of *Scolecobasidiella* is related to *Verruconis gallopava* in our phylogenetic analyses (Fig. 90). The pale brown colonies with conidiophores and conidia show a close affinity with Venturiales. Therefore, we accept this genus in *Sympoventuriaceae*.

***Scolecobasidium*** E.V. Abbott, Mycologia 19(1): 30 (1927).



**Fig. 91** *Verruconis hevea* (MFLU 17-1578, holotype). **a** Host specimen. **b** Colonies on the latex. **c** Arrangement of hyphal mass. **d** Hyphal mass **e** Conidiogenesis cells. **f** Attachment of conidia to hypha. **g–i** Conidia. Scale bars: **c** = 100 µm, **d–e** = 50 µm, **f** = 20 µm, **g–i** = 5 µm



*Index Fungorum number*: IF9840; *Facesoffungi number*: FoF 09214; – 34 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species*: *Scolecobasidium terreum* E.V. Abbott, Mycologia 19(1): 30 (1927).

*Notes*: *Scolecobasidium* are characterized by having T- or Y-shaped or bilobed, 2- to many-celled conidia and ampulliform conidiogenous cells, possessing one to three conidium-bearing denticles at the apex of the conidiophores (Hao et al. 2013). Shen et al. (2020) included this genus in *Sympoventuriaceae* based on morphology of slow growing olivaceous colonies. The type species of this genus also clusters inside the family. Therefore, we accept this genus in this family.

*Veronaeopsis* Arzanlou & Crous, Stud. Mycol. 58: 91 (2007).

*Index Fungorum number*: IF 504571; *Facesoffungi number*: FoF 06350 – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species*: *Veronaeopsis simplex* (Papendorf) Arzanlou & Crous, in Arzanlou et al., Stud. Mycol. 58: 91 (2007).

≡ *Veronaea simplex* Papendorf, Trans. Br. mycol. Soc. 52(3): 486 (1969).

*Notes*: *Veronaeopsis* is similar to *Veronaea* in its 1-septate conidia. *Veronaeopsis* differs from *Veronaea* based on its much shorter, macronematous conidiophores and conidiogenous cells. Furthermore, *Veronaeopsis* has a geniculate rachis and *Veronaea* has a more or less straight rachis (Arzanlou et al. 2007).

*Verruconis* Samerp., H.J. Choi, van den Ende, Horré & de Hoog, Fungal Diversity 65: 117 (2014).

*Index Fungorum number*: IF 519169; *Facesoffungi number*: FoF 06351; – 9 morphological species (Species Fungorum 2020), 9 species with molecular data.

*Type species*: *Verruconis gallopava* (W.B. Cooke) Samerp. & de Hoog, in Samerpitak, Van der Linde, Choi, Gerrits van den Ende, Machouart, Gueidan & de Hoog, Fungal Diversity 65: 117 (2013) [2014].

≡ *Diplorhinostrichum gallopavum* W.B. Cooke, in Georg, Bierer & Cooke, Sabouraudia 3: 242 (1964).

*Notes*: *Verruconis* are dematiaceous hyphomycetes characterized by clavate to cylindrical, two-celled conidia (Samerpitak et al. 2014). *Verruconis hevea* is illustrated below.

*Verruconis heveae* Huanraluek., Senwann., Jayaward. & K.D. Hyde, in Huanraluek et al., Phytotaxa 403(1): 50 (2019).

*Index Fungorum number*: IF 555289; *Facesoffungi number*: FoF 04838, Fig. 91

*Description*: see Huanraluek et al. (2019b).

*Material examined*: Thailand, Phayao Province, on dried latex of rubber, *Hevea brasiliensis* (*Euphorbiaceae*), 1 November 2016, C. Senwann M2 (MFLU 17-1578, **holotype**).

*Yunnanomyces* Tibpromma & K.D. Hyde, Fungal Diversity: 92: 75 (2018).

*Index Fungorum number*: IF 555334; *Facesoffungi number*: FoF 04518; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: *Yunnanomyces pandanicola* Tibpromma & K.D. Hyde, in Tibpromma et al., Fungal Diversity 93:75 (2018).

*Notes*: *Yunnanomyces* is characterized by globose to broadly oval and yellow–brown, muriform conidia (Zang et al. 2019). It is similar to *Pseudocoleodictyospora* reported from teak (Doilom et al. 2017), but phylogenetic analysis of *Yunnanomyces* does not support its placement in *Pseudocoleodictyosporaceae*. *Yunnanomyces* differs from *Fusicladium* and *Verruconis* based on characters of conidiophores and conidia (Tibpromma et al. 2018b).

### Economic and ecological significance

*Ochroconis* species are opportunistic pathogens which cause diseases of vertebrate animals and humans. *Ochroconis humicola* is the causal agent of muscular black spot disease of Atlantic salmon (Schaumann and Priebe 1994). *Verruconis gallopava* was considered to be the source of several zoonoses in broiler house chickens and trumpeters. Horré et al. (1999) have listed 13 brain infections in young birds and one in a cat brain (Samerpitak et al. 2014).

*Venturiaceae* E. Müll. & Arx ex M.E. Barr, Mycologia 71(5):947 (1979).

*Index Fungorum number*: IF 81516; *Facesoffungi numbers*: FoF 06352, 217 species.

*Saprobic* or *parasitic* on leaves or stems usually on dicotyledons, sometimes on monocotyledons. **Sexual morph**: *Ascomata* superficial or immersed or slightly erumpent at maturity, scattered or gregarious, single locules in a stroma or below a blackened clypeus, globose to subglobose, membranous or carbonaceous, usually with seta or without seta, ostiolate, sometimes occurring on a well-developed subiculum with *ascomata*. *Peridium* comprising a pigmented single cell layer of *textura angularis*. *Hamathecium* comprising branched, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, evanescent, broadly or usually obclavate or cylindrical, with or without short pedicel, ocular chamber distinct. *Ascospores* uni-seriate or overlapping 2-seriate, cylindrical to ellipsoidal, with broadly rounded apex, hyaline or light greenish, or pale yellow to brown, 1-septate upper cell shorter and broader than lower one. **Asexual morph**: Hyphomycetous. *Conidiophores* pigmented, singly or in

clusters, simple or branched. *Conidiogenous cells* integrated, terminal or sometimes intercalary, proliferating sympodially or percurrently, with conspicuous annellations *Conidia* solitary or arranged as chains, pigmented, aseptate or septate.

*Type: Venturia* Sacc.

*Notes: Venturiaceae* comprises 12 genera (Wijayawardene et al. 2018). The members of this family are characterized by having sphaerical superficial or erumpent ascomata comprising elongated or oblong or nearly cylindrical, bitunicate, 8-spored asci and 2-celled, symmetric or asymmetric ascospores, which are hyaline or pale green when immature and olive-brown or greyish green, or rarely dark brown at maturity (Li et al. 2014). Crous et al. (2018b) included *Cylindrosyndium*, *Pseudoanungitea*, *Sympodiella*, *Tothia*, and *Repetophragma* in *Venturiaceae* based on their phylogenetic analyses without including all genera of the family in their analyses. In our analyses (Fig. 90), we included all genera that have sequence data and found that the main clade of *Venturiaceae* comprises species of *Apiosporina*, *Caproventuria*, *Coleroa*, *Dimerosporiopsis*, *Metacoleroa*, *Protoventuria*, *Tyrannosorus*, and *Venturia* with high support (99% ML, 1.0 BYPP). *Cylindrosyndium*, *Pseudoanungitea*, *Sympodiella*, *Tothia*, and *Repetophragma* cluster together as a sister clade with the main clade of *Venturiaceae* with low support, but sometimes in other analyses, these genera did not cluster with members of the family (data not shown). We presume that this separate clade can be a new family in Venturiales, and tentatively accept *Cylindrosyndium*, *Pseudoanungitea*, and *Sympodiella* in *Venturiaceae* as their type species cluster within this clade. More sequence data are needed to confirm this clade as a new family. The placement of *Repetophragma* is not clear as the sequence data of type species is unavailable, thus we follow Wijayawardene et al. (2020) and place it in Pleosporales genera *incertae sedis*. We exclude *Tothia* from *Venturiaceae* base on its morphology (thyriothecial ascomata), and place the genus in Microthyriales genera *incertae sedis*.

*Venturia* Sacc., Syll. fung. (Abellini) 1: 586 (1882).

*Index Fungorum number:* IF 5717; *Facesoffungi number:* FoF 06353; 123 morphological species (Species Fungorum 2020), 58 species with molecular data.

*Type species: Venturia inaequalis* (Cooke) G. Winter.

≡ *Sphaerella inaequalis* Cooke, J. Bot., Lond. 4: 248 (1866).

*Notes: Venturia* species can be distinguished by separate or aggregated ascomata with or without stroma, or forming below a blackened clypeus, symmetrical or asymmetrical, olive green, pale brown or dark brown ascospores and being parasitic on leaves or stems of dicotyledons (Zhang et al. 2011).

#### Other genera included

*Apiosporina* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 119: 439 (1910).

*Index Fungorum number:* IF 266; *Facesoffungi number:* FoF 06354; – 3 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Apiosporina collinsii* (Schwein.) Höhn.

*Notes: Apiosporina* species are characterized by erumpent, subglobose, black ascomata, 8-spored bitunicate, subcylindrical or broadly clavate asci and hyaline to pale brown, clavate apiospores (Zhang et al. 2011). The asexual morph of *A. collinsii* was reported as *Cladosporium* sp. (Sivanesan 1984) and it was assigned as *Fusicladium sensu lato* by Braun et al. (2003). *Dibotryon* had been treated as a synonym of *Apiosporina* (von Arx and Müller 1975; Crous et al. 2007b). Although the black knots on branches of *Prunus cultis* formed by *Dibotryon morbosum* can readily be distinguished from the black spots on leaves formed by *Apiosporina*, their congeneric relationship was confirmed by molecular data (Winton et al. 2007). Sequence data are available for *Apiosporina collinsii* and *Apiosporina morbosa*.

*Apiosporina collinsii* (Schwein.) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 119: 439 (1910).

≡ *Sphaeria collinsii* Schwein., Trans. Am. phil. Soc., New Series 4(2): 211 (1832) [1834].

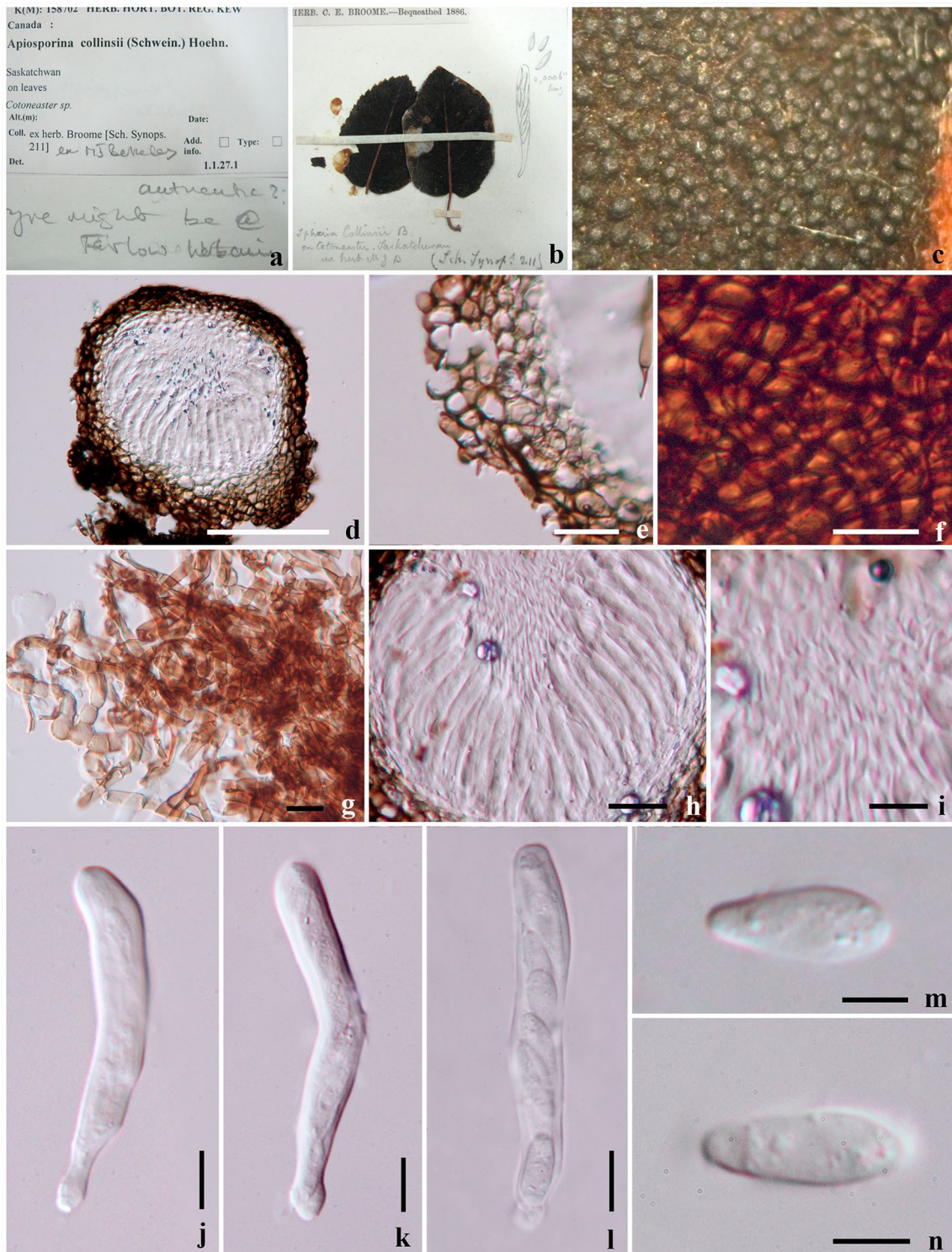
*Index Fungorum number:* IF 122234; *Facesoffungi number:* FoF 06355; Fig. 92

*Parasitic* on leaves, stems petioles, buds and flowers appearing as black dots like areas. **Sexual morph:** *Ascomata* 150–200 high × 150–200 diam.  $\mu\text{m}$  ( $\bar{x}$  = 194 × 195  $\mu\text{m}$ , n = 10) small, gregarious, superficial, globose to subglobose, developing on a dark hyphal mass, easily removed from the substrate, small papillate and ostiolate. *Hypha* 4  $\mu\text{m}$  wide, pale brown to dark brown, branched, septate. *Peridium* thin-walled, composed of three layers, dark brown to hyaline cells of *textura angularis*. *Hamathecium* comprising 4  $\mu\text{m}$  wide, rare, septate, cellular pseudoparaphyses. *Asci* 7–9 × 55–65  $\mu\text{m}$  ( $\bar{x}$  = 7.8 × 62.2  $\mu\text{m}$ , n = 10), 8-spored, bitunicate to narrowly obclavate, cylindrical, with a short, thick, furcate or knob-like pedicel or pedicel lacking. *Ascospores* 4–6 × 12–15  $\mu\text{m}$  ( $\bar{x}$  = 5.1 × 13.4  $\mu\text{m}$ , n = 10), uni-seriate and partially overlapping, ovoid to narrowly ovoid, hyaline to pale brown, apiosporous, 1-septate near the lower end, barely constricted at the septum, verrucose. **Asexual morph:** *Cladosporium* sp. (Sivanesan 1984).

*Material examined:* Canada, Saskatchewan, on leaves of *Cotoneaster* sp. (K(M):158702, ex herb. Broome).

*Atopospora* Petr., Anns mycol. 23(1/2): 100 (1925).

*Index Fungorum number:* IF 450; *Facesoffungi number:* FoF 06356; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.



**Fig. 92** *Apiosporina collinsii* (K(M):158702). **a, b** Herbarium specimens. **c** Ascomata on host substrate. **d** Cross section of ascoma. **e** Peridium. **f** Wall of ascoma composed darkly pigmented cells. **g**

Hyphal mass. **h** Arrangement of hamathecium. **i** Pseudoparaphyses. **j–l** Asci. **m, n** Ascospores. Scale bars: **d** = 100  $\mu$ m, **e, g, h** = 20  $\mu$ m, **f, i–l** = 10  $\mu$ m, **m, n** = 5  $\mu$ m

*Type species: Atopospora betulina* (Fr.) Petr., *Annlis mycol.* 23(1/2): 101 (1925).

$\equiv$  *Xyloma betulinum* Fr., *Observ. mycol. (Havniae)* 1: 198 (1815).

*Notes:* The multiloculate ascostromata, fusoid asci and lightly pigmented, bi-seriate, apiospores are the main characteristics that allows its placement in the family *Venturiaceae* (Müller and von Arx 1962).

**Caproventuria** U. Braun, Monogr. *Cercosporiella*, *Ramularia* Allied Genera (Phytopath. Hyphom.) 2: 396 (1998).

*Index Fungorum number:* IF 27882; *Facesoffungi number:* FoF 06357; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Caproventuria hanliniana* (U. Braun & Feiler) U. Braun, Anns mycol. 23(1/2): 101 (1925).

≡ *Capronia hanliniana* U. Braun & Feiler, Microbiol. Res. 150(1): 90 (1995).

*Notes:* Species of *Caproventuria* are characterized by astromatic, papillate, ostiolate ascostromata with aseptate dark brown setae and 8-spored bitunicate asci with yellowish olivaceous monostichous or distichous and ellipsoidovoid ascospores (Zhang et al. 2011). Crous et al. (2007b) and Seifert et al. (2011) suggested *Pseudocladosporium* as a synonym of *Fusicladium*. However, Zhang et al. (2011) concluded *Pseudocladosporium* to be asexual morph of *Caproventuria*. We accept *Pseudocladosporium* as asexual morph of *Caproventuria*, but this needs confirmation by phylogenetic analyses. In our phylogenetic analysis, *Caproventuria hanliniana* (CBS 588.93, type material) was observed to be phylogenetically distant from *Venturiaceae* (data not shown), while the strain ATCC 96019 is related to *Tyrannosorus* in *Venturiaceae*. We tentatively place this genus in *Venturiaceae* until more collections and sequence data are available to resolve its taxonomic placement.

**Coleroa** Rabenh., Klotzschii Herb. Viv. Mycol., Edn 1: no. 1456 (in sched.) (1850).

*Index Fungorum number:* IF 1174; *Facesoffungi number:* FoF 06358; – 30 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Coleroa chaetomium* (Kunze) Rabenh., Rabenh. Krypt.-Fl., Edn 2 (Leipzig) 1: 198 (1850).

≡ *Dothidea chaetomium* Kunze, Syst. mycol. (Lundae) 2(2): 563 (1823).

*Notes:* The scattered, setose ascostromata, deliquescent pseudoparaphyses, fusoid to obclavate asci and 1-septate, constricted ascospores are similar characters to other genera of *Venturiaceae*. However, the 1-septate ascospores with a pale brown to greenish tint, separates this genus (Zhang et al. 2011).

**Cylindrosymposium** W.B. Kendr. & R.F. Castañeda, in Castañeda Ruiz & Kendrick, Univ. Waterloo Biol. Ser. 32: 9 (1990).

*Index Fungorum number:* IF11257; *Facesoffungi number:* FoF 09215; – 12 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Cylindrosymposium variabile* (de Hoog) W.B. Kendr. & R.F. Castañeda, in Castañeda Ruiz & Kendrick, Univ. Waterloo Biol. Ser. 32: 10 (1990).

≡ *Subulispora variabilis* de Hoog, Stud. Mycol. 26: 56 (1985).

*Notes:* Species of *Cylindrosymposium* are characterized by cylindrical, hyaline or sub hyaline, erect conidiophores with cylindrical, septate hyaline conidia. Conidiogenous cells are conspicuous, flat-topped denticles and extended sympodially reduced from conidiophores (Paulus et al. 2003). In our analyses (Fig. 90), we tentatively accept this genus in *Venturiaceae* based on the sequence data of type species. However, the clade contains *Cylindrosymposium* is unstable within *Venturiales*, thus more sequence data are needed to clarify its placement within *Venturiales*.

**Dimeriella** Speg., Revta Mus. La Plata 15(2): 12 (1908).

*Index Fungorum number:* IF 1575; *Facesoffungi number:* FoF 06359; – 25 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Dimeriella hirtula* Speg., Revta Mus. La Plata 15(2): 12 (1908).

*Notes:* *Dimeriella* is a plant pathogenic genus characterized by brown ascospores and brown, superficial mycelium. This mycelium forms pale-coloured hyphal clumps and penetrate via hyaline hyphae through sub-stomatal chamber to the mesophyll (Farr 1965).

**Dimerosporiopsis** Henn., Hedwigia 40(Beibl.): (173) (1901).

*Index Fungorum number:* IF 1588; *Facesoffungi number:* FoF 08832; – 2 morphological species (Species Fungorum 2020; Crous et al. 2019b), 1 species with molecular data.

*Type species: Dimerosporiopsis engleriana* (Henn.) Henn., Hedwigia 40(Beibl.): (173) (1901).

≡ *Dimerosporium englerianum* Henn., Bot. Jb. 17: 31 (1893).

*Notes:* *Dimerosporiopsis* is similar to other genera such as *Proventuria* in having superficial pseudothecia with pseudoparaphyses, cylindrical asci and pale olivaceous 1-septate ascospores. However, this genus differs from other genera in having pluri-guttulate ascospores (Crous et al. 2019b).

**Magnohelicospora** R.F. Castañeda, Hern.-Restr., Gené & Guarro, Mycotaxon 121: 172 (2013).

*Index Fungorum number:* IF 563847; *Facesoffungi number:* FoF 06360; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Magnohelicospora iberica* R.F. Castañeda, Hern.-Restr., Gené & Guarro, in Castañeda-Ruiz et al., Mycotaxon 121: 172 (2013) [2012].

*Notes:* Members of *Magnohelicospora* can be distinguished by polyblastic, integrated, sympodial conidiogenous cells and solitary, doliiform or conical, multi-euseptate, brown conidia, tightly coiled in three planes (Castañeda-Ruiz et al. 2013).

**Metacoleroa** Petr., Anns mycol. 25(3/4): 332 (1927).

*Index Fungorum number:* IF 3139; *Facesoffungi number:* FoF 06361; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Metacoleroa dickiei* (Berk. & Broome) Petr. [as ‘dieckiei’], Anns mycol. 25(3/4): 332 (1927) [as ‘dieckiei’], Anns mycol. 25(3/4): 332 (1927).

≡ *Sphaeria dickiei* Berk. & Broome, Ann. Mag. nat. Hist., Ser. 2 9: 317 (1852).

*Notes:* *Metacoleroa* is a monotypic genus characterized by ascomata produced on well-defined subiculum, not cupulate when dry and olivaceous brown ascospores at maturity (Zhang et al. 2011). No mature ascomata were found on the specimen examined by Crous et al. (2007b).

**Neocoleroa** Petr., Hedwigia 74: 38 (1934).

*Index Fungorum number:* IF 3446; *Facesoffungi number:* FoF 06362; – 3 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Neocoleroa sibirica* Petr., Hedwigia 74: 38 (1934).

*Notes:* *Neocoleroa* is characterized by lobed to dichotomously branched, blunt-tipped setae and persistent pseudoparaphyses. Recent authors have used morphology to accommodate *Neocoleroa* in *Pseudoperisporiaceae* (e.g. Barr 1997, Kirk et al. 2008), although it was noted that these taxa are similar to *Venturiaceae* (Johnston and Park 2016).

**Protoventuria** Berl. & Sacc., Atti Soc. Veneto-Trent. Sci. Nat. 10(1): 174 (1887).

*Index Fungorum number:* IF 4399; *Facesoffungi number:* FoF 06363; – 19 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species: Proventuria rosae* De Not., G. bot. ital. 1(1): 332 (1844).

*Notes:* *Proventuria* is characterized by superficial ascomata developing on dead leaf tissues, sparse aerial mycelium, a subcuticular hypostroma and penetrating, intramatrical hyphae (Carris and Poole 1993).

**Pseudoanungitea** Crous, in Crous et al., Fungal Systematics and Evolution 1: 199 (2018).

*Index Fungorum number:* IF 824789; *Facesoffungi number:* FoF 08833; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Pseudoanungitea syzygii* (Crous, W.B. Kendr. & M.J. Wingf.) Crous, in Crous, et al., Fungal Systematics and Evolution 1: 199 (2018).

≡ *Anungitea syzygii* Crous, W.B. Kendr. & M.J. Wingf., Can. J. Bot. 73(2): 225 (1995).

*Notes:* Species of *Pseudoanungitea* are similar in characters to *Anungitea* in having dark, solitary conidiophores with flattened denticle heads and 1-septate, subhyaline conidia forming as a cylindrical chain with apical and basal scars (Crous et al. 2018b).

**Pseudoparodiella** F. Stevens, Illinois Biol. Monogr. (Urbana) 11(2): 166 (1927).

*Index Fungorum number:* IF 4467; *Facesoffungi number:* FoF 06364; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Pseudoparodiella vernoniae* F. Stevens, Illinois Biol. Monogr. (Urbana) 11(no. 2): 166 (1927).

*Notes:* *Pseudoparodiella* is similar with other genera in having smaller ascomata with or without pseudoparaphyses, obclavate asci and 1-septate, olivaceous brown ascospores (Zhang et al. 2011). However, this genus differs from the similar genus *Acantharia* in having mature pale brown ascospores (Zhang et al. 2011). Ascomata consisting of rare pseudoparaphyses and obclavate asci 1-septate, olivaceous brown ascospores showing a close affinity with *Venturiaceae* (Zhang et al. 2011).

**Sympodiella** W.B. Kendr., Trans. Br. mycol. Soc. 41(4): 519 (1958).

*Index Fungorum number:* IF10151; *Facesoffungi number:* FoF 09216; – 7 morphological species (Species Fungorum 2020), 4 species with molecular data.

*Type species: Sympodiella acicola* W.B. Kendr., Trans. Br. mycol. Soc. 41(4): 519 (1958).

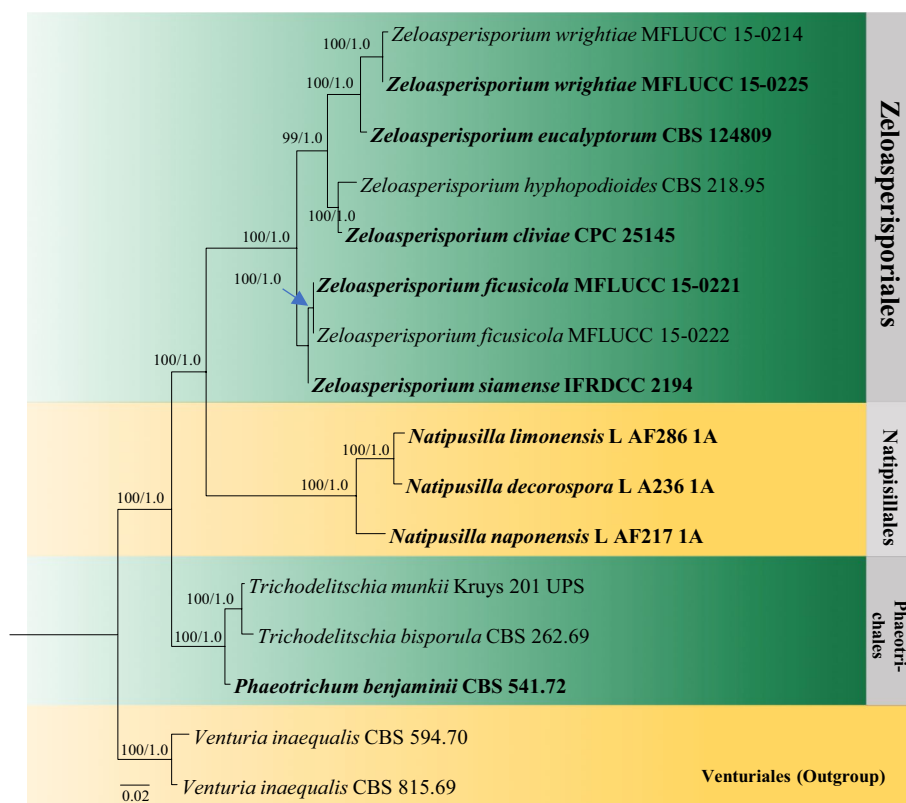
*Notes:* *Sympodiella* is characterized by superficial networks of darkly pigmented, septate, anastomosing hyphae. Conidiophores are simple, septate, and darkly pigmented except at the extreme apex and conidia are cylindrical, smooth-walled and hyaline (Kendrick 1958).

**Tyrannosorus** Unter. & Malloch, Mycol. Res. 99(8): 910 (1995).

*Index Fungorum number:* IF 11631; *Facesoffungi number:* FoF 06365; – 1 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species: Tyrannosorus pinicola* (Petrini & P.J. Fisher) Unter. & Malloch, Mycol. Res. 99(8): 910 (1995).

**Fig. 93** Phylogram generated from maximum likelihood analysis (RAxML) of genera in Zeloasporiales based on LSU and SSU sequence data. Maximum likelihood bootstrap values equal or above 70%, Bayesian posterior probabilities equal or above 0.90 (MLBS/PP) are given at the nodes. An original isolate number is noted after the species name. The tree is rooted to *Venturia inaequalis* (CBS 594.70, CBS 815.69). The ex-type strains are indicated in bold. Hyphen (-) represents support values below 70% MLBS and 0.90 PP



≡ *Capronia pinicola* Petrini & P.J. Fisher, in Müller et al., Trans. Br. mycol. Soc. 88(1): 68 (1987).

**Notes:** *Tyrannosorus* was introduced as a monotypic genus. *Helicodendron* is considered as the asexual morph (Untereiner et al. 1995). This genus differs from other genera in having a helicosporeous asexual morph and longitudinally ridged ascospores with multiple germ slits (Zhang et al. 2011).

### Economic and ecological significance

Most species in *Venturiaceae* are saprobic or parasitic. They are capable of growing in living or dead leaves, stalks, or twigs of various higher plants, rarely on *Sphagnum* or dung. Some are important plant pathogens which have a cosmopolitan distribution causing diseases of perennial plants, such as apple scab (*Venturia inaequalis*), pear scab (*V. pyrina*), poplar shoot blight (*V. populina*), soybean black leaf blight (*Arkoala nigra*), and the widespread black knot disease of cherry (*Dibotryon morbosum*) (von Arx and Müller 1975; Talbot 1971). *Apiospora mabosa* is another important pathogenic species causing black knot disease of *Prunus*, mainly affecting cultivated plum, prune and cherry and to a lesser extent wild plum and cherry (Snover and Arneson 2002).

**Zeloasporiales** Hongsanan & K.D. Hyde.

**Index Fungorum number:** IF 551336; **Facesoffungi number:** FoF 551336.

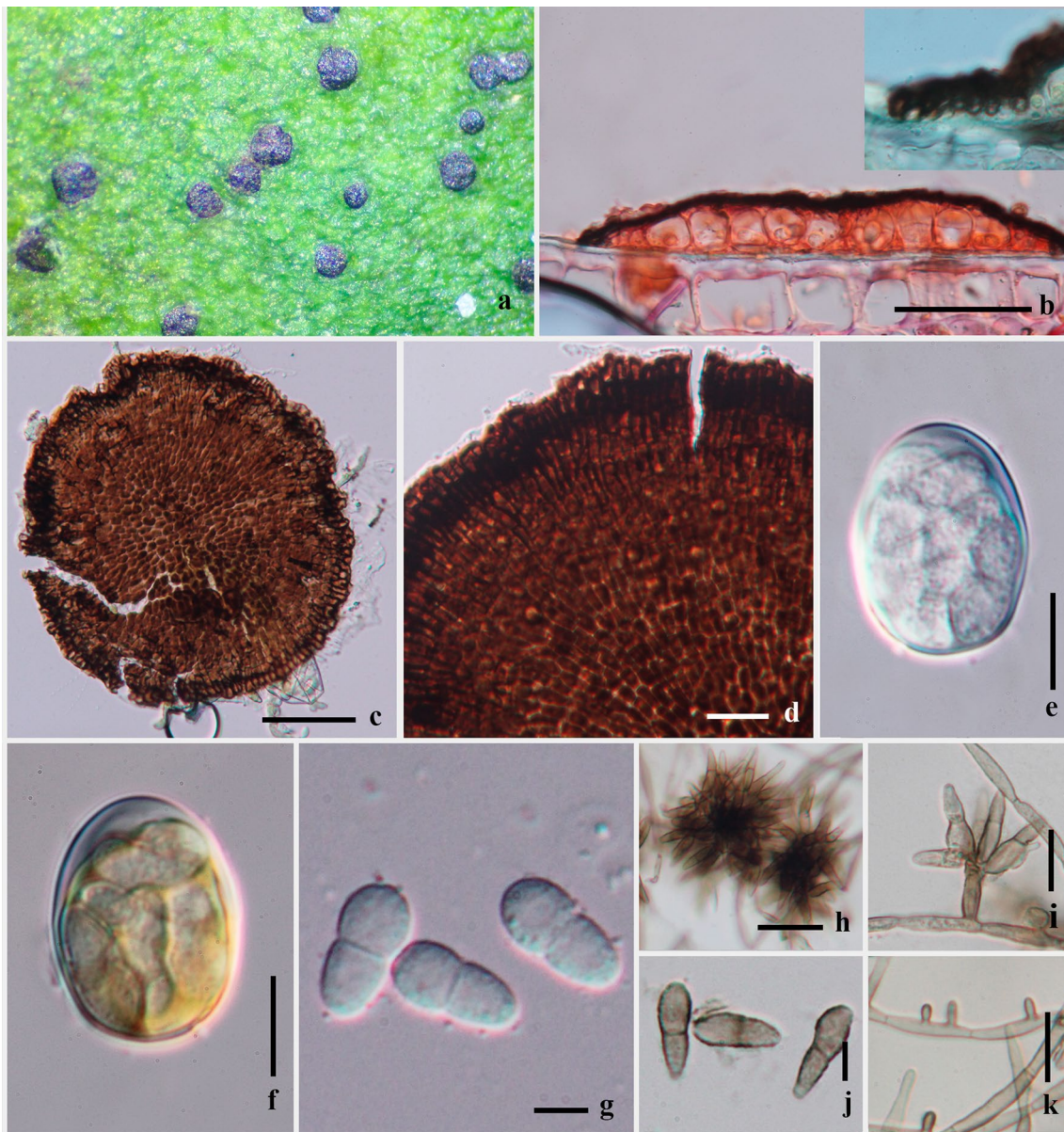
The order was established by Hongsanan et al. (2015b) to accommodate *Zeloasporiaceae*. Previous phylogenetic analyses using LSU and SSU sequence data indicated that this order is a distinct lineage from Microthyriales within Dothideomycetes, and formed as a sister clade to freshwater order Natipusillales. Morphologically, this order is very different from Natipusillales. Therefore, the order status of Zeloasporiales is strongly supported by both phylogeny and morphology (Figs. 93 and 94). The divergence time for Zeloasporiales is estimated as 180 MYA (stem age, Hongsanan et al. 2020).

**Accepted families:** *Zeloasporiaceae*.

**Zeloasporiaceae** Crous, Persoonia 34: 215 (2015).

**Index Fungorum number:** IF 812487; **Facesoffungi number:** FoF 08834, 8 species.

**Epiphytic** on the surface of living and dead fallen leaves, appearing as small black dots, or in air. **Superficial hyphae** absent. **Sexual morph:** *Thyriothecia* superficial, solitary, circular, flattened, brown to dark brown, poorly developed at the base, ostiole lacking. **Upper wall** comprises ellipsoid angular cells, radiating from the center to the outer rim. **Hamathecium** pseudoparaphyses not observed. **Asci** 8-spored, bitunicate, fissionate, globose to ovoid or clavate, apedicellate, with an apical ocular chamber. **Ascospores** 2–3-seriate, obovoid to clavate, hyaline, 1-septate, slightly constricted at the septum, wider in upper cell,



**Fig. 94** *Zeloasperisporium wrightiae* (MFLU 15-1308, **holotype**). **a** Thyriothecia on host surface. **b** Section through thyriothecium and close-up of margin. **c** Thyriothecium in squash mount. **d** Upper wall of thyriothecium in squash mount. **e** Ascus. **f** Ascus in Melzer's

reagent. **g** Ascospores. **h** Crowded conidia on conidiogenous cells. **i** Conidia on conidiogenous cell with sympodial proliferation. **j** Conidia. **k** Micronematous conidiogenous cells. Scale bars: **b**, **c** = 50  $\mu$ m, **d–f**, **h**, **i**, **k** = 10  $\mu$ m, **g**, **j** = 5  $\mu$ m

smooth-walled or verrucose, with or without thin mucilaginous sheath (Wu et al. 2011b; Crous et al. 2015b). **Asexual morph:** Hyphomycetous. *Hyphae* branched, septate, and swollen by constrictions at the septa, pale brown to brown, occasionally hyaline, smooth-walled, micronematous conidiogenous present or absent. *Conidiophores* reduced to conidiogenous cells, arising as lateral hyphal branches, cylindrical to subcylindrical, straight or slightly curved, unbranched, slightly tapering towards the apex, brown, slightly thick-walled. *Conidial proliferation* sympodial, with one to several

conidiogenous loci, mostly crowded at the apex, protuberant or thickened, refractive, conidial scars. *Conidia* fusiform to obclavate or cylindrical, straight to curved, pale brown to brown, 1–3-septate, distinctly or slightly constricted at the septum, tapered towards the apex, towards a protruding scar, somewhat thickened and darkened, refractive, smooth-walled or verrucose (Hongsanant et al. 2015b).

*Type:* *Zeloasperisporium* R.F. Castañeda.

*Notes:* *Zeloasperisporiaceae* was established by Crous et al. (2015b) to accommodate *Neomicrothyrium* (sexual

genus *Microthyrium*-like) and *Zeloasperisporium* (asexual genus). This family was poorly resolved in molecular analysis as it is related to freshwater taxa in Natipusillales, and morphology of *Zeloasperisporiaceae* is very different from Natipusillales (Ferrer et al. 2011; Wu et al. 2011b). Hongsanan et al. (2015b) linked morphs and synonymized *Neomicrothyrium* under *Zeloasperisporium*. Moreover, they introduced the new order, Zeloasperisporiales to accommodate *Zeloasperisporiaceae* based on its distinct clade within Dothideomycetes.

***Zeloasperisporium*** R.F. Castañeda, Mycotaxon 60: 284 (1996).

*Index Fungorum number*: IF 27808; *Facesoffungi number*: FoF 08835; 8 morphological species (Species Fungorum 2020), 8 species with molecular data

*Type species*: ***Zeloasperisporium hyphopodioides*** R.F. Castañeda.

*Notes*: *Zeloasperisporium* was introduced as genus *incertae sedis* by Castañeda-Ruíz et al. (1996), with the type species *Z. hyphopodioides* isolated from air in Cuba. Crous et al. (2007b) placed this genus in *Venturiaceae* based on phylogenetic placement basal to *Venturiaceae*. Two species from leaves of *Eucalyptus* and *Clivia* were introduced based on asexual characters and molecular data (Cheewangkoon et al. 2009; Crous et al. 2015b). Hongsanan et al. (2015b) linked the sexual morph genus (*Neomicrothyrium*) with *Zeloasperisporium* and added two new species to this genus. Phylogenetic analyses strongly support species of *Zeloasperisporium* as a distinct family and order (Hongsanan et al. 2015b).

***Zeloasperisporium wrightiae*** Hongsanan & K.D. Hyde, in Hongsanan et al., Cryptog. Mycol. 36(3): 310 (2015).

*Index Fungorum number*: IF 551313; *Facesoffungi number*: FoF 551313, Fig. 94

*Description*: see Hongsanan et al. (2015b).

*Material examined*: Thailand, Chiang Rai, Tasud, Mae Fah Luang University, on leaves of *Wrightia eligiosa* Benth. (*Apocynaceae*), 15 January 2015, S. Hongsanan MOK01 (MFLU 15-1308, **holotype**).

### Economic and ecological significance

Species of *Zeloasperisporiaceae* are usually found on living and dead fallen leaves, and rarely sampled in air. Species found on leaves sometimes produce organs to attach the surface of host plants at the ascomatal margin. However, it does not reveal any penetration of the host (Hongsanan et al. 2015b). The appearance of *Zeloasperisporiaceae* on leaves as a few small black dots is not a serious problem.

### Dothideomycetes, families *incertae sedis*

In this section we include families that cannot be accommodated in orders of Dothideomycetes, mainly because they lack molecular data. However, since they have a suite of characters that exclude them from other families, they are accepted as distinct families.

***Alinaceae*** Boonmee & K.D. Hyde, in Boonmee et al., Mycosphere 8(10): 1699 (2017).

*Index Fungorum number*: IF 553826; *Facesoffungi number*: FoF 03661, 1 species.

*Parasitic or epiphytic* on living leaves. **Sexual morph**: *Ascomata* superficial, developed on hyphae, globose to subglobose, brown, covered by brown hyphae. *Peridium* comprises brown cells of *textura angularis*, lacking pseudo-paraphyses. *Asci* 8-spored, bitunicate, subglobose to clavate, sessile, thick-walled. *Ascospores* overlapping, ovoid to obovoid, apex wider, narrower towards the lower and rounded end, brown, 1-septate. **Asexual morph**: Hyphomycetous, *Septoidium* sp., *Shivomyces* sp. (adapted from Boonmee et al. 2017).

*Type*: ***Alina*** Racib.

*Notes*: Boonmee et al. (2017) re-examined the ex-isotype of *Alina jasmini*, and concluded that the morphology of *Alina* has a set of characters that can differentiate it from other families in Dothideomycetes. Therefore, they introduced *Alinaceae* to accommodate the monotypic genus, *Alina* (Boonmee et al. 2017). Molecular data is unavailable to confirm its taxonomic placement.

***Alina*** Racib., Bull. int. Acad. Sci. Lett. Cracovie, Cl. sci. math. nat. Sér. B, sci. nat. 3: 374 (1909).

*Index Fungorum number*: IF 125; *Facesoffungi number*: FoF 07866; 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Alina jasmini*** Racib.

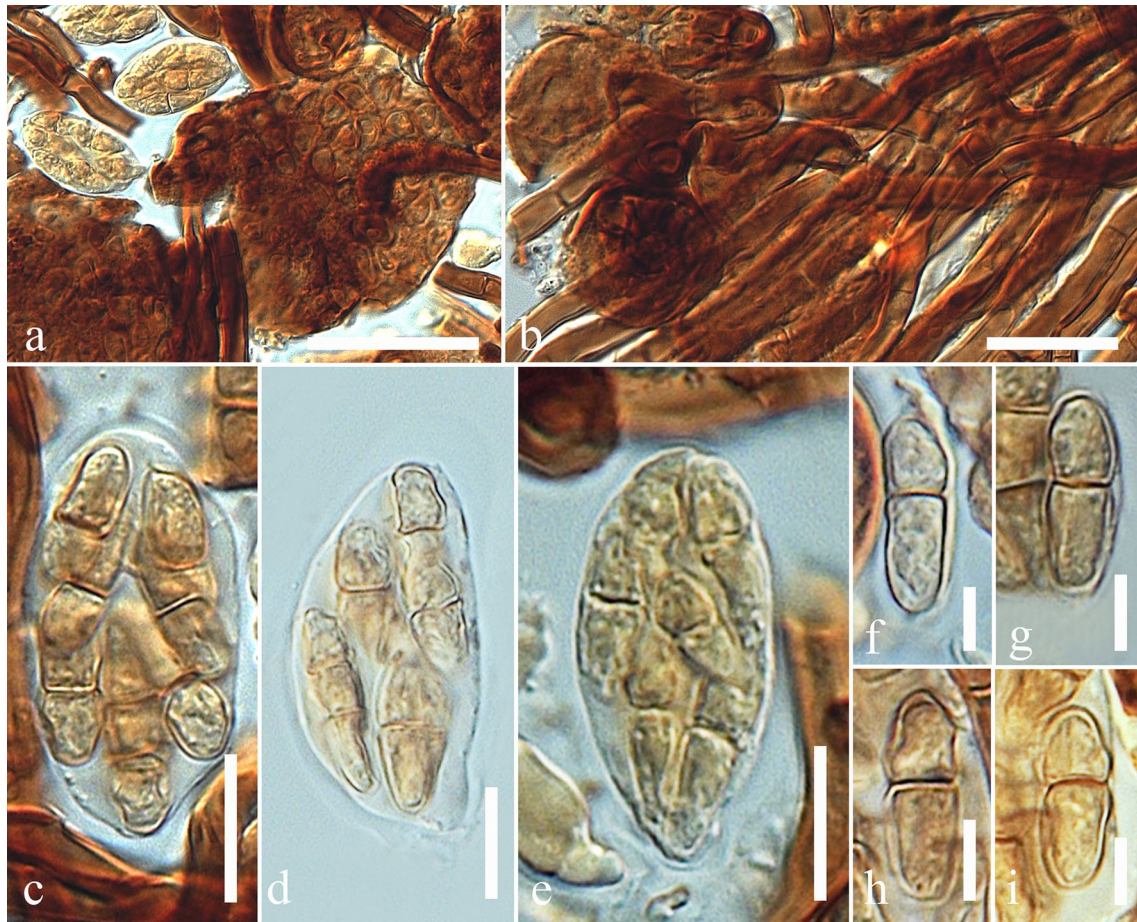
*Notes*: *Alina* was introduced from living leaves of *Jasminum* sp. *Alina* is similar to *Tretospora* (the asexual morph of *Balladynopsis*) based on some hyphomycetous conidial structures found on the ex-isotype of *Alina jasmini* (Sivanesan 1981). By re-examining the same specimen, Boonmee et al. (2017) reported that they were unable to find some structures e.g. setae, hyphopodia-like structures or even conidia as previously shown in Raciborski (1909) and Sivanesan (1981). They concluded that *Alina* has unique characters and could not be placed in any families in Dothideomycetes (Boonmee et al. 2017). Thus, they established *Alinaceae* to accommodate this genus.

***Alina jasmini*** Racib., Bull. int. Acad. Sci. Lett. Cracovie, Cl. sci. math. nat. Sér. B, sci. nat. 3: 375 (1909).

*Index Fungorum number*: IF 205013; *Facesoffungi number*: FoF 03662; Fig. 95

*Description*: see Boonmee et al. (2017).





**Fig. 95** *Alina jasmini* (IMI 214481, **ex-isotype**). **a** Squash mount of ascomata. **b** Mycelia. **c–e** Asci. **e–i** Ascospores. Scale bars: **a** = 20 µm, **b** = 50 µm, **c–e** = 10 µm

**Material examined:** Indonesia, Java, Djasinga, on living leaves of *Jasminum* sp. (*Oleaceae*), 1900, Raciborski M. (K(M) 177969 = IMI 214481, **ex-isotype**).

#### Economic and ecological significance

Species in *Alinaceae* are parasitic or epiphytic on living leaves, however they do not cause serious problem on plants.

**Argynnaceae** Shearer & J.L. Crane, Trans. Br. mycol. Soc. 75(2): 193 (1980).

**Index Fungorum:** IF 80470; **Facesoffungi numbers:** FoF 06386, 3 species.

**Saprobic** on plant stems or wood and in freshwater and terrestrial habitats. **Sexual morph:** *Ascomata* apothecial or perithecial, solitary, superficial to slightly immersed, discoid, dark brown to black, coriaceous, lacking ostioles, lacking a stipe. *Excipulum* thick, ectal excipulum composed of brown to dark brown tissues mixed with host cells, medullary excipulum composed of hyaline cells of *textura porrecta*. *Hymenium* composed of wide, septate, branching, hyaline, cellular pseudoparaphyses. *Epithecium* lacking. *Asci*

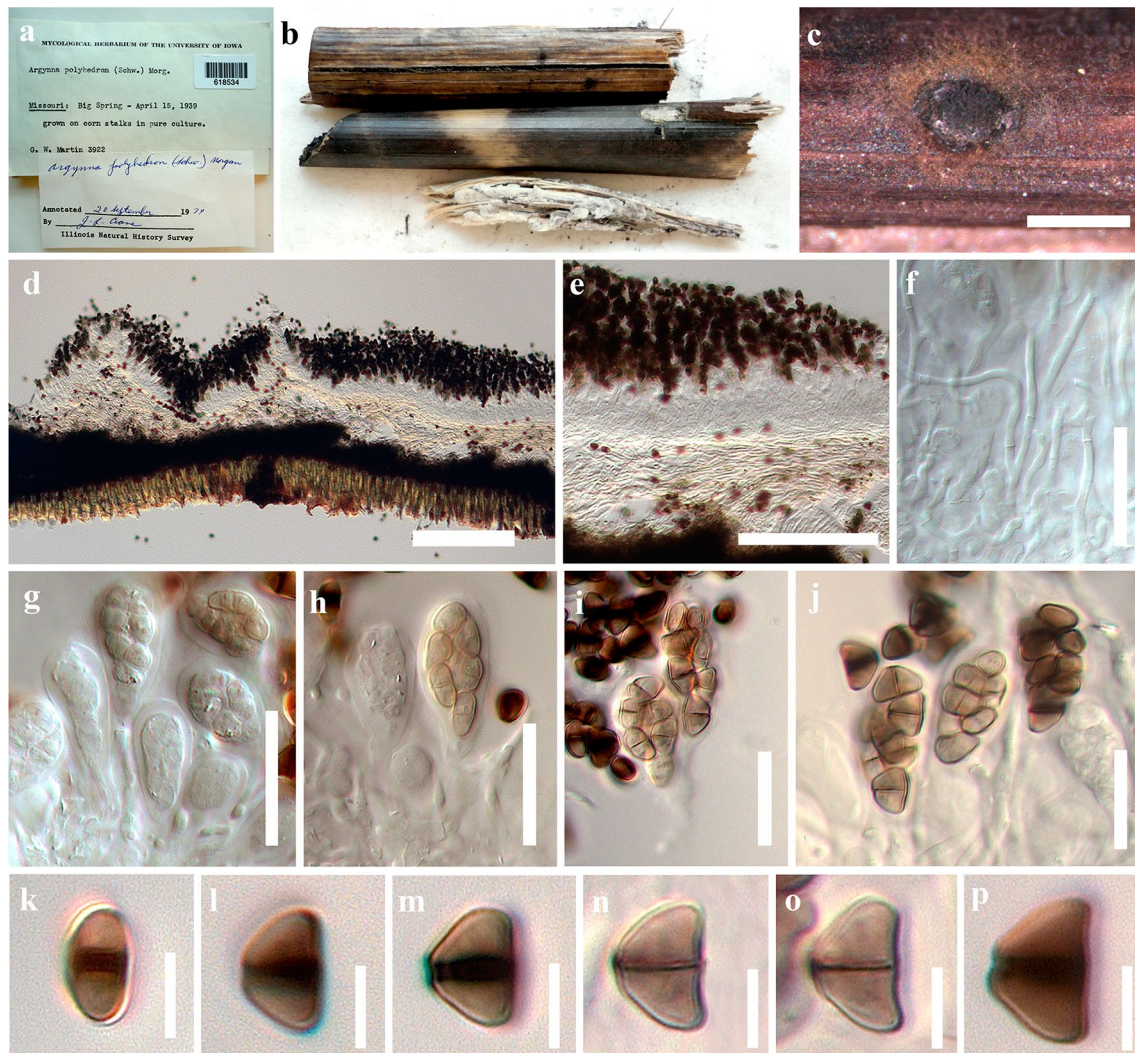
8-spored, bitunicate, fissitunicate, clavate, globose to subglobose, pedicellate, thick-walled, lacking an ocular chamber, exposed or not. *Ascospores* 2–3-seriate, or multi-seriate, papilionaceous to broadly reniform, light brown, orange to light orange-brown, 1-septate, smooth-walled, 2- to multi-guttulate, with a dark band at the septum. **Asexual morph:** Undetermined.

**Type:** *Argynna* Morgan.

**Notes:** *Argynnaceae* was introduced to accommodate two genera of *Argynna* and *Lepidopterella* (Hyde et al. 2013; Kirk et al. 2013; Wijayawardene et al. 2018). The species in *Argynnaceae* are saprobes and occurring on stems, twigs and woody debris from dicotyledonous and monocotyledonous plants. Additional collections and molecular study are required to clarify the phylogeny of this family.

**Argynna** Morgan, J. Cincinnati Soc. Nat. Hist. 18: 41 (1895).

**Index Fungorum number:** IF 306; **Facesoffungi numbers:** FoF 06387; 1 morphological species (Species Fungorum 2020), molecular data unavailable.



**Fig. 96** *Argynna polyhedron* (BPI 618534). **a** Material label. **b** Ascoma on the host substrate. **c** Ascoma. **d** Section of ascoma and peridium. **e** Hymenium. **f** Pseudoparaphyses. **g–j** Immature and

mature asci. **k–p** Papilionaceous ascospores. Scale bars: **c** = 1000  $\mu$ m, **d** = 200  $\mu$ m, **e** = 100  $\mu$ m, **f–j** = 20  $\mu$ m, **k–p** = 5  $\mu$ m

*Type species: Argynna polyhedron* (Schwein.) Morgan.

*Notes:* *Argynna* comprises a single species, *Argynna polyhedron* (Morgan 1895). The genus is characterized by solitary, superficial apothecia and 1-septate papilionaceous, light brown, smooth-walled ascospores with a dark band at the septum. *Argynna polyhedron* is a rare species and lacks molecular data to allow its taxonomic placement.

*Argynna polyhedron* (Schwein.) Morgan [as ‘polyedron’], J. Cincinnati Soc. Nat. Hist. 18: 41 (1895).

≡ *Physarum polyhedron* Schwein. [as ‘polyaedron’], Trans. Am. phil. Soc., New Series 4(2): 257 (1832) [1834].

*Index Fungorum:* IF 140004; *Facesoffungi number:* FoF 06388; Fig. 96

*Description:* see Hyde et al. (2013).

*Material examined:* USA, Missouri, Big Spring, on stalks of *Zea mays*, 15 April 1939, G.W. Martin (3922), BPI618534.

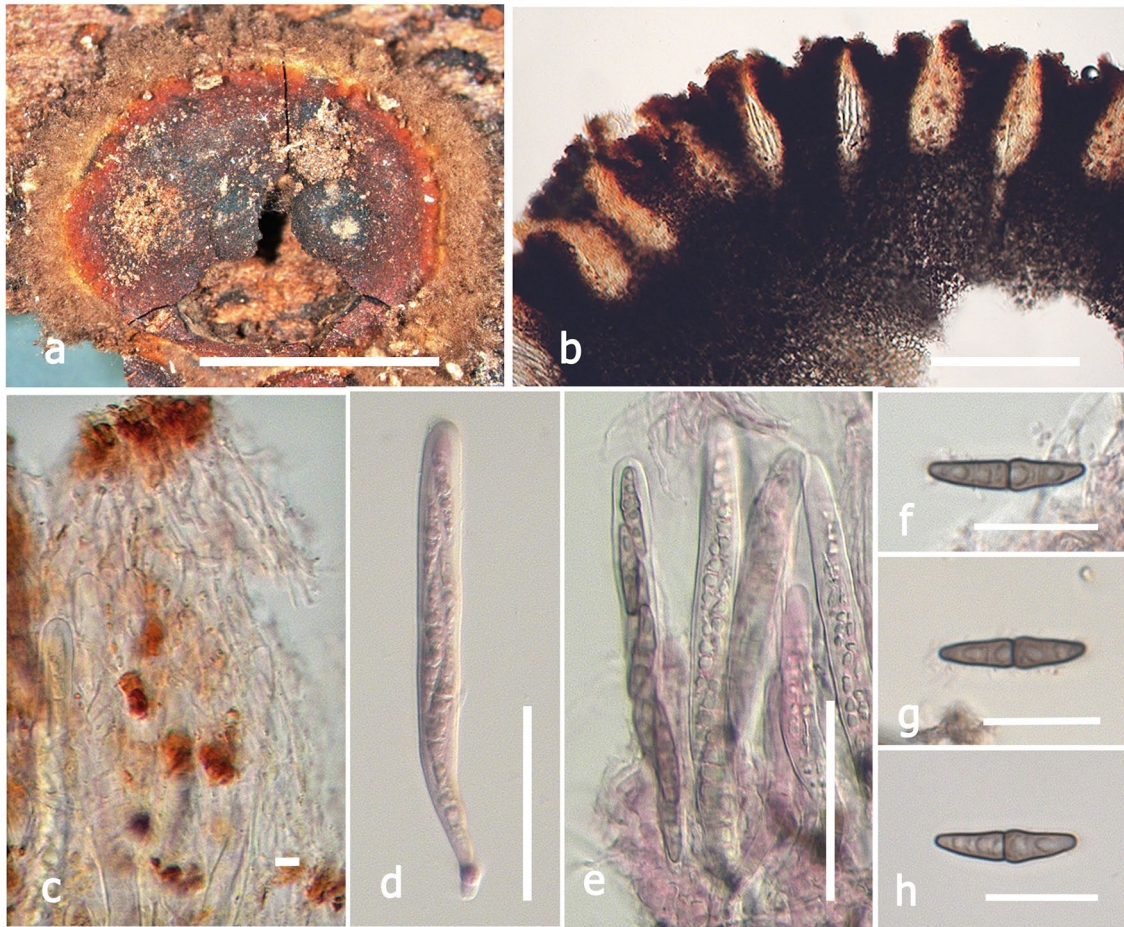
#### Other genera included

*Lepidopterella* Shearer & J.L. Crane, Trans. Br. mycol. Soc. 75(2): 194 (1980).

*Index Fungorum number:* IF 2746; *Facesoffungi numbers:* FoF 06389; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species: Lepidopterella palustris* Shearer & J.L. Crane, Trans. Br. mycol. Soc. 75(2): 194 (1980).

*Notes:* *Lepidopterella* was introduced by Shearer and Crane (1980) and placed in *Argynnaceae*. The asexual morph has not been reported. Species are saprobic fungi in aquatic habitats (Raja and Shearer 2008; Shearer et al. 2009;



**Fig. 97** *Ascoporia lateritia* (BPI 1109903). **a** Material, habit on decorticated wood and appearance of ascostroma on wood substrate. **b** Section of ascostroma showing arrangement of locules. **c** Hamathe-

cium pseudoparaphyses. **d, e** Asci changed to pinkish in 3% KOH. **f–h** Ascospores. Scale bars: **a** = 5 mm, **b** = 200 µm, **c** = 5 µm, **d, e** = 50 µm, **f–h** = 20 µm

Hyde et al. 2013). Sequence data are available for the type species, *Lepidopterella palustris*, and *L. tangerina*. Phylogenetic analysis indicated that the type species represents a basal taxon to Mytilinidiales in Dothideomycetes with moderate support (Shearer et al. 2009). *Lepidopterella* shares butterfly-shaped ascospores with *Argynna*, but differs in having globose to subglobose ascomata, and papilionaceous to broadly reniform, brown to orange-brown ascospores (Hyde et al. 2013).

#### Economic and ecological significance

Members of *Argynnaceae* are saprobic on plant stems or wood and in freshwater and terrestrial habitats and play a role in recycling organic matter.

*Ascoporiaceae* Kutorga & D. Hawksw., Syst. Ascom. 15(1–2): 25 (1997).

*Index Fungorum* number: IF 81923, *Facesoffungi* number: FoF 07867, 1 species.

*Saprobic* on decorticated wood in terrestrial habitats. **Sexual morph:** *Ascostromata* relatively large, superficial, circular or cupulate, slightly raised, pedicellate, solitary, exterior surrounded by brown mycelium, orange to red-brown at the margin or edge, dark brown to black in the centre, cells of ascostromata comprising a maze-like arrangement of mixed, brown-walled cells of *textura angularis* to *subglobosa* or *epidermoidea*, multi-loculate. *Locules* in a single layer at the periphery of the ascostromata, subcylindric-elongate, obpyriform to ovoid, crowded, opening by small, narrow, vertical ostiole. *Hamathecium* comprising numerous filiform, branched, septate, cellular pseudoparaphyses, embedded in a gelatinous matrix. *Asci* 8-spored, bitunicate, fissionate, narrowly cylindric-clavate, pedicellate, apically rounded with a small ocular chamber. *Ascospores* 2-seriate, fusiform, hyaline to yellowish when immature, olive-brown to dark brown when mature, 1-septate, constricted at the septum. **Asexual morph:** Coelomycetous.

*Type:* *Ascoporia* Samuels & A.I. Romero.

*Notes:* *Ascoporiaceae* is presently treated in Dothideomycetes as family *incertae sedis* (Wijayawardene et al. 2018). The family is monotypic with a single species *Ascoporia lateritia* (Hyde et al. 2013). *Ascoporiaceae* lacks molecular data to establish phylogenetic placement.

***Ascoporia*** Samuels & A.I. Romero, Bolm Mus. paraense ‘Emílio Goeldi’, sér. bot. 7(2): 264 (1993) [1991].

*Index Fungorum number:* IF 26458, *Facesoffungi number:* FoF 07945; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* ***Ascoporia lateritia*** Samuels & A.I. Romero.

*Notes:* *Ascoporia* was introduced to accommodate a single species *A. lateritia* that occurs on terrestrial decorticated wood (Samuels and Romero 1991).

***Ascoporia lateritia*** Samuels & A.I. Romero, Bolm Mus. paraense ‘Emílio Goeldi’, sér. bot. 7(2): 264 (1993) [1991].

*Index Fungorum number:* IF 360813, *Facesoffungi number:* FoF 07946; Fig. 97

*Description:* see Hyde et al. (2013).

*Material examined:* Brazil, Belem, Iha do Combu, Estacao Experimental Combu, Para. 01d30’s, 48d27’w, on decorticated wood, January 1989, G.J. Samuels; K.F. Rodrigues, 6207 (BPI1109903, **isotype** of *Ascoporia lateritia*).

### Economic and ecological significance

*Ascoporiaceae* is a small family only known from Brazil. Species in this family are saprobes on decorticated wood (Samuels and Romero 1991).

***Aulographaceae*** Luttrell ex P.M. Kirk et al., in Kirk et al., Ainsworth & Bisby’s Dictionary of the Fungi, Edn 9 (Wallingford): ix (2001).

*Index Fungorum number:* IF 80503; *Facesoffungi numbers:* FoF 06201, 50 species.

*Saprobic* on fallen leaves. *Mycelium* sparse, not radially arranged. **Sexual morph:** *Ascomata* forming as small black dots on host surfaces, solitary or clustered, nearly superficial, easily removed or breaking from the substrate, globose when immature, becoming sub-linear or v-shaped at maturity, rounded, carbonaceous, dark brown to black, absence of ostiole at the maturity, with slit-like opening. *Hamathecium* comprising septate, anastomosing and branched, trabeculate pseudoparaphyses, embedded in a gelatinous matrix with asci. *Asci* 8-spored, bitunicate, fissitunicate, oval to ellipsoid, apex thickened, short pedicellate or lacking, and with a wide indistinct ocular chamber. *Ascospores* overlapping 2–3-seriate, oblong to ovate, narrow at both ends, hyaline, 1-septate at the center, the upper cell often broader than lower cell. **Asexual morph:** Undertermined.

*Type:* ***Aulographum*** Lib.

*Notes:* *Aulographaceae* was established by Libert (1834) with the type genus *Aulographum*. They are characterized by superficial elongate thyriothechia, opening by longitudinal or slit-like, X- or Y-shaped dehiscence, with walls composed of dark cells that are pale at the margin of the scutellum, and lack of appressoria (Hyde et al. 2013; Hongsanan et al. 2014b). Hongsanan et al. (2014b) provided notes on this family and excluded the family from Asterinales based on morphology and phylogeny. Only a single species of *Aulographum* has sequence data and its placement is uncertain. Thus, more collections and sequence data are needed to clarify the taxonomic placement of this family within Dothideomycetes. Crous et al. (2019b) provided sequence data of *Lembosina* species and excluded this genus from *Aulographaceae*. *Aulographaceae* comprises three genera *Aulographum*, *Echidnodes*, and *Lembosiella* (Wijayawardana et al. 2018; Crous et al. 2019b).

***Aulographum*** Lib., Pl. crypt. Arduenna, fasc. (Liège) 3 (nos 201–300): no. 272 (1834)

*Index Fungorum number:* IF 461; *Facesoffungi number:* FoF 06202; 18 morphological species (Species Fungorum 2020), 1 species with molecular data

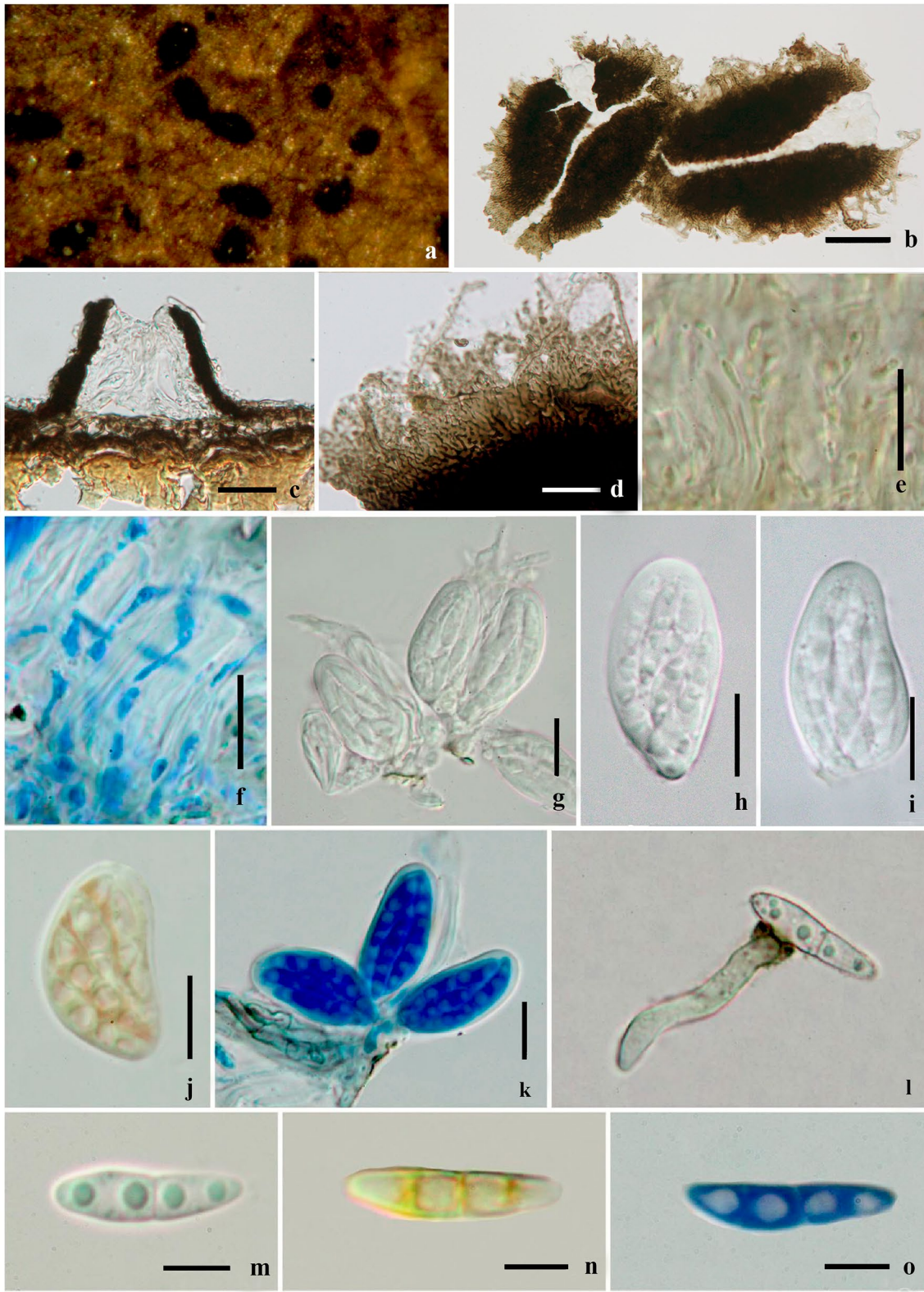
*Type species:* ***Aulographum hederæ*** Lib.

*Notes:* *Aulographum* is similar to *Aulographina* (*incertae sedis* genus in Capnodiales) and *Lembosia* (*Asterinaceae*) and these genera may be synonyms. However, only a single sequence is available for this genus, and its phylogenetic placement is uncertain. Molecular data of fresh specimens are needed to resolve its placement (Hyde et al. 2013). Several of the species however, were transferred to other families, such as *Asterinaceae*, *Elsinoaceae*, *Leptopeltidaceae*, or *Lophiostomataceae* (Hongsanan et al. 2014b).

***Aulographum hederæ*** Lib., Pl. crypt. Arduenna, fasc. (Liège) 3: no. 272 (1834).

*Index Fungorum number:* IF 161393; *Facesoffungi number:* FoF 07947; Fig. 98

*Saprobic* on fallen leaves of *Hedera helix*. *Mycelium* sparse, not radially arranged. **Sexual morph:** *Ascomata* 52–76 µm diam, 35–42 µm high ( $\bar{x} = 72 \times 40$  µm, n = 5), forming as small black dots on host surfaces, solitary or clustered, nearly superficial, easily removed or breaking from the substrate, globose when immature, becoming sub-linear or v-shaped at maturity, rounded, carbonaceous, dark brown to black, with slit-like opening, ostiolar canal filled with hyaline cells, with cells comprising parallel, radiating lines from center of the ostiole to outer cells, becoming pale brown at the margin. *Hamathecium* comprising 1 µm wide, septate, anastomosing, branched, trabeculate pseudoparaphyses, embedded in a gelatinous matrix with asci. *Asci* 24–30 × 10–15 µm ( $\bar{x} = 28$ –12 µm, n = 10) 8-spored, bitunicate, fissitunicate, oval to ellipsoid, apex



**Fig. 98** *Aulographum hederæ* (MFLUCC 12-0397). **a** Habit, ascomata on host substrate. **b** Ascomata with slit-like opening. **c** Section through ascoma. **d** Walled cells of ascoma. **e, f** Hamatecium in Melzer's reagent and Cotton blue reagent respectively. **g–i** Asci. **j**

Asci in Melzer's reagent. **k** Asci in Cotton blue reagent. **l** Ascospore germinated. **m–o** Ascospore in water, Melzer's reagent and Cotton blue reagent respectively. Scale Bars: **b** = 50  $\mu\text{m}$ , **c, g–k** = 20  $\mu\text{m}$ , **d–f** = 10  $\mu\text{m}$ , **l–o** = 5  $\mu\text{m}$

thickened, short pedicellate or lacking, and with a wide, indistinct ocular chamber. *Ascospores* 11–14 × 3–5 μm ( $\bar{x}$  = 12–3 μm, n = 10) overlapping 2–3-seriate, oblong to ovate, narrow at both ends, hyaline, 1-septate at the center, constricted at the septum, the upper cell often broader than lower cell, smooth-walled. **Asexual morph:** Undertermined.

*Material examined:* Germany, Frankfurt, on fallen leaves of *Hedera helix*, in 2012, Meike Piepenbring MFLU, culture MFLUCC 12-0397 (MFU) = CPC21373 (CBS).

*Notes:* *Aulographum hederæ* is the type species of *Aulographaceae*. It is characterized by longitudinally splitting ascomata and a perithecial wall appressed by mycelium with bright coloured margin (Hongsanan et al. 2014b). Sequence data of this specimen was provided by Hongsanan et al. (2014b), but without a plate and description. Therefore, we provide a photoplate of the same specimen with descriptions.

### Other Genera included

***Echidnodes*** Theiss. & Syd., *Annls mycol.* 15(6): 422 (1918).

*Index Fungorum number:* 1732; *Facesoffungi number:* FoF 07949; – 29 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* ***Echidnodes lituræ*** (Cooke) Theiss. & Syd. [as ‘litsuræ’], *Annls mycol.* 15(6): 422 (1918).

≡ *Aulographum lituræ* Cooke [as ‘Ailographium’], *Grevillea* 12(no. 61): 38 (1883).

*Notes:* Hongsanan et al. (2014b) placed *Echidnodes* in *Aulographaceae* based on its superficial hyphae, lack of appressoria and similar morphological characters of its asci and ascospores. However, molecular data is needed to confirm the placement of *Echidnodes* in Asterinales.

***Lembosiella*** Sacc., *Syll. fung.* (Abellini) 9: 1101 (1891).

*Index Fungorum number:* IF 2726; *Facesoffungi number:* FoF 07948; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* ***Lembosiella polyspora*** (Pat.) Sacc., *Syll. fung.* (Abellini) 9: 1101 (1891)

≡ *Lembosia polyspora* Pat., *Bull. Soc. mycol. Fr.* 3(2): 125 (1887).

*Notes:* Wu et al. (2011b) transferred *Lembosiella* to *Aulographaceae* based on the elongate thyriothecia with a slit-like opening and lack of appressoria on the superficial hyphae of *Lembosiella polyspora* (Hongsanan et al. 2014b).

***Thyriopsis*** Theiss. & Syd., *Annls mycol.* 13(3/4): 369 (1915).

*Index Fungorum number:* IF 5468; *Facesoffungi number:* FoF 07950; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* ***Thyriopsis halepensis*** (Cooke) Theiss. & Syd., *Annls mycol.* 13(3/4): 369 (1915).

≡ *Dothidea halepensis* Cooke, *Grevillea* 7(no. 41): 35 (1878).

*Notes:* Lumbsch and Huhndorf (2010) placed *Thyriopsis* in *Asterinaceae*. However, the thyriothecia of *Thyriopsis* differs from *Asterinaceae* in having elongate thyriothecia, globose asci, hyaline ascospores without surface mycelia bearing appressoria. While *Asterinaceae* has circular thyriothecia, surface mycelia with appressoria and brown ascospores at maturity (Hongsanan et al. 2014b). Therefore, *Thyriopsis* is replaced in *Aulographaceae* (Hongsanan et al. 2014b). However, *Thyriopsis* is somewhat different from other genera in this family as its thyriothecia lack a fibrous dark brown margin and has dark brown elongate peridium cells. Molecular data of fresh collection is needed to confirm its placement in this family.

### Economic and ecological significance

The members of this family differ from other species in Asterinales as these species can grow in artificial media indicating that the growth of the species is not reliant on the host (Hongsanan et al. 2014b). They are saprobic and play a role in recycling organic matter.

***Balladynaceae*** Boonmee & K.D. Hyde, in Boonmee et al., *Mycosphere* 8(10): 1701 (2017).

*Index Fungorum number:* IF 553827; *Facesoffungi numbers:* FoF 03663, 47 species.

*Parasitic* on living leaves. **Sexual morph:** *Mycelium* network-like, branched, septate, with hyphopodia, with or without setae. *Hyphopodia* numerous, knob-like, dark brown. *Ascomata* superficial, formed on hyphae, with a subiculum, solitary, scattered, globose to subglobose, with apical pore, minutely pedicellate at the base, olivaceous brown to dark brown, with transparent wall, surrounded by mycelium network. *Peridium* comprises 1–2 layers of olivaceous-brown cells of *textura angularis*, lacking pseudoparaphyses. *Asci* 8-spored, bitunicate, globose to subglobose, sessile. *Ascospores* multi-seriate, ellipsoid, upper cell wider, hyaline to light brown when immature, fawn to olivaceous-brown or brown at maturity, 1-septate. **Asexual morph:** Hyphomycetous. *Clasterosporium* sp., *Tretospora* sp. (adapted from Boonmee et al. 2017).

*Type:* ***Balladyna*** Racib.

*Notes:* *Balladynaceae* was established by Boonmee et al. (2017) to accommodate *Balladyna* (type), *Balladynocallia* and *Balladynopsis*. *Balladynaceae* can be distinguished from other families of Dothideomycetes based on its parasitic lifestyle, hyphae with hyphopodia, ascomata formed on hyphae, with or without setae, subglobose asci and 1-septate, hyaline to brown ascospores. No molecular data is available to confirm its phylogenetic placement within Dothideomycetes.



**Fig. 99** *Balladyna gardenia* (BPI 691469, isotype). **a, b** Herbarium specimen. **c** Colonies on leaf surface. **d** Hyphae with hyphopodia. **e** Setae. **f–h** Asci when immature and mature. **i–l** Ascospores. Scale bars: **c** = 200  $\mu$ m, **d** = 30  $\mu$ m, **e** = 100  $\mu$ m, **f–l** = 20  $\mu$ m

***Balladyna*** Racib., Parasit. Alg. Pilze Java's (Jakarta) 2: 6 (1900).

*Index Fungorum* number: IF 502; *Facesoffungi* number: FoF 07868; 35 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Balladyna gardeniae* Racib.

*Notes:* Seifert et al. (2011) reported the asexual morphs as *Clasterosporium* sp. found in *Balladyna vanderystii* var. *ferulae-foetidae* and *Tretospora* sp. found in *Balladyna negrii*. Boonmee et al. (2017) re-examined the isotype specimen (BPI 691469), but were unable to find asexual characters. They also established *Balladynaceae* to accommodate *Balladyna*, *Balladynocallia* and *Balladynopsis* based on morphology.

***Balladyna gardeniae*** Racib., Parasit. Alg. Pilze Java's (Jakarta) 2: 6 (1900).

*Index Fungorum* number: IF 218036; *Facesoffungi* number: FoF 03664; Fig. 99

*Description:* see Boonmee et al. (2017).

*Material examined:* Indonesia, Java, Bogor, on living leaves of *Gardenia lucida* Roxb. (*Rubiaceae*), M. Raciborski Nr. 88 (BPI 691469, isotype).

#### Other genera included

***Balladynocallia*** Bat., in Batista, Silva & Bezerra, Atas Inst. Micol. Univ. Pernambuco 2: 216 (1965).

*Index Fungorum* number: IF 505; *Facesoffungi* number: FoF 07951; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Balladynocallia glabra* (Hansf.) Bat., in Batista, Silva & Bezerra, Atas Inst. Micol. Univ. Recife 2: 216 (1965).

$\equiv$  *Balladynastrum glabrum* Hansf., Proc. Linn. Soc. London 157(3): 157 (1946) [1944–45].



**Fig. 100** *Cleistosphaera macrostegia* (S-F10853, holotype). **a, b** Herbarium specimen. **c** Habit on leaf surface. **d** Sections of asci. **e** Peridium. **f** Hyphae with hyphopodia. **g–i** Asci. **j–m** Ascospores. Scale bars: **c** = 1000  $\mu$ m, **d, g–i** = 100  $\mu$ m, **e** = 30  $\mu$ m, **f** = 50  $\mu$ m, **j–m** = 20  $\mu$ m

**Notes:** The genus was introduced to accommodate *B. amazonensis* and the type species *B. glabra*. Boonmee et al. (2017) re-examined the type specimen of *B. glabra*, but it was not in good condition. However, they used descriptions and illustrations from Sivanesan (1981) to place this *Balladynocallia* in *Balladynaceae*.

***Balladynopsis*** Theiss. & Syd., *Annls mycol.* 15(6): 475 (1918) [1917].

**Index Fungorum number:** IF 506; **Facesoffungi number:** FoF 07952; – 9 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Balladynopsis philippinensis* Syd. & P. Syd., *Annls mycol.* 15(6): 476 (1918) [1917].

$\equiv$  *Henningsomyces philippinensis* Syd. & P. Syd., *Philipp. J. Sci., C, Bot.* 9(2): 161 (1914)

**Notes:** Descriptions and illustrations can be seen in Boonmee et al. (2017).

#### **Economic and ecological significance**

Species in *Balladynaceae* are parasitic on living leaves. Currently there is no report concerning species economic significance. By considering their appearance on leaves which is somewhat similar to *Asterinaceae*, they probably reduce



respiration and photosynthesis of plants and probably cause leaf stunt disease or host tissues to become pale.

**Cleistosphaeraceae** Boonmee & K.D. Hyde, in Boonmee et al., *Mycosphere* 8(10): 1708 (2017).

*Index Fungorum number*: IF 553828; *Facesoffungi number*: FoF 03669, 1 species.

*Parasitic* or *saprobic* on leaves. *Mycelium* superficial, branched, septate, with hyphopodia. *Hyphopodia* formed on mycelium, subglobose, dark brown **Sexual morph**: *Ascomata* superficial, grouped to solitary, globose to subglobose, dark brown, covered with mycelium. *Hamathecium* comprising sparse, septate, cellular pseudoparaphyses. *Peridium* comprises dark brown cells of *textura angularis*. *Asci* 8-spored, bitunicate, ovoid to broadly clavate, sessile or with knob-like pedicel. *Ascospores* 2–3-seriate, ellipsoid-oblong, hyaline to pale grey, aseptate, smooth-walled, with granular contents, gelatinous sheath. **Asexual morph**: Coelomycetous (adapted from Boonmee et al. 2017).

*Type*: **Cleistosphaera** Syd. & P. Syd.

*Notes*: *Cleistosphaeraceae* was established to accommodate the monotypic genus *Cleistosphaera*. The morphology of this family is quite similar to *Botryosphaeriaceae*, however, the generic type of *Cleistosphaeraceae*, *Cleistosphaera* differs from *Botryosphaeriaceae* by its ascomata features, mycelium with hyphopodia and sparse pseudoparaphyses.

**Cleistosphaera** Syd. & P. Syd., *Annls mycol.* 14(1/2): 74 (1916).

*Index Fungorum number*: IF 1100; *Facesoffungi number*: FoF 07869; 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Cleistosphaera macrostegia** Syd. & P. Syd.

*Notes*: *Cleistosphaera* is similar to taxa in *Botryosphaeriaceae* based on its asci and ascospore features, however, it differs from *Botryosphaeriaceae* by mycelium with hyphopodia. The asexual morph of *C. macrostegia* are phoma-like (coelomycetous) which differentiates it from all genera in *Perisporiopsidaceae* (hyphomycetous).

**Cleistosphaera macrostegia** Syd. & P. Syd. [as ‘macrostegiae’], *Annls mycol.* 14(1/2): 75 (1916).

*Index Fungorum number*: IF 161307; *Facesoffungi number*: FoF 03670; Fig. 100

*Description*: see Boonmee et al. (2017).

*Material examined*: Peru, Amazonas, Rio Acre, Seringal Auristela, on leaves of *Piptadenia* sp. (Leguminosae), August 1911, E.H.G Ule No. 3502 (S-F10853, **holotype**).

### Economic and ecological significance

Species of *Cleistosphaeraceae* can be plant parasitic or play a role in recycling organic matter.

**Coccoideaceae** P. Henn. ex Sacc. & D. Sacc., Henn. ex Sacc. & D. Sacc., *Syll. fung.* (Abellini) 17: 860 (1905).

*Index Fungorum number*: IF 80616, *Facesoffungi number*: FoF 07953, 14 species.

*Parasitic* on living leaves. **Sexual morph**: *Ascostromata* large, up to 2 mm diam., single to solitary, or scattered, mostly superficial, slightly immersed in host tissue, circular to subcircular, discoid, cushion-like, semicircular in section, edge entire, slightly convex at the top, raised from the base, black, thickened at the base, soft, multi-loculate, in a layer in the upper part the ascostromata. *Cells* of ascostromata comprising heavily, pigmented cells of *textura angularis*. *Locules* completely immersed in ascostromata, globose, subglobose or obpyriform, with apical ostiole. *Hamathecium* comprising filiform, anastomosing, branched, septate, hyaline, relatively wide, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical to subclavate, pedicellate, apically rounded, with a distinct, wide, ocular chamber. *Ascospores* 2-seriate, apiosporous, ellipsoidal-obovoid, slightly oval, subglobose, tapering towards the narrow, lower end, yellowish to light brown, 1-septate at the lower end, not constricted at the septum, darkened at the septa, smooth-walled. **Asexual morph**: Undetermined.

*Type*: **Coccoidea** Henn.

*Notes*: *Coccoideaceae* includes *Coccoidea*, *Coccoidella* and *Englerodithis*, and is treated in Dothideomycetes as family *incertae sedis* (Hyde et al. 2013; Boonmee et al. 2017; Wijayawardene et al. 2018; Pem et al. 2019c). The characteristic feature of the family is ascostromata which are formed as circular to discoid or cushion-like with dark pigment, which is rather unique of its members. Boonmee et al. (2017) revisited *Coccoidella* and provided a description and illustration of type species *C. scutula* and accepted this genus in *Coccoideaceae*. Pem et al. (2019c) included *Englerodithis* in *Coccoideaceae*. The family lacks molecular data to establish phylogenetic placement, especially as the type species is yet to be sequenced and no additional new taxa in this family.

**Coccoidea** Henn., *Bot. Jb.* 28(3): 275 (1900).

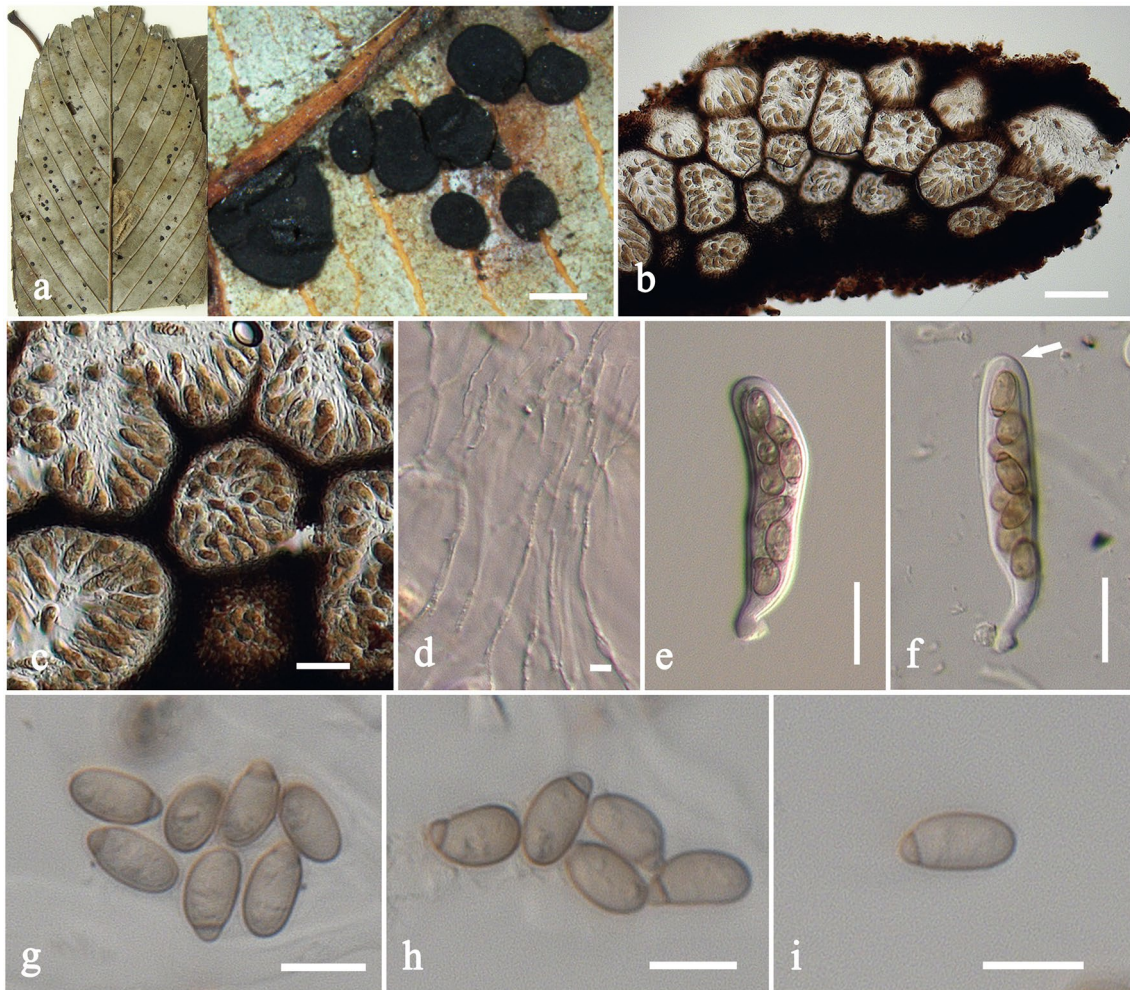
*Index Fungorum number*: IF 1144, *Facesoffungi number*: FoF 07954; 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Coccoidea quercicola** Henn. & Shirai.

*Notes*: *Coccoidea* was introduced by Hennings (1900) and typified by *C. quercicola*, which is parasitic on living leaves. The genus lacks molecular data to indicate its generic placement.

**Coccoidea quercicola** Henn. & Shirai, in Hennings, *Bot. Jb.* 28(3): 275 (1900).

*Index Fungorum number*: IF 167300, *Facesoffungi number*: FoF 07955; Fig. 101



**Fig. 101** *Coccoidea quercicola* (BPI 643971). **a** Material, habit on leaf and appearance of ascostromata on lower leaf surface. **b** Section of ascostroma showing arrangement of multilocule asci. **c** Close

up of peridial wall. **d** Hamathecium of trabeculate pseudoparaphyses. **e, f** Asci. **g–i** Ascospores. Scale bars: **a** = 1 mm, **b** = 100  $\mu$ m, **c** = 40  $\mu$ m, **d** = 5  $\mu$ m, **e, f** = 20  $\mu$ m, **g–i** = 10  $\mu$ m

*Description:* see Hyde et al. (2013).

*Material examined:* India, Sukliapokhari, Alt. 7,000 ft., on living leaves of *Quercus lamellosa* Sm., 11 May 1967, M.K. Maity PCC 1252, (BPI 643971).

#### Other genera included

*Coccoidella* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 847 (1909).

*Index Fungorum* number: IF 1145; *Facesoffungi* number: FoF 07956; – 9 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Coccoidella scutula* (Berk. & M.A. Curtis) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 847 (1909).

≡ *Dothidea scutula* Berk. & M.A. Curtis, Grevillea 4(no. 31): 105 (1876).

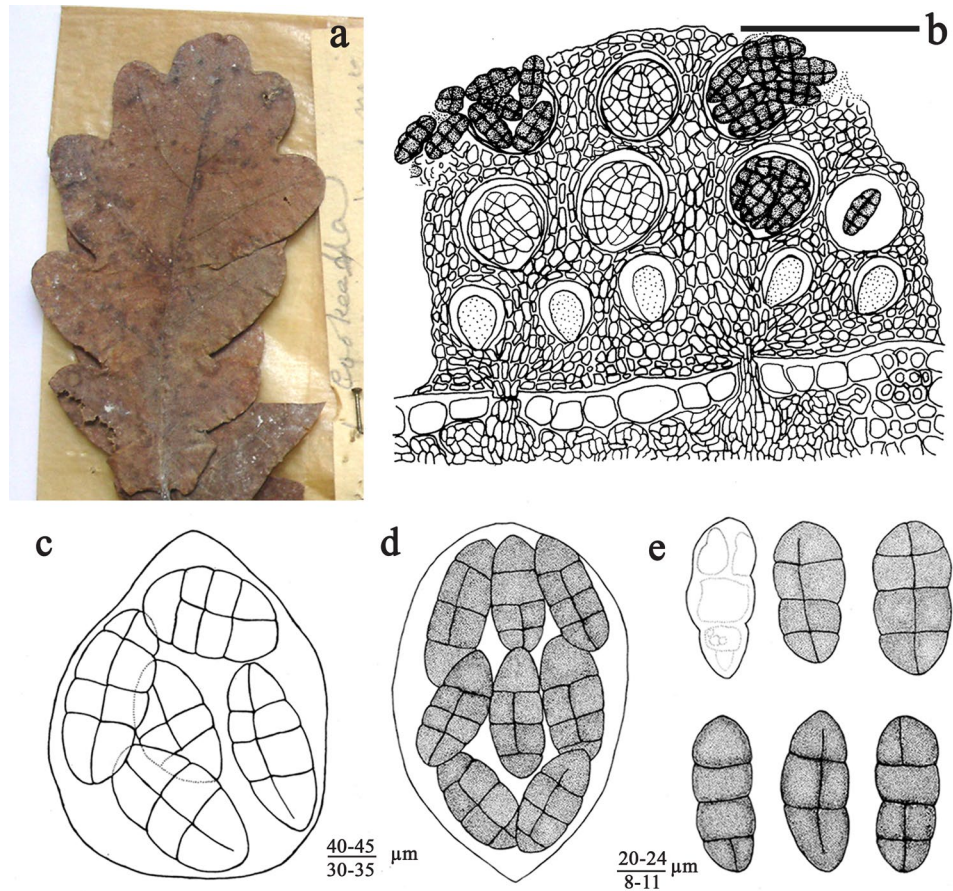
*Notes:* *Coccoidella* was revisited by Boonmee et al. (2017) with description and illustration under a specimen named *Coccoidella scutula* (BPI642219) to represent the genus. This species was reported as parasitic on living leaves of *Persea palustris* (Lauraceae) from the USA. *Coccoidella* is placed in *Coccoideaceae* based on ascomata features (Boonmee et al. 2017). However, collections and sequence data are required to confirm the placement of this genus.

*Englerodothis* Theiss. & Syd., Anns mycol. 13(3/4): 285 (1915).

*Index Fungorum* number: IF1818; *Facesoffungi* number: FoF 06240; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Englerodothis kilimandscharica* (Henn.) Theiss. & Syd., Anns mycol. 13(3/4): 285 (1915).

**Fig. 102** *Cookella microscopica* (PAD: no. 2509) **a** Material and habit on leaves. **b** Ascostroma with multilocule asci. **c, d** Young and mature asci. **e** Ascospores



≡ *Cocconia kilimandscharica* Henn., in Engler, Pflanzenw. Ost-Afrikas Nachbarg., Teil C: 31 (1895).

*Notes:* Pem et al. (2019c) re-examined the type species *Englerodothis kilimandscharica* (S-F203689). They included *Englerodothis* in *Coccideaceae* based on its superficial, circular or discoid, multi-loculate ascomata, saccate-oblong to cylindrical-cavate asci, and ellipsoidal-oblong to clavulate, 1-septate, light pigmented ascospores. Species of *Englerodothis* are reported as parasitic or saprobic on living and dead leaves. Fresh collections and sequence data are required to indicate phylogenetic placement.

#### Economic and ecological significance

*Coccoideaceae* includes three genera with 14 species and is distributed in temperate and tropical regions. Its members are parasitic or saprobic on living leaves of dicotyledons and angiosperms (Hyde et al. 2013; Boonmee et al. 2017; Pem et al. 2019c).

*Cookellaceae* Höhn.ex Saccardo & Trotter, in Saccardo, Syll. Fung. (Abellini) 22: 585 (1913).

*Index Fungorum number:* IF 80637; *Facesoffungi numbers:* FoF 07870, 6 species.

*Parasitic* (or *epiphytic*) on leaves in terrestrial habitats, some possibly fungicolous. **Sexual morph:** *Ascostromata* superficial, subglobose or irregular, pulvinate to effuse, cushion-shaped, surface rough, flat or applanate at the base, scattered, pigmented, containing locules with individual asci, apapillate, opening by breaks in the upper surface; soft textured, cells of ascostromata comprising *textura angularis* to *subglobulosa*, with a basal hypostroma, developing in the host tissue, appearing as stromal blocks and swollen cells, of compressed packages of *textura angularis* to *prismatica*. *Locules* scattered throughout ascostromata, small, globose to subglobose, containing single asci, wall not obvious. *Hamathecium* lacking pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, globose to subglobose or saccate, apedicellate, lacking an ocular chamber. *Ascospores* scattered in 3–5-seriate overlapping rows, muriform, ellipsoid to oblong, hyaline when immature, becoming brown at maturity, straight to slightly curved, ends rounded, with 3-transverse septa and 1-longitudinal septum in each cell, constricted at the septa, smooth-walled. **Asexual morph:** Coelomycetous, in genus *Stigmella*.

*Type:* *Cookella* Sacc.

*Notes:* The family includes only two genera *Cookella* and *Pycnoderma* (Wijayawardene et al. 2018), while *Uleomyces*

was transferred to *Myriangiaceae* by Boonmee et al. (2017). *Cookellaceae* is treated in Dothideomycetes as family *incertae sedis* (Wijayawardene et al. 2018). The family is parasitic or epiphytic on leaves of dicotyledons and monocotyledons, with cushion-shaped to irregular thyriothecial single to multiloculate, ascostromata or ascomata, absent of pseudoparaphyses, 8-spored, bitunicate asci and muriform, light to dark pigmented ascospores (Hyde et al. 2013). The family lacks molecular data to establish its phylogenetic placement, especially as the type species is yet to be sequenced and there are no additional new taxa in this family.

**Cookella** Sacc., *Michelia* 1(no. 4): 407 (1878).

*Index Fungorum number*: IF 1225, *Facesoffungi number*: FoF 07957; 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type*: **Cookella microscopica** Sacc.

*Notes*: *Cookella* was introduced to accommodate *C. microscopica* found on lower surface of leaves of *Quercus pedunculatum* (oak) in Italy (Saccardo 1878). The genus needs sequence data to resolve its generic placement.

**Cookella microscopica** Sacc., *Michelia* 1(no. 4): 407 (1878).

*Index Fungorum number*: IF 218808, *Facesoffungi number*: FoF 07958; Fig. 102

*Description and Material examined*: see Hyde et al. (2013).

#### Other genera included

**Pycnoderma** Syd. & P. Syd., *Annls mycol.* 12(6): 563 (1914).

*Index Fungorum number*: IF 4565, *Facesoffungi number*: FoF 07959; – 2 morphological species, (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Pycnoderma bambusinum** Syd. & P. Syd., *Annls mycol.* 12(6): 563 (1914).

*Notes*: *Pycnoderma* was introduced to accommodate *P. bambusinum* found on bamboo leaves (Sydow and Sydow 1914a). Only two species are accepted in the genus (Hongsan et al. 2014a; Wijayawardene et al. 2017a). Fresh collections of its members are needed to clarify the generic placement.

#### Economic and ecological significance

*Cookellaceae* includes two genera with six species. Its genera are parasitic or epiphytic on leaves of dicotyledons and monocotyledons (Hyde et al. 2013; Hongsan et al. 2014a).

**Dimeriaceae** E. Müll. & Arx ex Arx & E. Müll., *Stud. Mycol.* 9: 104 (1975).

*Index Fungorum*: IF 80704; *Facesoffungi number*: FoF 06390, 73 species.

*Parasitic* on living leaves, colonies dark brown, mycelium superficial, dark brown, amphigenous. **Sexual morph**: *Ascomata* superficial, subglobose, with hyphal appendages, flexuous, cylindrical, septate, dark brown, roughened. *Asci* 8-spored, bitunicate, fissitunicate, saccate-oblong to ellipsoidal, apically thickened. *Ascospores* conglobate, ellipsoid-fusiform to subclavate, ends rounded, olivaceous-brown to brown, 1-septate, darkly pigmented at the septum, upper cell wider than lower cell, septum suprmedian. **Asexual morph**: Hyphomycetous.

*Type*: **Dimerium** (Sacc. & P. Syd.) McAlpine.

*Notes*: *Dimeriaceae* accommodates taxa occurring on the surface of living leaves (Hawksworth and Eriksson 1986; von Arx and Müller 1975; Barr 1987b, 1997). Its members are characterized by solitary, superficial ascomata with hyphal appendages and 1-septate ellipsoidal, dark brown ascospores darkly pigmented at the septum (Boonmee et al. 2017). *Dimerium olivaceum* was assigned as the type species (Boonmee et al. 2017). However, the family lacks molecular data to confirm the taxonomic placement.

**Dimerium** (Sacc. & P. Syd.) McAlpine, *Proc. Linn. Soc. N.S.W.* 28: 98 (1903).

≡ *Dimerosporium* subgen. *Dimerium* Sacc. & P. Syd., *Syll. fung. (Abellini)* 16: 410 (1902).

*Index Fungorum number*: IF 25887; *Facesoffungi number*: FoF 06391; 73 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Dimerium olivaceum** Syd. & P. Syd.

*Notes*: *Dimerium* is a single genus in *Dimeriaceae* (Wijayawardene et al. 2018). Many species were transferred to other genera based on shared characters (Boonmee et al. 2017). More collections of the members in this genus and sequence data are needed to clarify their taxonomic placement.

**Dimerium olivaceum** Syd. & P. Syd., *Annls mycol.* 2(2): 169 (1904).

*Index Fungorum number*: IF 234107; *Facesoffungi number*: FoF 06392, Fig. 103

*Description*: see Boonmee et al. (2017).

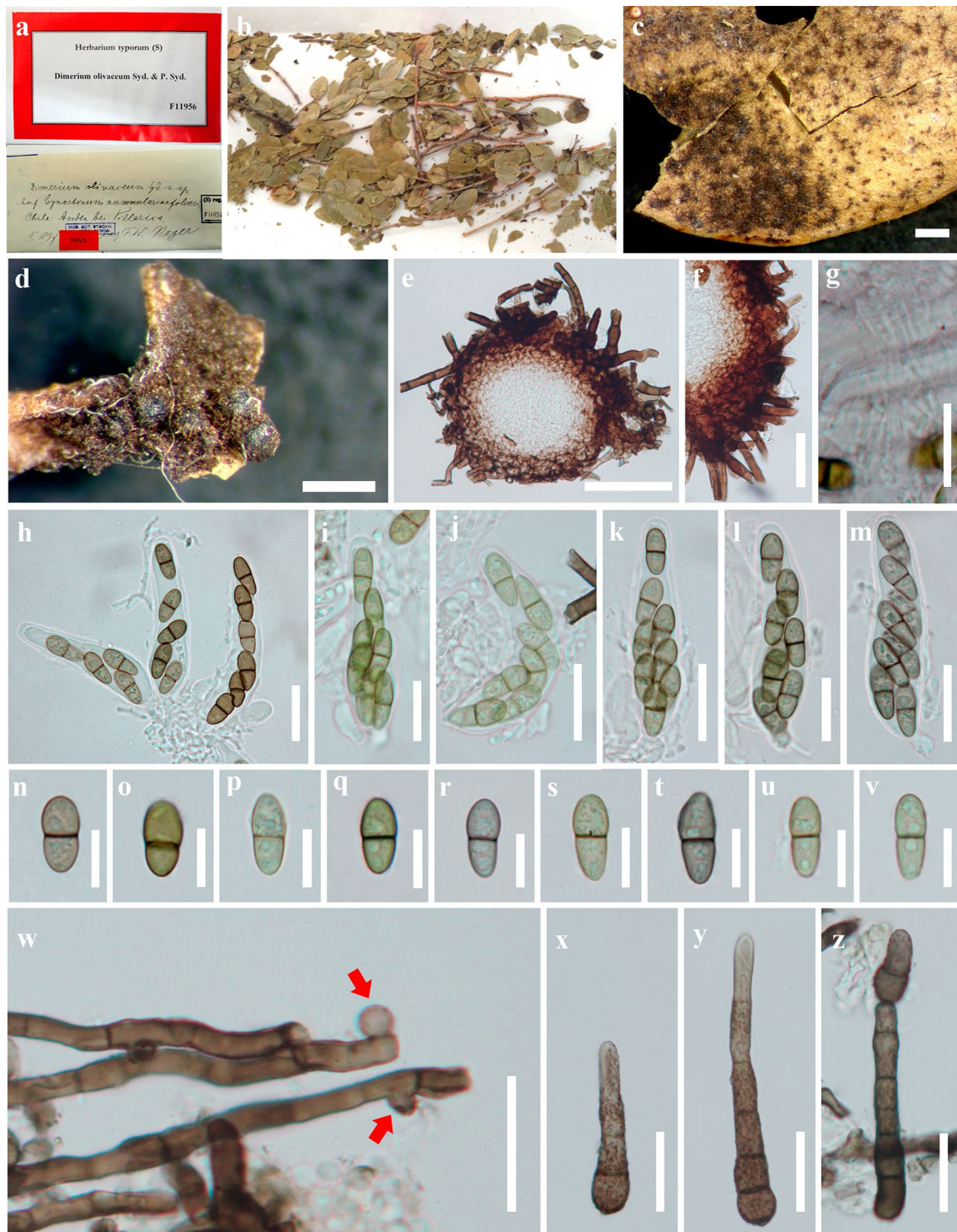
*Material examined*: Chile, Anden bei Villarica, on living leaves of *Cynoctonum nummulariaefolium* (*Asclepiadaceae*), February 1897, F.W. Neger (SF11956, **holotype**).

#### Economic and ecological significance

The members in *Dimeriaceae* are reported as parasitic on living leaves of various hosts.

**Dubujianaceae** D. Pem, Doilom & K.D. Hyde, *Mycosphere* 10(1): 1115–1246 (2019).

*Index Fungorum number*: IF 557065; *Facesoffungi number*: FoF 06679, 1 species.

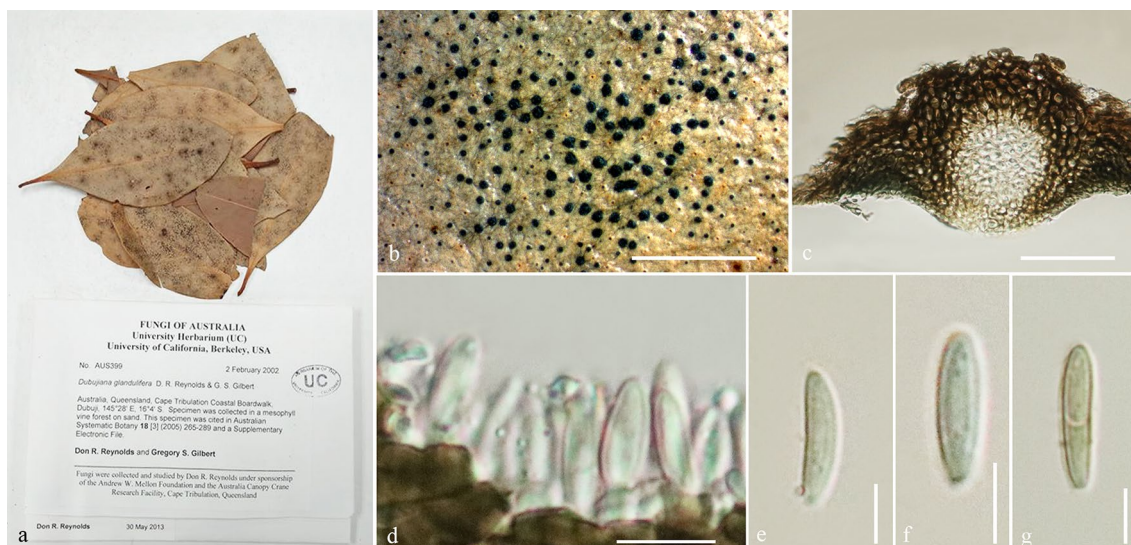


**Fig. 103** *Dimerium olivaceum* (SF11956, holotype). **a** Material label. **b** Herbarium specimen and habit on leaves. **c** Appearance of colonies on the leaves surface. **d** Ascómata, marked by arrows **e** Section of ascoma. **f** Peridium. **g** Hamathecium comprising pseudopara-

physes. **h–m** Asci. **n–v** Ascospores. **w** Mycelium with septate and hyphopodia-like structures (red arrows). **x–z** Conidiophores in different stages of developing conidia. Scale bars: **c, d** = 500 µm, **e** = 50 µm, **f–m** = 20 µm, **n–z** = 10 µm

*Endophytic, saprobic or pathogenic* on leaves. **Sexual morph:** Undetermined. **Asexual morph:** *Mycelium* at first subcuticular, developing onto leaf surface from leaf

glands forming scattered to sporadically confluent superficial thalli, circular in outline, composed of a basal layer of flattened, parallel, branching, brown hyphae with setae.



**Fig. 104** *Dubujiana glandulifera* (UC AUS399, holotype). **a** Details of herbarium material. **b** Habit and appearance of conidiomata on host surface. **c** Section of conidioma. **d** Conidiogenesis. **e–g** Conidia. Scale bars: **b** = 2 mm, **c** = 40  $\mu$ m, **d** = 100  $\mu$ m, **e**, **f** = 5  $\mu$ m, **g** = 10  $\mu$ m

Lacking hyphopodia, Hyphal strands radiate from base of central, raised pycnidium over the basal layer and onto the substrate. *Conidiomata* wall composed of thick dark-brown walled cells of *textura globulosa*. *Conidiophores* densely aggregated, slender, subulate, simple, frequently branched above, reduced to conidiogenous cells, or with 1–2 supporting cells. *Conidiogenous cells* annellidic, simple, tapering, hyaline, smooth, rarely with percurrent proliferations. *Conidia* ellipsoidal, fusiform to lunate, hyaline becoming pale brown at maturity, 1-septate, punctate, smooth-walled.

*Type: Dubujiana* D.R. Reynolds & G.S. Gilbert.

*Notes:* Pem et al. (2019c) introduced *Dubujianaceae* with *Dubujiana* as the type genus. Species of *Dubujianaceae* have an epifoliar lifestyle with pycnidia arising from leaf glands in the outer portions of the hyphal system with individual hyphal strands extending from the large central pycnidium.

***Dubujiana*** D.R. Reynolds & G.S. Gilbert, Aust. Syst. Bot. 18(3): 282 (2005).

*Index Fungorum* number: IF 28993; *Facesoffungi* number: FoF 06238; 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Dubujiana glandulifera* D.R. Reynolds & G.S. Gilbert.

*Notes:* The monotypic genus *Dubujiana* is characterized by raised pycnidia over the basal layer of the substrate, densely aggregated, slender conidiophores, and tapering, hyaline conidiogenous cells giving rise to pale brown, 1-septate, punctate conidia. No cultures or sequence data are available for this genus.

***Dubujiana glandulifera*** D.R. Reynolds & G.S. Gilbert, Aust. Syst. Bot. 18(3): 282 (2005).

*Index Fungorum* number: IF 344434; *Facesoffungi* number: FoF 08038; Fig. 104

*Description:* see Pem et al. (2019c).

*Material examined:* Australia, Queensland, Cape Tribulation Coastal Boardwalk Dubuji, 145°28' E, 16°4' S., on leaves, 2 February 2002, D.R. Reynolds (UC AUS399, holotype).

#### Economic and ecological significance

Species of *Dubujiana* are epifoliar and maintain a commensal relationship with the host (Reynolds and Gilbert 2005).

***Dysrhynchaceae*** Boonmee & K.D. Hyde [as '*Dysrhynchis-ceae*'], in Boonmee et al., Mycosphere 8(10): 1714 (2017).

*Index Fungorum:* IF 628246; *Facesoffungi* number: FoF 06393, 4 species.

*Saprobic* on dead leaves. **Sexual morph:** *Ascomata* superficial, globose to subglobose, dark brown, solitary, aggregated, with central pore, with a protruding synnematus neck, comprised of tightly compacted hyphae, sparse superficial mycelium with hyphopodia, brown to dark brown, with partially immersed mycelia, lacking setae, lacking pseudoparaphyses. *Peridium* membranous, comprising brown cells of *textura angularis*. *Asci* 8-spored, bitunicate, broadly obclavate to ovoid, sessile, apically thickened. *Ascospores* multi-seriate, conglobate, ellipsoidal, clavate to obpyriform, hyaline to light brown. **Asexual morph:** Hyphomycetous.

*Type: Dysrhynchis* Clem.

*Notes:* Boonmee et al. (2017) introduced *Dysrhynchisceae* as a new family to accommodate *Dysrhynchis*. The morphological features of sexual and asexual morphs were described in Boonmee et al. (2017). Additional collections and molecular study are required to further clarify the phylogeny of this family.

***Dysrhynchis*** Clem., Gen. fung. (Minneapolis): 32 (1909).

*Index Fungorum number:* IF 1728; *Facesoffungi number:* FoF 06394; 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* ***Dysrhynchis pulchella*** (Sacc.) Clem.

*Notes:* *Dysrhynchis* is the type genus of *Dysrhynchisceae* and both morphs of the life cycle have been reported. The genus lacks molecular data to establish phylogenetic placement and no additional new taxa have been introduced.

***Dysrhynchis pulchella*** (Sacc.) Clem., in Clements & Shear, Gen. fung., Edn 2 (Minneapolis): 253 (1931).

≡ *Henningsomyces pulchellus* Sacc. & D. Sacc., Syll. fung. (Abellini) 17: 689 (1905).

*Index Fungorum:* IF 254191; *Facesoffungi number:* FoF 06395; Fig. 105

*Description:* see Boonmee et al. (2017).

*Material examined:* Brazil, Rio de Janeiro, Mauá, on dead leaves of *Byrsonima sericae* A. Juss. (*Malpighiaceae*), 21 July 1899, E.H.G. Ule, Mycotheca brasiliensis no. 71 (PAD No. 71, **holotype**).

### Economic and ecological significance

*Dysrhynchisceae* are saprobes, occurring on plants from terrestrial habitats (Wijayawardene et al. 2017a). This family has no report as causing plant diseases.

***Endosporiaceae*** D. Pem, Doilom & K.D. Hyde, Mycosphere 10(1): 1115–1246 (2019).

*Index Fungorum number:* IF 557066; *Facesoffungi number:* FoF 06681, 2 species.

*Pathogenic* on bud of *Populus tremuloides*. **Sexual morph:** Undetermined. **Asexual morph:** *Colonies* (conidiomata) on PDA, OA and CA black, raised, cerebriform, comprising numerous cellular clumps in a thin covering, subcircular to irregular in outline, reverse black. Margin irregular with scarce, occasionally aggregated hyphae on PDA, even with adpressed or submerged hyphae on MEA. On PDA, cells more broad, swollen, subhyaline and dumbbell-shaped when two-celled, becoming multicellular by splitting in all directions, becoming darkly pigmented, irregular in shape, frequently separating into smaller clumps. *Hyphae* cylindrical or toruloid, light to dark brown, branched or unbranched, aerially determinate in growth, mostly elongated, hyaline at apex, forming muriform and darkly pigmented bodies.

*Endoconidia* developing from the separation of adjacent daughter cells in cellular clumps through septum schizolysis, ellipsoidal to subglobose becoming broadly ellipsoidal to globose, hyaline, aseptate. *Blastic conidia* abundant in mature colonies, arising from cells of cellular clumps or seldom from sides of hyphae, cylindrical to ellipsoidal, regularly truncate at the base, sometimes globose, obovoid, fusiform, hyaline or light brown, aseptate.

*Type:* ***Endosporium*** Tsuneda.

*Notes:* Pem et al. (2019c) introduced *Endosporiaceae* to accommodate *Endosporium*. The family is characterized by cylindrical hyphae, ellipsoidal, subglobose to globose endoconidia and cellular clumps, globose, obovoid, fusiform blastic conidia. *Endosporiaceae* is unique in producing endoconidia from cellular clumps.

***Endosporium*** Tsuneda, in Tsuneda et al., Botany 86(9): 1022 (2008).

*Index Fungorum number:* IF 536893; *Facesoffungi number:* FoF 06239; 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species:* ***Endosporium populi-tremuloides*** Tsuneda.

*Notes:* *Endosporium* is characterized by cylindrical hyphae, ellipsoidal, subglobose to globose endoconidia and cellular clumps, globose, obovoid, fusiform blastic conidia. The sexual morph is unknown. Two species are known, *E. aviarium* and *E. populi-tremuloides*.

***Endosporium populi-tremuloides*** Tsuneda, in Tsuneda et al., Botany 86(9): 1023 (2008).

*Index Fungorum number:* IF 536901; *Facesoffungi number:* FoF 08836; Fig. 106

*Description:* see Pem et al. (2019c).

*Material examined:* Canada, Whitemud Creek, Edmonton, Lansdowne, ca. 1 km west of the Northern Forestry Centre, Alberta, on bud of *Populus tremuloides* (*Salicaceae*), 3 November 2002, A. Tsuneda (UAMH 10529, **holotype**).

### Economic and ecological significance

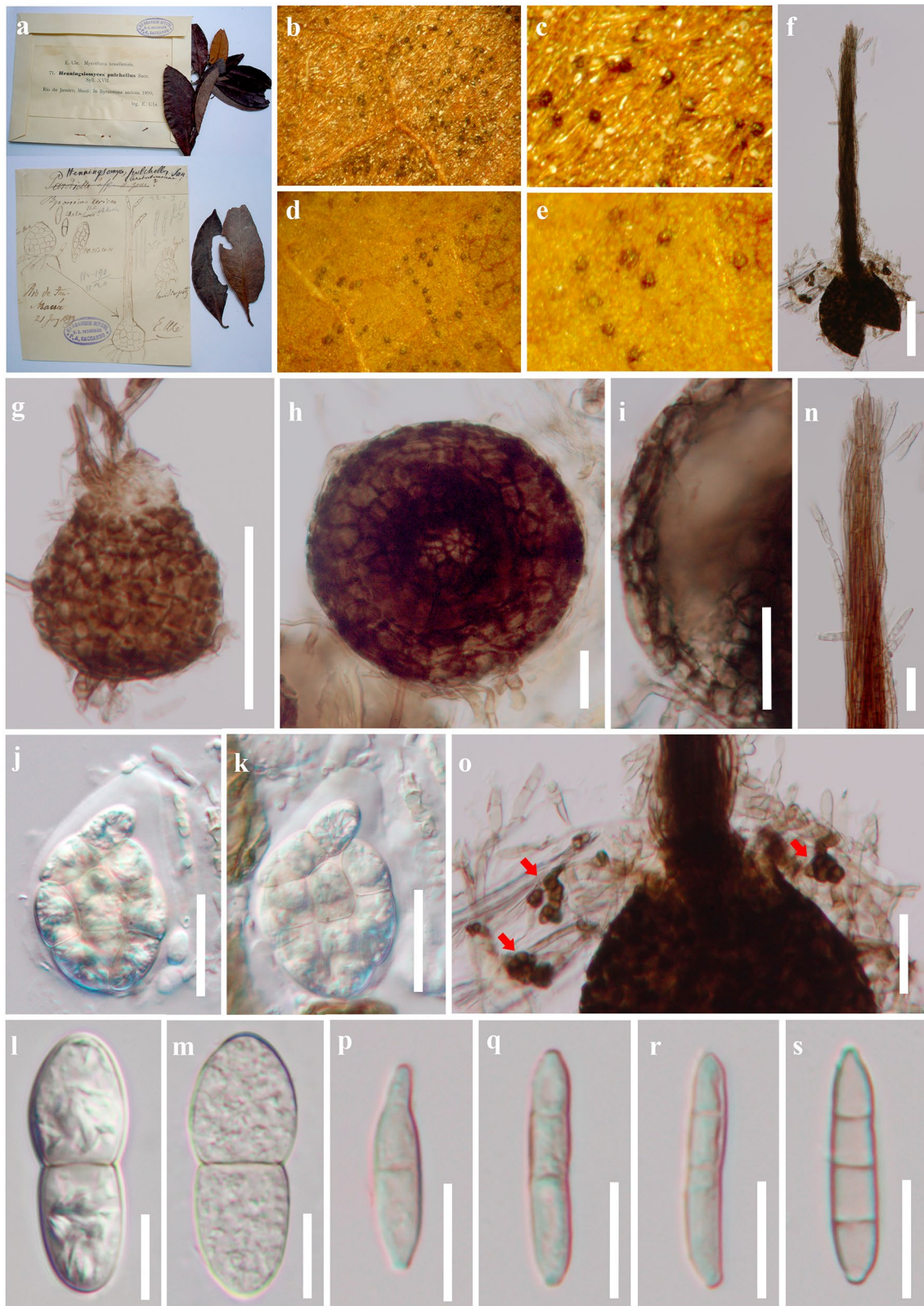
Two species in *Endosporiaceae* were found as pathogens which can uptake nutrients from plants.

***Englerulaceae*** Henn., Hedwigia 43: 353 (1904).

= *Schiffnerulaceae* Hosag., Pl. Pathol. Quarant. 1(2): 132 (2011).

*Index Fungorum number:* IF 80736; *Facesoffungi number:* FoF 07960, 125 species.

*Parasitic* or *epiphytic* on living leaves, primarily tropical. *Colonies* superficial, thin to dense, brown to dark brown, confluent, velvety, with unicellular appressoria. *Hyphae* straight to flexuous, septate, irregularly to reticulate branched, brown. *Hyphopodia* globose, brown, thick-walled, irregular or absent. **Sexual morph:** *Ascomata* relatively



small, superficial on the hyphae or on a short stalk-cell, scattered, ellipsoid to globose, cupulate, brown to black, membranous, containing few asci, lacking ostioles, dissolving

at center to release asci. *Hamathecium* comprising brown, septate, cellular pseudoparaphyses or pseudoparaphyses lacking. Asci 2 to 8 spored, bitunicate, thick-walled, ovate,



◀**Fig. 105** *Dysrhynchis pulchella* (PAD No. 71, holotype). **a, b** Material label and herbarium specimen. **b** Appearance of ascomata on the upper leaf surface. **c** Close up the appearance of ascomata on the upper leaf surface. **d** Appearance of ascomata on the lower leaf surface. **e** Close up the appearance of ascomata on the lower leaf surface. **f** Squash mount of ascoma with protruding synnematosus necks. **g** Appearance of ascoma at from the side. **h** Appearance of ascomam from at below. **i** Peridium. **j, k** Asci. **l, m** Ascospores. **n** Synnema with apical conidia. **o** Hyphopodia and appressoria (red arrows). **p–s** Conidia. Scale bars: **f, g** = 50  $\mu\text{m}$ , **h–k, n, o** = 20  $\mu\text{m}$ , **l, m, p–s** = 10  $\mu\text{m}$

globose to subglobose, pedicellate, with an ocular chamber. *Ascospores* uni- to multi-seriate, oblong to ellipsoid, ellipsoid to ovate, or fusiform, hyaline to dark brown, 1-septate, smooth-walled, constricted at the septum. **Asexual morph:** *Conidiomata* pycnidial, similar to ascomata, superficial, globose, thin-walled. *Conidiogenous cells* holoblastic, phialidic, discrete, hyaline, smooth, 1-celled, nearly ampulliform, alternate or absent. *Conidia* oblong to ovate, globose or nearly globose, hyaline to brown, aseptate.

*Type:* *Englerula* Henn.

*Notes:* *Englerulaceae* was introduced by Hennings (1904a, b) for taxa with brown to dark brown colonies on host leaves, with superficial hyphae, scattered, ascomata lacking ostioles. Lumbsch and Huhndorf (2007, 2010) included seven genera (*Englerula*, *Goosia*, *Parenglerula*, *Rhizotexis*, *Rhytidenglerula*, *Schiffnerula* and *Thrauste*) in the family, while Hyde et al. (2011) considered *Schiffnerulaceae* (Hosagoudar 2011) to be a synonym. *Schiffnerula* was introduced by von Höhnelt (1909b) and placed in *Englerulaceae* based on its globose ascomata and globose to ovate asci. Hosagoudar (2011) included four asexual genera in the family with more than 100 species. *Schiffnerula* has dark colonies on the leaf surface, with brown, superficial, septate mycelium, 8-spored, bitunicate, cylindrical to globose asci, and brown, 1-septate, ascospores which are constricted at the septa. With such characters *Schiffnerula* can be accommodated in *Englerulaceae* (Hyde et al. 2013). Dai et al. (2014b) redescribed and illustrated type species of all genera in this family. They suggested that *Rhizotexis* should be excluded from this family and placed into Dothideomycetes genera *incertae sedis* based on having stromatic ascomata and lack of hyphae.

There is no molecular data for any species of *Englerulaceae* in GenBank. Fresh collections and molecular data are required to clarify the relationships in *Englerulaceae*. *Englerulaceae* are closely related to the *Asterinaceae*, but differ in having sphaerical ascomata without radiate wall and growing on brown mycelium (von Arx and Müller 1975; Eriksson 1981; Hyde et al. 2013).

*Englerula* Henn., Bot. Jb. 34: 49 (1904).

= *Anatexis* Syd., Annl. mycol. 26(1/2): 90 (1928).

*Index Fungorum number:* IF 1820; *Facesoffungi number:* FoF 07961; 10 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Englerula macarangae* Henn.

*Notes:* This genus is characterized by brown to black colonies with angled hyphae, globose to subglobose ascomata with a thin peridium and obovoid to globose asci (von Arx and Müller 1975; Eriksson 1981; Hosagoudar et al. 2011; Hyde et al. 2013; Dai et al. 2014b). The species of this genus needs to be recollected.

*Englerula macarangae* Henn., Bot. Jb. 34: 49 (1904).

*Index Fungorum number:* IF 140464; *Facesoffungi number:* FoF 07962; Fig. 107

*Description:* see Dai et al. (2014b).

#### Other genera included

*Allosoma* Syd., Annl. mycol. 24(5/6): 353 (1926).

*Index Fungorum number:* IF 143; *Facesoffungi number:* FoF 08927; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Allosoma cestri* Syd., Annl. mycol. 24(5/6): 353 (1926).

*Notes:* The genus is characterized by superficial, globose to subglobose ascomata, subglobose asci, and oblong-ellipsoid to ellipsoid, 1-septate ascospores. This genus was placed this genus in *Englerulaceae* by Thambugala et al. (2014b) and Wijayawardene et al. (2017a, 2020). Sequence data is needed to confirm its placement.

*Digitosarcinella* S. Hughes, Can. J. Bot. 62(11): 2208 (1984).

*Index Fungorum number:* IF 11070; *Facesoffungi number:* FoF 08928; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Digitosarcinella caseariae* S. Hughes, Can. J. Bot. 62(11): 2208 (1984).

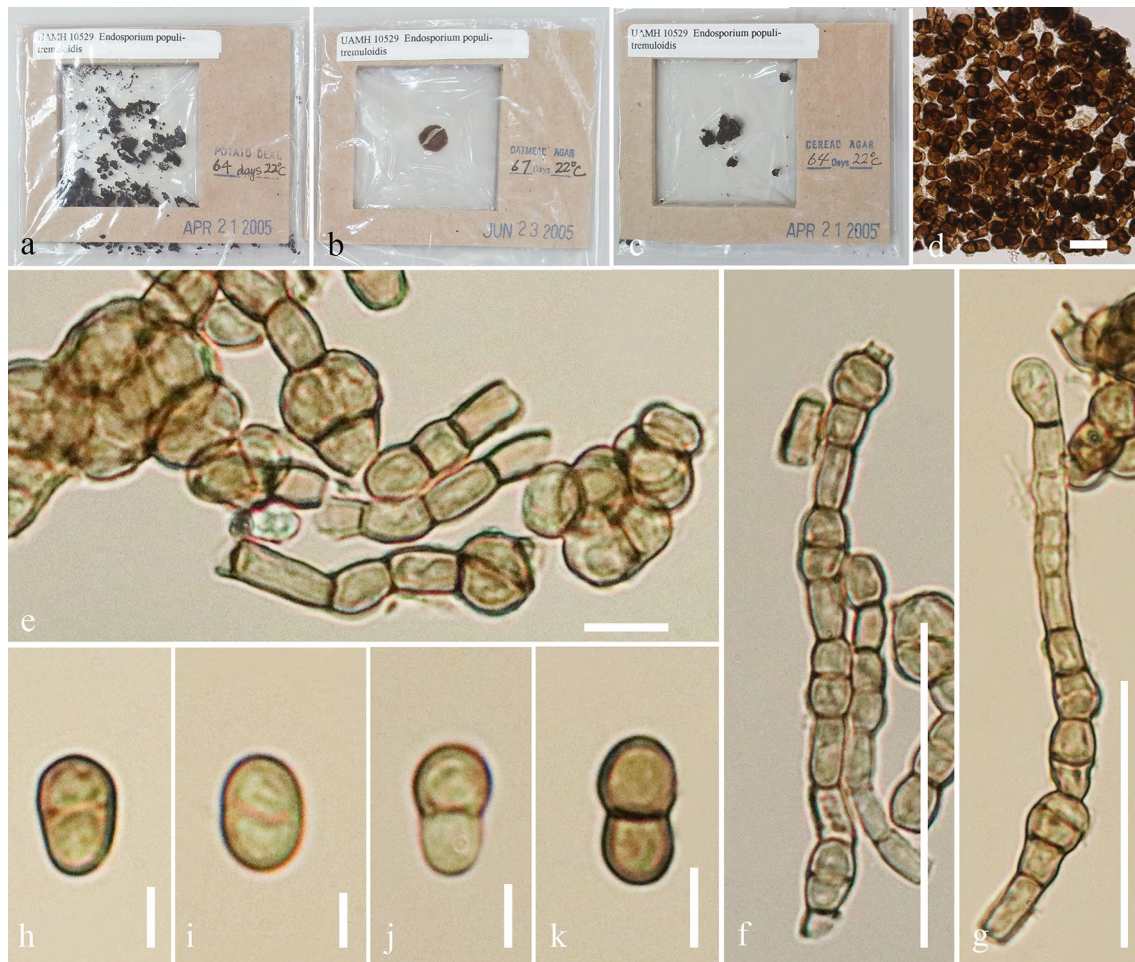
*Notes:* The genus is characterized by cheiroid conidia, hyphae with sessile hyphopodia and as asexual state of *Schiffnerula* (Hughes 1984). Wijayawardene et al. (2017a, 2020) placed this genus in *Englerulaceae*.

*Goosia* B. Song, Mycotaxon 87: 413 (2003).

*Index Fungorum number:* IF 28768; *Facesoffungi number:* FoF 07963; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Goosia melastomatis* B. Song, Mycotaxon 87: 413 (2003).

*Notes:* The monotypic genus is characterized by dark brown phialides developing directly on the hyphae, and obovoid asci containing two ascospores (Bin 2003). This genus is similar to *Thrauste* in its superficial, ellipsoid ascomata and globose hyphopodia formed on dark brown hyphae. Bin



**Fig. 106** *Endosporium populi-tremuloides* (UAMH 10529, holotype). **a–c** Details of herbarium material. **d** Squash mount of mycelium. **e–g** Hyphae giving rise to cellular clumps. **h–k** Blastoconidia. Scale bars: **d, e** = 20  $\mu$ m, **f, g** = 30  $\mu$ m, **h–k** = 5  $\mu$ m

(2003) did not observe mature ascomata and considered that *Goosia* differs from *Thrauste* with the former having phialides and smaller ascospores. Fresh collections are needed to confirm if they are different and also show its natural taxonomic relationships. Dai et al (2014b) redrew the main characters from Bin (2003).

***Parenglerula*** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 119: 465 [73 repr.] (1910).

*Index Fungorum number*: IF 3727; *Facesoffungi number*: FoF 07964; – 6 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Parenglerula macowaniana*** (Thüm.) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 119: 465 [73 repr.] (1910).

≡ *Meliola macowaniana* Thüm., Mycoth. Univ., cent. 6: no. 568 (1876).

*Notes*: *Parenglerula* was erected by von Höhnelt (1910) with seven species. *Parenglerula* is similar to *Englerula* in

having superficial, globose to subglobose, dark ascomata containing obovoid asci and broadly ellipsoid to subobovoid ascospores with a single septum, but differs by darker ascomata and ascospores (von Höhnelt 1910; Dai et al. 2014b). The genus has not been studied recently and thus needs fresh collections.

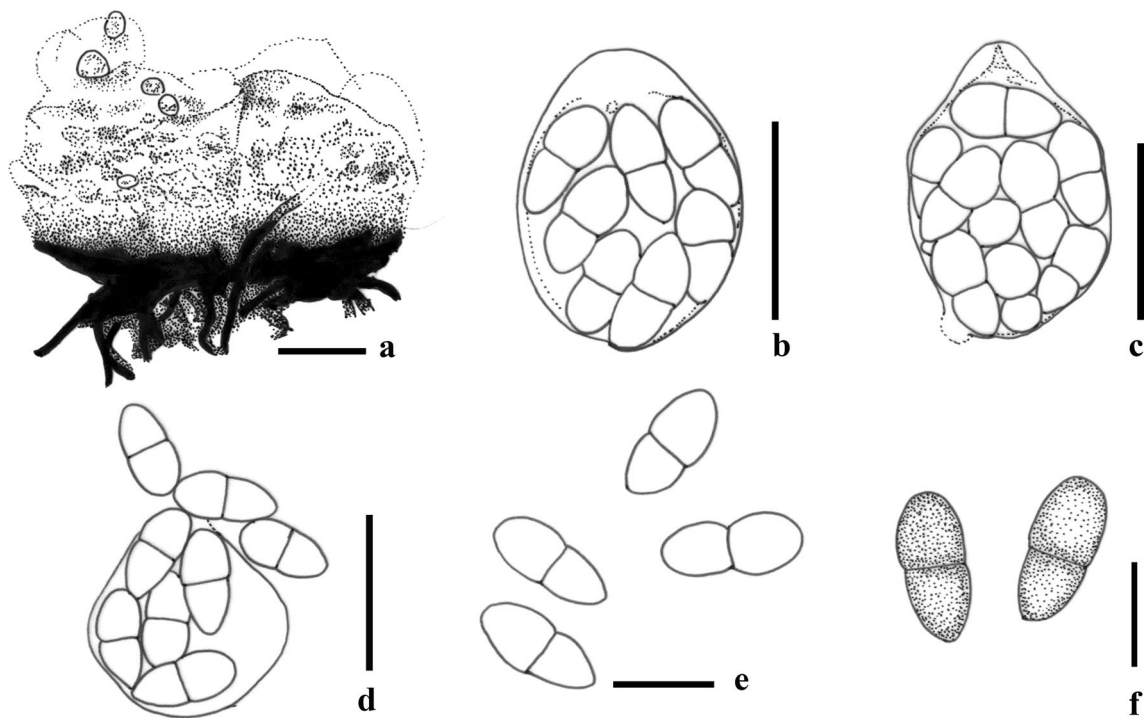
***Rhytidenglerula*** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 127: 386 [58 repr.] (1918).

*Index Fungorum number*: IF 4738; *Facesoffungi number*: FoF 07965; – 9 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Rhytidenglerula carnea*** (Ellis & G. Martin) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 127(4): 386 [58 repr.] (1918).

≡ *Asterina carnea* Ellis & G. Martin, Am. Nat. 17(2): 1285 (1883).

*Notes*: *Rhytidenglerula* has small ascomata forming in dark hyphae, a character that distinguishes it from other



**Fig. 107** *Englerula macarangae* (redrawn from Dai et al. 2014b). **a** Squash mount of ascoma. **b–d** Asci with ascospores. **e–f** Ascospores with one septum. Scale bars: **a–d** = 50 µm, **e, f** = 20 µm

genera with large and dark ascomata in the family. *Rhytidenglerula* is similar to *Schiffnerula* in having hyphopodia and globose ascomata, obovoid asci and hyaline ascospores with a single septum. *Rhytidenglerula* is linked to a coelomycetous asexual morph, *Capnodiastrum* (Kirk et al. 2008; Wijayawardene et al. 2012) which is characterized by holoblastic, doliiform, conidiogenous cells and ellipsoid, pale brown, 1-celled conidia with a conic apex (Sutton 1980). *Schiffnerula* has been linked to four different hyphomycetous asexual morphs, *Digitosarcinella*, *Mitteriella*, *Questieriella* and *Sarcinella* (Hosagoudar 2011; Hosagoudar et al. 2011; Seifert et al. 2011). These four genera are characterized by monoblastic to polyblastic conidiogenous cells and sigmoid to ellipsoid, dark brown to reddish brown, or black, 0–4-celled conidia (Hosagoudar 2011).

***Schiffnerula*** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 867 [55 repr.] (1909).

*Index Fungorum number*: IF 4886; *Facesoffungi number*: FoF 07966; – 96 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Schiffnerula mirabilis*** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 868 [56 repr.] (1909).

*Notes*: Hosagoudar (2011) considered *Schiffnerula* as a new family, because *Schiffnerula* has young ascomata which look like a shield-plate on hyphae. According to von Höhnel

(1909b, 1910), both *Rhytidenglerula* and *Schiffnerula* have thin, shield-like immature ascomata and should belong to *Englerulaceae*. In addition, *Schiffnerula* has globose, ascomata, developing on brown hyphae and contain a few globose to ovate asci with multi-seriate, ellipsoid, 1-septate ascospores, with *Digitosarcinella*, *Mitteriella*, *Sarcinella*, *Questieriella* as its asexual morph. Therefore, we retain *Schiffnerula* as a genus in *Englerulaceae*.

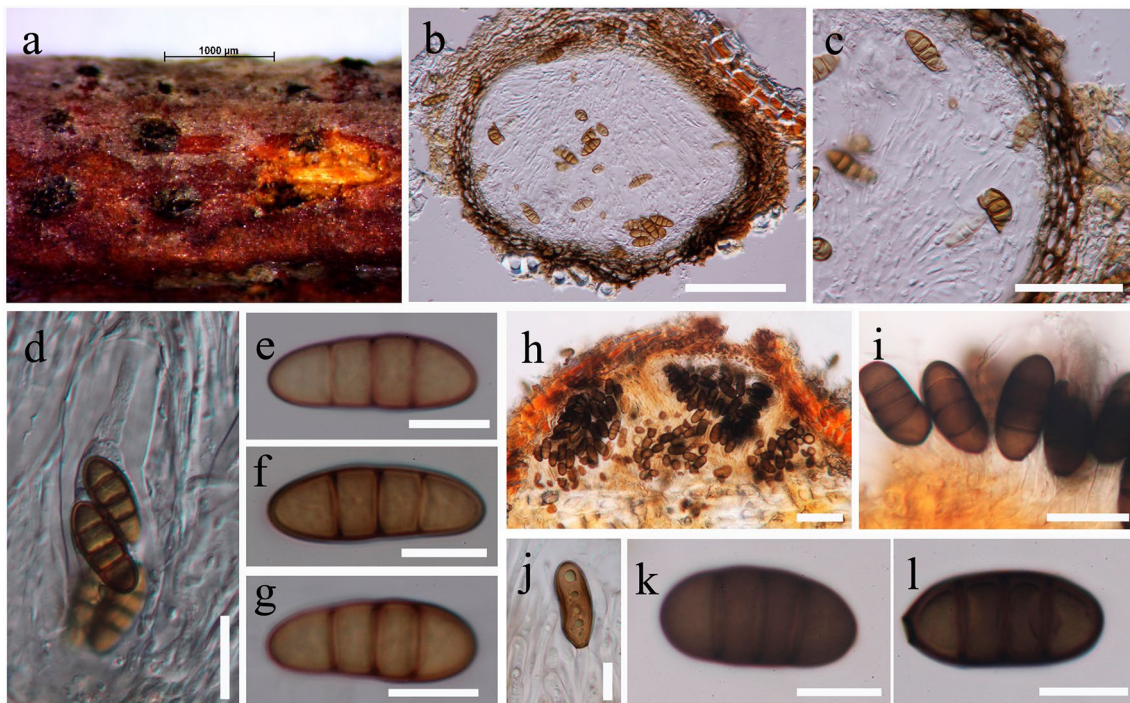
***Thrauste*** Theiss., Verh. zool.-bot. Ges. Wien 66: 337 (1916).

*Index Fungorum number*: IF 5455; *Facesoffungi number*: FoF 07967; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Thrauste medinillae*** (Racib.) Theiss., Verh. zool.-bot. Ges. Wien 66: 338 (1916).

≡ *Balladyna medinillae* Racib., Bull. int. Acad. Sci. Lett. Cracovie, Cl. sci. math. nat. Sér. B, sci. nat. 3: 373 (1909).

*Notes*: This genus is similar to *Goosia* in its dark hyphopodia and ellipsoid immature ascomata growing directly on hyphae (Theissen 1916; Bin 2003). However, *Thrauste* differs in its 8-spored, pyriform to clavate asci with an ocular chamber, while *Goosia* has 2-spored, obovoid asci and the ocular chamber is not well-developed. Dai et al. (2014b) examined a collection (F: 111745), labelled *T. medinillae*, obtained from S. There are marked differences in the shape and size of asci and ascospores between the original description of the species (Saccardo 1913) under the genus. Based



**Fig. 108** *Homortomyces tamaricis* (a–g = MFLU 14-0595; h–l = MFLU 14-0167). **a** Appearance of ascomata on host surface **b** Vertical section through ascoma **c** Peridium **d** Pseudoparaphyses and

mature ascus **e–g** Ascospores **h** Vertical sections through conidioma. **i, j** Developing conidia and paraphyses **k–l** Conidia. Scale bars: **b** = 100 µm, **c, h** = 50 µm, **d, i** = 20 µm, **e–g, j** = 10 µm

on these differences, they proposed a new species for this specimen (*Thrauste parvii*).

### Economic and ecological significance

*Englerulaceae* is a poorly known family, most species are parasitic on leaves. There is no sequence data for any members of this family in GenBank and more fresh collections are required to clarify the relationships in *Englerulaceae*.

***Homortomycetaceae*** Thambug., A.J.L. Phillips & K.D. Hyde, in Thambugala et al., *Fungal Diversity* 82: 45 (2016).

*Index Fungorum number*: IF 552086; *Facesoffungi number*: FoF 02150, 2 species.

*Foliicolous*, associated with leaf spots or saprobic on dead twigs or branches. **Sexual morph**: *Ascomata* scattered, immersed to erumpent, black, globose to subglobose, ostiolate. *Peridium* composed of a few layers of brown to dark brown, thick-walled cells of *textura angularis*. *Hamathecium* comprising septate, cellular pseudoparaphyses. *Asci* 2–6-spored, bitunicate, fissitunicate, cylindrical, apically rounded. *Ascospores* 1–2-seriate, fusiform with broadly to narrowly rounded ends, yellowish brown to brown, 3-septate, smooth-walled. **Asexual morph**: Coelomycetous. *Conidiomata* pycnidial, solitary or gregarious, immersed or slightly erumpent, uniloculate or multi-loculate, globose to subglobose, ostiolate. *Conidiomatal wall* comprising a few

layers, of lightly pigmented to hyaline cells of *textura angularis*. *Hamathecium* comprising cylindrical, smooth, flexuous, apex obtuse, hyaline, sparingly septate, paraphyses, intermingled among conidiogenous cells. *Conidiophores* reduced to conidiogenous cells or one supporting cell. *Conidiogenous cell* with supporting cell, hyaline, percurrently proliferating at the tip of the supporting cells. *Conidia* ellipsoid to subcylindrical, straight to slightly curved, golden brown to dark brown, 3(–4)-euseptate, apex obtuse, base truncate with a visible scar.

*Type*: ***Homortomyces*** Crous & M.J. Wingf.

*Notes*: Thambugala et al. (2017) introduced the monotypic family *Homortomycetaceae* to accommodate its type *Homortomyces*, as its phylogenetic placement is uncertain. Thambugala et al. (2017) placed *Homortomycetaceae* in Dothideomycetes, families *incertae sedis*.

***Homortomyces*** Crous & M.J. Wingf., in Crous et al., *IMA Fungus* 3(2): 110 (2012).

*Index Fungorum number*: IF 801349; *Facesoffungi number*: FoF 07968; 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: ***Homortomyces combreti*** Crous & M.J. Wingf.

*Notes*: Crous et al. (2012a) established *Homortomyces* in Dothideomycetes genera *incertae sedis* to accommodate

*H. combreti*, which was associated with leaf spots on *Combretum erythrophyllum*. The second species, *H. tamaricis* was introduced by Wijayawardene et al. (2014b) from dead branches of *Tamarix gallica*. Thambugala et al. (2017) described the sexual morph of *H. tamaricis* associated with the same host. *Homortomyces* is similar to *Stilbospora*, which is classified in *Stilbosporaceae*, Diaporthales, Sordariomycetes (Wijayawardene et al. 2014b; Senanayake et al. 2017), while the genera *Endocoryneum*, *Hendersoniopsis*, *Angiopomopsis* and *Ceratopycnis* show similar conidial characteristics of *Homortomyces*. However, all these genera have been classified in *incertae sedis* due to lack sequence data (Crous et al. 2012a; Thambugala et al. 2017).

***Homortomyces tamaricis*** Wijayaw., Camporesi & K.D. Hyde, in Wijayawardene et al., Phytotaxa 176(1): 160 (2014).

*Index Fungorum*: IF 550192; *Facesoffungi number*: FoF 02151; Fig. 108

*Saprobic* on *Tamarix gallica* L. **Sexual morph**: *Ascomata* 190–280  $\mu\text{m}$  high  $\times$  280–350  $\mu\text{m}$  diam. ( $\bar{x}$  = 234  $\times$  310  $\mu\text{m}$ ,  $n$  = 6), scattered, sometimes aggregated, immersed to partially erumpent through the host tissues, black, globose to subglobose, unilocular, ostiolate. *Peridium* 20–40  $\mu\text{m}$  wide, comprising several layers of brown to dark brown, thick-walled cells of *textura angularis*. *Hamathecium* comprising 2–4  $\mu\text{m}$  wide, septate, cellular pseudoparaphyses. *Asci* 80–100  $\times$  18–23  $\mu\text{m}$  ( $\bar{x}$  = 87  $\times$  21  $\mu\text{m}$ ,  $n$  = 6), mostly 2–6-spored, bitunicate, fissitunicate, cylindrical, short pedicellate, apically rounded, with a distinct ocular chamber. *Ascospores* 23–30  $\times$  8–12  $\mu\text{m}$  ( $\bar{x}$  = 25  $\times$  10  $\mu\text{m}$ ,  $n$  = 25), 1–2-seriate, fusiform with broadly to narrowly rounded ends, yellowish brown to brown, 3-septate, smooth-walled, without a mucilaginous sheath. **Asexual morph**: Coelomycetous. *Conidiomata* 150–250  $\mu\text{m}$  high  $\times$  300–350  $\mu\text{m}$  diam. ( $\bar{x}$  = 200  $\times$  330  $\mu\text{m}$ ,  $n$  = 5), solitary or gregarious, immersed to slightly erumpent, pycnidial to irregular, uniloculate to multi-loculate, subglobose, ostiolate. *Conidiomatal wall* 10–22  $\mu\text{m}$ , comprising a few layers of lightly pigmented to hyaline cells of *textura angularis*. *Hamathecium* comprising numerous, aseptate, cylindrical, guttulate, paraphyses. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cell* 6–25  $\times$  2.5–5.5  $\mu\text{m}$  ( $\bar{x}$  = 15  $\times$  3.6  $\mu\text{m}$ ,  $n$  = 20), with supporting cell, hyaline, percurrently proliferating at the tip of the supporting cells. *Conidia* ellipsoid to subcylindrical, straight to slightly curved, 20–30  $\times$  9–12.5  $\mu\text{m}$  ( $\bar{x}$  = 25  $\times$  11  $\mu\text{m}$ ,  $n$  = 30), golden brown to dark brown, becoming coloured before release from conidiogenous cells, smooth-walled, initially aseptate to 1-septate, becoming at maturity 3-septate, apex obtuse, base truncate, smooth-walled.

*Material examined*: Italy, Province of Forlì-Cesena [FC]), Ravaldino in Monte Forlì, on dead branches of *Tamarix*

*gallica* L. (*Tamaricaceae*), 22 November 2012, Erio Camporesi IT 922 (MFLU 14-0595 & MFLU 14-0167).

*Notes*: Wijayawardene et al. (2014b) introduced *Homortomyces tamaricis* from *Tamarix gallica* based on its asexual morph, while Thambugala et al. (2017) described the sexual morph of this species from the same host based both morphological traits and molecular sequence data.

### Economic and ecological significance

As the species of *Homortomyces* are associated with ornamental plants such as *Combretum erythrophyllum* and *Tamarix gallica*, they reduce the value of those plants.

***Hyalomeliolinaceae*** Boonmee & K.D. Hyde, in Boonmee et al., Mycosphere 8(10): 1718 (2017).

*Index Fungorum*: IF 553830; *Facesoffungi number*: FoF 06396, 2 species.

*Parasitic* on living leaves. **Sexual morph**: *Colonies* form on a lower surface of leaves, black, subcircular, with outwardly radiating mycelium, with hyphae that are long hairy, flexible, dark brown to black, densely, fluffy, partially erect, unbranched, and septate. *Ascomata* superficial, globose to subglobose, black, seated on dark hyphae, covered by dense hyphae, superficial mycelium, unbranched, septate, dark to black. *Peridium* comprising dark brown to black cells of *textura angularis*. *Hamathecium* comprising elongate-filiform, septate, unbranched, filamentous, cellular pseudoparaphyses, extending over asci, constricted at the septa. *Asci* 8-spored, bitunicate, fissitunicate, saccate-oblong to ellipsoidal, sessile, lower median widest, with the small ocular chamber. *Ascospores* 2–3-seriate, ellipsoid-fusiform, end narrow, pigmented, multi-septate. **Asexual morph**: Undetermined.

*Type*: *Hyalomeliolina* F. Stevens.

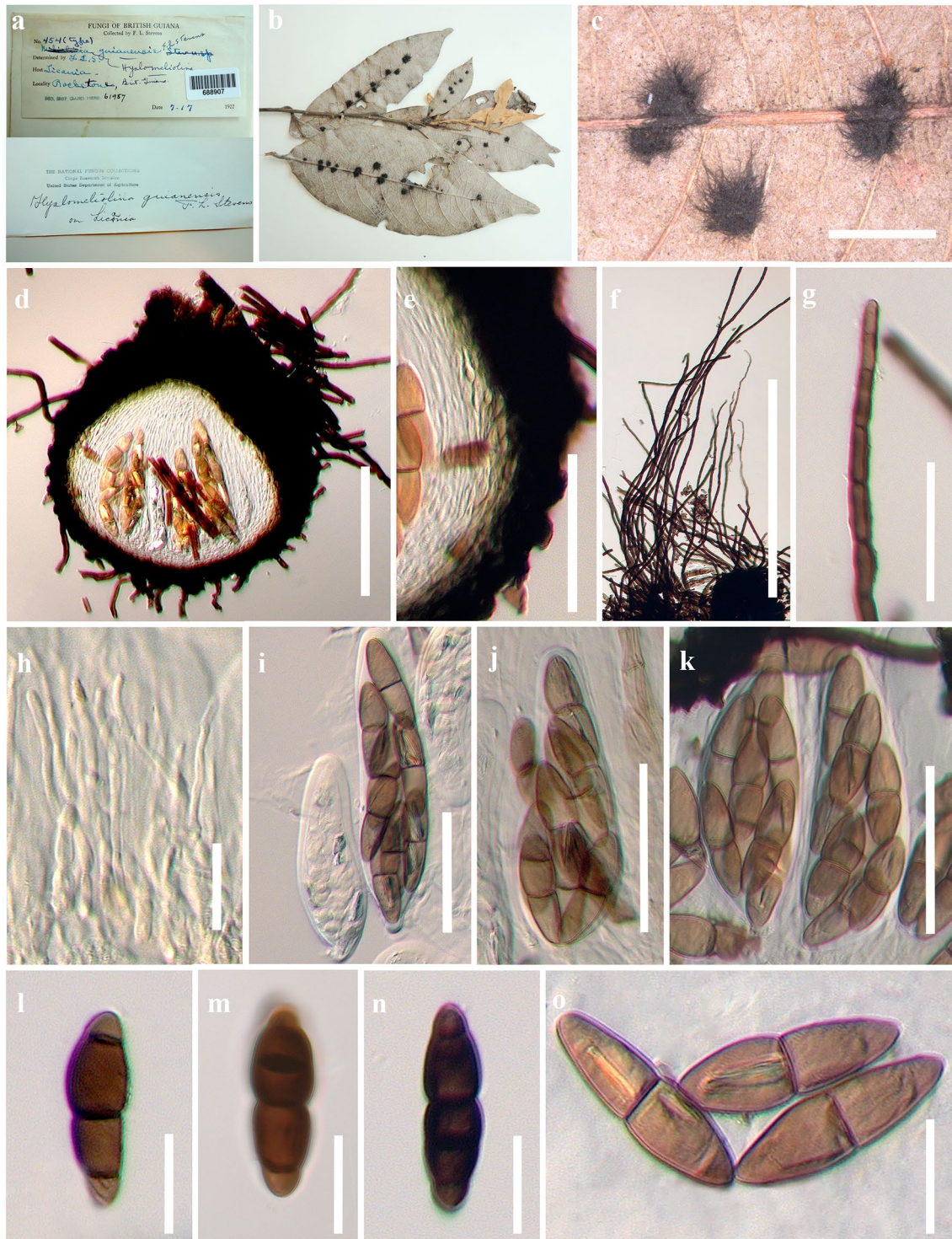
*Notes*: Boonmee et al. (2017) re-examined the type species *Hyalomeliolina guianensis* and concluded the unique suite of characters and could not place it in any families in Dothideomycetes. Therefore, *Hyalomeliolinaceae* was established to accommodate *Hyalomeliolina* (Boonmee et al. 2017). No molecular data is available to confirm its phylogenetic placement within Dothideomycetes.

***Hyalomeliolina*** F. Stevens, Illinois Biol. Monogr. (Urbana) 8(no. 3): 27 (1924).

*Index Fungorum*: IF 553830; *Facesoffungi number*: FoF 06397; 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Hyalomeliolina guianensis* F. Stevens.

*Notes*: *Hyalomeliolina* is a single genus in *Hyalomeliolinaceae*, and it was established by Stevens (1923) based on morphology. The genus is characterized by a life mode as parasites on living leaves, forming black colonies on leaf surfaces, ascomata covered by dense hyphae and



**Fig. 109** *Hyalomeliolina guianensis* (BPI688907, holotype). **a** Material label. **b** Herbarium specimen. **c** Ascomata covered by hyphae on the leaf surface. **d** Section of ascoma. **e** Peridium. **f**, **g**

Hairy hyphae. **h** Pseudoparaphyses. **i–k** Asci. **l–o** Ascospores. Scale bars: **c** = 5 mm, **d**, **f** = 500 µm, **e**, **g**, **i–k** = 50 µm, **h**, **l–o** = 20 µm

ellipsoid-fusiform, 1–3-septate, light to dark pigmented ascospores. The genus comprises *Hyalomeliolina guianensis*

and *H. linderi*, while *H. costaricensis* were transferred to *Nematostoma* by Hansford (1946).

***Hyalomeliolina guianensis*** F. Stevens, Illinois Biol. Monogr. (Urbana) 8(no. 3): 28 (1924) [1923].

*Index Fungorum number*: IF 266643; *Facesoffungi number*: FoF 06398, Fig. 109

*Description*: see Boonmee et al. (2017).

*Material examined*: Guyana (= British Guiana), Rockstone, on living leaves of *Licania* Aubl. (*Chrysobalanaceae*), 17 July 1922, F.L. Stevens No. 454 (BPI688907, **holotype**).

### Economic and ecological significance

Members in *Hyalomeliolinaceae* play roles in host plant penetration by being parasitic.

***Leptopeltidaceae*** Höhn. ex Trotter [as ‘Leptopeltineae’], Syll. fung. (Abellini) 24(2): 1255 (1928).

*Index Fungorum*: IF 81594; *Facesoffungi number*: FoF 07969, 15 species.

*Epiphytic* on ferns (*Aspidium*), *Aruncus*, *Potentilla* and other flowering herbaceous plants as well as *Connarus suberosus* Planch. **Sexual morph**: *Ascomata* thyriothecial, superficial, visible as black dots or irregular on host surface, producing vegetative mycelium penetrating the host, solitary to gregarious, flattened, circular, round, elongate or irregular, or Y-shaped, easily removed from the host, brown to dark brown, waxy, in section lenticular, scutate, conical, or quadrilateral trapezoid, dehiscence by slit-like opening, or splitting of the upper wall. *Peridium* thin-walled, composed of reddish-brown to dark brown, isodiametric or polygonal upper-walled cells with a parallel or irregular arrangement, radiating from the centre, basal layer poorly developed, occasionally forming basal cell layers, arranged in a *textura angularis* in vertical section. *Hamathecium* comprising broadly filamentous, septate, unbranch, tapering towards the apex, paraphyses, embedded in gelatinous matrix. *Asci* 8-spored, bitunicate, broadly cylindrical to cylindrical-clavate, or subglobose to ampulliform, with obtuse to truncate or acute apex, sessile to subsessile, with truncate base, ocular chamber indistinct, clearly visible when young. *Ascospores* overlapping 1–3-seriate, twisted or fasciculate, varied in shape, ellipsoidal, broadly fusiform, cylindrical, lunate, or muriform, with rounded to acute ends, hyaline, aseptate or septate, smooth-walled, with or without small guttules. **Asexual morph**: Hyphomycetous idriella-like (asexual morph of *Dothiopeltis*) and coelomycetous leptothyrium-like (asexual morph of *Leptopeltis*) (Wijayawardene et al. 2017b).

*Type*: ***Leptopeltis*** Höhn.

*Notes*: von Höhnel (1917) invalidly introduced *Leptopeltidaceae* as ‘Leptopeltineen’ and treated the family in Phacidiales. However, the family was validly introduced by Saccardo (1928). The familial concept contained highly heterogeneous taxa which were described as epiphytic fungi having excipular or subcuticular, uni-loculate ascomata with

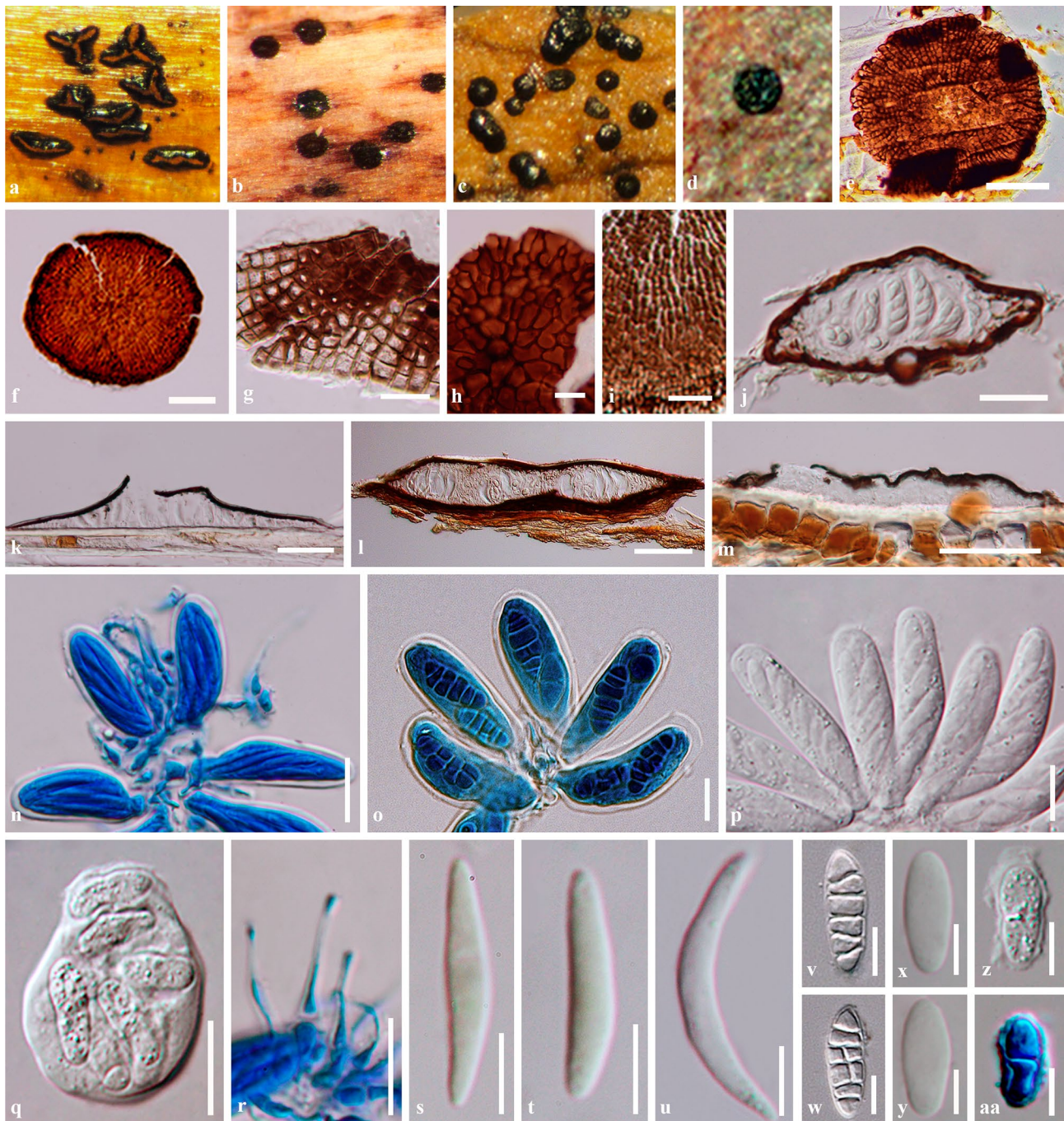
longitudinal irregular scratch-like openings and hyaline, fusoid, two-celled ascospores with paraphyses (von Höhnel 1917; Holm and Holm 1977; Hyde et al. 2013). von Höhnel (1917) included 12 genera in this family, *Bifusella*, *Coccomyces*, *Duplicaria*, *Entopeltis*, *Haplophyse*, *Leptopeltella*, *Leptopeltis*, *Lophodermina*, *Phacidina*, *Schizothyrioma*, *Thyriopsis* and *Vizella*. The family has a long historical discussion by various authors and many genera were included and excluded from this family (Petraček 1947a, b; von Arx and Müller 1975; Holm and Holm 1977; Eriksson 1981; Lumbsch and Huhndorf 2010; Hyde et al. 2013). Holm and Holm (1977) mentioned that taxa in *Leptopeltidaceae* have unitunicate asci as they could not find the “Jack in the box” dehiscence exhibited by *Leptopeltis* asci based on their observation under the transmission electron microscope (TEM). Eriksson (1981) disagreed with Holm and Holm (1977) and demonstrated bitunicate asci with “Jack in the box” dehiscence in *Leptopeltidaceae* as he had found the endotunica and ectotunica layers of the asci. However, there was no sharp delimitation between endotunica and ectotunica in ascomycetes. Hence, it is difficult to name the bitunicate or unitunicate asci in many cases of which *Leptopeltis* is one of these cases (Eriksson 1981; Hyde et al. 2013).

Hyde et al. (2013) re-circumscribed genera in *Leptopeltidaceae* following the lists of Lumbsch and Huhndorf (2010). Based on the generic type studies, Hyde et al. (2013) accepted five genera in *Leptopeltidaceae* viz. *Leptopeltis*, *Dothiopeltis*, *Nannfeldtia* *Ronnigeria* and *Staibia* and classified the family in Dothideomycetes, family *incertae sedis*. Hyde et al. (2013) excluded *Phacidina* from *Leptopeltidaceae* as the type genus, *P. gracilis* has unitunicate asci, with J+, subapical ring. However, Wijayawardene et al. (2018) listed the genus in *Leptopeltidaceae*. We re-examine the type of genera in *Leptopeltidaceae* and exclude *Nannfeldtia* from *Leptopeltidaceae*. The generic type of *Nannfeldtia*, *N. atra* has morphological similarity with taxa in Leotiomyces in having apothecial ascomata, apically swollen paraphyses and unitunicate asci, with J+ apex (Phookamsak, pers. comm.). Therefore, we accept four genera: *Leptopeltis*, *Dothiopeltis*, *Ronnigeria* and *Staibia* in *Leptopeltidaceae*. However, these genera lack molecular data to clarify their phylogenetic affinities, and their morphological characteristics are heterogeneous. A taxonomic revision of genera in this family based on molecular data awaits study and will resolve whether these taxa are Dothideomycetes or belong in another class.

***Leptopeltis*** Höhn., Ber. dt. bot. Ges. 35: 418 (1917).

*Index Fungorum number*: IF 2786; *Facesoffungi number*: FoF 07970; 9 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Leptopeltis flicina*** (Lib.) Höhn., Ber. dt. bot. Ges. 35: 422 (1917).



**Fig. 110** Morphological characteristics of genera in *Leptopeltidaceae* based on the type studies (a, g, k, n, r–u = *Leptopeltis filicina* ( $\equiv$  *Aulographum filicinum*); b, e, h, l, o, v, w = *Dothiopeltis arunci*; c, j, p, x, y = *Ronnigeria arctica* ( $\equiv$  *Microthyrium arcticum* Oudem.); d, f, i, m, q, z, aa = *Staibia connari*). **a–d** Appearance of ascomata on host surface. **e, f** Upper view of ascomata. **g–i** Upper view of peridium showing cell arrangement. **j–m** Section through ascomata. **n–q** Asci (n, o = stained by cotton blue). **r** Paraphyses stained by cotton blue. **s–aa** Ascospores (s, t, x, y = stained by Melzer’s reagent, aa = stained by cotton blue). Scale bars: **e, l, m** = 50  $\mu$ m, **f, h, i–k** = 20  $\mu$ m, **g, n–r** = 10  $\mu$ m, **s–aa** = 5  $\mu$ m

$\equiv$  *Aulographum filicinum* Lib., Pl. crypt. Arduenna, fasc. (Liège) 3(nos 201–300): no. 275 (1834).

*Notes* *Leptopeltis* was introduced by von Höhnelt (1917) and is typified by *L. filicina* ( $\equiv$  *Aulographum filicinum* 1834).

The genus is characterized by subcuticular or superficial, elongate or Y-shaped thyriothechia, opening with slit-like ostiole. The peridium is composed of a single layer of dark brown to black, isodiametric cells, which are paler at the



base. Asci are 8-spored, bitunicate, cylindrical to cylindrical-clavate, ellipsoidal to oblong, sessile, apically rounded, with an indistinct ocular chamber, raising in between broad, aseptate paraphyses and ascospores are fusiform, oblong to cylindrical, or sometimes falcate to reniform, hyaline, 0–3-septate (Hyde et al. 2013). The genus lacks a modern taxonomic treatment and molecular data to investigate its phylogenetic placement. The type species, *L. filicina* was collected from *Asplenium felix-mas* in Belgium and is currently treated as a synonym of *Fouragea filicina* ( $\equiv$  *Opegrapha filicina* 1845) in *Opegraphaceae* (Index Fungorum 2020, accessed 8 June 2020). However, the basionym of *Leptopeltis filicina* was introduced earlier than the basionym of *Fouragea filicina*. We therefore, reinstate *Leptopeltis* based on its generic type being introduced earlier. The asexual morph of *Leptopeltis* was reported as coelomycetous, leptothyrium-like, forming in dimidiate or scutate pycnidial cavities, with small, one-celled conidia (von Arx and Müller 1975; Hyde et al. 2013; Wijayawardene et al. 2017b). However, the connection of the sexual and asexual morphs has not been proven (Fig. 110).

#### Other genera included

***Dothiopeltis*** E. Müll., Sydowia 10(1–6): 197 (1957) [1956].

*Index Fungorum number*: IF 1700; *Facesoffungi number*: FoF 07971; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Dothiopeltis arunci*** E. Müll., Sydowia 10(1–6): 198 (1957) [1956].

*Notes*: *Dothiopeltis arunci* was collected from *Aruncus silvester* in Switzerland. The genus is epiphytic on dry stems. Ascumata are superficial, rounded, lenticular, scattered to clustered, shiny, lacking ostioles, forming brown, septate, vegetative hyphal webs at the margin, immersed in host tissue and lack paraphyses. The upper wall of the peridium is composed of thickened, dark, radially globose or angular cells, with well-developed basal walls. Asci are 8-spored, bitunicate, ellipsoidal to clavate, sessile to subsessile and ascospores are hyaline, muriform, ellipsoidal to cylindrical and occasionally clavate to obclavate (Müller 1956). Holm and Holm (1977) found that *D. arunci* has longitudinal slit-like openings and they did not see the basal layers of the peridium. The second species, *D. cicerbitae* Granmo & Math. was found on stalks of *Cicerbita alpina* in Norway and is distinct from *D. arunci* in several aspects (Granmo and Mathiassen 2013). The asexual morph of *Dothiopeltis* was reported as hyphomycetous, idriella-like which is characterized by hyaline or brown hyphae, brown, simple, aseptate geniculate conidiophores, tapering towards the tip and lunate or falcate conidia with acuminate tips, produced in dry heads (Nelson and Wilhelm 1956; Hyde et al. 2013; Wijayawardene et al. 2017b).

***Ronnigeria*** Petr., Sydowia 1(4–6): 310 (1947).

*Index Fungorum number*: IF 4782; *Facesoffungi number*: FoF 07972; – 1 morphological species (Species Fungorum 2020), molecular data unavailable

*Type species*: ***Ronnigeria arctica*** (Oudem.) Petr., Sydowia 1(4–6): 310 (1947).

$\equiv$  *Microthyrium arcticum* Oudem., Ned. kruidk. Archf. 2 sér. 3: 160 (1886).

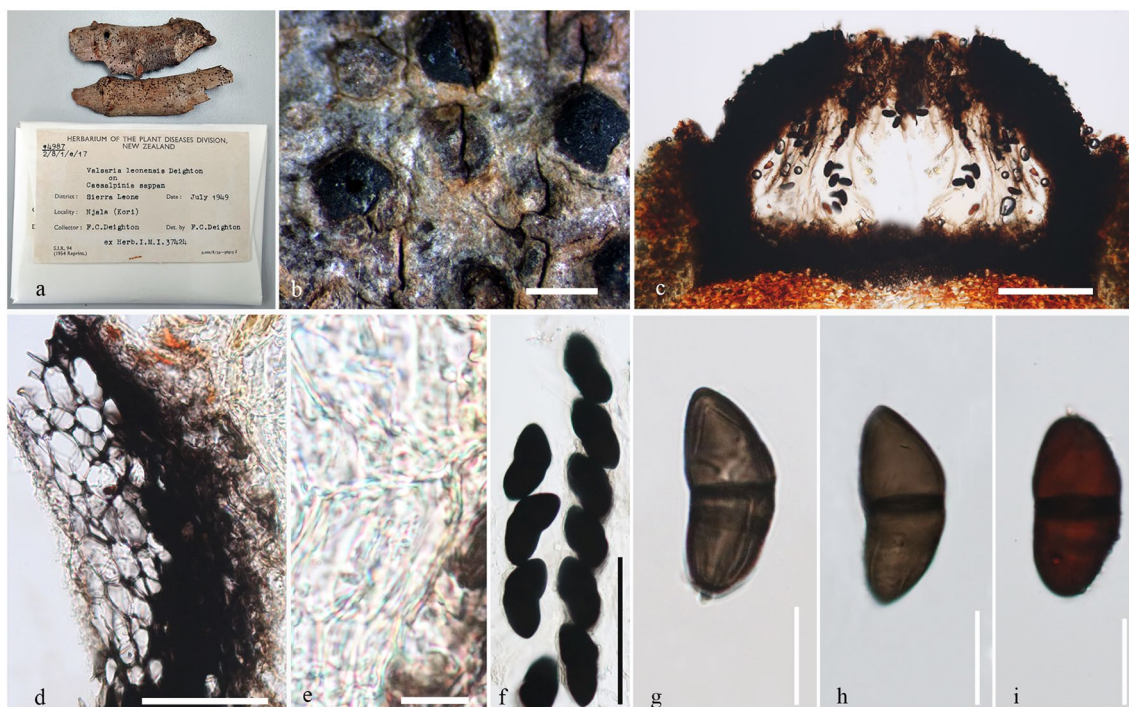
*Notes*: Petrak (1947b) introduced a monotypic genus *Ronnigeria* to accommodate *Ronnigeria arctica* ( $\equiv$  *Microthyrium arcticum*), epiphytic on *Potentilla fragiformis* in Novaya Zemlya, Russia (Holm and Holm 1977). The genus is characterized by perithecial, subcuticular, gregarious, amphigenous, orbicular to elliptical ascumata, lacking ostioles, opening by peridial cracks, with a thin-walled peridium, composed of a single layer of dark brown, membranous, pseudoparenchymatous cells and with paraphyses. Asci are 8-spored, clavate, with rounded to truncate bases and ascospores are hyaline, oblong to clavate, or subfusoid (Petrak 1947b; Holm and Holm 1977). The asexual morph of this genus is undetermined. Petrak (1947b) accommodated the genus in *Leptopeltidaceae* and this was followed by various subsequent authors (von Arx and Müller 1975; Holm and Holm 1977; Lumbsch and Huhndorf 2010; Hyde et al. 2013; Wijayawardene et al. 2014a, 2018). The genus has an arctic-alpine distribution and is commonly found on *Potentilla* spp. in northern Scandinavia and central Europe (Holm and Holm 1977; Farr and Rossman 2020). However, the genus lacks modern taxonomic treatment and molecular data to confirm its phylogenetic affinity. Recollection based on type material is required for a better understanding of this genus.

***Staibia*** Bat. & Peres, in Batista et al., Atas Inst. Micol. Univ. Pernambuco 3: 142 (1966).

*Index Fungorum number*: IF 5181; *Facesoffungi number*: FoF 07973; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Staibia connari*** Bat. & Peres, in Batista et al., Atas Inst. Micol. Univ. Recife 3: 142 (1966).

*Notes*: *Staibia* was introduced as a monotypic genus to accommodate an epiphytic fungus occurring on leaves of *Connarus suberosus* in Brazil and is characterized by subcuticular, dark brown, orbicular, dimidiate, membranous ascumata, lacking ostioles and paraphyses. The upper wall of the peridium is radiate, with longitudinally isodiametric cells, endowed with multiple hymenium, black at the margin and with a poorly-developed base. Asci are 8-spored, bitunicate and globose and ascospores are hyaline, oblong to subovoid and 1-septate (Batista et al. 1966). The asexual morph of this genus is undetermined. Batista et al. (1966) treated the genus in *Leptopeltidaceae* and this was followed by subsequent authors (von Arx and Müller 1975; Lumbsch and Huhndorf 2010; Hyde et al. 2013; Wijayawardene et al.



**Fig. 111** *Macrovalsaria megalospora* (= *M. leonensis* PDD 14987, **co-extype**). **a** Details of herbarium material. **b** Habit and appearance of ascostromata on host surface. **c** Section of ascoma. **d** Peridium. **e**

Hamathecium. **f** Asci. **g–i** Ascospores. Scale bars: **b** = 1 mm, **c, d** = 200  $\mu$ m, **e** = 10  $\mu$ m, **g–i** = 20  $\mu$ m

2014a, 2018). The genus is poorly known and lacks molecular data to reveal its taxonomic status, hence, it was tentatively placed in this family pending further studies.

### Economic and ecological significance

Taxa in *Leptopeltidaceae* are commonly as epiphytic occurring on stems or leaves of ferns and some dicotyledonous plants. Species in this family are mainly distributed in Europe, except *Staibia connari* which was found on leaves of *Connarus suberosus* in Brazil (Batista et al. 1966; von Arx and Müller 1975; Holm and Holm 1977; Farr and Rossman 2020).

**Macrovalsariaceae** D. Pem, Doilom & K.D Hyde, in Pem et al., *Mycosphere* 10(1): 1149 (2019).

*Index Fungorum number*: IF 557067; *Facesoffungi number*: FoF 06682, 2 species.

*Saprobic* on dead twigs, wood, bamboo and culms of a wide range of hosts. **Sexual morph**: *Ascostromata* dark brown to black, immersed to erumpent, solitary to a few in a group, carbonaceous, oblate, sphaeroid to subsphaerical, with a central ostiole. *Peridium* comprising brown and small-celled *textura angularis*. *Asci* 8-spored, bitunicate, fissitunicate, cylindro-clavate, with a short fine pedicel,

apically rounded with a small ocular chamber. *Hamathecium* comprising unbranched, tapering upwards, apically free, paraphyses. *Ascospores* uni-seriate to irregularly uni-seriate, elliptical-fusoid, brown, 1-septate, slightly constricted at septum, with skull cap-like germ apparatus at the lower end, transverse striation near the center of lower cell with longitudinal striations from transverse striation to the end cell surface smooth, granular to verrucose. **Asexual morph**: Undetermined.

*Type*: **Macrovalsaria leonensis** (Deighton) Petr.

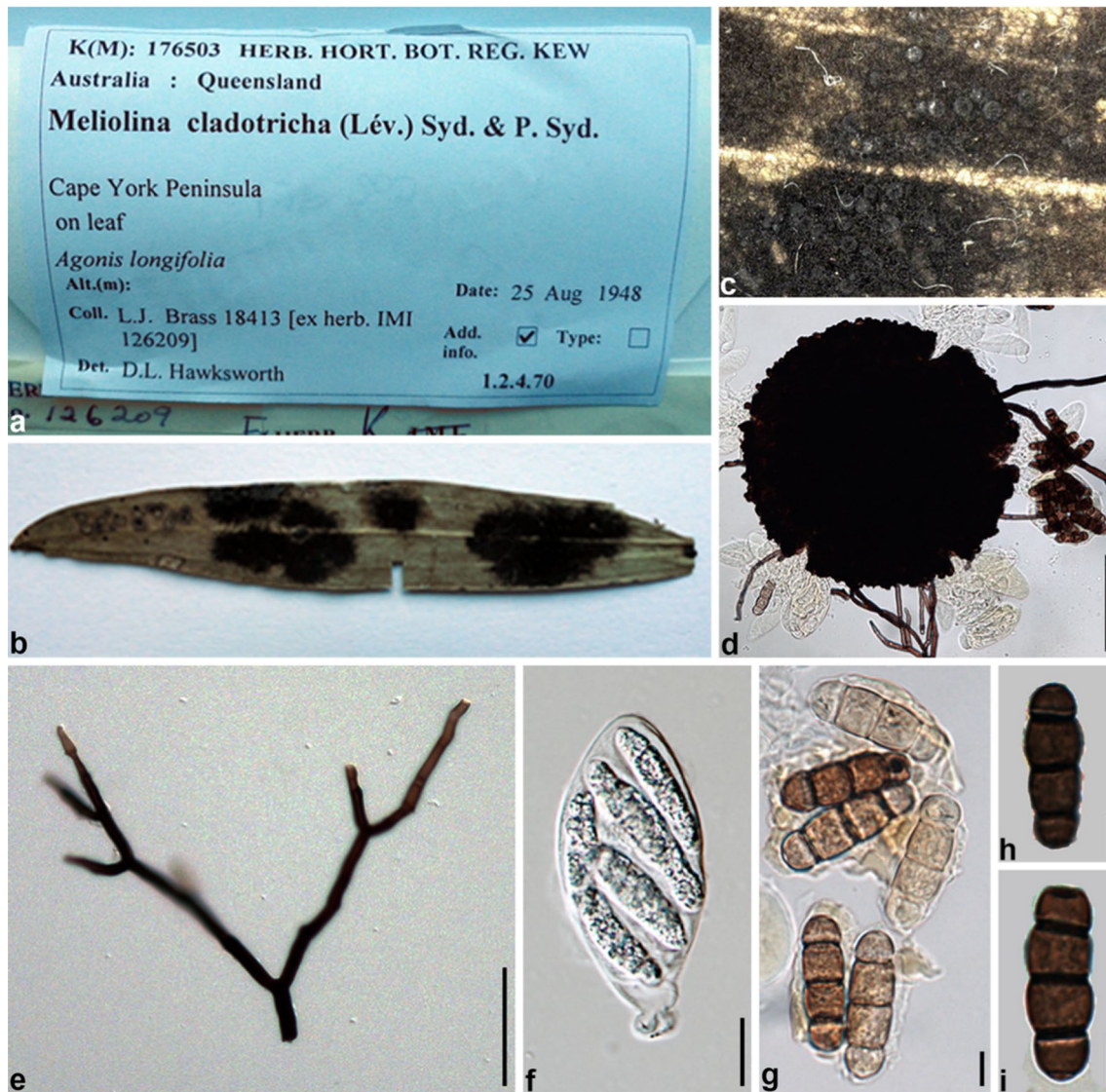
*Notes*: Pem et al. (2019c) introduced *Macrovalsariaceae* to accommodate *Macrovalsaria*. The family is characterized by dark brown to black ascostromata, cylindro-clavate asci, with a short fine pedicel and elliptical to fusoid ascospores with skull cap-like germ apparatus.

**Macrovalsaria** Petr., *Sydowia* 15(1–6): 298 (1962) [1961].

*Index Fungorum number*: IF 2971; *Facesoffungi number*: FoF 06251; 2 morphological species (Species Fungorum 2020), 2 species with molecular data.

*Type species*: **Macrovalsaria megalospora** (Mont.) Sivan.

*Notes*: *Macrovalsaria* is unique in producing brown, uni-septate ascospores that are constricted at the septum and the



**Fig. 112** *Meliolina cladotricha* (K 176503). **a** Herbarium packet. **b** The host leaf. **c** Ascomata on the leaf surface. **d** Squash mount of ascoma. **e** Hyphae with dichotomously branched phialophores. **f** Ascus. **g–i** Ascospores. Scale bars: **c** = 400  $\mu$ m, **d** = 100  $\mu$ m, **f** = 20  $\mu$ m, **e**, **g–i** = 10  $\mu$ m

skull cap-like germ apparatus at the base (Sivanesan 1975). The asexual morph is unknown.

***Macrovalsaria megalospora*** (Mont.) Sivan. Trans. Br. Mycol. Soc. 65: 400 (1975).

≡ *Sphaeria megalospora* Mont., Anns Sci. Nat., Bot., sér. 2 14: 324 (1840).

*Index Fungorum number*: IF 317110; *Facesoffungi number*: FoF 01868; Fig. 111

*Description*: see Pem et al. (2019c).

*Material examined*: Africa, Sierra Leone, Njala (Kori), on dead branches of *Caesalpinia sappan* (Fabaceae), 12 July 1949, F.C Deighton (PDD 14987, co-extype).

#### Economic and ecological significance

This family is saprobic and thus involved in nutrient recycling.

***Meliolinaceae*** S. Hughes, Mycol. Pap. 166: 176 (1993).

*Index Fungorum number*: IF 81959; *Facesoffungi numbers*: FoF 06889; 50 species.

*Parasitic* on living leaves. *Colonies* superficial, dense to subdense, black. *Hyphae* superficial, brown, straight to substraight, branched, septate, darker at septa, reticulate, with setiform phialides. **Sexual morph**: *Ascomata* globose to subglobose, dense, gregarious, with a central ostiole, verrucose. *Hamathecium* lacking paraphyses. *Asci* 4–8-spored, fissionic, ellipsoid to broadly clavate, evanescent. *Ascospores* overlapping 2–4-seriate, cylindrical, hyaline when young, becoming brown at maturity, 3-septate, end

cells shorter and smaller, with hyaline subterminal bands.

**Asexual morph:** Undetermined.

*Type:* *Meliolina* Syd. & P. Syd.

*Notes:* *Meliolinaceae* comprises a single genus *Meliolina* and 38 species, all but one of which are confined to members of *Myrtaceae*. Reynolds (1989) described *Briania fruticetum* as the mitosporic state of *Meliolina*, and this was accepted by Kirk et al. (2008). The only phylogenetic study of *Meliolinaceae* was carried out by Saenz and Taylor (1999), illustrating that it is a separate family from *Meliolaceae*. Lumbsch and Huhndorf (2010) and Wijayawardene et al. (2018) placed the family as *Dothideomycetes incertae sedis*.

*Meliolina* Syd. & P. Syd., *Annl. mycol.* 12(6): 553 (1914).

*Index Fungorum number:* IF 3105; *Facesoffungi number* FoF06890; 49 morphological species (Species Fungorum 2020), 1 species with molecular data.

*Type species:* *Meliolina cladotricha* (Lév.) Syd. & P. Syd.

*Notes:* *Meliolina* species produce thick, spongy, hypophyllous colonies that predominantly infect *Myrtaceae* plants. Stevens (1927, 1928) included the genus in *Meliolaceae*. Eriksson (1981) postulated that *Meliolaceae* and *Meliolina* may share a common ancestry, but the result from Saenz and Taylor (1999) demonstrated that *Meliolina* is phylogenetically distant from *Meliolaceae*. However, Hyde et al. (2013) treated this genus as a member of *Meliolales* based on morphology. There are several morphological differences between *Meliola* and *Meliolina*. *Meliola* species produce haustoria from capitate hyphopodia, while *Meliolina* species penetrate the host by stomatopodia (Hansford 1946; Hughes 1993) and develop internal hyphae. The superficial mycelium of *Meliola* develops directly from an ascospore, while the superficial mycelium of *Meliolina* is the result of egress cells which grow out of leaf stomata and produce mini-colonies of superficial hyphae (Hughes 1993). *Meliola* produce phialospores by possessing sessile phialides (mucronate hyphopodia) which are produced directly from the superficial hyphae, while *Meliolina* produces setiform phialides which are produced from arborescent branches of the superficial hyphae (Hughes 1981; Reynolds 1989; Mueller et al. 1991). *Meliolina* usually forms eight ascospores per ascus (Hughes 1993), whereas *Meliola* never produces eight mature ascospores within an ascus (Stevens 1925; Hansford 1961; Hongsanan et al. 2015d). The ascospores of *Meliolina* usually display hyaline subterminal bands, which are never found in *Meliola*.

*Meliolina cladotricha* (Lév.) Syd. & P. Syd., *Annl. mycol.* 12(6): 553 (1914).

≡ *Meliola cladotricha* Lév., *Annl. Sci. Nat., Bot., sér. 3* 5: 266 (1846).

*Index Fungorum number:* IF 120177; *Facesoffungi number:* FoF 06891; Fig. 112

*Parasitic* on living leaves. *Colonies* hypophyllous, superficial, dense to subdense, black. *Hyphae* superficial, brown, straight to substraight, branched, septate, darker at septa, closely reticulate. **Sexual morph:** *Ascomata* globose to subglobose, dense, gregarious, with a central ostiole, verrucose. *Hamathecium* lacking paraphyses. *Asci* 6–8-spored, fissitunicate, ellipsoid to broadly clavate, with short pedicel, evanescent. *Ascospores* overlapping 2–4-seriate, cylindrical with somewhat flattened ends, hyaline when young, becoming brown at maturity, 3-septate, constricted and darken at septa, end cells shorter and smaller than central cells, with hyaline bands near the septum, with roughened walls. **Asexual morph:** Undetermined.

*Material examined:* Australia, Queensland, Cape York Peninsula, on leaves of *Agonis longifolia*, L.J. Brass, 25 August 1948 (K 176503).

#### Other genus included

*Briania* D.R. Reynolds, *Pacific Sci.* 43(2): 161 (1989).

*Index Fungorum number:* IF 11017; *Facesoffungi numbers:* FoF 06892; 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Briania fruticetum* D.R. Reynolds, *Pacific Sci.* 43(2): 161 (1989).

*Notes:* *Briania* is a monotypic genus introduced as the asexual morph of *Meliolina sydowiana* found on leaves of *Metrosideros polymorpha*. The link between the sexual and asexual morph are questionable.

#### Economic and ecological significance

*Meliolinaceae* is a poorly understood family with limited taxa. Similar to black mildews and sooty moulds, their colonies cover the leaf surface and may reduce photosynthesis and increase the temperature and respiration in those areas (Hongsanan et al. 2015c).

*Mesnieraceae* Arx & Müller, *Stud. Mycol.* 9: 94 (1975).

*Index Fungorum number:* IF 80998, *Facesoffungi numbers:* FoF 07871, 6 species.

Synonym: *Stegasphaeriaceae* Syd. & P. Syd., *Annl. mycol.* 14(5): 364 (1916).

*Parasitic* on leaves, causing necrotic symptoms on leaves, or saprobic. **Sexual morph:** *Mycelium* hyaline, developing within host tissue. *Ascomata* densely gregarious, immersed, spherical, flattened or globose to subglobose, yellowish-green, fleshy, light with peridium composed of many cells, uni-loculate, with numerous asci and pseudoparaphyses. *Ostiole* present or lacking, usually opening apically with a pore, or with wide and large hole in mature ascomata, erumpent through the upper epidermis, comprising elongated columnar cells. *Peridium* thin-walled, hyaline, composed of many layers of flattened cells of *textura angularis*, or comprising a few layers of elongate cells. *Hamathecium*

comprising numerous, hypha-like, filamentous, septate pseudoparaphyses, embedded in a gelatinous matrix. *Asci* 4–24-spored, bitunicate, cylindrical to clavate, or elongate-ellipsoidal, short-pedicellate, inner membrane thickened in the upper part, apex rounded, with or without a well-developed ocular chamber. *Ascospores* 2- to multi-seriate, ellipsoidal, dark brown to brown, or dark reddish-brown, 0–1-septate, thick-walled, constricted at the septum, with or without a mucilaginous sheath. **Asexual morph:** Undetermined.

*Type: Mesniera* Sacc. & P. Syd.

*Notes: Mesnieraceae* was introduced by von Arx and Müller (1975) and type species is *Mesniera rottlerae*. *Mesnieraceae* includes the genera *Bondiella*, *Mesniera* and *Stegasphaeria* (Kirk et al. 2008). Hyde (1996) considered *Bondiella* as a good member in *Mesnieraceae* (Pirozynski 1972; Eriksson 1981) and observed, redescribed and illustrated *Bondiella palmicola* from leaf blades of dried fallen palm fronds, while Lumbsch and Huhndorf (2010) included four genera with the addition of *Helochora*. *Helochora* was isolated from *Puya* sp. in Chile, and described as a new genus by Sherwood (1979) and was accommodated in *Poly-stigmataceae*. It has ornamented spores which are uni-seriate in the asci. Hyde et al (2013) observed the type specimen of *Helochora hypertropha* and considered that *Helochora* does not belong to *Mesnieraceae* therefore *Helochora* was transferred to Sordariomycetes genera *incertae sedis*.

*Mesniera* Sacc. & Syd., Syll. Fung. 16: 440 (1902).

*Index Fungorum number:* IF 3134; *Facesoffungi number:* FoF 07872; 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Mesniera rottlerae* (Racib.) Sacc. & P. Syd. [as ‘rotlerae’], Syll. fung. (Abellini) 16: 441 (1902).

≡ *Anthostomella rottlerae* Racib., Parasit. Alg. Pilze Java’s (Jakarta) 2: 11 (1900).

*Notes:* Eriksson (1981) examined several collections of *Mesniera* and all had concentric rings of ascomata in necrotic patches, wide pores usually containing mature asci with ascospores, and mature ascomata present on both of the upper and lower side of the leaves. Unfortunately, the type species of *Mesniera rottlerae* (≡ *Anthostomella rottlerae*) may be lost (Hyde et al. 2013) and need recollecting and neotypifying.

#### Other genera included

*Bondiella* Piroz., Mycol. Pap. 129: 6 (1972).

*Index Fungorum number:* IF 625; *Facesoffungi number:* FoF 07873; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Bondiella palmicola* Piroz., Mycol. Pap. 129: 6 (1972).

*Notes:* Barr (1987b) placed *Bondiella* in Pleosporales, but did not mention about *Bondiella* or *Mesnieraceae*. Hyde (1996) observed type species *Bondiella palmicola* and considered *Bondiella* is a member of *Mesnieraceae* which supports the findings of Pirozynski (1972) and Eriksson (1981).

*Bondiella palmicola* Piroz., Mycol. Pap. 129: 6 (1972).

*Index Fungorum number:* IF 309834; *Facesoffungi number:* FoF 07874; Fig. 113

*Description:* see Hyde et al (2013).

*Material examined:* Tanzania, Kigoma, Kakombe, on fallen fronds of *Elaeis guineensis*, 19 December 1963, K.A. Pirozynski M26c, IMI 105789c, **holotype**).

*Stegasphaeria* Syd. & P. Syd., Anns mycol. 14(5): 362 (1916).

*Index Fungorum number:* IF 5190; *Facesoffungi number:* FoF 07875; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Stegasphaeria pavonina* Syd. & P. Syd., Anns mycol. 14(5): 362 (1916).

*Notes: Stegasphaeria* is pathogenic forming very rough round spots on leaves, consisting of many individual ascomata arranged in narrow rings. The mature ascospore are released through breakdown of the upper part of ascomata as in *Mesniera*; this is the main character that places them in *Mesnieraceae*.

*Stegasphaeria pavonina* Syd. & P. Syd., Anns mycol. 14(5): 362 (1916).

= *Mesniera pavonina* (Syd. & P. Syd.) Petr., Anns mycol. 39(4/6): 345 (1941).

*Index Fungorum number:* IF 139864; *Facesoffungi number:* FoF 07876; Fig. 114

*Description:* see Hyde et al (2013).

*Material examined:* Philippines, Laguna, Mount Maquiling, near Los Baños, on living leaf of *Macaranga* sp., 7 March 1914 (C.F. Baker no.4032, **holotype**)

#### Economic and ecological significance

Parasitic on leaves causing necrotic patches, this is important as it can cause serious problems to economic plants. Fungi can be saprobic over the winter on dead wood or leaves, forming the sexual morph and waiting to infect the plant in the next crop.

*Naetrocymbaceae* Höhn. [as ‘Naetrocymbeen’], Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 1200 (1909).

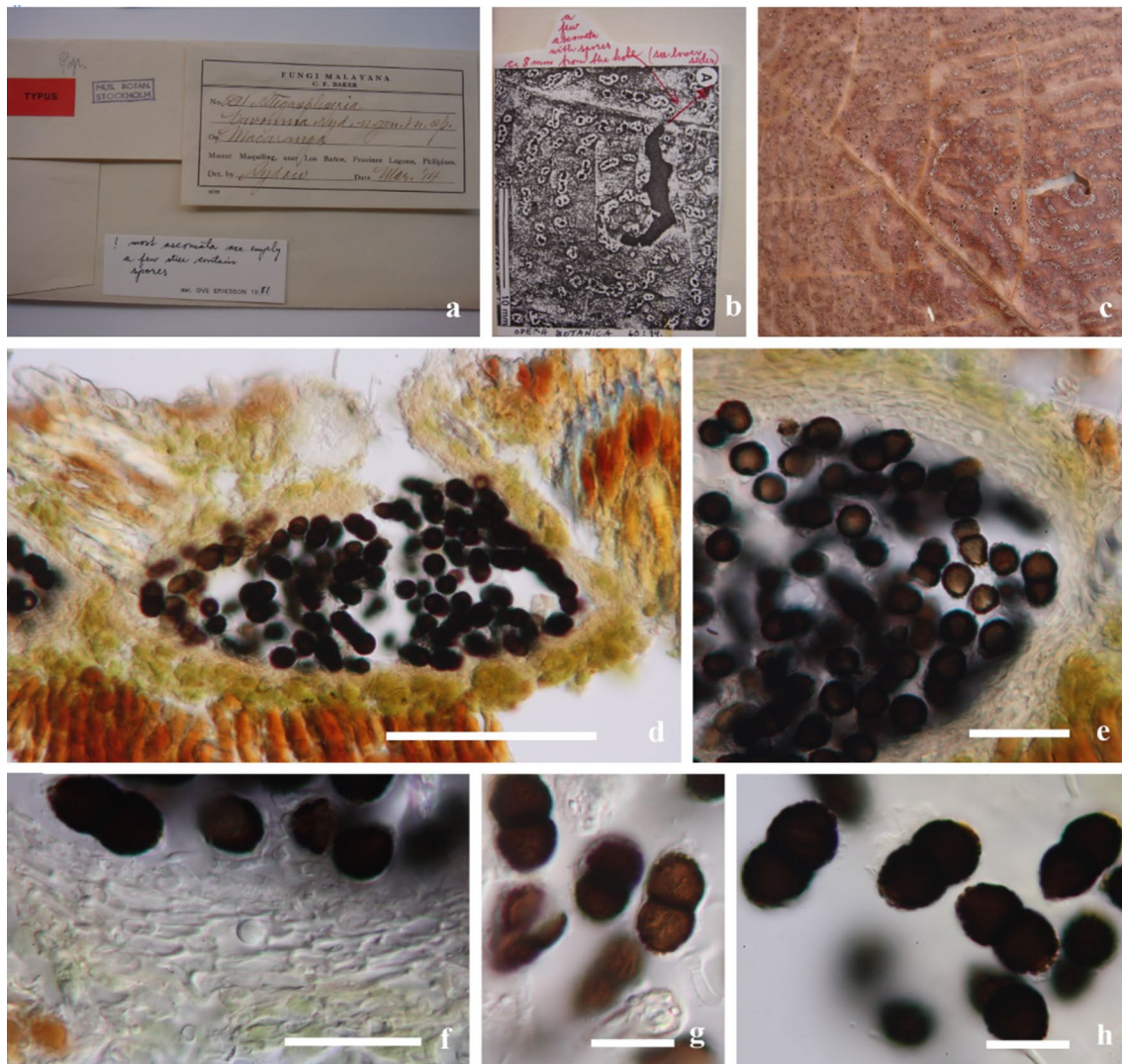
*Index Fungorum number:* IF 81056; *Facesoffungi number:* FoF 07877, 41 species.

*Epiphytic* or *Lichenicolous* on twigs, wood, or on upper and lower surface of living leaves, rarely on stone. *Mycelium* on host surface, branched, septate, brown to grayish. **Sexual**



**Fig. 113** *Bondiella palmicola* (IMI 105789c, holotype). **a** Herbarium specimens. **b** Ascomata semi-immersed on host. **c** Peridium. **d** Vertical section of ascoma. **e** Ostiolar canal with hyaline periphyses. **f**,

**h** Asci. **g** Immature bitunicate asci. **i**, **j** Ascospores with 2 cells. **k**, **l** Ascospores strained in India ink. Scale bars: **d** = 100  $\mu$ m, **e** = 50  $\mu$ m, **c**, **f**–**h** = 20  $\mu$ m, **i**, **j** = 10  $\mu$ m, **k**, **l** = 5  $\mu$ m



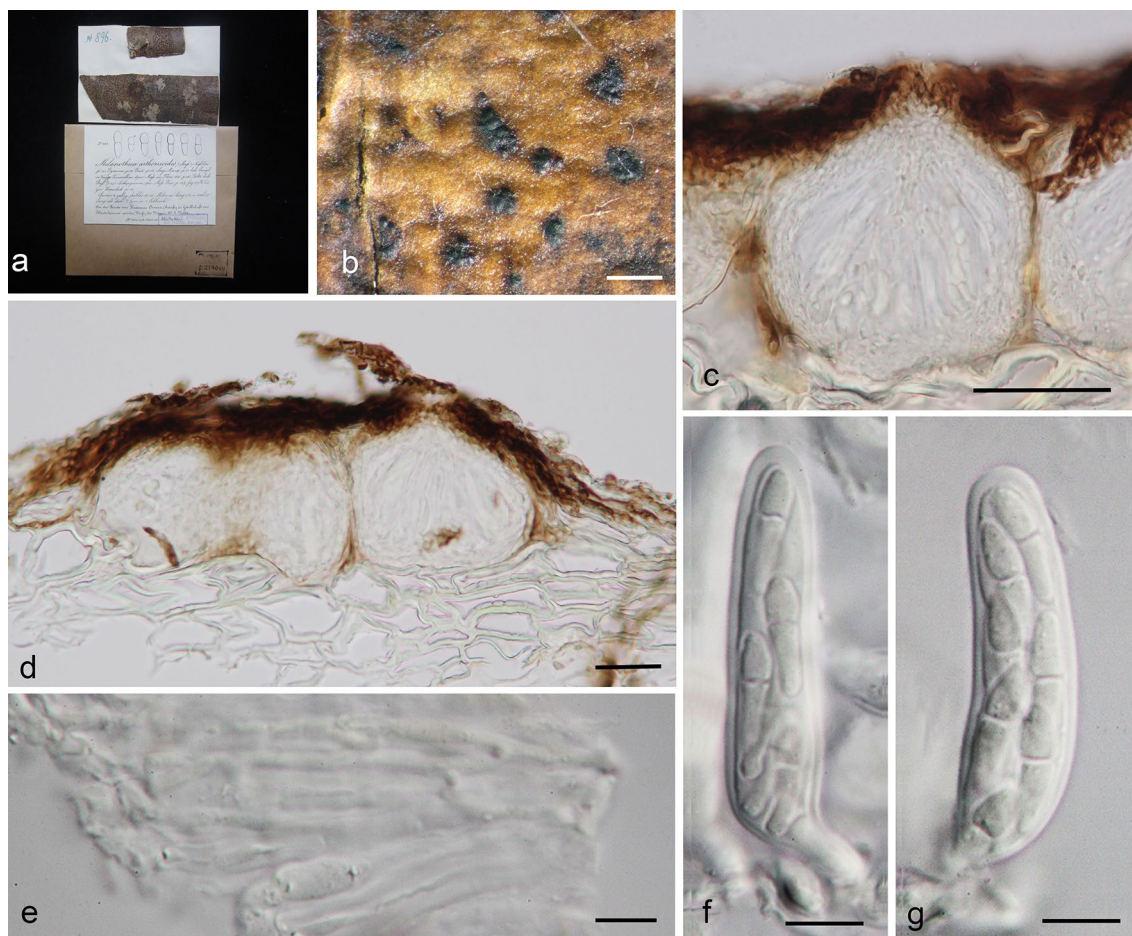
**Fig. 114** *Stegasphaeria pavonina* (C.F. Baker no.4032, **holotype**). **a, b** Herbarium specimen labels. **c** Ostiolate ascomata on leaf of *Macaranga* sp. **d** Vertical section through ascoma. **e, f** Peridium. **g, h** Ascospores. Scale bars: **d** = 100  $\mu$ m, **e, f** = 20  $\mu$ m, **g, h** = 10  $\mu$ m

**morph:** *Ascomata* perithecial or thyriotheacial, superficial to immersed, globose to subglobose, comprises a single to multiple chambers, dark brown to black, ostiolate. *Peridium* thin, comprises hyaline to dark brown cells of *textura angularis* to *epidermoidea*. *Hamathecium* comprising coarse, branching pseudoparaphyses, hyaline, often with refractive or differentially-staining, cellular pseudoparaphyses tips. *Asci* 6–8-spored, bitunicate, fissitunicate, obpyriform, globose-subglobose or oblong, thick-walled near apex, with a short pedicellate, apically rounded and endotunica, lacking an ocular chamber. *Ascospores* 2–3 to multi-seriate, oblong to broad ellipsoid, elongate to ellipsoid, or fusiform, hyaline, olivaceous-brown when mature, 1- to multi-septate, slightly constricted at septa, wall slightly ornamented. **Asexual morph:** *Microconidia* short and rod-shaped, macroconidia known from some *Leptorhaphis* species (Hyde et al. 2013).

*Type: Naetrocymbe* Körb.

*Notes:* The family (as Naetrocymbeen) was originally described by von Höhnelt (1909b), but without Latin or in accordance with ICBN rules. Harris (1995) validated the family name and included four genera in this family, *Jarxia*, *Leptorhaphis*, *Naetrocymbe*, and *Tomasellia*. This was followed by Lumbsch and Huhndorf (2010), Hyde et al. (2013), Doilom et al. (2018) and Wijayawardene et al. (2018). Pem et al. (2019c) included *Bonaria* in this family based on morphological characters. Sequence data is not available for this family.

*Naetrocymbe* Körb., Parerga lichenol. (Breslau) 5: 441 (1865).



**Fig. 115** *Tomasellia arthonioides* (F217044). **a** Herbarium materials. **b** Black stromata on the host. **c, d** Section of astroma. **e** Pseudoparaphyses. **f, g** Asci with ascospores. Scale bars: **b** = 500  $\mu$ m, **c, d** = 50  $\mu$ m, **e–g** = 10  $\mu$ m

*Index Fungorum number*: IF 3410; *Facesoffungi number*: FoF 07878; 25 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Naetrocymbe fuliginea* Krb.

*Notes*: Most species in *Naetrocymbe* were transferred to *Limacinula* (Reynolds 1971), however, Luttrell (1973) noted that *Naetrocymbe* has questionable status. *Naetrocymbe* species are characterized by immersed, globose, black ascomata, surrounded by dark brown fungal tissue, thick-walled, clavate to obovoid asci, and 1-septate, oblong to long ellipsoid, hyaline ascospores. *Naetrocymbe* was accepted as a distinct genus by Barr (1979a) and Eriksson (1981). Species in this genus were found as non-lichen-forming fungi (Harris 1995) and found associated with *Trentepohlia* algae (Roux 2009; Coppins 2002). Hyde et al. (2013) noted that the concept of this genus is debatable.

#### Other genera included

*Bonaria* Bat., Publicaes Inst. Micol. Recife 56: 438 (1959).

*Index Fungorum number*: IF 624; *Facesoffungi number*: FoF 05164; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Bonaria lithocarpi* (V.A.M. Mill. & Bonar) Bat., Publicaes Inst. Micol. Recife 56: 439 (1959).

$\equiv$  *Protopeltis lithocarpi* V.A.M. Mill. & Bonar, University of Calif. Publ. Bot. 19: 412 (1941).

*Notes*: *Bonaria* was treated as a genus *incertae sedis* in Dothideomycetes by (Wijayawardene et al. 2018). Pem et al. (2019c) re-examined the isotype specimen of *B. lithocarpi* (S-F 3573) and concluded that *Bonaria* should be placed in *Naetrocymbaceae* based on its immersed, subglobose, black ascomata, 8-spored, thick-walled, obpyriform asci, and multi-seriate, oblong to long ellipsoid, hyaline, 1-septate ascospores (Pem et al. 2019c).

*Jarxia* D. Hawksw., Stud. Mycol. 31: 93 (1989).

*Index Fungorum number*: IF 25310; *Facesoffungi number*: FoF 07879; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.



*Type species: Jarxia thelenula* (Müll. Arg.) D. Hawksw., Stud. Mycol. 31: 95 (1989).

≡ *Microthelia thelenula* Müll. Arg., Bot. Jb. 6: 416 (1885).

*Notes:* *Jarxia* contains two non lichen-forming species (Doilom et al. 2018; Index Fungorum 2020). Doilom et al. (2018) re-examined the syntype of *J. thelenula* which has the same morphology as the holotype (Hawksworth 1989), thus they agree to place this genus in *Naetrocymbaceae*.

***Leptorhaphis*** Körb., Syst. lich. germ. (Breslau): 371 (1855).

*Index Fungorum number:* IF 2795; *Facesoffungi number:* FoF 07880; – 8 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Leptorhaphis oxyspora* (Nyl.) Körb., Syst. lich. germ. (Breslau): 371 (1855).

≡ *Verrucaria oxyspora* Nyl., Bot. Notiser: 179 (1852).

*Notes:* *Leptorhaphis* occurs on bark, with a high level of host-specificity (Aguirre-Hudson 1991, 2009; Aguirre-Hudson et al. 2002). This genus has been considered as saprotrophic and non lichen-forming (Vainio 1921a; Swinscow 1965a; Harris 1973, 1995; Aguirre-Hudson and Hawksworth 1987). One species is lichenicolous (Kalb et al. 1995), while some species are associated with algae (Swinscow 1965a; Aguirre-Hudson 1991, 2009; Aguirre-Hudson and Fiol 1993; Aguirre-Hudson et al. 2002). This genus has been placed in *Naetrocymbaceae* by Harris (1995), Aguirre-Hudson et al. (2002), and Doilom et al. (2018). However, Harris (1995) mentioned that *Leptorhaphis* differs from other genera in *Naetrocymbaceae* based on the characters of hamathecium, asci, and macroconidia.

***Tomasellia*** A. Massal., Flora, Regensburg 39: 283 (1856).

*Index Fungorum number:* IF 5489; *Facesoffungi number:* FoF 07881; – 6 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Tomasellia arthonioides* (A. Massal.) A. Massal., Flora, Regensburg 39: 284 (1856).

*Notes:* The morphology of *Tomasellia* has often been discussed with reference to *Mycoporum* based on compound ascomata containing several locules, each producing their own ostiole (Harris 1995). These two genera can be distinguished based on ascus, ascospore, conidial and hamathecial characters (Harris 1995). Harris (1995) transferred most species of this genus to *Mycoporum* (*Mycoporaceae*), and accepted only five non lichen-forming species in *Tomasellia*. The generic delimitations in Harris (1995) have been accepted by Sanderson and Coppins (2009a, b), while others accept a different circumscription (Aptroot 2002b, c). Although, sequence data is not available for *Tomasellia*, it is accepted as a genus in *Naetrocymbaceae* in many studies (Hyde et al. 2013; Wijayawardene et al. 2017a; Doilom et al. 2018).

***Tomasellia arthonioides*** (A. Massal.) A. Massal., Flora, Regensburg 39: 284 (1856).

≡ *Arthopyrenia arthonioides* A. Massal., Ric. auton. lich. crost. (Verona): 169 (1852).

*Index Fungorum number:* IF 124738; *Facesoffungi number:* FoF 04652; Fig. 115

*Description:* see Doilom et al. (2018).

*Material examined:* Italy, Trentino-Alto Adige Province, on the bark of *Fraxinus ornus* L., J. Milde. (S, F217044).

### **Economic and ecological significance**

Species in *Naetrocymbaceae* are not harmful to plants or animals. However, they have lichenicolous lifestyle which is a parasitic fungus living on lichens as the host.

***Nematotheciaceae*** Boonmee & K.D. Hyde, in Boonmee et al., Mycosphere 8(10): 1728 (2017).

*Index Fungorum number:* IF 553836; *Facesoffungi number:* FoF 03700, 12 species.

*Parasitic* on lower surface of living leaves. *Mycelium* covered ascomata, with or without hyphopodia-like structures. **Sexual morph:** *Ascomata* superficial, with a subiculum, gregarious or solitary, globose to subglobose, dark brown, with apical ostiole, covered by dark brown mycelium. *Peridium* comprises multilayers of dark brown cells of *textura angularis*. *Hamathecium* comprising numerous, cylindrical, filiform, branched, septate, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, cylindrical-subclavate, sessile. *Ascospores* fasciculate, multi-seriate, elongate fusiform, curved or flexuous, tapering towards the acute ends, brown, multi-septate. **Asexual morph:** Undetermined (adapted from Boonmee et al. 2017).

*Type: Nematothecium* Syd. & P. Syd.

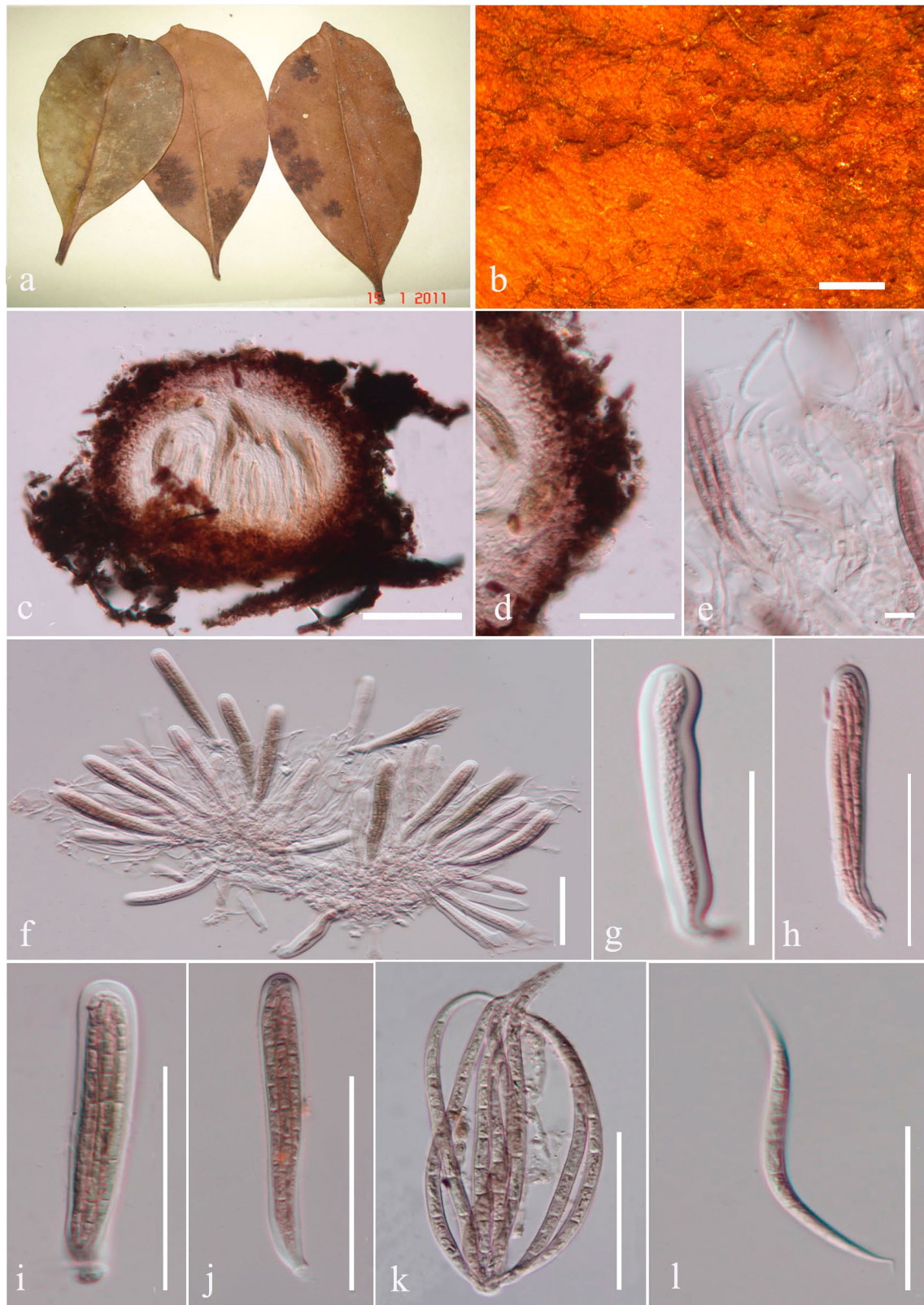
*Notes:* *Nematotheciaceae* was established based on morphology by Boonmee et al. (2017) to accommodate three parasitic genera *Nematothecium* (type genus), *Nematostigma* and *Ophioparodia*. Boonmee et al. (2017) mentioned that *Nematotheciaceae* is similar to *Tubeufiaceae* in the features of ascomata, asci and ascospores, however, it differs from *Tubeufiaceae* by being parasitic and occurring on living leaves. Sequence data is not available for this family.

***Nematothecium*** Syd. & P. Syd., Leafl. of Philipp. Bot. 5(no. 76): 1534 (1912).

*Index Fungorum number:* IF 3444; *Facesoffungi number:* FoF 07882; 5 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Nematothecium vinosum* Syd. & P. Syd.

*Notes:* The genus was introduced from the Island of Palawan in the Philippines. *Nematothecium* is characterized by large mycelium colonies, irregular, superficial ascomata with dark red ascomata, bitunicate asci and elongate fusiform, curved or flexuous, multi-septate, hyaline to red brown



**Fig. 116** *Nematothecium vinosum* (S-F10269, **holotype**). **a** Herbarium specimen and habit on leaves. **b** Appearance of ascomata on leaf surface. **c** Section of ascoma. **d** Peridium. **e** Pseudoparaphyses. **f**

Arrangement of asci. **g–j** Asci. **k, l** Ascospores. Scale bars: **b** = 500  $\mu\text{m}$ , **c** = 200  $\mu\text{m}$ , **f–l** = 50  $\mu\text{m}$ , **d** = 40  $\mu\text{m}$ , **e** = 5  $\mu\text{m}$

ascospores. *Nematothecium* was placed in *Pseudoperisporiaceae* by Kirk et al. (2008), Lumbsch and Huhndorf (2010), and Hyde et al. (2013). Boonmee et al. (2017) re-examined the holotype and lectotype of *N. vinosum* and concluded that the shape and septation of ascospores are typical of *Tubeufiaceae*, however, its habitat can differentiate them from *Tubeufiaceae*. Therefore, *Nematothecium* is placed in the new family *Nematotheciaceae* (Boonmee et al. 2017).

***Nematothecium vinosum*** Syd. & P. Syd., Leaflet of Philipp. Bot. 5(no. 76): 1534 (1912).

*Index Fungorum number*: IF 249022; *Facesoffungi number*: FoF 03243, Fig. 116

*Description*: see Boonmee et al. (2017).

*Material examined*: Philippines, Palawan, Island of Palawan: Puerto Princesa, Mt Pulgar, on living leaves of *Eugenia incarnata* Elmer. (*Myrtaceae*), May 1911, A.D.E. Elmer (no. 13232), (S-F10269, holotype, BPI 699632, **lectotype**).

#### Other genera included

***Nematostigma*** Syd. & P. Syd., *Annls mycol.* 11(3): 262 (1913).

*Index Fungorum number*: IF 3442; *Facesoffungi number*: FoF 07883; – 6 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Nematostigma obducens*** Syd. & P. Syd., *Annls mycol.* 11(3): 262 (1913).

*Notes*: The genus is characterized by dark brown, sparse setae, sphaerical ascomata, and hyaline, multi-septate ascospores. *Nematostigma* was transferred to *Dimeriaceae*, *Parodiopsidaceae* (= *Parodiellinaceae*), and *Pseudoperisporiaceae* (Hansford 1946; von Arx and Müller 1975; Eriksson and Hawksworth 1993; Hawksworth et al. 1995; Barr 1997; Hyde et al. 2013). However, Boonmee et al. (2017) included this genus in *Nematotheciaceae* based on morphology.

***Ophioparodia*** Petr. & Cif., *Annls mycol.* 30(3/4): 223 (1932).

*Index Fungorum number*: IF 3610; *Facesoffungi number*: FoF 07884; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Ophioparodia pulchra*** Petr. & Cif., *Annls mycol.* 30(3/4): 223 (1932).

*Notes*: The genus was introduced to accommodate a single species *Ophioparodia pulchra*, with septoidium as its asexual morph. *Ophioparodia* was placed in *Parodiopsidaceae* by Sivanesan (1984) based on its septoidium-like conidia. However, Boonmee et al. (2017) re-examined the type specimens and could not find pseudoparaphyses or the asexual morph. They included *Ophioparodia* in a new family *Nematotheciaceae* as it has superficial, globose to subglobose, uniloculate ascomata, cylindrical asci and

long, multi-septate ascospores and a hyphomycetous asexual morph (Boonmee et al. 2017).

#### Economic and ecological significance

Species in *Nematotheciaceae* are found as parasitic on leaves which can uptake nutrients from plants.

***Neoparodiaceae*** Boonmee & K.D. Hyde, in Boonmee et al., *Mycosphere* 8(10): 1734 (2017).

*Index Fungorum number*: IF 553832; *Facesoffungi number*: FoF 03683, 1 species.

*Epiphytic* or *parasitic* on living leaves. **Sexual morph** Colonies up to 2 mm diam. appear as black spots, superficial, subcircular, outwardly radiating, dense, branched, septate, with dark brown mycelia. *Ascstromata* epiphyllous or hypophyllous, superficial, crustose, on a subiculum, solitary, scattered, dark brown, multi-loculate, comprises subglobose locules, thickened at the base. *Peridium* comprises hyaline to brown cells of *textura angularis*. *Hamathecium* lacking pseudoparaphyses. *Asci* 8-spored, bitunicate, broadly clavate, oblong to obovoid, sessile or with short pedicel, apically thickened, with an acute to subacute ocular chamber. *Ascospores* overlapping 2-seriate, conglobate, broadly ellipsoid, ends rounded, each cell subglobose, reddish-brown to dark brown, separated by light brown regions, 1-septate. **Asexual morph**: Undetermined (adapted from Boonmee et al. 2017).

*Type*: ***Neoparodia*** Petr. & Cif.

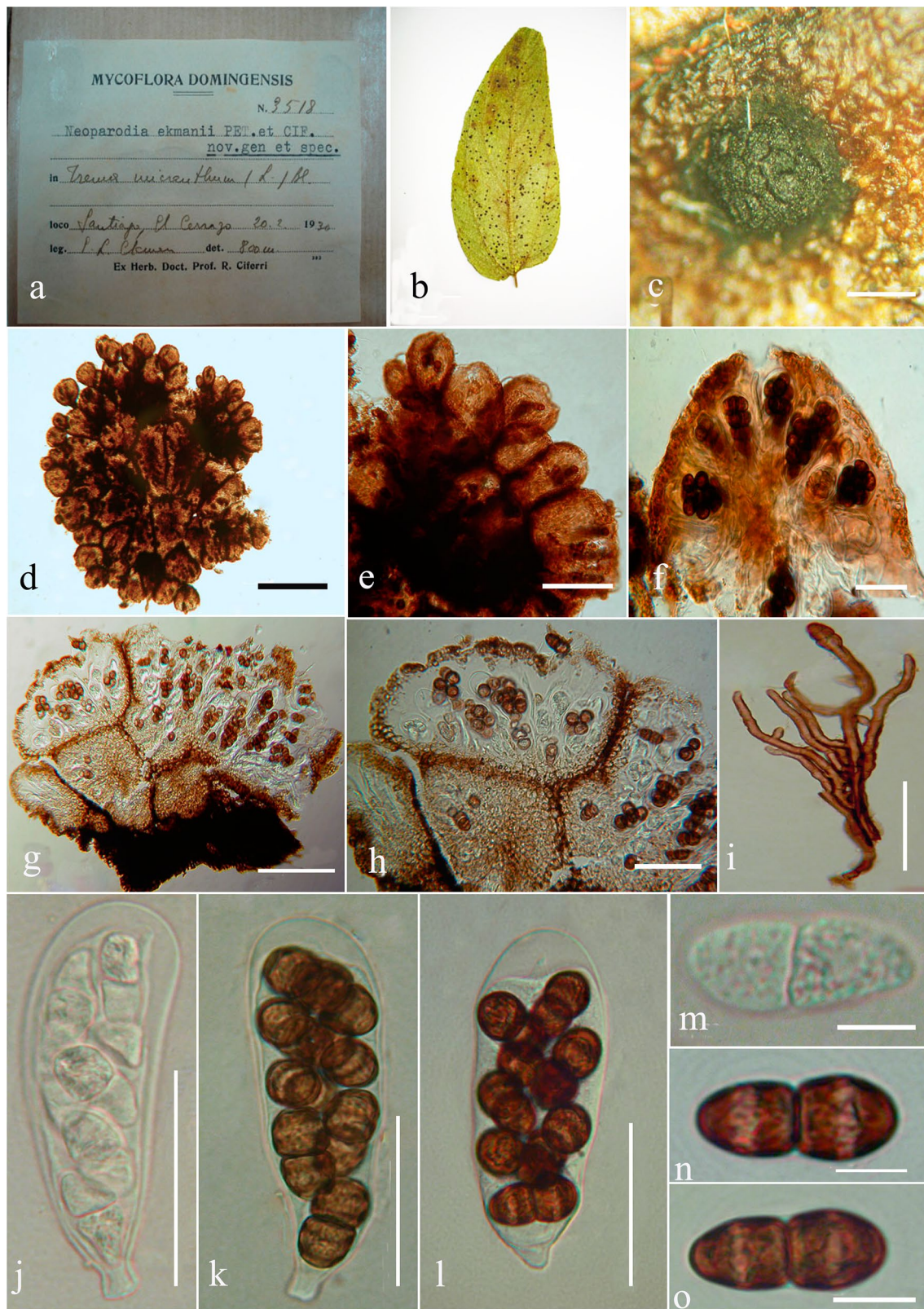
*Notes*: *Neoparodiaceae* was established to accommodate a single genus *Neoparodia* based on morphology by Boonmee et al. (2017). This family shares some characters with *Cookellaceae* and *Myriangiaceae* (Hyde et al. 2013; Dissanayake et al. 2014; Boonmee et al. 2017). However, *Neoparodiaceae* differs from *Cookellaceae* and *Myriangiaceae* in having ascstromata, broadly clavate asci and broadly ellipsoid, 1-septate, dark brown ascospores (Boonmee et al. 2017).

***Neoparodia*** Petr. & Cif., *Annls mycol.* 30(3/4): 219 (1932).

*Index Fungorum number*: IF 3471; *Facesoffungi number*: FoF 07885; 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Neoparodia ekmanii*** Petr. & Cif.

*Notes*: *Neoparodia* was placed in *Perisporiopsidaceae* by Müller and von Arx (1962), but later it was transferred to *Parodiopsidaceae* (Kirk et al. 2008; Lumbsch and Huhndorf 2010; Hyde et al. 2013; Wijayawardene et al. 2014a). Boonmee et al. (2017) examined the holotype of *N. ekmanii* and its asexual morph, and introduced a new family *Neoparodiaceae* to accommodate this genus based on its distinct morphological characters.



**Fig. 117** *Neoparodia ekmanii* (W Krypto 1977-0019515, holotype). **a** Herbarium specimen and habit on leaves. **b** Appearance of colony and ascostromata seated on mycelium. **c** Close up of ascostroma. **d**, **e** Squash mount of ascostroma. **f** Section of ascomal locules. **g**, **h**

Close up of ascomal locules. **i** Anastomosing and branched mycelium and apical conidium-like spores. **j–l** Immature and mature asci. **m–o** Immature and mature ascospores. Scale bars: **b** = 1 mm, **c–h** = 100  $\mu$ m, **i–l** = 50  $\mu$ m, **m–o** = 10  $\mu$ m

*Neoparodia ekmanii* Petr. & Cif. *Annls mycol.* 30(3/4): 219 (1932).

*Index Fungorum number*: IF 263814; *Facesoffungi number*: FoF 03684, Fig. 117

*Description*: see Boonmee et al. (2017).

*Material examined*: Dominican Republic, Santiago, El Cerrazo, on living leaves of *Trema micrantha* (*Ulmaceae*), 19.53°N, 70.62°W elev. 800 msl, 20 February 1930, P.L. Clemens No. 3518 (W Krypt 1977–0019515, **holotype**).

### Economic and ecological significance

The family is poorly studied which comprises a single species and it is epiphytic or parasitic on living leaves. Its habitats and distributions have not been reported.

**Palawaniaceae** Mapook & K.D. Hyde, in Mapook et al., *Mycosphere* 7(11): 1737 (2016).

*Index Fungorum*: IF 552528; *Facesoffungi number*: FoF 02653, 3 species.

*Saprobic* on surface of dead rachides and spines of *Areaceae*. **Sexual morph**: *Ascomata* superficial, solitary or scattered, coriaceous, appearing as circular, scattered, flattened, dark brown to black spots, covering the host, without a subiculum, with a poorly developed basal layer and an irregular margin. *Ostiole* central. *Peridium* comprising of dark brown or black to light brown cell of *textura epidermoidea* at top with light brown cells of *textura angularis* at side. *Hamathecium* comprising cylindrical to filiform, septate, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, inequilateral to ovoid, pedicellate, straight or slightly curved, without small ocular chamber. *Ascospores* overlapping, irregularly arranged, broadly fusiform, hyaline, 1-septate, constricted at the septum, guttulate, surrounded by hyaline gelatinous sheath, observed clearly when mounted in Indian ink. **Asexual morph**: Undetermined.

*Type*: *Palawania* Syd. & P. Syd.

*Notes*: The family was placed in *Muyocoproneales*, based on phylogeny and morphology, together with the use of divergence times as additional evidence for the introduction of this family (Mapook et al. 2016c). *Palawania* species share some morphological characters with *Muyocopronea* species, but differ in its peridium, shape of asci and ascospores which are surrounded by a hyaline gelatinous sheath, while the character was not found in *Muyocopronea*. In the analyses of Hongsanan et al. (2020, Fig. 1), *Palawaniaceae* has uncertain phylogenetic placement. Thus, we place this family in *Dothideomycetes* families *incertae sedis*, until sequence of type species is available.

*Palawania* (Niessl) Syd. & P. Syd., *Philipp. J. Sci., C, Bot.* 9(2): 171 (1914).

*Index Fungorum number*: IF 3682; *Facesoffungi number*: FoF 06426; 3 morphological species (*Species Fungorum* 2020), 1 species with molecular data.

*Type species*: *Palawania grandis* (Niessl) Syd. & P. Syd., *Philipp. J. Sci., C, Bot.* 9(2): 171 (1914).

≡ *Microthyrium grande* Niessl, in Rabenhorst, *Fungi europ. exsicc.*: no. 2467 (1876).

*Notes*: Species in this genus are known from the genera *Calamus*, *Cocos* and *Dypsis* (*Areaceae*). There are eight species epithets listed in *Index Fungorum* (2020), while five species were transferred to *Parmulariaceae*. The type material was re-examined by Wu et al. (2011b). Recently, a fresh collection was described and illustrated by Mapook et al. (2016c) from Thailand.

**Palawania thailandensis** Mapook & K.D. Hyde, in Mapook et al., *Mycosphere* 7(11): 1740 (2016).

*Index Fungorum number*: IF 552527; *Facesoffungi number*: FoF 02654; Fig. 118

*Description*: see Mapook (2016c).

*Material examined*: Thailand, Chiang Rai, Chiang Rai Horticultural Research Center, on dried petiole and rachis of *Phoenix roebelenii* (*Areaceae*), 09 September 2014, A. Mapook, (MFLU 16-1873, **paratype**).

*Notes*: *Palawania thailandensis* was introduced as a new species in Mapook et al. (2016c) with molecular data to confirm the phylogenetic placement of the genus. The species clusters with the *Muyocoproneae* clade and diverged at 172 MYA in the Jurassic period (Mapook et al. 2016c).

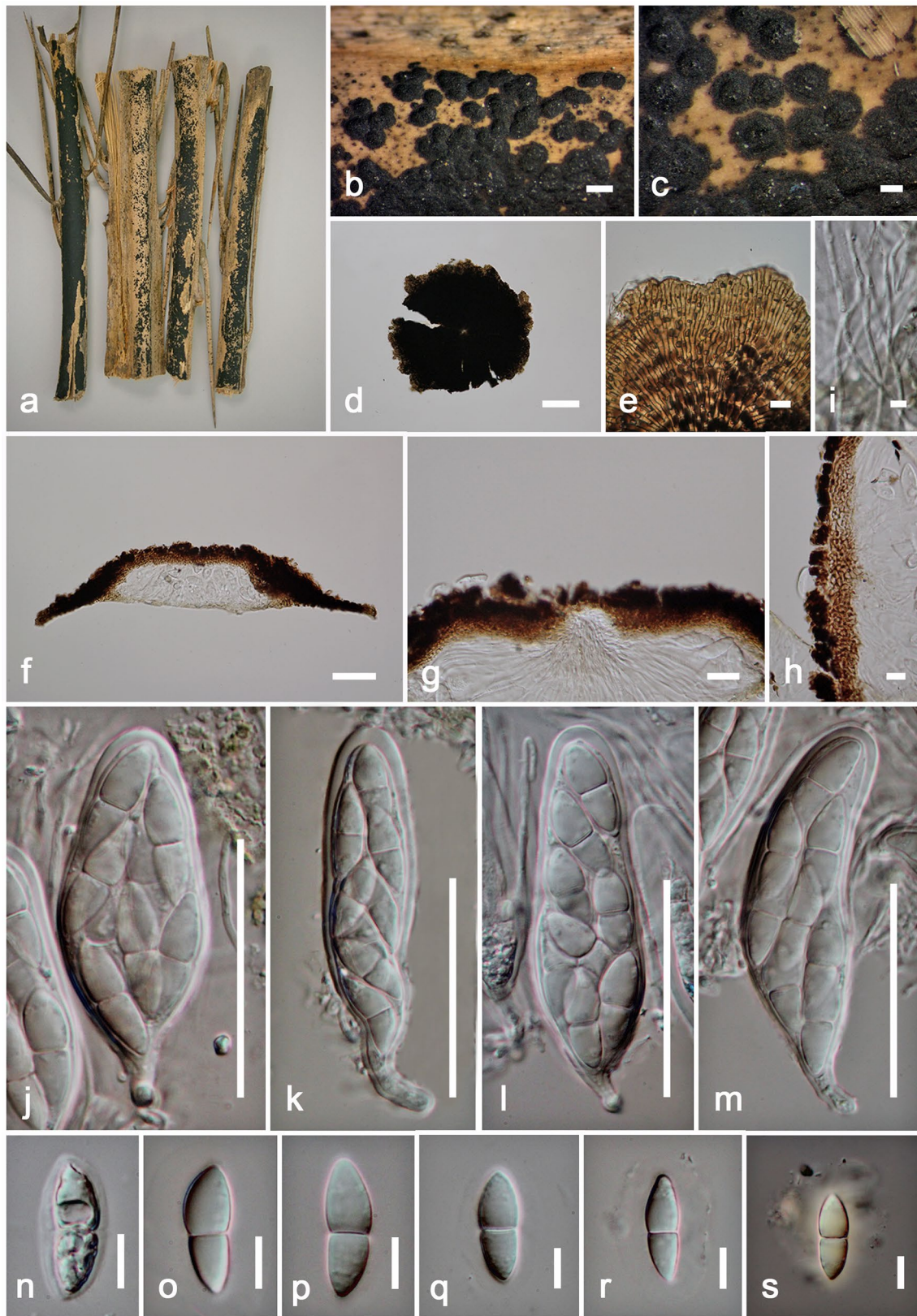
### Economic and ecological significance

Members in this family are usually common on dried petioles and rachises of palms (*Areaceae*), and are mostly saprobes (Batista and Vital 1960; Mapook et al. 2016c; Sydow and Sydow 1914b; Wu et al. 2011b).

**Paranectriellaceae** Boonmee & K.D. Hyde, in Hyde et al., *Fungal Diversity* 63: 186 (2013).

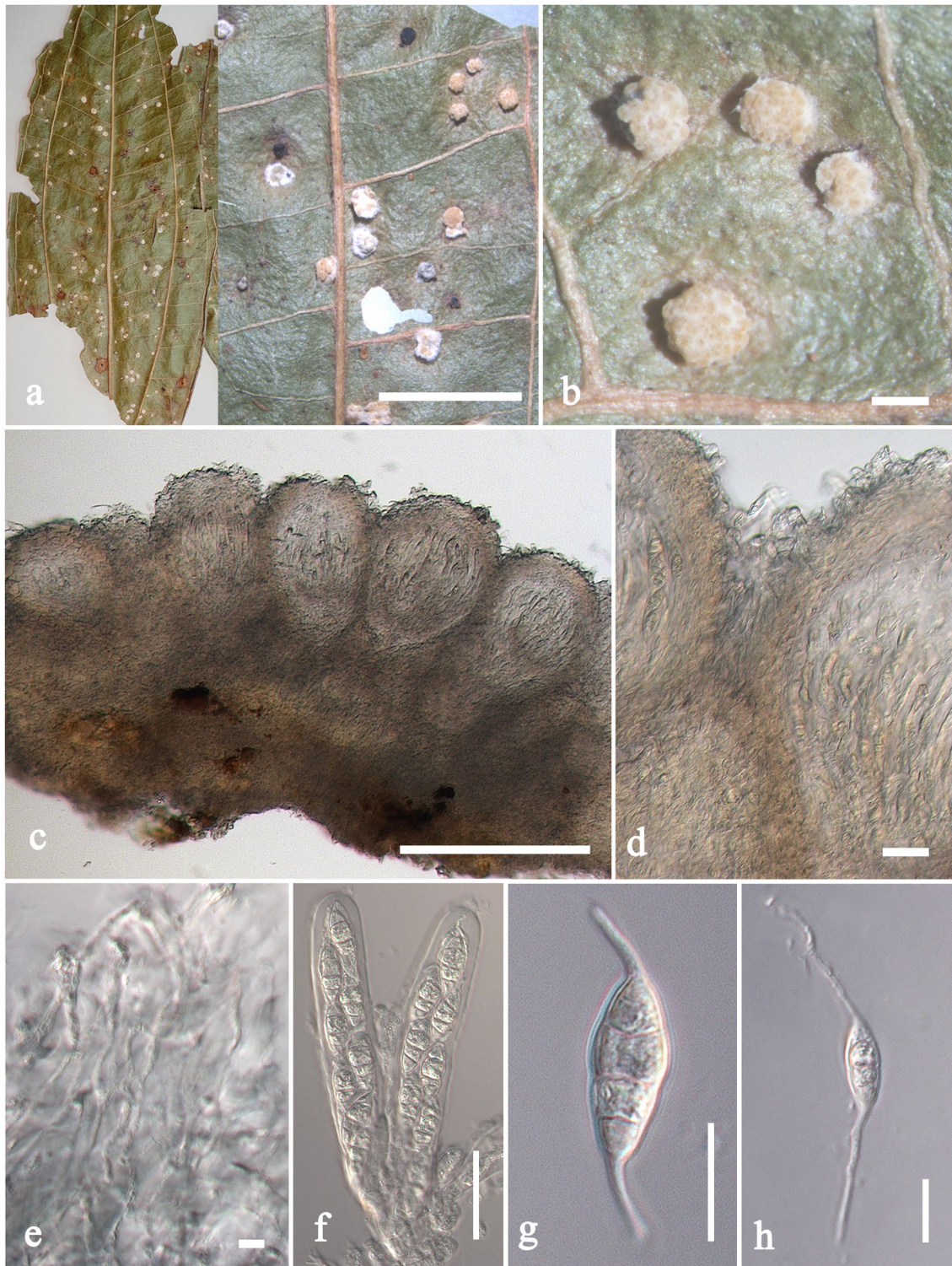
*Index Fungorum number*: IF 804521, *Facesoffungi number*: FoF 07886, 24 species.

*Parasitic* (or *biotrophic*, *hyperparasitic*) on leaves causing slight discoloration around fruiting bodies. **Sexual morph**: *Ascostromata* superficial, crustose, solitary, scattered, white to light orange, fleshy, soft in texture, surrounded by colourless, sparse hairs, multi-loculate, with ascomata arranged in a peripheral outer layer. *Locules* globose to subglobose, with individual ostioles. *Peridium* relatively thin, composed of light yellow, thick-walled cells of *textura angularis*. *Hamathecium* comprising filiform, septate, branched, pseudoparaphyses, extending over asci and embedded in a gelatinous layer. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, oblong-clavate, apedicellate, rounded at the apex. *Ascospores* 2-seriate, broadly fusiform,



**Fig. 118** *Palawania thailandensis* (MFLU 16-1873, paratype). **a–c** Superficial ascomata on substrate. **d, e** Squash mounts showing ascomata walls. **f** Section of ascoma. **g** Ostiole **h** Peridium. **i** Pseudoparaphyses. **j–m** Asci. **n–r** Ascospores. **s** Ascospores surrounded by hya-

line gelatinous sheath in Indian ink. Scale bars: **b** = 500  $\mu$ m, **c** = 200  $\mu$ m, **d** = 100  $\mu$ m, **f, j–m** = 50  $\mu$ m, **g** = 20  $\mu$ m, **e, h, n–s** = 10  $\mu$ m, **i** = 5  $\mu$ m



**Fig. 119** *Paranectriella juruana* (BPI 632134). **a** Material and habit on leaf. **b** Appearance of ascostromata on lower leaf surface. **c** Section of ascostroma. **d** Close up of peridium. **e** Pseudoparaphyses. **f**

**g, h** Ascospores. Scale bars: **a, e** = 5 mm, **b** = 500  $\mu$ m, **c** = 200  $\mu$ m, **d, f** = 20  $\mu$ m, **g, i** = 10  $\mu$ m

hyaline, narrowed at the ends, multi-septate, slightly constricted at the septa, with apical spine-like appendages. **Asexual morph:** Hyphomycetous, staurosporous.

**Type:** *Paranectriella* (Henn. ex Sacc. & D. Sacc.) Magnus.

**Notes:** *Paranectriellaceae* was introduced to accommodate two hyperparasitic genera *Paranectriella* and *Puttemansia* (Hyde et al. 2013; Boonmee et al. 2014b). Rossman et al. (2015) proposed to protect *Paranectriella* over *Araneomyces* because *Paranectriella* was more widely reported and most species were not linked with *Araneomyces*. Currently, *Paranectriellaceae* is placed in Dothideomycetes families *incertae sedis* (Wijayawardene et al. 2017a, 2020). Sequence data are needed to confirm the placement of taxa in this family.

***Paranectriella*** (Henn. ex Sacc. & D. Sacc.) Magnus., Bot. Zbl. 98: 587 (1905).

= *Araneomyces* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 118: 894 (1909).

= *Paranectria* subgen. *Paranectriella* Henn. ex Sacc. & D. Sacc., Syll. fung. (Abellini) 17: 812 (1905).

**Index Fungorum number:** IF 3708, **Facesoffungi number:** FoF 07887, 8 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Paranectriella juruana* (Henn.) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 119: 899 (1910).

**Notes:** *Paranectriella* was introduced to accommodate *Paranectriella juruana* a tropical hyperparasitic. *Araneomyces* was accepted as the asexual state of *Paranectriella* (Sutton 1984; Wu et al. 1997). Wijayawardene et al. (2014a) synonymized *Araneomyces* under *Paranectriella*.

***Paranectriella juruana*** (Henn.) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 119: 899 (1910).

≡ *Paranectria juruana* Henn., Hedwigia 43(4): 245 (1904).

**Index Fungorum number:** IF 319198, **Facesoffungi number:** FoF 07888, Fig. 119

**Description:** see Hyde et al. (2013).

**Material examined:** Haiti, Dept. de la Grand' anse, Massif de la Hotte, "Geffrard" 44 km south of Roseaux Road to Camp Perrin, alt. 780m, 18°25'N73°53'W, on leaves of *Miconia* sp., William R. Buck (9169), 14 November 1982, determined by A.Y. Rossman, (BPI 632134).

### Other genera included

***Puttemansia*** Henn., Hedwigia 41: 112 (1902).

**Index Fungorum number:** IF 4562, **Facesoffungi number:** FoF 00217; – 16 morphological species, (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Puttemansia lanosa* Henn., Hedwigia 41: 112 (1902).

**Notes:** *Puttemansia* was introduced to accommodate parasitic or hyperparasitic taxa occurring on leaves (Hennings 1902). Its asexual morphs are hyphomycetous in the genera *Guelichia* and *Tetranacrium* and may need synonymizing (Hyde et al. 2011, 2013). *Puttemansia* is presently placed in *Paranectriellaceae* (see morphological description in Boonmee et al. 2014b). The genus needs sequence data to indicate the generic placement.

### Economic and ecological significance

*Paranectriellaceae* comprises two genera and their type species occurring on living leaves of dicotyledonous and monocotyledonous plants and are distributed widely in tropical regions, mostly in Africa and South America (Hyde et al. 2013; Boonmee et al. 2014b).

***Parodiellaceae*** Theiss. & Syd. ex M.E. Barr, Mycotaxon 29: 503 (1987).

**Index Fungorum number:** IF 81844; **Facesoffungi number:** FoF 07889, 23 species.

**Biotrophic** on upper side of leaves. **Sexual morph:** *Ascomata* superficial, scattered, gregarious between veins, uniloculate, subglobose to globose, with short stalk when mature, smooth or verrucose, black, with blackened fungal tissue in the leaf below stalk. *Central ostiole* with periphyses. *Peridium* thick-walled, comprising brown to dark brown cells of *textura angularis* at outer layer, and pale brown, flattened cells towards the inner layer. *Hamathecium* comprising irregular pseudoparaphyses. *Asci* 8-spored, bitunicate, cylindrical to clavate, with broad, with lobed pedicel, apically rounded with ocular chamber. *Ascospores* overlapping 1–2-seriate, fusoid to ellipsoidal, brown to dark brown, 1-septate, constricted at septum, inequilateral, upper cell broader and longer than lower cell, slightly narrowed at the ends, smooth-walled or striate, lacking a mucilaginous sheath. **Asexual morph:** Coelomycetous, assumed as *Ascochytopsis*. *Conidiomata* thick-walled, black. *Conidiogenous cell* cylindrical, proliferating percurrently. *Conidia* straight to falcate, hyaline, aseptate (Sivanesan 1984; Cannon and Kirk 2007; Hyde et al. 2013).

**Type:** *Parodiella* Speg.

**Notes:** *Parodiellaceae* was invalidly introduced by Theissen and Sydow (1918) and was validated by Barr (1987b). Hyde et al. (2013) provided an updated description based on the syntype of *Parodiella hedyari* (K(M) 176017) from Kew collection to represent *Parodiellaceae*. *Parodiellaceae* comprises a single genus, *Parodiella* and is treated as Dothideomycetes families *incertae sedis* (Wijayawardene et al. 2018). Sequence data is not available for this family.

***Parodiella*** Speg., Anal. Soc. cient. argent. 9(4): 178 (1880).





**Fig. 120** *Parodiella hedysari* (K(M) 176017, syntype). **a** Herbarium specimens. **b, c** Ascomata on host. **d–f** Vertical section through the ascoma and peridium. **g, h** Bitunicate asci. **i** Pedicel of ascus. **j–l**

Ascospores. Scale bars: **d** = 200  $\mu$ m, **c** = 100  $\mu$ m, **e, f** = 50  $\mu$ m, **g–i** = 20  $\mu$ m, **j–l** = 10  $\mu$ m

*Index Fungorum number*: IF 3749 *Facesoffungi numbers*: FoF 07890; 23 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Parodiella perisporioides* (Berk. & M.A. Curtis) Speg.

*Notes*: *Parodiella* is monotypic genus in *Parodiellaceae* (Lumbsch and Huhndorf 2010), typified by *P. perisporioides*. Barr (1987b) and Kirk et al. (2008) included *Pododimeria* and *Neopectia* in *Parodiellaceae*, respectively.

However, Wijayawardene et al. (2018) accepted only a single genus in this family. The type specimen was not located, therefore, Hyde et al. (2013) illustrated *Parodiella hedysari*.

*Parodiella hedysari* (Schwein.) S. Hughes, Can. J. Bot.: 75 (1958).

$\equiv$  *Coryneum hedysari* Schwein., Trans. Am. phil. Soc., New Series 4(2): 306 (1832) [1834].



**Fig. 121** *Perisporiopsis struthanthi* (S-F9814, holotype). **a** Material and habit on leaves. **b** Appearance of ascomata. **c** Superficial mycelium. **d** Sections of ascoma. **e** Peridium. **f** Hamathecium pseudopara-

physes. **g–i** Asci. **j, k** Ascospores. Scale bars: **b** = 200  $\mu$ m, **c, j, k** = 20  $\mu$ m, **d** = 100  $\mu$ m, **e** = 40  $\mu$ m, **f** = 10  $\mu$ m, **g–i** = 50  $\mu$ m

*Index Fungorum number*: IF 302296; *Facesoffungi numbers*: FoF 07891; Fig. 120

*Description*: see Hyde et al. (2013).

*Material examined*: USA, South Carolina, on leaves of *Rhynchosia* sp., 1879, H.W Ravenel s.n. [ex herb M.J. Berkeley] (K(M) 176017, **syntype**).

#### Economic and ecological significance

*Parodiella* is a biotrophic fungus found in several hosts especially Leguminosae, and in different areas such as Australia, Brazil, Columbia, India, Japan, Kenya and Philippines. Based on the type specimen of *Parodiella hedsari*, it can

colonize leaf surfaces and this may produce some compound against other fungus/microbe.

**Perisporiopsidaceae** E. Müll. & Arx ex R. Kirschner & T.A. Hofm., in Kirschner et al., *Sydowia* 62(2): 238 (2012).

= *Perisporiopsidaceae* E. Müll. & Arx, *Beitr. Kryptfl. Schweiz* 11(no. 2): 167 (1962).

*Index Fungorum number*: IF 567164, *Facesoffungi number*: FoF 07892, 23 species.

*Parasitic, hyperparasitic or pathogenic* on living leaves of various plants. **Sexual morph**: *Ascomata* or *ascostromata*, superficial, gregarious, solitary, uni to multi-locules,

seated on a subiculum, sometimes surrounded by aerial mycelium, globose to subglobose, obovoid, bright to dark pigmented, with or without apical ostiole. *Peridium* relatively thick-walled, comprising hyaline and bright to dark brown cells of *textura angularis*. *Hamathecium* comprising branched, septate, anastomosed, hyaline, cellular pseudo-paraphyses. *Asci* 8-spored, bitunicate, fissitunicate, broadly ellipsoid, apically thickened, with or without ocular chamber, short pedicellate. *Ascospores* 2–3-seriate, ellipsoidal-oblong or fusiform widest in the middle to upper part of the apical cell, with broadly rounded apex and tapering towards the ends, slightly curved, 0–4-septate, hyaline to light pigmented, sometimes pale-yellow brown, smooth- to rough-walled. **Asexual morph:** Hyphomycetous.

**Type:** *Perisporiopsis* Henn.

**Notes:** *Perisporiopsidaceae* includes only five genera *Asteronia*, *Byssocallis*, *Chevalieropsis*, *Parodiellina* and *Perisporiopsis* and is treated in Dothideomycetes as family *incertae sedis* (Boonmee et al. 2017; Wijayawardene et al. 2018; Index Fungorum 2020). Taxa in this family are parasitic on the surface of living leaves. Phylogenetic analyses are known from putative *Perisporiopsis* strains (endophytic taxa) and place the strains close to some genera in Pleosporales, but with no detail of morphology (Chaverri and Gazis 2010; Hyde et al. 2013). Furthermore, other sequence strains in GenBank are unpublished. Therefore, *Perisporiopsidaceae* is of uncertain taxonomic placement.

***Perisporiopsis*** Henn., Hedwigia 43(2): 83 (1904).

**Index Fungorum number:** IF 3827, **Facesoffungi number:** FoF 07893; 17 morphological species, (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Perisporiopsis struthanthi* Henn.

**Notes:** *Perisporiopsis* was revisited by Boonmee et al. (2017) and provided with a description and illustration of the type species *P. struthanthi* from the holotype (S-F9814).

***Perisporiopsis struthanthi*** Henn., Hedwigia 43(2): 83 (1904).

**Index Fungorum number:** IF 216818, **Facesoffungi number:** FoF 03687; Fig. 121

**Description:** see Boonmee et al. (2017).

**Material examined:** Brazil, Rio de Janeiro, Estado de Rio de Janeiro, Serra dos Orgaos, on leaves of *Struthanthus* sp. (*Apocynaceae*), August 1899, E.H.G. Ule No. 2631 (S-F9814, **holotype**).

#### Other genera included

***Asteronia*** (Sacc.) Henn., Hedwigia 34: 104 (1895).

**Index Fungorum number:** IF425, **Facesoffungi number:** FoF 06215; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Asteronia sweetiae* Henn., Hedwigia 34: 104 (1895).

= *Parodiopsis sweetiae* (Henn.) G. Arnaud, Anns Épiphyt. 7: 53 (1921).

**Notes:** Wu et al. (2010) revisited *Asteronia* and provided a description and illustration of the holotype of *A. sweetiae* (K (M) 159800) and suggested to place this genus in families *Asterinaceae* or *Meliolaceae* more suitable than place in *Microthyriaceae*. Later, Wu et al. (2011b) transferred *Asteronia* to Venturiales *incertae cedis*. Pem et al. (2019c) provided description and illustration of this genus based on the isotype of *A. sweetiae* (S-F46114). Its morphology and substrate are consistent with genera in *Perisporiopsidaceae*. Therefore, *Asteronia* was transferred to *Perisporiopsidaceae* by Pem et al. (2019c). Furthermore, species in *Asteronia* need sequence data to indicate the generic placement.

***Byssocallis*** Syd., Anns mycol. 25(1/2): 14 (1927).

**Index Fungorum number:** IF 700, **Facesoffungi number:** FoF 06224; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Byssocallis phoebes* Syd., Anns mycol. 25(1/2): 14 (1927).

**Notes:** Boonmee et al. (2011) excluded this genus from *Perisporiopsidaceae* based on morphology of isolectotype specimen (F10891). Pem et al. (2019c) re-examined the syntype specimen of *Byssocallis phoebes* (E00455471) and found that it shares common characters with genera in *Perisporiopsidaceae* such as occur on leaf surface, superficial ascomata with surrounding mycelium and ellipsoidal oblong, multi-septate, hyaline ascospores. Thus, they transferred *Byssocallis* to *Perisporiopsidaceae*.

***Chevalieropsis*** G. Arnaud, Anns Épiphyt. 9: 2 (1923).

**Index Fungorum number:** IF 992, **Facesoffungi number:** FoF 07894; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

**Type species:** *Chevalieropsis ctenotricha* (Pat. & Har.) G. Arnaud, Anns Épiphyt. 9: 2 (1923).

≡ *Dimerosporium ctenotrichum* Pat. & Har., J. Bot., Paris 14: 242 (1900).

**Notes:** *Chevalieropsis* is placed in *Perisporiopsidaceae* based on its parasitic habit on leaves and shares some characteristics that unite the genus into this family, such as ascomata (or ascostromata) features, thick-walled bitunicate asci and lightly pigmented ascospores.

***Parodiellina*** Henn. ex G. Arnaud, Annals d'École National d'Agric. de Montpellier, Série 2 16(1–4): 21 (1918) [1917].

**Index Fungorum number:** IF 3750, **Facesoffungi number:** FoF 07895; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Parodiellina manaosensis* (Henn.) G. Arnaud, *Annals d'École National d'Agric. de Montpellier*, Série 2 16(1–4): 21 (1918) [1917].

≡ *Parodiella manaosensis* Henn., *Hedwigia* 43(6): 358 (1904).

*Notes:* Boonmee et al. (2017) revisited *Parodiellina* and provided a description and illustration of the holotype of *P. manaosensis* (PC0084492). *Parodiellina* is placed in *Perisporiopsidaceae* based on its parasitic habit on leaves and shares some characteristics that unite the genus into *Perisporiopsidaceae*.

### Economic and ecological significance

Taxa in this family are parasitic or hyperparasitic on living leaves and occur on upper and lower leaf surfaces. They are widespread in temperate to subtropical and tropical regions such as in Central America and South America (Boonmee et al. 2011, 2017; Hyde et al. 2013; Pem et al. 2019c).

***Phaeodimeriellaceae*** Boonmee, Mapook & K.D. Hyde, in Boonmee et al., *Mycosphere* 8(10): 1748 (2017).

*Index Fungorum number:* IF 553833; *Facesoffungi number:* FoF 03689, 27 species.

*Epiphytic* on living leaves, or associated with other fungi on leaves. **Sexual morph:** *Ascomata* superficial, solitary or scattered, coriaceous, globose to subglobose, dark brown, surrounded by brown to dark brown mycelium at the base, apical ostiole, with hook-like and dark brown setae. *Peridium* brown to dark brown cells of *textura angularis*. *Hamathecium* comprising cylindrical to filiform, branched, septate, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, oval to ellipsoidal, apex rounded, short pedicellate, with a small ocular chamber. *Ascospores* 2–3-seriate, oblong to broadly fusiform, hyaline when immature and pale brown to brown at maturity, 1-septate, with a mucilaginous sheath. **Asexual morph:** Coelomycetous. *Conidiomata* pycnidial, superficial, globose to subglobose. *Conidiomatal setae* long, hook-like, aseptate, dark brown, with blunt apex. *Peridium* comprises brown cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* enteroblastic, monophialidic. *Conidia* fusiform, hyaline, aseptate, guttulate (adapted from Boonmee et al. 2017).

*Type: Phaeodimeriella* Speg.

*Notes:* Mapook et al. (2016a) provided sequence data for *Phaeodimeriella cissampeli* and *P. dilleniae*, and indicated that both species clustered in a distinct clade within Dothideomycetes. Although, Mapook et al. (2016a) treated *Phaeodimeriella* as a genus in *Pseudoperisporiaceae*, Boonmee et al. (2017) excluded this genus and placed it in *Phaeodimeriellaceae*.

***Phaeodimeriella*** Speg., *Revta Mus. La Plata* 15(2): 13 (1908).

*Index Fungorum number:* IF 3908; *Facesoffungi number:* FoF 01927; 27 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Phaeodimeriella parvula* (Cooke) Hansf.

*Notes:* *Phaeodimeriella* was lectotypified by *P. occulta* (Theissen 1912). However, *P. occulta* was synonymized under *P. parvula* by Hansford (1946), therefore the current name of the type species is *P. parvula*. Mapook et al. (2016a) provided molecular data of *P. cissampeli* and *P. dilleniae*. In their analyses, the clade of *Phaeodimeriella* is related to the clade of *Lentitheciaceae* with moderate support. However, *Phaeodimeriella* differs from genera in *Lentitheciaceae* (see Mapook et al. 2016a). Boonmee et al. (2017) included this genus in the new family *Phaeodimeriellaceae* based on its morphology and phylogeny. *Phaeodimeriella* comprises three species, *P. parvula*, *P. dilleniae* and *P. cissampeli*.

***Phaeodimeriella parvula*** (Cooke) Hansf., *Mycol. Pap.* 15: 64 (1946).

≡ *Dimerosporium parvulum* Cooke, *Grevillea* 20(no. 93): 5 (1891).

*Index Fungorum number:* IF 289280; *Facesoffungi number:* FoF 07896; Fig. 122

*Description:* see Boonmee et al. (2017).

*Material examined:* Australia, Queensland, on leaves of *Trema tomentosa* var. *viridis* (*Cannabaceae*). Coll. Bailey 902, Det. A. Sivanesan, (K(M) 181461, **holotype**).

### Economic and ecological significance

Species in *Phaeodimeriellaceae* are epiphytic on living leaves, however, they do not cause serious problem on plants. Their life style is unclear.

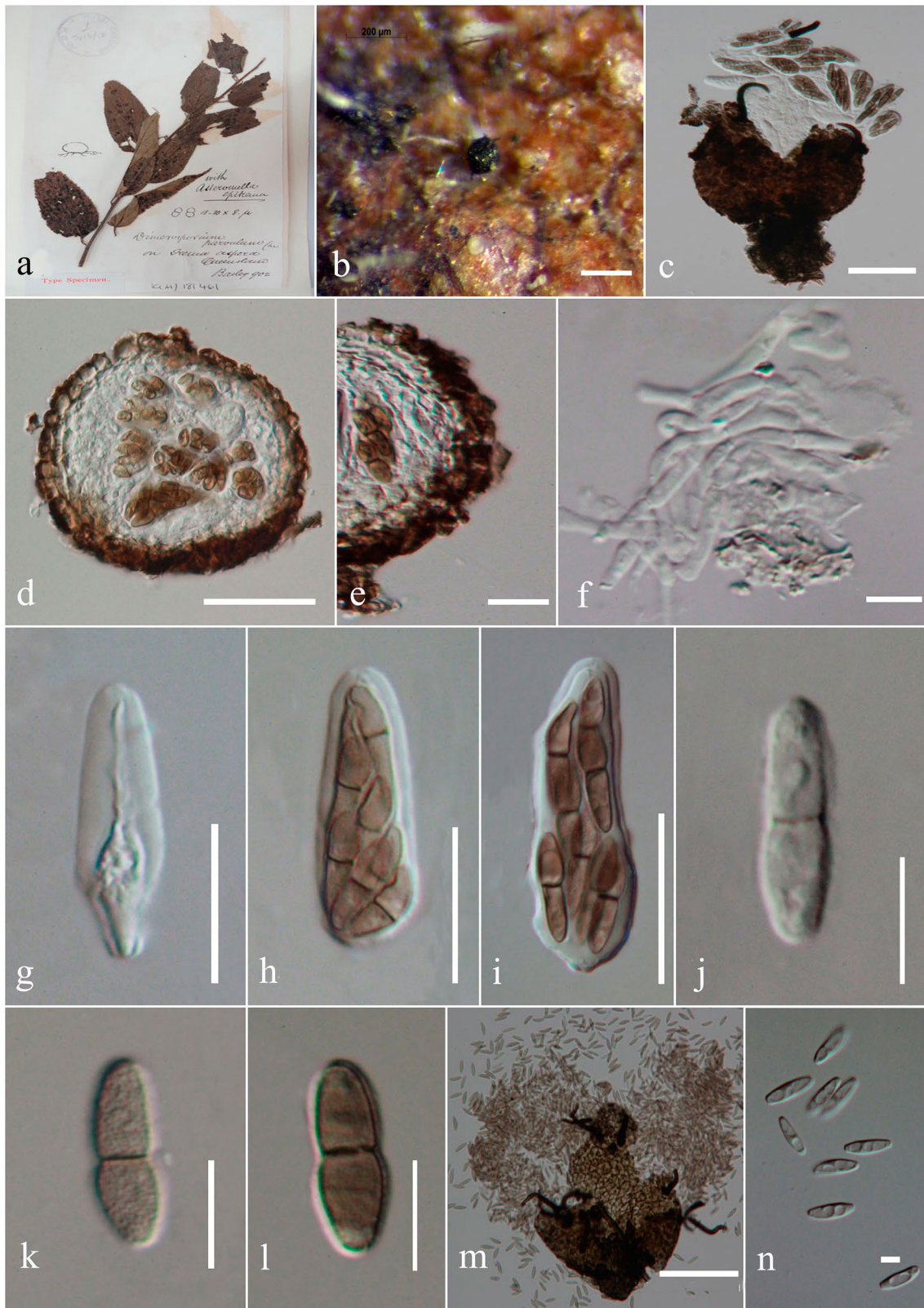
***Pododimeriaceae*** Boonmee & K.D. Hyde, in Boonmee et al., *Mycosphere* 8(10): 1750 (2017).

*Index Fungorum number:* IF 553834; *Facesoffungi number:* FoF 03692, 5 species.

*Parasitic* on living coniferous leaves. **Sexual morph:** *Ascomata* superficial, with or without hypostroma, solitary, scattered, easily removed, black, with apical ostiole. *Peridium* comprises multi-layers of brown to dark brown cells of *textura angularis*. *Hamathecium* comprising dense, branched, septate, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, cylindrical to broadly clavate or ellipsoid, sessile or with knob-like pedicel, rounded at apex, with an ocular chamber. *Ascospores* 2–3-seriate, irregularly arranged, ellipsoid-fusiform to subclavate, rounded at both ends, olivaceous-brown, 1-supramedian-septate, constricted at the septum, upper cell wider than lower cell. **Asexual morph:** Undetermined.

*Type: Pododimeria* E. Müll.

*Notes:* *Pododimeriaceae* was introduced by Boonmee et al. (2017) based on morphology to accommodate two



**Fig. 122** *Phaeodimeriella parvula* (K(M) 181461, holotype). **a** Herbarium specimen and habit on leaves. **b** Appearance of ascoma on leaf surface. **c** Setae. **d** Section of ascoma. **e** Peridium. **f** Hamathe-

cium of pseudoparaphyses. **g, h** Asci. **i–k** Ascospores. **l** Section of conidioma. **m** Setae. **n** Conidia. Scale bars: **b, d** = 40 µm, **c, e, j–l** = 10 µm, **f, n** = 5 µm, **g, i** = 20 µm, **m** = 50 µm



**Fig. 123** *Pododimeria gallica* (Z 33992, holotype). **a** Herbarium specimen and habit on coniferous leaves. **b** Appearance of ascomata on leaf surface. **c** Section of ascoma. **d** Close up of apical ostiole. **e**

Pseudoparaphyses. **f–i** immature to mature asci. **j–n** Immature and mature ascospores. Scale bars: **b** = 500 µm, **e** = 5 µm, **c, d, f–i** = 40 µm, **k–n** = 10 µm

genera *Chaetoscutula* and *Pododimeria*. No sequence data is available for this family.

**Pododimeria** E. Müll., Sydowia 12(1–6): 193 (1959) [1958].

*Index Fungorum number*: IF 4279; *Facesoffungi number*: FoF 07897; 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Pododimeria gallica** E. Müll.

*Notes*: *Pododimeria* was placed in different families, *Capnodiaceae*, *Dimeriaceae*, *Parodiellaceae*, and *Pseudoperisporiaceae* based on its ascomata and ascospores features and its epiphytic habitat (Gäumann 1964; von Arx and Müller 1975; Barr 1987b; Jaklitsch et al. 2002; Kirk et al. 2008; Lumbsch and Huhndorf 2010; Hyde et al. 2013; Wijayawardene et al. 2014a). However, Boonmee et al. (2017) studied the holotype specimen of *P. gallica* and concluded that *Pododimeria* differs from the species in these families mentioned above. Thus, they introduced a new family *Pododimeriaceae* to accommodate two genera, *Chaetoscutula* and *Pododimeria*.

**Pododimeria gallica** E. Müll., Sydowia 12(1–6): 195 (1959) [1958].

*Index Fungorum number*: IF 304077; *Facesoffungi number*: FoF 03693; Fig. 123

*Description*: see Boonmee et al. (2017).

*Material examined*: France, Province Gorges du Verdon, above the bridge over the Artuby River, on living leaves of *Juniperus phoenicea* (*Cupressaceae*), 24 June 1956, E. Müller 22813/11 (Z 33992, **holotype**).

#### Other genera included

**Chaetoscutula** E. Müll., Sydowia 12(1–6): 190 (1959) [1958].

*Index Fungorum number*: IF 967; *Facesoffungi number*: FoF 07898; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Chaetoscutula juniperi** E. Müll., Sydowia 12(1–6): 191 (1959) [1958].

*Notes*: *Chaetoscutula* was placed in *Pseudoperisporiaceae* by Tian et al. (2014) based on morphology of the herbarium specimen, *C. juniper* (F225899). Boonmee et al. (2017) included this genus with *Pododimeria* in the new family *Pododimeriaceae*, and suggested that molecular data can clarify the relationship between *Chaetoscutula* and *Pododimeria*.

#### Economic and ecological significance

*Pododimeriaceae* are parasitic on living leaves of coniferous plants (Butin 1973; Luttrell and Barr 1978; Boonmee et al. 2017).

**Polyclypeolinaceae** Boonmee & K.D. Hyde, in Boonmee et al., Mycosphere 8(10): 1754 (2017).

*Index Fungorum number*: IF 553835; *Facesoffungi numbers*: FoF 03695, 1 species.

*Saprobic, epiphyllous* on dried leaves. **Sexual morph**: *Thyriothecium* superficial, irregular, scattered to loosely clustered, dark brown to black, slightly shield-like or shallow-convex, epithecium membranaceous cells, edge entire, with apical ostiole. *Peridium* comprises multi-layers of dark brown cells of *textura angularis*. *Hamathecium* comprising branched, septate, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, saccate, cylindrical-clavate, with pedicellate. *Ascospores* irregularly arranged, ellipsoid to fusiform, narrowly obovoid, hyaline, 1-septate, upper cell wider, tapering towards narrow end (adapted from Boonmee et al. 2017). **Asexual morph**: Undetermined.

*Type*: **Polyclypeolina** Bat. & I.H. Lima.

*Notes*: Boonmee et al. (2017) established *Polyclypeolinaceae* to accommodate a single genus *Polyclypeolina* based on its distinct morphology from other families in Dothideomycetes. No sequence data is available for this family.

**Polyclypeolina** Bat. & I.H. Lima, in Batista, Publicações Inst. Micol. Recife 56: 457 (1959).

*Index Fungorum number*: IF 4307; *Facesoffungi number*: FoF 07899; 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Polyclypeolina brideliae** (Hansf.) Bat.

*Notes*: The genus was placed in *Aulographaceae* based on its branched colonies, superficial, irregular, multi-loculate ascomata, with slit-like opening, and 1-septate, hyaline ascospores (Luttrell 1973). However, Boonmee et al. (2017) introduced *Polyclypeolinaceae* to accommodate this genus based on its thyriothecium and ascospore features.

**Polyclypeolina brideliae** (Hansf.) Bat., Publicações Inst. Micol. Recife 56: 457 (1959).

≡ *Polyclypeolum brideliae* Hansf., Proc. Linn. Soc. London 157: 37 (1945) [1944–45].

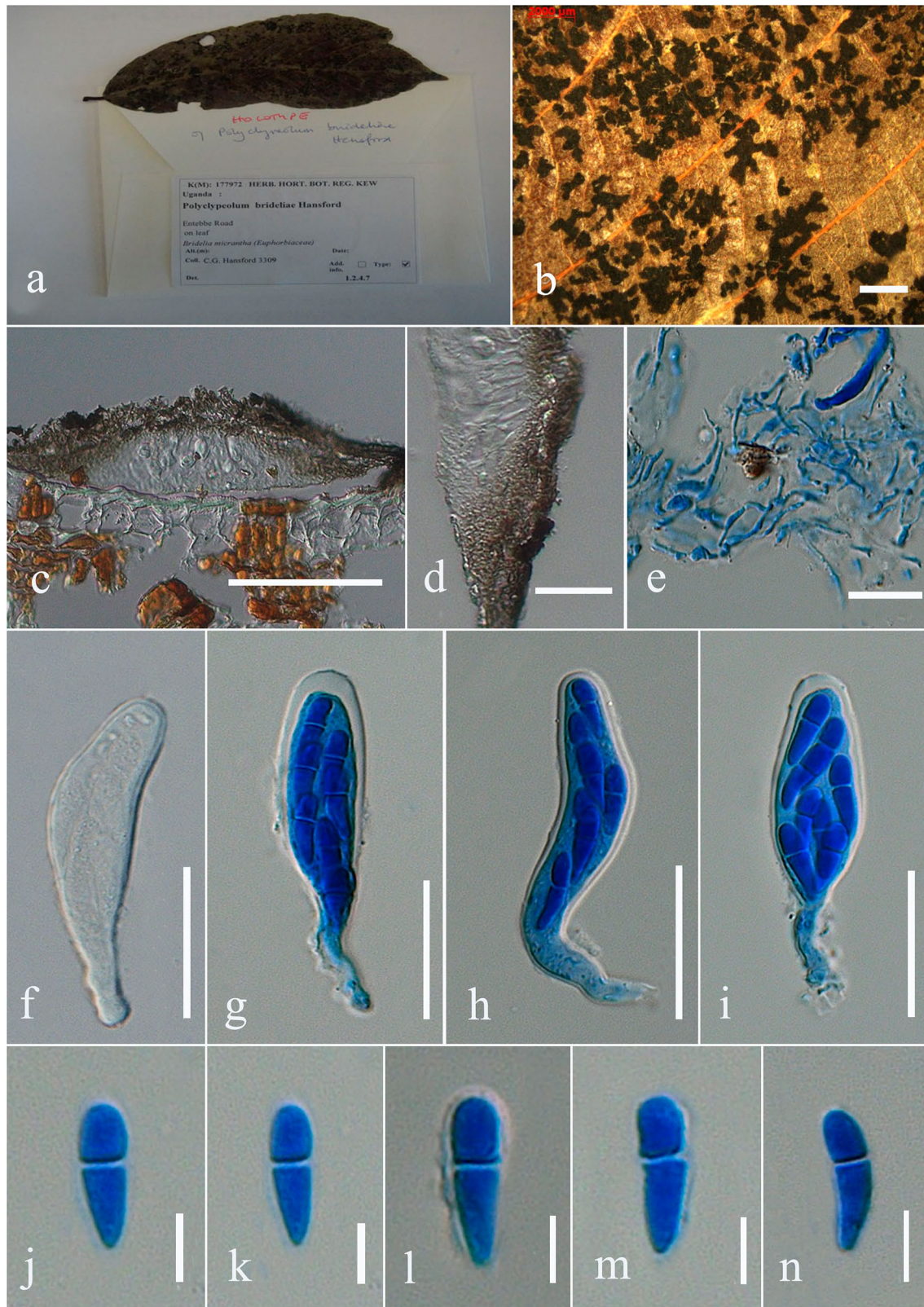
*Index Fungorum number*: IF 304116; *Facesoffungi number*: FoF 03696; Fig. 124

*Description*: see Boonmee et al. (2017).

*Materials examined*: Uganda, Entebbe, on dried leaves of *Bridelia micranthae* (*Euphorbiaceae*), 1945, G.C. Hansford 3309 (K (M) 177972, **holotype**).

#### Economic and ecological significance

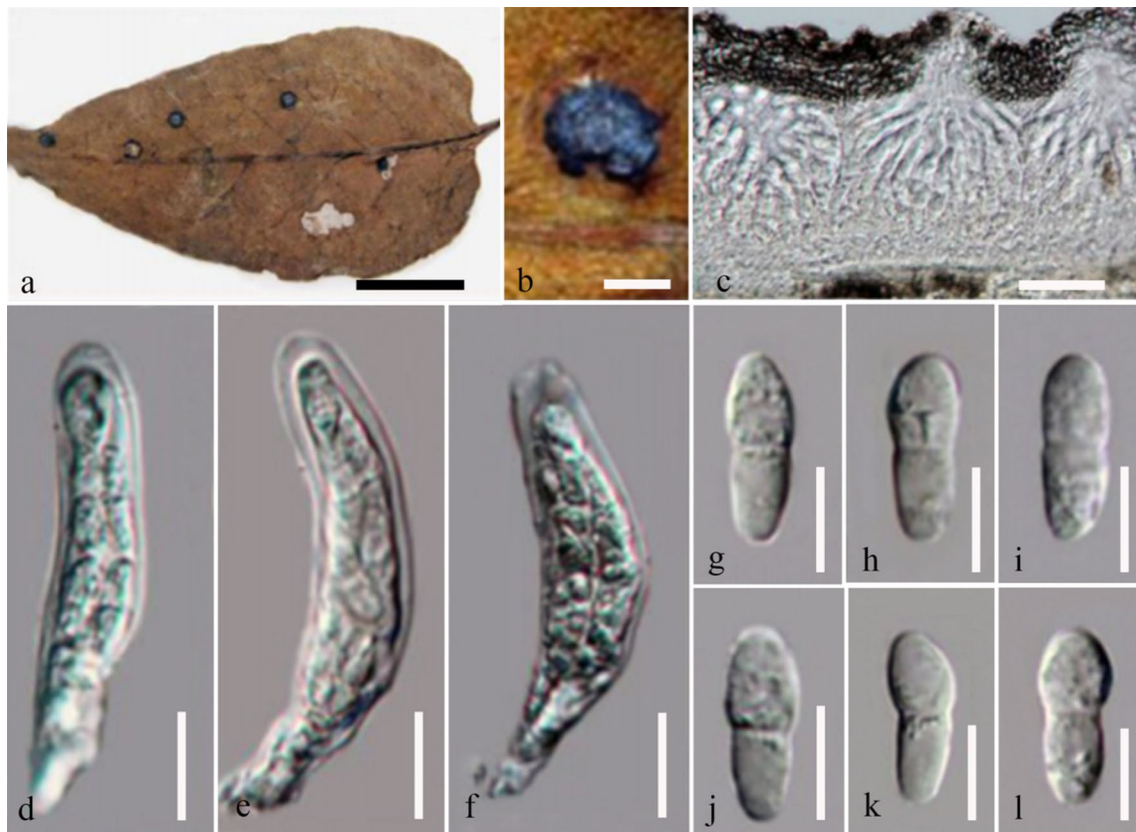
*Polyclypeolinaceae* comprises a single species found on dried leaves. There is no report concerning its economic and ecological significance. More collections and sequence data will help to understand its roles in the environment.



**Fig. 124** *Polyclypeolina brideliae* (K (M) 177972, **holotype**). **a**, **b** Herbarium specimen and habit on leaf. **c** Section of ascoma. **d** Peridium **e** Pseudoparaphyses. **f–i** Immature and mature asci. **j–n**

Ascospores. Scale bars: **b** = 2 mm, **c** = 100  $\mu$ m, **d** = 50  $\mu$ m, **e** = 10  $\mu$ m, **f–i** = 20  $\mu$ m, **j–n** = 5  $\mu$ m





**Fig. 125** *Dothidella australis* (LPS 318, holotype). **a** Type material. **b** Appearance of black ascomata on the host. **c** Section of ascomata. **d–f** Asci **g–l** Ascospores. Scale bars: **a** = 1 cm, **b** = 1 mm, **c** = 50  $\mu$ m, **d, e** = 15  $\mu$ m, **g–l** = 10  $\mu$ m

**Polystomellaceae** Theiss. & P. Syd., *Annls mycol.* 13(3/4): 158 (1915).

*Index Fungorum*: IF 81205; *Facesoffungi number*: FoF 06489, 43 species.

= *Munkiellaceae* (Theiss. & Syd.) Luttr., in Ainsworth et al., *The fungi* (London) 4a: 154 (1973).

*Biotrophic* or *parasitic* on leaves, typical tropical and subtropical distribution. **Sexual morph**: *Stromata* superficial or subcuticular, black, erumpent, pulvinate, and circular to suborbicular, elliptical or elongate, rugulose, containing mostly fungal tissue, globose to subglobose, uniloculate or multiloculate (with 5 to numerous locules), hyphae flattened and ribbon-like with discrete central ostiole. *Cells of ascostromata* murky brown-walled *textura angularis*. *Peridium* of locules soft, often lightly pigmented thick-walled cells of *textura angularis* and in side view pseudoparenchymatous, darken above locules. *Hamathecium* comprising numerous, hyaline, septate or aseptate cellular pseudoparaphyses without branching, often deliquescent at maturity. *Asci* 8-spored, bitunicate, fissitunicate, relatively short, oblong to cylindro-clavate or occasionally obclavate, often ventricose, with a short pedicel, apically rounded, with a small ocular chamber. *Ascospores* 1–2-seriate, fusiform to ellipsoidal or

obpyriform, hyaline, yellowish to olive brown, 0–1-septate, upper cell wider and shorter than the lower cell, euseptate, septate near the lower end or middle, with or without constrictions at the septum, asymmetric, lacking a sheath, wall smooth or verruculose with guttulate contents, sometimes crowded in ascus. **Asexual morph**: Coelomycetous, acervular, linked to *Lasmenia* and *Stictochorella* (Wakefield 1940; Swart 1987; Kirk et al. 2008); conidiogenesis often holoblastic.

*Type*: *Dothidella* Speg.

*Notes*: *Polystomellaceae* was introduced by Theissen and Sydow (1915) for *Munkiella*, *Parmularia* and *Polystomella* (the type genus) based upon a foot or hypostroma which anchors the thyrothecium within the host (von Arx and Müller 1975). Other names used for this family are *Stigmatateaceae* (Theissen 1916) and *Munkiellaceae* (Luttrell 1973). *Polystomellaceae* consists of species with superficial ascomata, while in *Munkiellaceae* ascomata are subcuticular, yet the two families were combined by Eriksson (1981). Barr (1987a) included *Polystomellaceae* as a family in *Pleosporales* with the genera *Atopospora*, *Hormotheca* (currently referred to *Venturiaceae*) and *Ellisiodothis* (currently referred to *Microthyriaceae*). Lumbsch and Huhndorf

(2010) included three genera *Dothidella* (= *Polystomella*) with ascospores having a median septum, *Munkiella* with apiospores and *Parastigmatea* in *Polystomellaceae* under Dothideomycetes, family *incertae sedis*, and this was followed by Index Fungorum (2020). All share similar characteristics such as a stromatic ascostromata resulting from ascocellular ontogeny, with uni- to multi-locular ascostromata, and hyaline ascospores, with one or two cells. Several other genera with amerspores and two with phragmospores have been included in *Munkiellaceae* (Luttrell 1973). von Arx and Müller (1954) placed *Parastigmatea* under *Botryosphaeriaceae*, while in a recent review of the family, Liu et al. (2012) did not include the genus in this family. The three genera placed in *Polystomellaceae* were described before 1965 (Index Fungorum 2020) and no molecular sequence data is available. Thus, fresh collections are needed to establish the phylogenetic relationships of the genera and *Polystomellaceae*. *Munkiella* and *Parastigmatea* are presently listed in *Polystomellaceae*, but their inclusion is uncertain for the purpose of keying out the genera.

***Dothidella*** Speg., Anal. Soc. Cient. Argent. 9: 9 (1880).

*Index Fungorum number*: IF 4327; *Facesoffungi number*: FoF 06490, 34 morphological species (Species Fungorum 2020), molecular data unavailable.

= *Polystomella* Speg., Anal. Soc. cient. argent. 26(1): 53 (1888).

*Type species*: ***Dothidella australis*** Speg.

*Notes*: *Dothidella* is the type genus of *Polystomellaceae* and was introduced by Spegazzini (1880). Many species of *Dothidella* were transferred to *Endodothella*, *Microcyclus*, *Phyllachora*, *Rehmiodothis* and *Stigmochora* which belong to *Mycosphaerellaceae* and *Phyllachoraceae* (Index Fungorum 2017). They share similar characters such as being biotrophic or parasitic on leaves and have 1–2-celled, hyaline ascospores. *Dothidella* differs from other genera by its multi-loculate ascostromata and ellipsoidal hyaline two celled ascospores, while *Phyllachora* (*Phyllachoraceae*) has uni-locular ascostromata, unitunicate asci and one celled, hyaline ascospores, and *Microcyclus* (*Mycosphaerellaceae*) has multi-loculate ascostromata with two celled hyaline obovoid ascospores (Monkai et al. 2013).

***Dothidella australis*** Speg., Anal. Soc. Cient. Argent. 10: 21 (1880).

≡ *Polystomella pulcherrima* Speg., Anal. Soc. cient. argent. 26(1): 53 (1888).

*Index Fungorum number*: IF 233978; *Facesoffungi number*: FoF 06491; Fig. 125

*Biotrophic or parasitic* on leaves. **Sexual morph**: *Ascostromata* black, superficial to erumpent, pulvinate, and circular to suborbicular, elliptical or elongate, globose to subglobose, with five to numerous locules, with individual

central ostioles, cells of ascostromata composed of dark brown-walled cells of *textura angularis*. *Peridium* of locules composed of small heavily pigmented thick-walled cells of *textura angularis*. *Hamathecium* comprising numerous, hyaline, septate or aseptate pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, oblong, cylindro-clavate or obclavate with a short pedicel, apically rounded, with a small ocular chamber. *Ascospores* 2-seriate, ellipsoidal or obpyriform, hyaline, septate, 1-septate, upper cell wider and shorter than the lower cell, euseptate, constricted at the septum, lacking a sheath. **Asexual morph**: linked to *Stictochorella* (Wakefield 1940; Swart 1987).

*Material examined*: Argentina, Buenos Aires, Tigre; on the leaves of *Solanum boerhaviaefolium* (*Solanaceae*), O. Schnyder, April 1880 (LPS 318, **holotype**).

### Other genera included

***Dermatodothella*** Viégas, Bragantia 4(1–6): 150 (1944).

*Index Fungorum number*: IF 1472; *Facesoffungi number*: FoF 06492; – 1 species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Dermatodothella multiseptata*** Viégas, Bragantia 4(1–6): 150 (1944).

*Notes*: *Dermatodothella* shares similar characteristics to *Dothidella* in having multi-loculate, globose to subglobose ascostromata, with widely porate ostioles. *Dermatodothella* differs from *Dothidella* in having filiform pseudoparaphyses and multi-septate ascospores, while *Dothidella* has bi-celled ascospores and lacks pseudoparaphyses (Hyde et al. 2013). *Dermatodothella* was placed in *Polystomellaceae* by Ariyawansa et al. (2013b) because of its similarities to other genera in the family.

***Munkiella*** Speg., Anal. Soc. Cient. Argent. 19(6): 248 (1885).

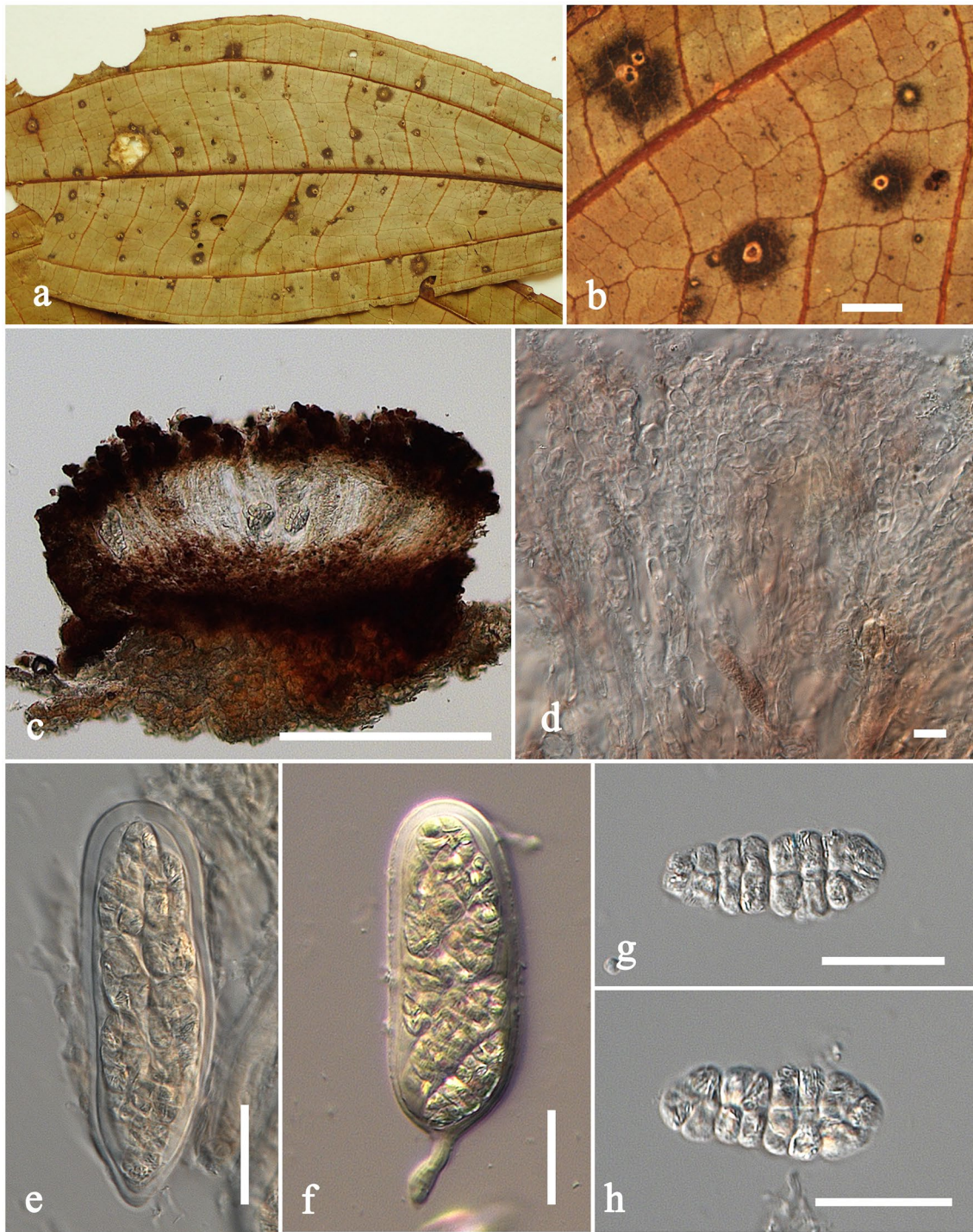
*Index Fungorum number*: IF 3288; *Facesoffungi number*: FoF 06493; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Munkiella caa-guazu*** Speg., Anal. Soc. cient. argent. 19: 248 (1885).

*Notes*: The asexual morph of this genus is undetermined. The type species of the genera *Munkiella*, *Coscinopeltis* and *Apiotrabutia* were found to be the same fungus, which was named *Munkiella caa-guazu*. *Munkiella* was accepted in *Polystomellaceae*, Dothideomycetes families *incertae sedis* (Lumbsch and Huhndorf 2010; Hyde et al. 2013; Wijayawardene et al. 2014a).

***Parastigmatea*** Doidge, Bothalia 1(1): 22 (1921).

*Index Fungorum number*: IF 3723; *Facesoffungi number*: FoF 06494; – 7 morphological species (Species Fungorum 2020), molecular data unavailable.



**Fig. 126** *Protoscypha pulla* (BPI663043, **type**). **a** Material and habit on leaves. **b** Appearance of ascostromata. **c** Sections of ascostroma. **d** Hamathecium pseudoparaphyses. **e, f** Asci. **g, h** Ascospores. Scale bars: **b** = 2 mm, **c** = 200  $\mu$ m, **d** = 5  $\mu$ m, **e–h** = 20  $\mu$ m

*Type species: Parastigmatea nervisita* Doidge, Bothalia 1(1): 22 (1921).

*Notes: Parastigmatea nervisita* was isolated from leaves of *Stephania hernandifolia* in South Africa. *Parastigmatea* is characterised by epiphyllous ascostromata, ovate or broadly

ellipsoid, 8-spored asci and conglobate, hyaline ascospores. *Parastigmatea* was accepted in *Polystomellaceae*, Dothideomycetes families incertae sedis (Lumbsch and Huhndorf 2010; Hyde et al. 2013; Wijayawardene et al. 2018). The sexual morph is undetermined.

### Economic and ecological significance

*Dothidella* include many species which are of economic importance. They play a negative role by causing crop diseases. The Amazon's loss of the rubber market was caused by species from *Dothidella* making the more efficient plantation cropping impossible in the Amazon (Bunker 1985)

**Protoscyphaceae** Kutorga & D. Hawksw., Syst. Ascom. 15(1–2): 70 (1997).

*Index Fungorum number*: IF 81924, *Facesoffungi number*: FoF 07900, 2 species.

*Parasitic* on living leaves of *Miconia thomasiana*. **Sexual morph**: *Ascostromata* superficial, solitary, scattered, occurring on the lower leaf surface, discoid or cup-shaped, slightly convex or raised pulvinate, semi-immersed, flattened and thickened at the base, occurring in lesions of light brown regions and surrounded by external black mycelial, multi-locular, opening by rupturing or cracking of the apical ascostromata. *Peridium* thick, composed of dark cells arranged in a *textura angularis*. *Hamathecium* comprising hyaline, relatively wide, anastomosing, septate, cellular pseudoparaphyses, often with swollen cells, intermixed with reddish brown colouration, and surrounded by a gelatinous matrix. *Asci* 8-spored, bitunicate, fissitunicate, subglobose oblong, broadly cylindrical to subclavate, somewhat thickened at the apex, short pedicellate, with a wide, but short ocular chamber. *Ascospores* 2–3-seriate, muriform, oblong to oval-sub ellipsoid, hyaline, pale brown or light brown, multi-septate, constricted at the septum, surrounded by a thin gelatinous sheath. **Asexual morph**: Undetermined.

*Type*: **Protoscypha** Syd.

*Notes*: The family currently comprises a monotypic genus *Protoscypha* with two species and is treated in Dothideomycetes as family *incertae sedis* (Hyde et al. 2013; Wijayawardene et al. 2018). The family lacks molecular data to establish phylogenetic placement, especially as the type species is yet to be sequenced and no additional new taxa in this family.

**Protoscypha** Syd., Anns mycol. 23(3/6): 402 (1925).

*Index Fungorum number*: IF 4394; *Facesoffungi number*: FoF 07901; – 2 species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Protoscypha pulla** Syd.

*Notes*: *Protoscypha* is a tropical genus and comprises only two parasitic species on living leaves (Index Fungorum 2020). The genus is characterized by discoid to cup-like ascostromata, asci in a single locule and muriform, hyaline to lightly pigmented ascospores (Hyde et al. 2013).

**Protoscypha pulla** Syd., Anns mycol. 23(3/6): 403 (1925).

*Index Fungorum number*: IF 275651; *Facesoffungi number*: FoF 07902; Fig. 126

*Description*: see Hyde et al. (2013).

*Material examined*: Costa Rica, Los Angeles de San Ramon, on leaves of *Miconia thomasiana*, 30 January 1925, H. Sydow, BPI663043 (**type**).

### Economic significance

*Protoscyphaceae* is a parasitic family occurring on living leaves and distributed in tropical countries such as Costa Rica and Brazil.

**Pseudoperisporiaceae** Toro, in Seaver & Palacios Chardon, Scient. Surv. P. Rico 8(1): 40 (1926).

*Index Fungorum number*: IF 81227, *Facesoffungi number*: FoF 00122, 48 species.

*Parasitic, biotrophic* or *saprobic* on leaves, or other fungi, primarily in tropical regions. **Sexual morph**: *Ascomata* superficial, solitary to gregarious, scattered, globose to subglobose, collapsed when dry, surrounded by brown mycelium at the base, ostiole central and surrounded by brown, septate setae, tapering to subacute apex. *Peridium* composed of cells of *textura angularis*, brown to red brown, thin-walled, sometimes collapsed when dry. *Hamathecium* comprising cylindrical, filiform, hyaline, branched, septate, cellular pseudoparaphyses, in a gelatinous matrix. *Asci* 8-spored, bitunicate, fissitunicate, oblong-clavate, slightly curved, thickened at the apex, sessile, or with knob-like pedicel, with small ocular chamber. *Ascospores* 2-seriate, fusoid-ellipsoid, rounded and subacute ends, hyaline, becoming brownish at maturity, 1-septate, slightly constricted at the septum, wall minutely verrucose. **Asexual morph**: Coelomycetous.

*Type*: **Lasiostemma** Theiss., Syd. & P. Syd.

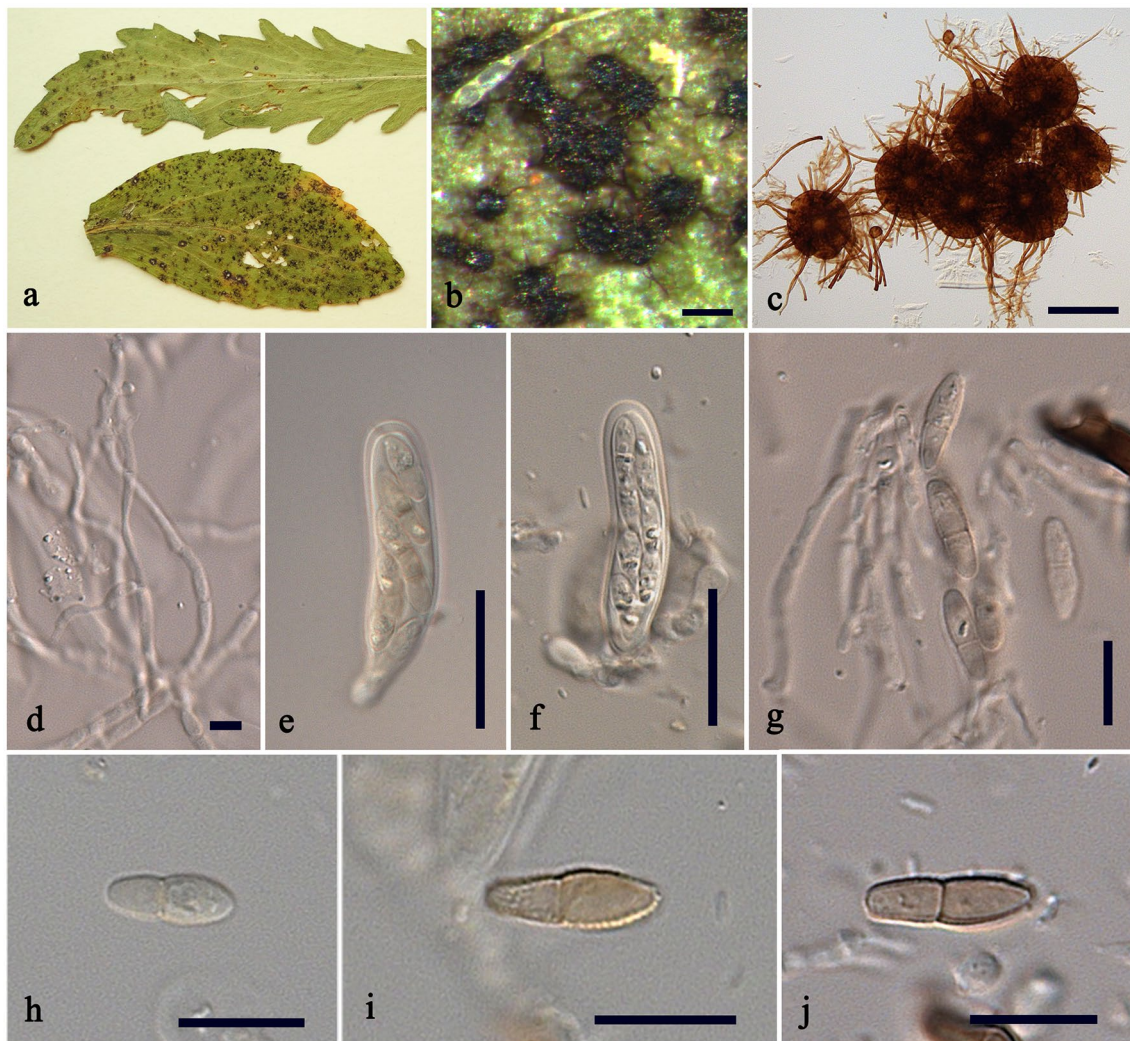
*Notes*: *Pseudoperisporiaceae* comprises only four genera *Bryomyces*, *Eudimeriolum*, *Lasiostemma* and *Nematostoma* and is treated in Dothideomycetes as family *incertae sedis* (Boonmee et al. 2017; Wijayawardene et al. 2018). Taxa in this family are reported as parasitic or saprobic on leaves (Hyde et al. 2013, 2017; Boonmee et al. 2017). The family lacks molecular data to establish phylogenetic placement, especially as the type species is yet to be sequenced.

**Lasiostemma** Theiss., Syd. & P. Syd., in Sydow & Sydow, Anns mycol. 15(3/4): 218 (1917).

*Index Fungorum number*: IF 2660, *Facesoffungi number*: FoF 07903, 6 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Lasiostemma melioides** (Berk. & Ravenel) Theiss., Syd. & P. Syd.

*Notes*: The genus is characterized by superficial, red-brown to dark brown ascomata, with long hyphae, oblong-clavate asci, fusoid-ellipsoid, 1-septate, light brown ascospores. *Lasiostemma* comprises eight species on living leaves and is distributed in tropical regions e.g., Brazil, Cuba, Malaysia, Uganda (Hyde et al. 2013; Boonmee et al.



**Fig. 127** *Lasiostemma melioloides* (BPI699548). **a** Material and habit on leaves. **b** Appearance of ascomata. **c** Squash mount of ascoma showing ostiole. **d** Hamathecium pseudoparaphyses. **e, f** Asci. **g–j** Ascospores. Scale bars: **b, c** = 100  $\mu$ m, **d** = 5  $\mu$ m, **e, f** = 20  $\mu$ m, **g–j** = 10  $\mu$ m

2017). Hyde et al. (2013) examined a specimen of *Lasiostemma melioloides* (BPI699548). The type species *Lasiostemma melioloides* and its members need sequence data to establish taxonomic placement of this genus.

***Lasiostemma melioloides*** (Berk. & Ravenel) Theiss., Syd. & P. Syd., in Sydow & Sydow, *Annls mycol.* 15(3/4): 218 (1917).

≡ *Sphaeria melioloides* Berk. & M.A. Curtis, in Berkeley, *J. Linn. Soc., Bot.* 10(no. 46): 387 (1868) [1869].

*Index Fungorum* number: IF 102249, *Facesoffungi* number: FoF 03698; Fig. 127

*Description*: see Hyde et al. (2013) and Boonmee et al. (2017).

*Material examined*: Venezuela, Federal district, Puerto La Cruz Valley, El Limón, on leaves of *Erigeron bonariensis*,

16 January 1928, H. Sydow, *Fungi venezuelani* No. 249 (BPI699548).

#### Other genera included

***Bryomyces*** Döbbeler, *Mitt. bot. StSamml., Münch.* 14: 233 (1978).

*Index Fungorum* number: IF 664, *Facesoffungi* number: FoF 07904; – 9 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Bryomyces scapaniae*** Döbbeler, *Mitt. bot. StSamml., Münch.* 14: 254 (1978).

*Notes*: Hyde et al. (2017) revisited *Bryomyces* and accepted this genus in *Pseudoperisporiaceae* based on its parasitic or biotrophic habit on living hairy leaves of moss-like plants (liverworts or hornworts). Taxa in this genus are widely distributed and have been found in Austria, Bolivia,

Japan and Sweden. Hyde et al. (2017) provided description and illustration of the holotype specimen *Bryomyces scapaniae*, habit on living hairy leaves of *Scapania undulata* from Austria.

**Eudimeriolium** Spég., Anal. Mus. nac. Hist. nat. B. Aires 23: 36 (1912).

*Index Fungorum number*: IF 1922, *Facesoffungi number*: FoF 07905; – 16 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Eudimeriolium elegans** Spég., Anal. Mus. nac. Hist. nat. B. Aires 23: 36 (1912).

*Notes*: Boonmee et al. (2017) revisited *Eudimeriolium* and accepted this genus in *Pseudoperisporiaceae* based on its parasitic and saprobic habit on leaves. Taxa in this genus are widely distributed such as in Brazil, Germany, Philippines, Puerto Rico, Tanzania and other tropical countries. Boonmee et al. (2017) provided a description and illustration of the type species *Eudimeriolium elegans* based on the protologue of Spégazzini (1912).

**Nematostoma** Syd. & P. Syd., Annl. mycol. 12(2): 161 (1914).

*Index Fungorum number*: IF 3443, *Facesoffungi number*: FoF 07906; – 17 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: **Nematostoma artemisiae** Syd. & P. Syd., Annl. mycol. 12(2): 161 (1914).

*Notes*: Boonmee et al. (2017) revisited *Nematostoma* and accepted this genus in *Pseudoperisporiaceae* based on parasitic and saprobic habit on leaves. Taxa in this genus are widely distributed such as in Argentina, Japan, Mexico, the USA and other tropical countries. Boonmee et al. (2017) provided a description and illustration of the holotype specimen *Nematostoma artemisiae*, habit on living leaves of *Artemisia vulgaris* var. *indica* from Japan.

### Economic and ecological significance

*Pseudoperisporiaceae* is rather a large family and comprises 48 taxa which are parasitic, biotrophic or saprobic habit on leaves. All taxa in this family are widespread in distribution and usually associated on living leaves, but some taxa are found on dead leaves. *Bryomyces* is commonly associated with moss-like plants such as liverwort and hornworts (Döbeler 1978; Hyde et al. 2017).

**Pseudorobillardaceae** Crous, Fungal Systematics and Evolution 3: 108 (2019).

*Index Fungorum number*: IF 829342; *Facesoffungi number*: FoF 07907, 18 species.

*Saprobic, pathogenic or endophytic* on soil or decaying living and dead leaves, stems. **Sexual morph**: Undetermined. **Asexual morph**: *Conidiomata* immersed, globose,

unilocular, with central ostiole. *Conidiogenous cells* thin-walled with of 3–6 layers, composed of flattened cells of *textura angularis*. *Hamathecium* numerous, hyphae-like, aseptate, flexuous, paraphyses, intermingled among conidiophores. *Conidiogenous cells* sub-cylindrical to ampulliform, hyaline, smooth. *Conidia* contain micro- or macroconidia, subcylindrical, hyaline, aseptate, smooth-walled, guttulate, apex obtuse, base truncate; apical appendages hair-like, flexuous, unbranched, fragile, flexuous, unbranched.

*Type*: **Pseudorobillarda** M. Morelet.

*Notes*: *Pseudorobillardaceae* (Dothideomycetes) was informally introduced by Crous et al. (2018a) based on morphology and phylogeny. Later *Pseudorobillardaceae* was formally introduced by Crous et al. (2019a) to accommodate *Pseudorobillarda*. In previous studies this genus was placed in Dothideomycetes genera *incertae sedis* (Tangthirasunun et al. 2014; Wijayawardene et al. 2018).

**Pseudorobillarda** M. Morelet, Bull. Soc. Sci. nat. Arch. Toulon et du Var 175: 5 (1968).

*Index Fungorum number*: IF 9607; *Facesoffungi number*: FoF 07559; 18 morphological species (Species Fungorum 2020), 7 species with molecular data.

*Type species*: **Pseudorobillarda phragmitis** (Cunnell) M. Morelet.

*Notes*: The members of this genus can be saprobic, pathogenic and endophytic and are known from temperate and tropical countries such as Argentina, Canada, Cuba, Germany, India, Nigeria, South Africa, Thailand, UK, Ukraine, and the USA (Petrini 1986; Nag-Raj 1993; Bianchinotti 1997; Vujanovic and St-Arnaud 2003; Plaingam et al. 2005; Tangthirasunun et al. 2014; Crous et al. 2018a). This genus occurs on both living and dead leaves, stems or bark and is also commonly found in soil (Petrini 1986; Vujanovic and St-Arnaud 2003; Kadowaki et al. 2014). Keys to species in *Pseudorobillarda* were provided in Sutton (1980), Nag-Raj (1993) and Vujanovic and St-Arnaud (2003). The revised descriptions and illustrations of *Pseudorobillarda*, based on morphological characteristics are available in Plaingam et al. (2005). No sexual morph is linked to *Pseudorobillarda* (Hyde et al. 2011; Wijayawardene et al. 2012, 2017a; Tangthirasunun et al. 2014).

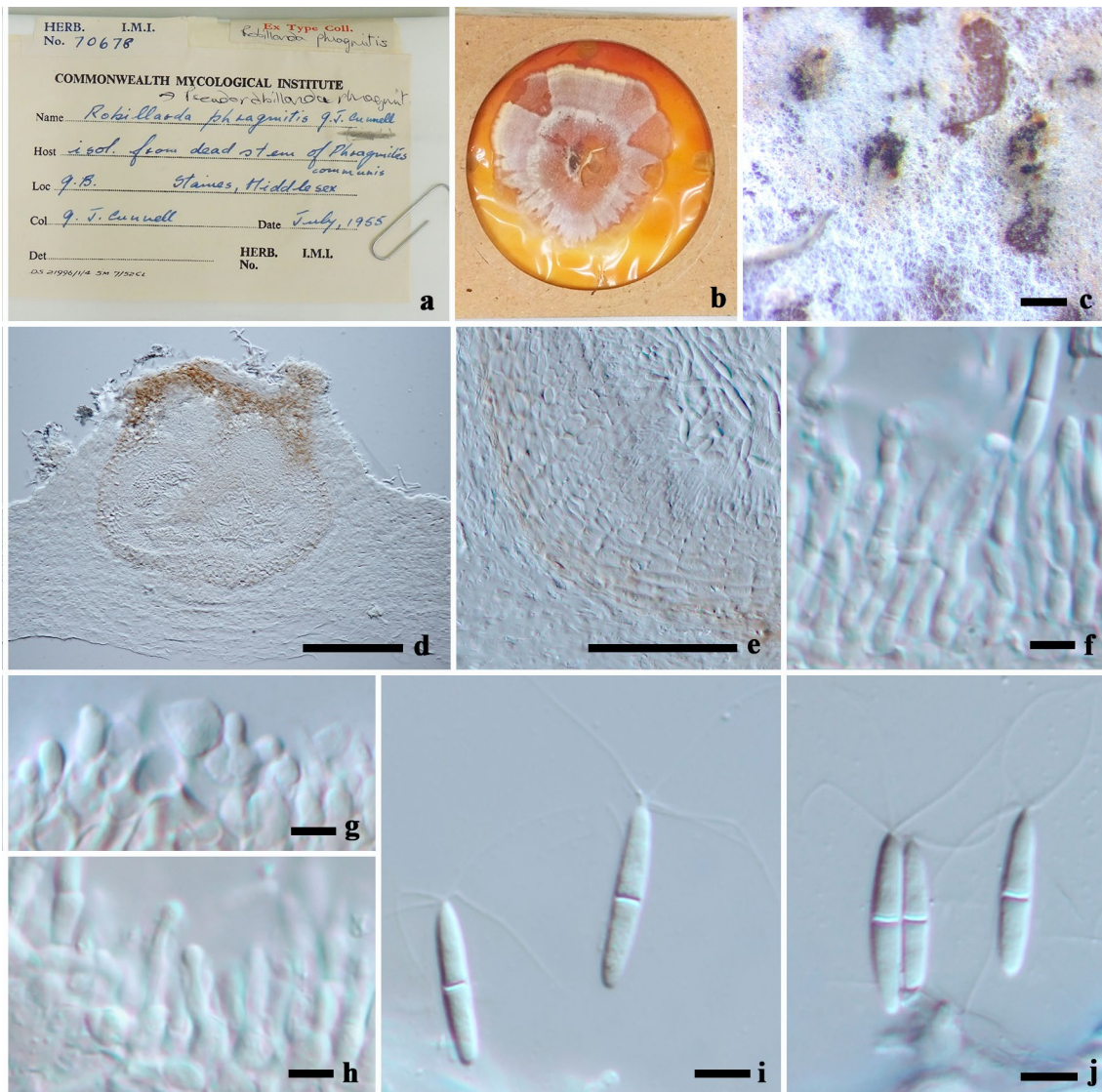
**Pseudorobillarda phragmitis** (Cunnell) M. Morelet, Bull. Soc. Sci. nat. Arch. Toulon et du Var 175: 6 (1968).

≡ *Robillarda phragmitis* Cunnell, Trans. Br. mycol. Soc. 41(4): 405 (1958).

*Index Fungorum number*: IF 321865; *Facesoffungi number*: FoF 07565, Fig. 128

*Description*: see Li et al. (2020).

*Materials examined*: UK, England, Middlesex, near Staines, on dead stems of *Phragmites communis* (*Poaceae*), July 1955, G. J. Cunnell (IMI 70768, **holotype**).



**Fig. 128** *Pseudorobillarda phragmitis* (IMI 70768, holotype). **a** Herbarium packet. **b** Dried culture. **c** Colony characteristics in culture. **d** Section of conidioma. **e** Conidiogenous cells with developing conidia.

**f–h** Conidiogenous cells. **i, j** Conidia. Scale bars: **c** = 200  $\mu$ m, **d** = 100  $\mu$ m, **e** = 50  $\mu$ m, **f–j** = 5  $\mu$ m,

### Economic and ecological significance

*Pseudorobillardaceae* is a small family containing only a single genus and they are important for nutrient cycling as they are saprobic on a wide variety of plant substrates. On the other hand, some species of *Pseudorobillarda* are known as one of the top ten most abundant soil fungi (Kadowaki et al. 2014).

**Pyrenidiaceae** Zahlbr. in Engler, syllabus der Pflanzenfamilien, Edn 2 (Berlin): 46 (1898).

*Index Fungorum* number: IF 81790; *Facesoffungi* numbers: FoF 07908, 13 species.

*Lichenicolous* on various substrates such as bark, rock, soil, bryophytes or living leaves. **Sexual morph**: *Ascomata* perithecioid, densely grouped or dispersed over large areas of the thallus, sessile or immersed in the host thallus, black, in longitudinal section, subglobose to broadly ovoid or pyriform, often with light greenish-blue tint in the ostiolar canal. *Peridium* with isodiametric to elongated cells, brown to dark brown. *Hymenium* hyaline, I-, KI-. *Hamathecium* of numerous, persistent, branched, anastomosing pseudoparaphyses; apical cells not enlarged; non-branching periphyses. *Asci* 4–8-spored, bitunicate, short pedicellate, I-, KI-, ocular chamber not distinct. *Ascospores* 1–2-seriate, oblong to ellipsoidal, or fusiform, dark brown, often paler brown at

**Fig. 129** *Pyrenidium actinellum* (Ertz. 16557 (BR)). **a** Appearance of ascomata on host surface. **b** Vertical section of host with perithecioid ascoma visible. **c, d** Asci. **e–g** Ascospores. Scale bars: **b** = 50  $\mu$ m, **c, d** = 10  $\mu$ m, **e–g** = 5  $\mu$ m



the spore tips, 3-septate, smooth-walled. **Asexual morph:** Undetermined (adapted from Huanraluek et al. 2019a).

**Type:** *Pyrenidium* Nyl.

**Notes:** Huanraluek et al. (2019a) provided sequence data for *Pyrenidium* species and indicated that *Pyrenidium* formed a distinct clade outside *Dacampiaceae*. However, Huanraluek et al. (2019a) did not assign *Pyrenidiaceae* to any order. *Pyrenidiaceae* formed a distinct clade outside Pleosporales in personal analyses of Hongsanan et al. (2020, data not showed), and formed within Pleosporales as a distinct family (data not showed) in the dataset which includes all representative families in Dothideomycetes (data not

showed). Therefore, we agree with Huanraluek et al. (2019a) to treat this family as *incertae sedis* in Dothideomycetes until more collections with multi-loci are available to clarify its phylogenetic placement.

***Pyrenidium*** Nyl., Flora, Regensburg 48: 210 (1865).

**Index Fungorum number:** IF 4578; **Facesoffungi numbers:** FoF 07909; 13 morphological species (Species Fungorum 2020), 3 species with molecular data.

**Type:** *Pyrenidium actinellum* Nyl.

**Notes:** *Pyrenidium* was placed in *Dacampiaceae* based on morphology and the environmental habitats (Hyde et al.



2013; Wijayawardene et al. 2014a, 2018; Jaklitsch et al. 2016). Crivelli (1983) suggested that *Pyrenidium* has close relationship with *Dacampia* in *Dacampiaceae* in its similar ascomatal structures and wall tissues (Crivelli 1983). However, sequence data of three species, *Pyrenidium actinellum*, *P. aff. aggregatum* and *P. borbonicum*, were provided by Huanraluek et al. (2019a). These sequence data formed a distinct clade far from *Dacampiaceae*. Thus, *Pyrenidiaceae* was resurrected to accommodate species of *Pyrenidium*.

***Pyrenidium actinellum*** Nyl., Flora, Regensburg 48: 210 (1865).

*Index Fungorum number*: IF 403001; *Facesoffungi number*: FoF 04634; Fig. 129

*Description*: see Huanraluek et al. (2019a).

*Materail examined*: Belgium, Aywaille, versant droit de l'Amblève, Heid des Gattes, 200 m elev. Paroi de grès à *Anema*, on the lichen *Scytinium plicatile*, 2011, (Ertz. 16557 (BR)).

### Economic and ecological significance

Species of *Pyrenidium* are lichenicolous developing on lichen thalli, with parasymbionts living in symbiosis (Hawksworth 1982; Diederich et al. 2018). The ascomata of *Pyrenidium* are immersed to erumpent in host thalli with the upper part exposed and sometimes causing gall-like malformations of the host (Eriksson and Hawksworth 1993; Matzer 1996; Pirogov 2014; Lendemer 2017; Muscavitch et al. 2017).

***Seynesiopeltidaceae*** K.D. Hyde, in Hyde et al., Fungal Diversity 63: 232 (2013).

*Index Fungorum number*: IF 804042; *Facesoffungi number*: FoF 06522, 1 species.

*Foliar epiphytes* on leaves, causing black spots, usually confluent in groups, forming black colonies. **Sexual morph**: Mycelium superficial, sparse, light, septate, olive-green. *Thyriothecia* solitary or gregarious, superficial, circular, shield-like, shallow, conical, dome-like, flattened, upper region, carbonaceous, unilocular, brown to black, basal layer poorly developed, lacking a distinct central ostiole. *Upper wall* comprising radiating arranged parallel cells, cells at margin branching. *Hamathecium* comprising 1–3 µm wide, comprising numerous, cellular, branched pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, saccate, with a knob-like pedicel, and conspicuous ocular chamber (in Congo red). *Ascospores* irregularly 2–3-seriate, dark brown when mature, 1-septate, strongly constricted at septum, upper cells longer and wider, basal cell shorter and narrower with an acute base, with a thick, structured, hyaline, cell wall. **Asexual morph**: Undetermined.

*Type*: *Seynesiopeltis* F. Stevens & R.W. Ryan.

*Notes*: *Seynesiopeltidaceae* was introduced by Hyde et al. (2013) based on the unique brown ascospores with thick structured walls and thick ascus wall when stained in Congo red. The cells of the peridium consist of two strata of *textura angularis* cells. Ascomata are described as thyriothecia-like and they resemble some genera in *Parmulariaceae* (e.g. *Polycyclus andinus*, Inácio and Cannon 2008). Genera such as *Dothidasteroma* and *Cocconia* (also *Parmulariaceae*) may also be related as they have brown ascospores, but the asci are significantly different (Inácio and Cannon 2008). Notably, *Seynesiopeltis* differs from *Parmularia*, the type genus of *Parmulariaceae*. In *Parmularia styracis*, the thyriothecia have a similar appearance to shells on the host surface, the asci are obclavate and ascospores are hyaline.

***Seynesiopeltis*** F. Stevens & R.W. Ryan, in Stevens, Bulletin of the Bernice P. Bishop Museum, Honolulu, Hawaii 19: 69 (1925).

*Index Fungorum number*: IF 5020; *Facesoffungi number*: FoF 07910, 1 morphological species (Species Fungorum 2020), molecular data unavailable.

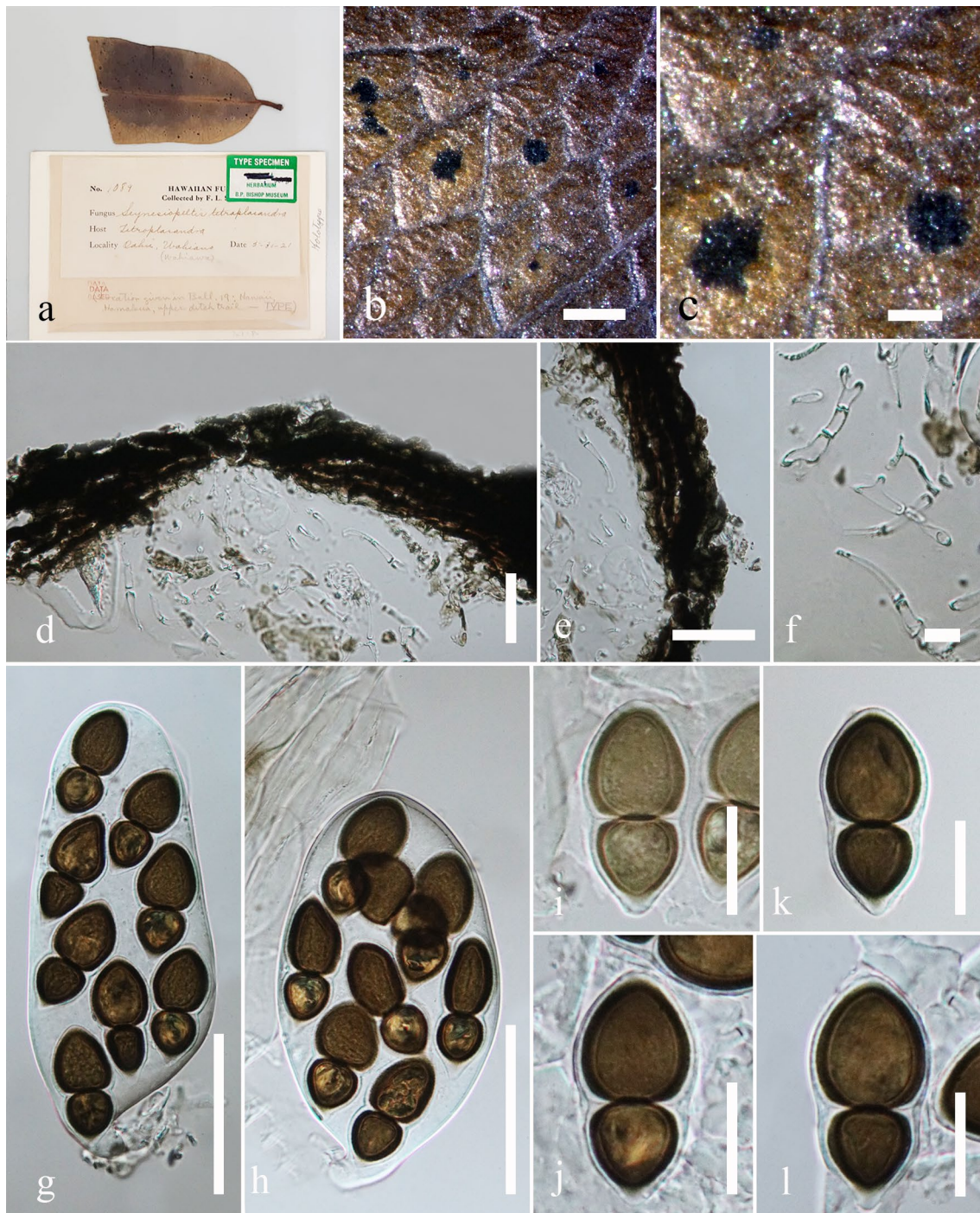
*Type species*: *Seynesiopeltis tetraplasandrae* F. Stevens & R.W. Ryan.

*Notes*: *Seynesiopeltis* is the type genus of *Seynesiopeltidaceae* and it was established by Stevens (1925) as a monotypic genus with *S. tetraplasandrae* as the type and has remained monotypic. This genus was earlier assigned to *Microthyriaceae* by Stevens (1925) which was followed by Muller and von Arx (1962) and Lumbsch and Huhndorf (2010). This genus was moved to Dothideomycetes genera *incertae sedis* by Wu et al. (2011b) since it was unlike any other member of the class Dothideomycetes. It is characterised by unfree mycelium, round and radiate ascomata with thallus being setose. Stevens (1925) mentioned that species in this genus resembles *Seynesia* but are different in that they possess one to several ascomata in one fungus body and that this bears setae which intensify the uniqueness of the genus and family. However, no setae in the type specimen was observed by Hyde et al. (2013). A plausible reason might be loss of setae during storage as the latter is described as being fragile. The genus is monotypic and warrants further investigation.

***Seynesiopeltis tetraplasandrae*** F. Stevens & R.W. Ryan, Bulletin of the Bernice P. Bishop Museum, Honolulu, Hawaii 19: 70 (1925).

*Index Fungorum number*: IF 158371; *Facesoffungi number*: FoF 06523; Fig. 130

*Foliar epiphyte* on leaves, causing black spots, typically confluent, forming black colonies. **Sexual morph**: Mycelium superficial, sparse, septate, olive-green. *Thyriothecia* 347–483 µm diam. 438–565 µm high, solitary or gregarious, superficial, with a circular, shield-like, shallow, conical,



**Fig. 130** *Seynesiopeltis tetraplasandrae* (BISH 1089, holotype). **a** Details of herbarium material. **b**, **c** Habit and appearance of thyrrothecia on the host surface. **d** Section of ascoma. **e** Peridium. **f**

Hamathecium. **g**, **h** Asci. **i–l** Ascospores. Scale bars: **b** = 2000  $\mu\text{m}$ , **c** = 500  $\mu\text{m}$ , **d** = 25  $\mu\text{m}$ , **e** = 35  $\mu\text{m}$ , **f** = 10  $\mu\text{m}$ , **g**, **h** = 50  $\mu\text{m}$ , **i–l** = 20  $\mu\text{m}$

dome-like, flattened, upper region, carbonaceous, unilocular, brown to black, basal layer poorly developed, lacking a distinct central ostiole. Upper wall comprising radiating parallel cells, cells at margin branching. *Hamathecium* comprising 1–3  $\mu\text{m}$  wide, numerous, cellular, branched

pseudoparaphyses. *Asci* 117–142  $\times$  59–68  $\mu\text{m}$  ( $\bar{x}$  = 127  $\times$  65  $\mu\text{m}$ ,  $n$  = 20), 8-spored, bitunicate, fissionic, saccate, with a knob-like pedicel and conspicuous ocular chamber. *Ascospores* 36–41  $\times$  13–15  $\mu\text{m}$  ( $\bar{x}$  = 39  $\times$  14  $\mu\text{m}$ ,  $n$  = 20) irregularly 2–3-seriate, dark brown when mature, 1-septate,



**Fig. 131** *Stomatogene agaves* (NY 02977047). **a** Herbarium specimen and habit on leaves. **b** Appearance of ascomata on leaf surface. **c** Section of ascoma. **d** Peridium. **e** Hamathecium. **f, g** Asci. **h–k** Ascospores. Scale bars: **b** = 200  $\mu$ m, **c** = 50  $\mu$ m, **f, g** = 20  $\mu$ m, **h–k** = 10  $\mu$ m

strongly constricted at septum, upper cells longer and wider, basal cell shorter and narrower with an acute base, with a thick, structured, hyaline, cell wall. **Asexual morph:** Undetermined.

**Material examined:** USA, Hawaii, Oahu, Hamakua, upper ditch trail, on leaves of *Tetraplasandra* (*Araliaceae*), 31 May 1921, Stevens F.L. (BISH 1089, **holotype**).

**Notes:** *Seynesiopeltis tetraplasandrae* was introduced by Stevens and Ryan (1925). It was found on leaves of *Tetraplasandra* in Hawaii and was described as having unfree mycelium, round ascomata consisting several locules and lacking paraphyses. Further collections are required to resolve this genus.

#### Economic and ecological significance

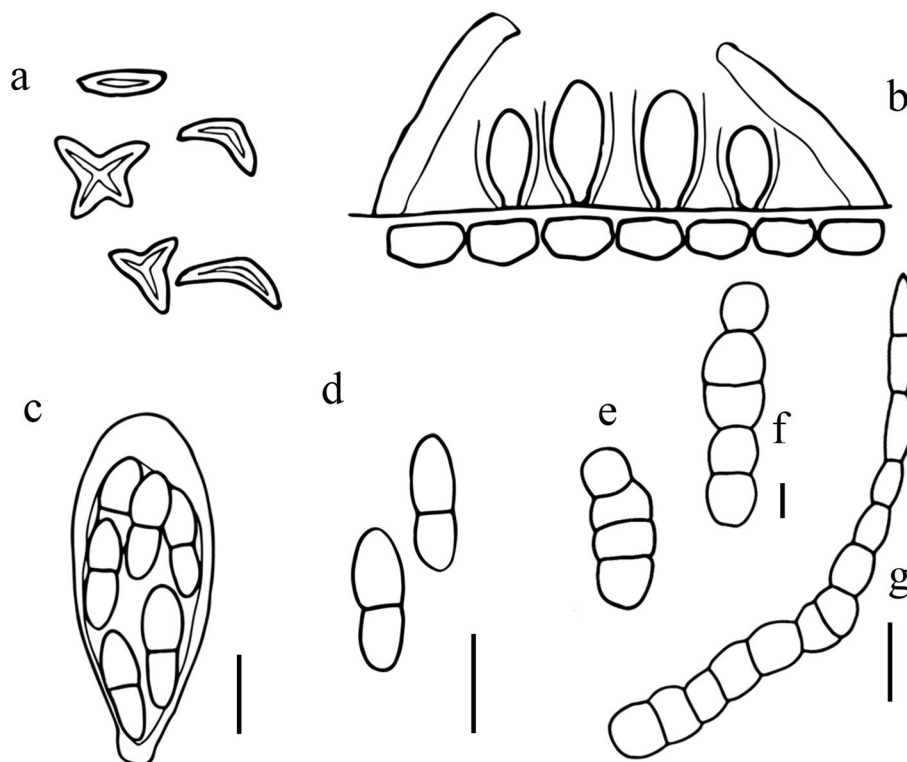
*Seynesiopeltis* is a monotypic genus and foliar epiphytes on leaves. Its life style is unclear as to whether it is saprobic or parasitic.

**Stomatogeneaceae** Boonmee & K.D. Hyde, in Boonmee et al., *Mycosphere* 8(10): 1762 (2017).

**Index Fungorum number:** IF 553837; **Facesoffungi numbers:** FoF 03703, 4 species.

**Parasitic** on living leaves of *Agave* sp. (*Asparagaceae*) and mosses. **Colonies** large, superficial, subcircular, irregular, with numerous, dark brown mycelium, radiating outwards, flexuous, septate. **Sexual morph:** *Ascomata* superficial, semi-immersed at the base, with a basal hypostroma developing in the host tissue, gregarious, or solitary, black, with apical pore, surrounded by dark brown mycelium.

**Fig. 132** Morphology of *Thyrrinula* spp. (a–d = *Thyrrinula eucalypti* redrawn from Crous et al. 2019c; e–g = *Thyrrinula parasitica* redrawn from Summerell et al. 2006). **a** Ascomata on lesion surface. **b** Vertical section through ascomata. **c** Asci. **d** Ascospores. **e–g** Conidiophores and conidia. Scale bars = 10  $\mu$ m



*Peridium* 3–4 layers, dark pigmented cells of *textura angularis*, lacking pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, subglobose, broadly ovoid to subclavate, apically thickened, with an ocular chamber at apex, knob-like pedicellate. *Ascospores* multi-seriate, ellipsoidal oblong, hyaline when immature, brown at maturity, 1-septate, upper cell slightly broader and shorter than lower cell, verrucose or smooth-walled. **Asexual morph:** Undetermined (adapted from Boonmee et al. 2017).

*Type:* *Stomatogene* Theiss.

*Notes:* This family was introduced by Boonmee et al. (2017) to accommodate the single genus, *Stomatogene*. *Stomatogeneaceae* can be differentiated from other families in Dothideomycetes by its colonies, ascumata, asci and ascospore features. However, no sequence data is available in GenBank.

*Stomatogene* Theiss., *Annls mycol.* 14(6): 406 (1917) [1916].

*Index Fungorum number:* IF 5270; *Facesoffungi number:* FoF 03704; 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Stomatogene agaves* (Ellis & Everh.) Theiss.

*Notes:* The genus was placed in *Parodiopsisaceae* by Eriksson et al. (2001), Kirk et al. (2008), Lumbsch and Huhndorf (2010) and Hyde et al. (2013). Boonmee et al.

(2017) concluded that *Stomatogene* should be placed in its own family based on its unique morphological characters.

*Stomatogene agaves* (Ellis & Everh.) Theiss., *Annls mycol.* 14(6): 406 (1918) [1917].

≡ *Asterina agaves* Ellis & Everh., *Bull. Torrey bot. Club* 27: 571 (1900).

*Index Fungorum number:* IF 121867; *Facesoffungi number:* FoF 03705; Fig. 131

*Description:* see Boonmee et al. (2017).

*Material examined:* Mexico, Sonora, in the vicinity of Álamos, on living leaves of *Agave* sp. L (*Asparagaceae*), March 1910, J.N. Rose No.13063 (NY 02977047).

#### Economic and ecological significance

Species in *Stomatogeneaceae* are parasitic on living leaves of *Agave* sp. (*Asparagaceae*) and mosses.

*Thyrrinulaceae* X.Y. Zeng, S. Hongsanan & K.D. Hyde, **fam. nov.**

*Index Fungorum number:* IF 557945; *Facesoffungi number:* FoF 06898, 10 species.

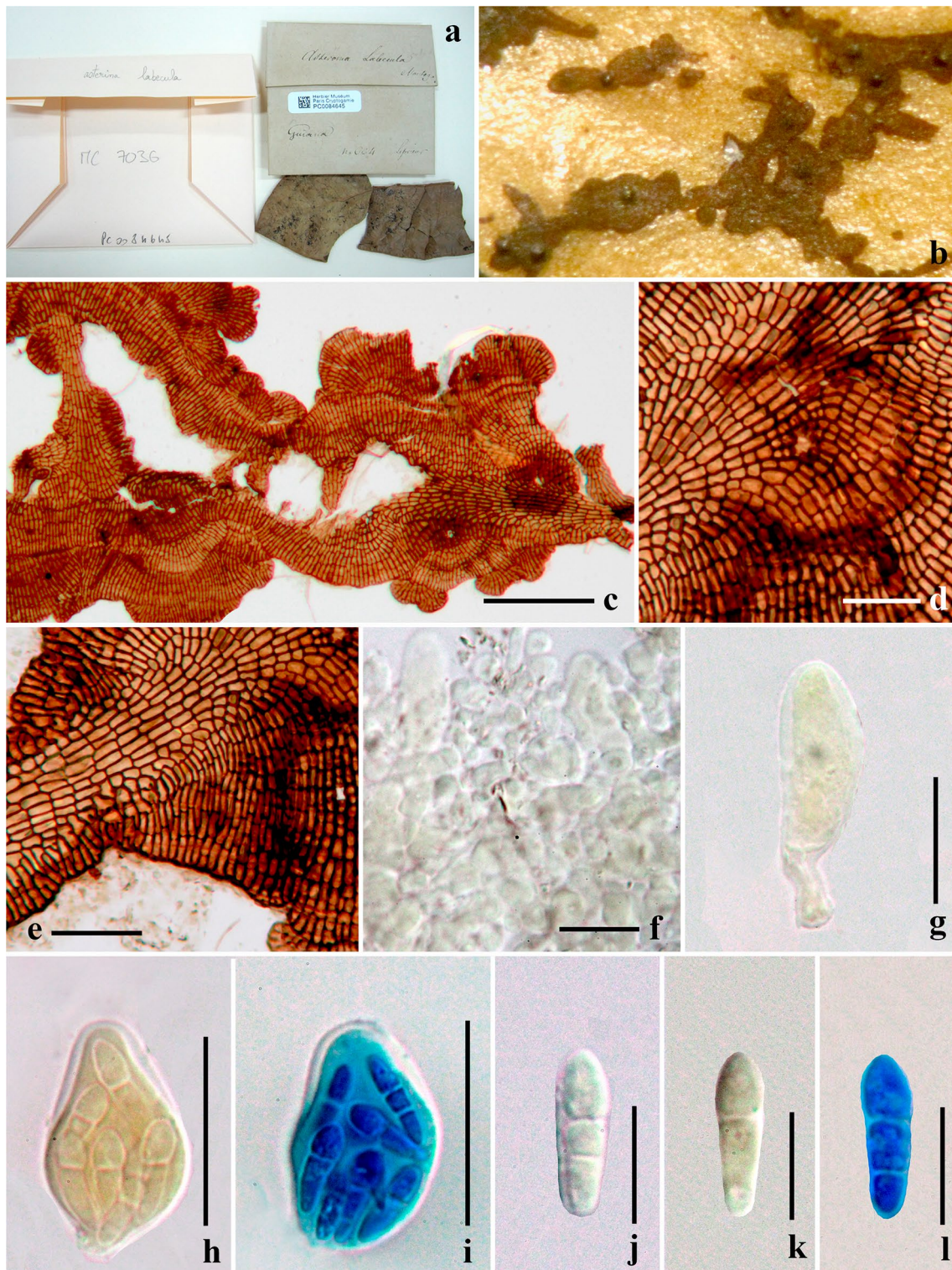
*Pathogens* on surface of leaves or petioles. Leaf spots epiphyllous or hypophyllous, circular to irregular, single to confluent, brown. **Sexual morph:** *Ascomata* superficial, dark brown, hysterothecial, opening by elongated, longitudinal



**Fig. 133** *Toroa dimerosporioides* (BPI 692120). **a** Herbarium specimen. **b** Ascomata on leaf surface. **c** Section of ascoma. **d** Peridium. **e** Hamathecium. **f, g** Asci. **h–j** Ascospores. Scale bars: **b** = 100  $\mu$ m, **c, f, g** = 50  $\mu$ m, **d, h–j** = 20  $\mu$ m, **e** = 10  $\mu$ m

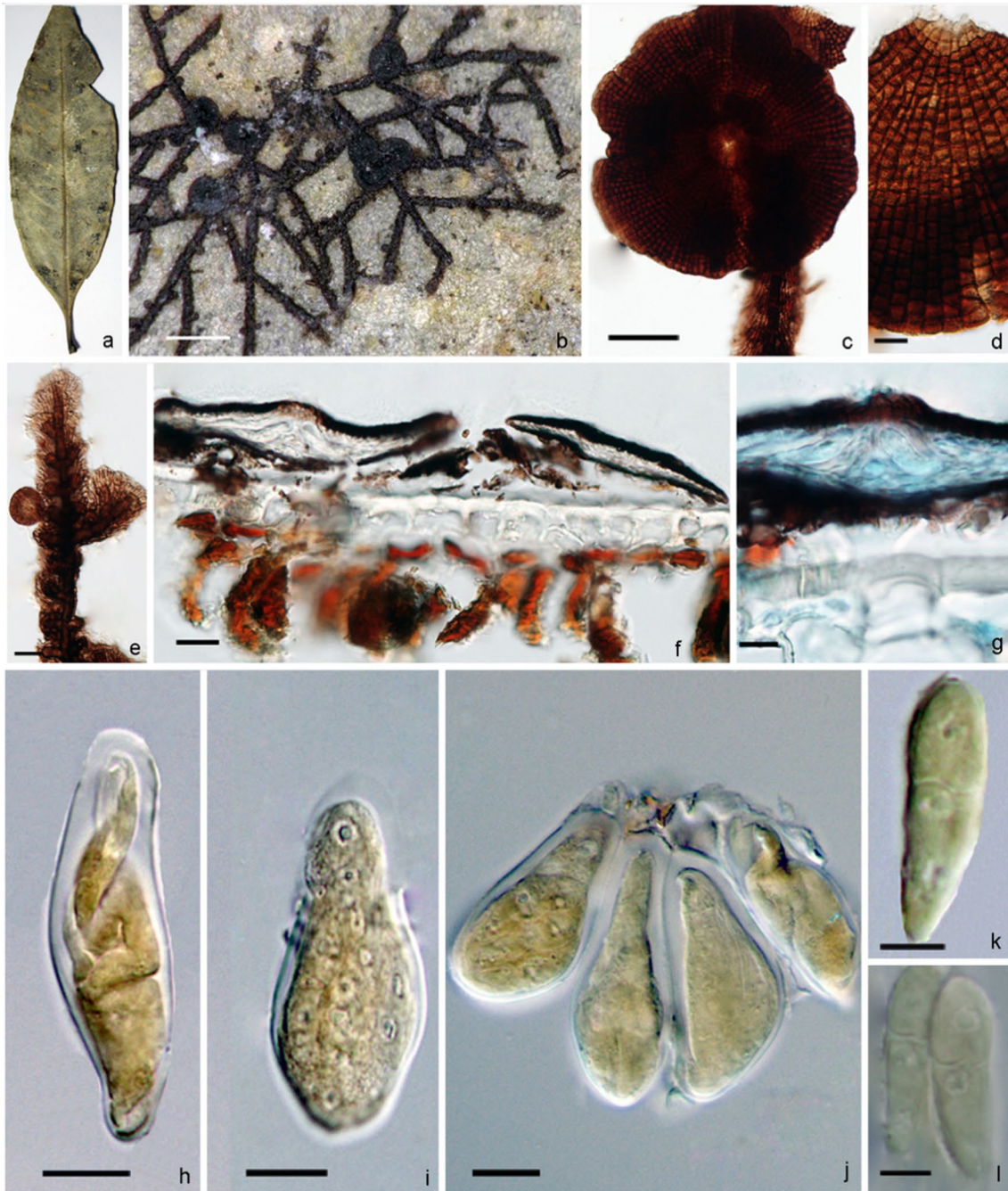
or Y-shaped slits, margin without restricted brown, superficial hyphae. *Asci* 8-spored, bitunicate, broadly ellipsoid to somewhat obovoid, intermixed among hyphae-like, septate, branched pseudoparaphyses, with ocular chamber. *Ascospores* cylindrical to ellipsoid, hyaline, 1-septate, constricted at septum, ends obtusely rounded, guttulate, smooth-walled. **Asexual morph:** Coelomycetous or hyphomycetous. Coelomycetous: *Mycelium* brown, septate, branched, verrucous. *Conidiomata* brown, acervular, solitary to gregarious or confluent, immersed to erumpent, depressed globose, unilocular. *Ostiole* absent, dehiscence by irregular splits of apical wall in the middle part. *Conidiomatal wall* composed of a single layer of brown cells in

the basal part. *Conidiophores* arising from inner wall layer of basal stroma, brown, branched at the base, septate. *Conidiogenous cells* brown, holothallic, cylindrical, integrated or discrete, determinate, verrucous. *Conidia* brown, arthric, formed by disarticulation of the conidial chain, produced in simple unbranched chains with the youngest conidium at the base, surrounding by mucoid sheath, ellipsoidal to globose or subcylindrical, truncate at the base, aseptate, verrucose, guttulate (adapted from Giraldo et al. 2017). Hyphomycetous asexual morph: *Conidiophores* single or sporodochial, if conidiophores single, micronematous, mononematous, straight to slightly flexuous, brown, septate, smooth; if conidiophores sporodochial, brown, verrucose, thick-walled,



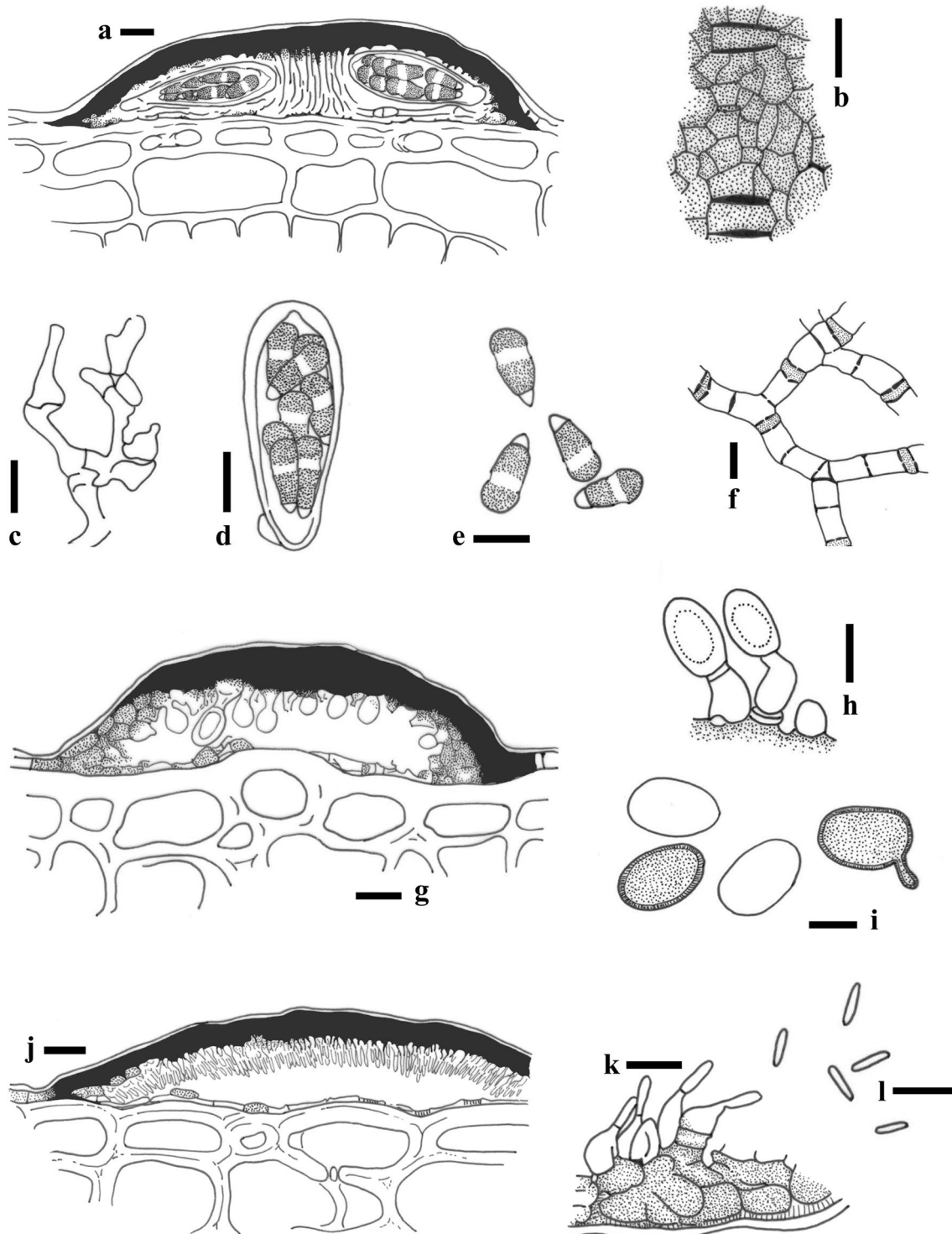
**Fig. 134** *Asterina labecula* (PC 0084645, syntype). **a** Specimens. **b** Ascomata on host substrate. **c** Ascomata with thin and superficial thallus in 70% lactic acid. **d** Walled cells of ascoma and ostiole. **e** Walled cells of thallus composed darkly pigmented cells. **f** Hamathecium in Melzer's reagent. **g** Asci when immature in Melzer's reagent.

**h** Asci in Melzer's reagent. **i** Asci in cotton blue reagent. **j** Ascospore 2-septate in 70% lactic acid. **k** Ascospore uniseptate in Melzer's reagent. **l** Ascospore 2-septate in cotton blue reagent. Scale bars: **c** = 100  $\mu$ m, **e-i** = 20  $\mu$ m. **j-l** = 10  $\mu$ m



**Fig. 135** *Trichothyrium sarciniferum* (LPS1441, holotype). **a** The leaf substrate. **b** Colonies on the leaf surface. **c** Squash mount of the ascoma. **d** The upper wall of ascomata. **e** Superficial mycelium forming thalli on hyphae of *Meliolaceae* species. **f, g** Cross section of

the ascoma. **h–j** Asci mounted in Melzer's reagent. **k, l** Ascospores mounted in Melzer's reagent. Scale bars: **b** = 200  $\mu\text{m}$ , **c** = 50  $\mu\text{m}$ , **e–f** = 20  $\mu\text{m}$ , **d, g–j** = 10  $\mu\text{m}$ , **k–l** = 5  $\mu\text{m}$



**Fig. 136** *Vizella oleariae* (Redrawn from Swart 1971). **a** Section through ascoma. **b** Surface of ascoma. **c** Proliferating croziers. **d** Ascus. **e** Ascospores. **f** Surface view of hypha. **g–l** Conidia and spermatia. Scale bars: **a–g, j** = 10  $\mu$ m, **h, i, k, l** = 5  $\mu$ m



branched, septate. *Appressoria* when present, numerous, entire, globose to cylindrical, alternate to unilateral, aseptate, brown, penetration peg central on the appressorial cell. *Conidiogenous cells* holoblastic, monoblastic, integrated, intercalary, cylindrical to elliptical, light brown to brown, smooth, sometimes with indistinct scars. *Conidial secession* schizolytic. *Conidia* solitary or in branched or simple acropetal chains, ellipsoidal to cylindrical, aseptate to multi-septate, medium brown to brown, smooth or verruculose, sometimes with rounded ends.

*Type: Thyrinula* Petr. & Syd.

*Notes:* This family is introduced to accommodate species that are phylogenetically related to Asterinales *sensu lato*, a clade that is typified by the type sequence data of *Asterina* and *Lembosia* obtained by Guatimosim et al. (2015). However, the genetic distance between the two genera is less than the two *Asterina* species in their phylogeny, indicating that these two sequences are questionable. There are three genera included in this family based on phylogeny, and they are sister to *Parmulariaceae* (Parmulariales).

*Thyrinula* Petr. & Syd., *Annls mycol.* 22(3/6): 373 (1924).

= *Alysiidiella* Crous, in Summerell et al., *Fungal Diversity* 23: 325 (2006).

*Index Fungorum number:* IF 10218; *Facesoffungi number:* FoF 06728; 5 morphological species (Crous et al. 2019c), 5 species with molecular data.

*Type species: Thyrinula eucalyptina* Petr. & Syd., *Annls mycol.* 22(3/6): 373 (1924)

*Notes:* *Thyrinula* is characterized by hysterothecia opening by elongated, longitudinal or Y-shaped slits, and 1-septate ascospores. Its asexual morph *Alysiidiella* was introduced to accommodate a single species with both aseptate and multi-septate conidia. Crous et al. (2019c) provided sequence data of all members of the genus from fresh collections, and synonymized *Alysiidiella* under *Thyrinula* based on morphology (Fig. 132).

#### Other genera included

*Blastacervulus* H.J. Swart, *Trans. Br. mycol. Soc.* 90(2): 289 (1988).

*Index Fungorum number:* IF 11029; *Facesoffungi number:* FoF 06733; – 4 morphological species (Species Fungorum 2020), 3 species with molecular data.

*Type species: Blastacervulus eucalypti* H.J. Swart, *Trans. Br. mycol. Soc.* 90(2): 289 (1988).

*Notes:* *Blastacervulus* is a coelomycetous genus characterised by acervular conidiomata and thallic, 1-septate conidia with truncate, flat hila. Wijayawardene et al. (2016) showed that *B. eucalypti* clustered in *Planistromellaceae*, however, it forms within the *Thyrinulaceae* in our analyses (Fig. 5).

*Paraopeba* V.P. Abreu, A.A.M. Gomes, Firmino & O.L. Pereira, in Crous et al., *Persoonia* 39: 349 (2017).

*Index Fungorum number:* IF 821209; *Facesoffungi number:* FoF 06740; – 1 morphological species (Species Fungorum 2020), with molecular data.

*Type species: Paraopeba schefflerae* V.P. Abreu, A.A.M. Gomes, Firmino & O.L. Pereira, in Crous et al., *Persoonia* 39: 349 (2017).

*Notes:* *Paraopeba* is hyphomycetous characterized by schizolytic conidiogenous cells, 2–13-septate conidia and the present of appressoria. Crous et al. (2017) introduced it as a monotypic genus in Asterinales based on the phylogenetic analysis.

#### Economic and ecological significance

Members of this family are important plant pathogens that can cause leaf and petiole lesions.

*Toroaceae* Boonmee & K.D. Hyde, in Boonmee et al., *Mycosphere* 8(10): 1769 (2017).

*Index Fungorum number:* IF 553838; *Facesoffungi numbers:* FoF 03708, 1 species.

*Saprobic* on dried leaves. **Sexual morph:** *Ascomata* superficial, globose to subglobose, solitary to gregarious, scattered, black, with a subiculum, collapsing when dry, with apical ostiole. *Peridium* comprising red brown to dark brown cells of *textura angularis*. *Asci* 4-spored, bitunicate, oblong-ellipsoid to ovoid, sessile, apically thickened. *Ascospores* 2-seriate, ellipsoid-fusiform, narrow towards the ends, pale brown to orange brown, light at both ends, smooth-walled. **Asexual morph:** Undetermined (adapted from Boonmee et al. 2017).

*Type: Toroa* Syd.

*Notes:* Boonmee et al. (2017) established this family to accommodate the genus *Toroa*. *Toroaceae* differs from other families in the Dothideomycetes in having only four ascospores in the ascus and a combination of other characters (Boonmee et al. 2017). No sequence data is available for this family.

*Toroa* Syd., in Toro, J. *Dept. Agric. Porto Rico* 10(2): 19 (1926).

*Index Fungorum number:* IF 5500; *Facesoffungi number:* FoF 07911; 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Toroa dimerosporioides* (Speg.) Syd.

*Notes:* *Toroa* was established to accommodate the type species *T. dimerosporioides* which is the current name of *Asteridium dimerosporioides*, *Zukalia dimerosporioides*, *Gibberella dimerosporioides*, *Perisporium bromeliae* and *Chaetosphaeria bromeliae* (Spegazzini 1888; Saccardo 1891; von Höhnelt 1907; Stevens 1917; González-Fragoso and Ciferri 1925; Toro 1926; Boonmee et al. 2017). Barr

(1997) transferred *Toroa* to *Pseudoperisporiaceae*, however, *Toroa* can be distinguished from *Pseudoperisporiaceae* and other families in Dothideomycetes in having 4-spored asci, and 2–3-septate, pale brown to orange brown ascospores which are light at both ends (Boonmee et al. 2017).

*Toroa dimerosporioides* (Speg.) Syd. [as ‘dimerosporioides’], J. Dept. Agric. Porto Rico 2: 20 (1926).

≡ *Asteridium dimerosporioides* Speg., Anal. Soc. cient. argent. 26(1): 19 [no. 50] (1888).

*Index Fungorum number*: IF 263219; *Facesoffungi number*: FoF 03245; Fig. 133

*Description*: see Boonmee et al. (2017).

*Material examined*: Puerto Rico, La Vega, on dried leaves *Bromelia pinguin* L. (*Bromeliaceae*), 19 March 1919, Kern and R.A. Toro (No. 207 / No. I.T.A 5413, BPI 692120).

### Economic and ecological significance

*Toroaceae* comprises a single genus which was found as saprobic on dead leaves (Boonmee et al. 2017). It plays a role in recycling organic matter.

*Trichopeltinaceae* Bat., C.A.A. Costa & Cif., Atti dell’Istituto Botanico della Università e Laboratorio Critogamico di Pavia 15: 37 (1958).

*Index Fungorum number*: IF 81489; *Facesoffungi number*: FoF 06203, 29 species.

*Epiphytic* on living leaves, appearing as rounded or linear, or “root-like” darkened areas. *Thallus* very thin on the surface of the host plant, superficial, comprising neatly or irregularly arranged, angular or cylindrical to cuboid cells, with brown to dark brown walls. **Sexual morph**: *Thyriothecia* developing under thallus tissue, globose to subglobose, flattened, with a porate, central ostiole. *Hamathecium* usually lacking pseudoparaphyses, sometimes comprising hyaline pseudoparaphyses. *Asci* 6–8-spored, bitunicate, fissitunicate, subglobose to clavate, short pedicellate or apedicellate, long pedicellate when immature in some species, apically rounded, sometimes with small ocular chamber or apical ring. *Ascospores* 2–4-seriate, oblong to ellipsoidal, or clavate, hyaline to pale brown, 1–3-septate or muriform, slightly constricted at the septa in some species, smooth-walled. **Asexual morph**: Undetermined.

*Type*: *Trichopeltina* Theiss.

*Notes*: *Trichopeltinaceae* are epiphytes on leaves of various plants with a worldwide distribution. The name *Trichopeltinaceae* was predated by *Trichopeltaceae* (Theissen 1914b). Batista et al. (1958) renamed the family to *Trichopeltinaceae* based on *Trichopeltina*, and accommodated genera that have flattened thyriothecia developing under a thallus viz. *Brefeldiella*, *Petrakiopeltis*, *Phragmoscutella*, *Trichopeltella*, *Trichopeltheca*, *Trichopeltina*, *Trichopeltospora* and *Trichopeltum*. Genera of

*Trichopeltinaceae* with thyriothecia were transferred to *Stephanothecaceae* (Petraik 1947c; Luttrell 1951). However, *Stephanothecaceae* (type genus *Stephanotheca*) has a hypostroma, and was considered to be distinct from *Trichopeltinaceae* (Bessey 1952; Batista et al. 1958). This was supported by Jayawardena et al. (2014) who illustrated the thyriothecia of *Stephanotheca* as individual and not covered by a thallus. Hyde et al. (2013) referred the name *Brefeldiellaceae* to this group, and divided *Brefeldiellaceae* into *Brefeldiineae* and *Trichopeltineae*. However, the older name *Trichopeltinaceae* should be used to accommodate this group (Hongsanan et al. 2014a). In the following account, *Acrogenotheca*, *Brefeldiella*, *Saccardinula*, *Trichopeltella*, *Trichopeltheca* and *Trichopeltina* (*Trichopeltum*) are included in *Trichopeltinaceae* based on their thyriothecia being covered by a “skin-like” thallus.

*Trichopeltina* Theiss., Beih. bot. Zbl., Abt. 2 32: 3 (1914).

*Index Fungorum number*: IF 5566; *Facesoffungi number*: FoF 06204; 5 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: *Trichopeltina labecula* (Mont.) Theiss.

*Notes*: *Trichopeltina* was established by Theiss (1914a) based on *Trichopeltina labecula* (≡ *Asteroma labecula*). Clements and Shear (1931) placed fossil material with a thin thallus and 1-septate ascospores in *Trichopeltina*. Species of *Trichopeltina* are characterized by a superficial, irregularly arranged thin thallus, globose to subglobose flattened ostioles, thyriothecia, 8-spored, clavate, fissitunicate asci with hyaline, long clavate, 1–3-septate ascospores (Hongsanan et al. 2014a). However, Dilcher (1965) disagreed that the fossil material cited by Clements and Shear (1931) is *Trichopeltina*.

*Trichopeltina labecula* (Mont.) Theiss., Zentbl. Bakt. ParasitKde, Abt. II 39: 630 (1914).

≡ *Asteroma labecula* Mont., Anns Sci. Nat., Bot., sér. 2 14: 328 (1840).

*Index Fungorum number*: IF 220570; *Facesoffungi number*: FoF 07912, Fig. 134

*Epiphytic* on leaves, appearing as “root-like” darkened areas. *Thallus* very thin, superficial, comprising neatly or irregularly arranged, angular or cylindrical to cuboid cells, with brown to dark brown walls. **Sexual morph**: *Thyriothecia* 65–78 µm diam. × 33–48 µm high ( $\bar{x}$  = 74 × 39 µm, n = 10), developing under thallus tissue, globose to subglobose, flattened, with a porate, central ostiole. *Hamathecium* comprising branched, aseptate pseudoparaphyses. *Asci* 20–29 × 14–17 µm ( $\bar{x}$  = 26 × 15 µm, n = 10), 8-spored, bitunicate, fissitunicate, clavate, short pedicellate or apedicellate, long pedicellate when immature, apically rounded, usually with a small ocular chamber. *Ascospores* 15–17 × 3–4 µm ( $\bar{x}$  = 16 × 3 µm, n = 10), 2–3-seriate, long clavate, hyaline,

sometimes pale brown in the lower cells, 1–2-septate, slightly constricted at each septum, upper cells wider and shorter than lower cells, smooth-walled. **Asexual morph:** Undetermined.

*Material examined:* France, Guiana, Gabaret River, on coriaceous leaf of *Desfontainia*, September 1835, Collec no. 664 (PC 0084645, **syntype** of *Asterina labecula*).

#### Other genera included

*Acrogenotheca* Cif. & Bat., in Batista & Ciferri, *Saccardo* 2: 51 (1963).

*Index Fungorum number:* IF 49; *Facesoffungi number:* FoF 07913; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Acrogenotheca pulcherrima* Bat. & Cif, *Saccardo* 2: 52 (1963).

*Notes:* *Acrogenotheca* comprises three species, *A. elegans*, *A. ornata* and *A. pulcherrima*. Hongsanan et al. (2014a) examined the type material of *A. pulcherrima* and found that it has clavate asci, with clavate, 3-celled, greyish brown ascospores which differ from those of *Trichopeltina*.

*Brefeldiella* Speg., *Boln Acad. nac. Cienc. Córdoba* 11(4): 558 (1889).

*Index Fungorum number:* IF 648; *Facesoffungi number:* FoF 07914; – 4 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Brefeldiella brasiliensis* Speg., *Boln Acad. nac. Cienc. Córdoba* 11(4): 558 (1889).

*Notes:* The type collection of this genus was examined by Eriksson (1981), but specimens were considered immature (Hyde et al. 2013). Species of *Brefeldiella* are characterized by a superficial, irregularly arranged thin thallus, globose to subglobose flattened ostioles, thyriothecia, 8-spored, cylindrical or clavate, fissitunicate asci with hyaline, oblong to ellipsoidal, 1-septate ascospores (Hongsanan et al. 2014a). *Brefeldiella* and *Trichopeltella* need molecular studies to investigate their separation (Hongsanan et al. 2014a).

*Saccardinula* Speg., *Anal. Soc. cient. argent.* 19(6): 257 (1885).

*Index Fungorum number:* IF 4809; *Facesoffungi number:* FoF 07915; – 12 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type Species:* *Saccardinula guaranitica* Sacc., *Anal. Soc. Cient. Argent.* 19:257 (1885).

*Notes:* *Saccardinula* was introduced by Spegazzini (1885) and the type species (*Saccardinula guaranitica*) was illustrated in Li et al. (2011). *Saccardinula guaranitica* has a less well-developed thallus than *Elsinoaceae* species which covers the thyriothecia. Asci are saccate and typical of *Trichopeltinaceae*, while ascospores differ from *Elsinoaceae* as they are muriform (Hyde et al. 2013; Li et al. 2011). Li

et al. (2011) and Jayawardena et al. (2014) placed *Saccardinula* in *Brefeldiellaceae* and thus the genus should belong in *Trichopeltinaceae* (Hongsanan et al. 2014a).

*Trichopeltella* Höhn., *Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1* 119: 458 (1910).

*Index Fungorum number:* IF 5564; *Facesoffungi number:* FoF 07916; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Trichopeltella montana* (Racib.) Höhn., *Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1* 119: 458 (1910).

≡ *Trichopeltis montana* Racib., *Bull. int. Acad. Sci. Lett. Cracovie, Cl. sci. math. nat. Sér. B, sci. nat.* 3: 378 (1909).

*Notes:* Wu et al. (2014) examined the holotype of *T. montana*, but the specimen only comprised the asexual morph. Thus, the comparison with *Brefeldiella* and *Trichopeltella* is unclear. Hyde et al. (2013) mentioned that *Trichopeltella* may be a synonym of *Brefeldiella*. Based on its distinct asexual morph, with a “root-like” thallus and aseptate hyaline conidia it is accommodated as a separate genus in *Trichopeltinaceae* (Hongsanan et al. 2014a).

*Trichopelthea* Bat., C.A.A. Costa & Cif., *Atti Ist. bot. Univ. Lab. crittog. Pavia, Ser. 5* 15: 44 (1958).

*Index Fungorum number:* IF 5565; *Facesoffungi number:* FoF 07917; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Trichopelthea asiatica* Bat., C.A.A. Costa & Cif., *Publicações Inst. Micol. Recife* 90: 13 (1958).

*Notes:* *Trichopelthea* is similar to *Saccardinula* based on its muriform ascospores, but differs in ascus shape and thallus form. *Saccardinula* has globose to ovoid asci and the thallus is rounded (Spegazzini 1885), while *Trichopelthea* has clavate to sub-cylindrical asci and the thallus appears “root-like” (Batista et al. 1958).

*Trichothyrinula* Petr. *Sydowia* 4(1–6): 171 (1950).

*Index Fungorum number:* IF 5595; *Facesoffungi number:* FoF 07918; – 2 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species:* *Trichothyrinula sydowii* Petr., *Sydowia* 4(1–6): 171 (1950).

*Notes:* Müller and von Arx (1962) introduced the second species, *Trichothyrinula petrakii* and assigned it to *Trichothyriaceae*. Lumbsch and Huhndorf (2010) placed *Trichothyrinula* in *Microthyriaceae*. However, *Trichothyrinula* is similar to *Brefeldiella*, but differs by its smaller globose to subglobose, apedicellate asci (*Brefeldiella* has cylindrical-clavate, short-pedicellate asci), and rough ornamented spore wall, with spores becoming brownish at maturity (Wu et al. 2014).

### Economic and ecological significance

Members of this family are epiphytic on living leaves. However, there is no record on penetration organs which can uptake nutrients from plants. The thallus covers host surface and can reduce respiration and photosynthesis of its plant host.

**Trichothyriaceae** Theiss., Beih. bot. Zbl., Abt. 2 32: 3 (1914).

*Index Fungorum number*: IF 81497; *Facesoffungi number*: FoF 06893; 75 species.

*Parasitic on Diatrypaceae, Meliolaceae and lichens, or on their conidial morphs. Mycelium superficial, forming thalli on hyphae of parasitized fungus, membranous. Sexual morph: Thyriothecia superficial, solitary flattened, circular, brown, with a central ostiole. Upper wall comprising radial arranged cells in parallel rows of textura epidermoidea, anastomosing at the ostiole. Basal wall well-developed, with a single-cell thick layer. Asci 8-spored, bitunicate, fissionate, obclavate, arranged at the periphery and converge towards the ostiole. Ascospores overlapping, hyaline or light brown, 1-septate, not constricted at the septum, sometimes with ciliate appendages. Asexual morph: Hyphomycetous, reported as Hansfordiella and Isthmospora (Hyde et al. 2011).*

*Type: Trichothyrium* Speg.

*Notes: Trichothyriaceae* was introduced by Theissen (1914a) accommodating *Loranthomyces*, *Trichothyriella*, *Trichothyriopsis* and the type genus *Trichothyrium*, Hawksworth et al. (1983) included genera of *Trichothyriaceae* under *Microthyriaceae*, and this was followed by Lumbsch and Huhndorf (2010). Wu et al. (2011b) transferred them back to *Trichothyriaceae* based on its fungicolous life mode and a well-developed basal peridium, and included another parasitic genus *Lichenopeltella* in the family. This was followed by Hyde et al. (2013) and Wijayawardene et al. (2018). *Trichothyriaceae* differs from other thryriothecial families by a well-developed peridium, but there are too few morphological characters to delimit those similar genera. Sequence data is not available for this family.

**Trichothyrium** Speg., Boln Acad. nac. Cienc. Córdoba 11(4): 555 (1889).

*Index Fungorum number*: IF 5598; *Facesoffungi number*: FoF 06894; 25 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Trichothyrium sarciniferum* Speg.

*Notes: Trichothyrium* is characterized by flattened ascostromata with an upper and lower, single-cell thick layer occurring on the surface of parallel hyphal bands. Another genus forming a similar cellular hypostroma with lobed thalli is *Brefeldiella*, which is characterized by ascostromata dispersed beneath the band-like thallus and opening by a fissure of the

upper covering cells. Hawksworth et al. (1983) included *Trichothyrium* under *Microthyriaceae*, Wu et al. (2011b) transferred *Trichothyrium* back to *Trichothyriaceae* based on its fungicolous life mode and a well-developed basal peridium. This was followed in subsequent studies (Hyde et al. 2013; Wijayawardene et al. 2018).

**Trichothyrium sarciniferum** Speg., Boln Acad. nac. Cienc. Córdoba 11(4): 556 (1889).

*Index Fungorum number*: IF 161963; *Facesoffungi number*: FoF 07919; Fig. 135

*Description*: see Hyde et al. (2013).

*Material examined*: Brazil, Apizhy, on *Meliolaceae* on unidentified leaves, 1881, C. Spegazzini (LPS1441, holotype).

### Other genera included:

**Lichenopeltella** Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 128: 553 (1919).

*Index Fungorum number*: IF 2850; *Facesoffungi number*: FoF 06895; 48 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Lichenopeltella maculans* (Zopf) Höhn. Sber. Akad. Wiss. Wien, Math.-naturw.Kl., Abt.1128(7–8):553 (1919).

≡ *Microthyrium maculans* Zopf, Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 70(4): 258 (1898).

*Notes: Müller and von Arx (1962) and von Arx and Müller (1975) placed Lichenopeltella in Leptopeltidaceae, and this was followed in Kirk et al. (2008) who accept Leptopeltidaceae as one of three families in Microthyriales. However, this is not followed in the more recent classifications in Lumbsch and Huhndorf (2010), and Wu et al. (2011b) placed it in Trichothyriaceae based on its fungicolous life mode.*

**Macrographa** Etayo, in Etayo & Sancho, Bibliothca Lichenol. 98: 116 (2008).

*Index Fungorum number*: IF 532867; *Facesoffungi number*: FoF 06896; 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species: Macrographa antarctica* Etayo, in Etayo & Sancho, Bibliothca Lichenol. 98: 116 (2008).

*Notes: Macrographa* was introduced as a monotypic genus occurring on lichens. This genus is characterised by multiloculate ascostromata, ellipsoidal-fusiform asci and 1-septate ascospores (Wu et al. 2011b). Lumbsch and Huhndorf (2010) accepted it as a member of *Microthyriaceae*. Wu et al. (2011b) placed it in *Trichothyriaceae*, along with *Lichenopeltella*, due to their fungicolous life mode.

**Pachythyrium** G. Arnaud ex Spooner & P.M. Kirk, Mycol. Res. 94(2): 228 (1990).

*Index Fungorum number*: IF 25378; *Facesoffungi number*: FoF 06897; 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Pachythyrium parasiticum*** (Fabre) G. Arnaud ex Spooner & P.M. Kirk, Mycol. Res. 94(2): 228 (1990).

≡ *Bertia parasitica* Fabre, Anns Sci. Nat., Bot., sér. 6 9: 95 (1879) [1878].

*Notes*: *Pachythyrium* was introduced as a monotypic genus, which is synonymised from *Bertia parasitica* occurring on *Eutypa lata*. Hawksworth et al. (1995) and Lumbsch and Huhndorf (2010) accepted it as a member of *Microthyriaceae*. Wu et al. (2011b) placed it in *Trichothyriaceae*, and noted that the placement of this genus in *Trichothyriaceae* may be warranted.

### Economic and ecological significance

*Trichothyriaceae* is a poorly studied family parasitic on fungi.

***Vizellaceae*** H.J. Swart, Trans. Br. mycol. Soc. 57: 456 (1971).

*Index Fungorum number*: IF 81519; *Facesoffungi number*: FoF 07920, 31 species.

*Parasitic* or *saprophytic* on leaves, tropical in distribution, developing in or beneath the cuticle, often forming an intracuticular mycelium, without superficial hyphae. **Sexual morph**: *Ascostromata* dimidiate, scutate or crustose, roundish or elongated in outline, with a thin wall composed of small, dark cells, opening by a fissure or dehiscence, central part of loculus may be sterile. *Hamathecium* comprising filamentous, pseudoparaphyses, often filling the central part of the loculus or may be sparse or absent. *Asci* 6–8-spored, bitunicate, probably evanescent, broadly clavate or nearly cylindrical. *Ascospores* 2–3-seriate, overlapping, hyaline to brown, 1–2-celled or with small appendage cell at the base, with a light transverse band. **Asexual morph**: linked to *Chrysogloeum* and *Manginula*. *Pycnidia* disc-shaped with upper wall of irregularly arranged cells, subglobose, dark brown to black, scutate or crustose. *Conidiogenous cells* hyaline, cylindrical, holoblastic. *Conidia* ovoid to ellipsoidal or rarely subglobose, brown to dark brown, with transverse hyaline band, formed on phialidic, hyaline cells lining the inner cavity of the upper wall (Hughes 1953a, b; Petrak 1953).

*Type*: ***Vizella*** Sacc.

*Notes*: *Vizellaceae* was introduced to include *Blasdalea* and *Vizella* (Swart 1971). *Entopeltis* was synonymized under *Vizella* (Swart 1971). Hughes (1953a) described the mycelium of the type species and confirmed mycelium composed of hyaline to light brown hyphae with thick, dark brown cross walls. Swart (1971) suggested that the mycelium might well be of diagnostic value, but several authors could not

observe this because mycelium is entirely hyaline and thus difficult to see. In most species of *Vizellaceae*, the mycelium branches frequently at fairly wide angles, and so forms a network without radial orientation (Hyde et al. 2013). von Arx and Müller (1975) noted that *Vizella* and *Entopeltis* can be distinguished by the arrangement of the asci and ascospores characters. van Wyk et al. (1976) studied the type species and other *Entopeltis* and *Vizella* species and suggested that they could not be distinguished. Therefore, *Entopeltis* should be synonymised under *Vizella*.

The asexual morph of most species in this family are undetermined, except for three *Vizella* species and *Blasdalea disciformis*. Hughes (1953a) described a conidial form associated with *Vizella hendrickxii*. Swart (1971) introduced two new species to this genus from Australia with conidial morphs. The asexual morph of *Blasdalea* is *Chrysogloeum* (Petrak 1953). Wijayawardene et al. (2012) listed the asexual morphs as *Chrysogloeum* and *Manginula*. *Chrysogloeum* was established to accommodate the coelomycetous asexual morphs of *Blasdalea* (as *Singeriella*). Sivanesan (1984) considered that *Vizella* has *Manginula* or “*Manginula*”-like asexual morphs.

***Vizella*** Sacc., Syll. Fung. (Abellini) 2: 662 (1883).

*Index Fungorum number*: IF 5747; *Facesoffungi number*: FoF 07921; 30 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Vizella conferta*** (Cooke) Sacc.

≡ *Micropeltis conferta* Cooke, Grevillea 6(no. 39): 118 (1878)

*Notes*: The confusion between *Entopeltis* and *Vizella* is discussed in the family notes and in Hyde et al. (2013). The ascomata of *Vizella* have thin walls as in *Entopeltis* (Fig. 136). This intermediate form between *Vizella* and *Entopeltis* further indicates they all two genera may be congeneric. *Mycerema* was introduced by Batista et al. (1963). It was considered to resemble *Vizella* in ascospores and pseudoparaphyses characters (Hyde et al. 2013). However, Phookamsak et al. (2016) indicated that the characters described in Hyde et al. (2013) is *Vizella bingervilliana* (see more detail in the note of *Mycerema*, Hongsanan et al. 2020).

### Other genera included

***Acarella*** Syd., Anns mycol. 25(1/2): 123 (1927).

*Index Fungorum number*: IF 7005; *Facesoffungi number*: FoF 06207; – 3 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Acarella costaricensis*** Syd., Anns mycol. 25(1/2): 123 (1927).

*Notes*: *Acarella* is characterized by scattered, small, completely superficial pycnidia, with a thin peridium, and ellipsoid to cylindrical conidia. The sexual morph of *Acarella* is

undetermined. *Perizomella* was synonymised under *Acarella* based on the host relationship and morphological characters (Pem et al. 2019c). *Acarella* is placed in *Vizellaceae* due to the asexual species have ovoid to ellipsoidal or rarely subglobose, brown to dark brown, with transverse hyaline band, formed on phialidic, hyaline cells lining the inner cavity of the upper wall (Hyde et al. 2013; Pem et al. 2019c), pending fresh collections and molecular data.

***Blasdalea*** Sacc. & P. Syd., Syll. Fung. (Abellini) 16: 634 (1902).

*Index Fungorum number*: IF 592; *Facesoffungi number*: FoF 07922; – 1 morphological species (Species Fungorum 2020), molecular data unavailable.

*Type species*: ***Blasdalea disciformis*** (Rehm) Sacc. & P. Syd., Syll. Fung. (Abellini) 16: 634 (1902).

≡ *Vizella disciformis* Rehm, Hedwigia 39(4): 227 (1900).

*Notes*: von Arx and Müller (1954) illustrated the type species which has cylindrical asci and abundant pseudo-paraphyses and ascomata opening by a large ostiole. Hyde et al. (2013) were unable to find the sexual morph in the holotype which was described in Rehm (1900). They found one-celled, brown conidia with a hyaline transverse band, some two-celled, hyaline to brown, with a medium lighter septum. *Blasdalea* may be related with *Fasciatispora* which has unitunicate asci, but the nature of the asci in the illustration provided in von Arx and Müller (1954) is not clear. In this study, *Blasdalea* is maintained as a distinct genus in *Vizellaceae* pending fresh collections and molecular studies.

### Economic and ecological significance

Most species in *Vizellaceae* are parasitic on leaves which can uptake nutrients from plant issue.

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