



<b>Title</b>	<b>Pleosporales</b>
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<b>Citation</b>	<b>Fungal Diversity, 2011, v. 53, n. 1, p. 1-221</b>
<b>Issued Date</b>	<b>2011</b>
<b>URL</b>	<b><a href="http://hdl.handle.net/10722/147095">http://hdl.handle.net/10722/147095</a></b>
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# Pleosporales

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Received: 31 March 2011 / Accepted: 13 June 2011 / Published online: 9 October 2011  
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**Abstract** One hundred and five generic types of *Pleosporales* are described and illustrated. A brief introduction and detailed history with short notes on morphology, molecular phylogeny as well as a general conclusion of each genus are provided. For those genera where the type or a representative specimen is unavailable, a brief note is given. Altogether 174 genera of *Pleosporales* are treated. *Phaeotrichaceae* as well as *Kriegeriella*, *Zeuctomorpha* and *Muroia* are excluded from *Pleosporales*. Based on the multigene phylogenetic analysis, the suborder *Massarineae* is emended to accommodate five families, viz. *Lentitheciaceae*, *Massarinaceae*, *Montagnulaceae*, *Morosphaeriaceae* and *Trematosphaeriaceae*.

**Keywords** Generic type · *Massarineae* · Molecular phylogeny · Morphology · *Pleosporales* · Taxonomy

## Introduction

Historic overview of *Pleosporales*

*Pleosporales* is the largest order in the *Dothideomycetes*, comprising a quarter of all dothideomycetous species (Kirk et al. 2008). Species in this order occur in various habitats, and can be epiphytes, endophytes or parasites of living leaves or stems, hyperparasites on fungi or insects, lichenized, or are saprobes of dead plant stems, leaves or bark (Kruys et al. 2006; Ramesh 2003).

The *Pleosporaceae* was introduced by Nitschke (1869), and was assigned to *Sphaeriales* based on immersed ascomata and presence of pseudoparaphyses (Ellis and Everhart 1892; Lindau 1897; Wehmeyer 1975; Winter 1887). Taxa in this family were then assigned to *Pseudosphaeriaceae* (Theissen and Sydow 1918; Wehmeyer 1975). *Pseudosphaeriales*, represented by *Pseudosphaeriaceae*, was introduced by Theissen and Sydow (1918), and was distinguished from *Dothideales* by its uniloculate, perithecioid ascostromata. Subsequently, the uni- or pluri-loculate ascostromata was reported to be an invalid character to separate members of *Dothideomycetes* into different orders (Luttrell 1955). In addition, the familial type of *Pseudosphaeriales* together with its type genus, *Pseudosphaeria*, was transferred to *Dothideales*, thus *Pseudosphaeriales* became a synonym of *Dothideales*. The name “*Pseudosphaeriales*” has been applied in different senses, thus *Pleosporales* (as an invalid name due to the absence of a Latin diagnosis) was proposed by Luttrell (1955) to replace the confusing name, *Pseudosphaeriales*, which included seven families, i.e.

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*Botryosphaeriaceae*, *Didymosphaeriaceae*, *Herpotrichiellaceae*, *Lophiostomataceae*, *Mesnieraceae*, *Pleosporaceae* and *Venturiaceae*. Müller and von Arx (1962) however, reused *Pseudosphaeriales* with 12 families included, viz. *Capnodiaceae*, *Chaetothyriaceae*, *Dimeriaceae*, *Lophiostomataceae*, *Mesnieraceae*, *Micropeltaceae*, *Microthyriaceae*, *Mycosphaerellaceae*, *Pleosporaceae*, *Sporormiaceae*, *Trichothyriaceae* and *Venturiaceae*.

Familial circumscriptions of the *Pleosporales* were based on characters of ascomata, morphology of asci and their arrangement in locules, presence and type of hamathecium, shape of papilla or ostioles, morphology of ascospores and type of habitats (Luttrell 1973) (Table 1). Based on these characters, Luttrell (1973) included eight families, i.e. *Botryosphaeriaceae*, *Dimeriaceae*, *Lophiostomataceae*, *Mesnieraceae*, *Mycoporaceae*, *Pleosporaceae*, *Sporormiaceae* and *Venturiaceae* in *Pleosporales*. In their review of bitunicate ascomycetes, von Arx and Müller (1975) accepted only a single order, *Dothideales*, with two suborders, i.e. *Dothideineae* (including *Atichiales*, *Dothiorales*, *Hysteriales* and *Myriangiales*) and *Pseudosphaeriineae* (including *Capnoidiales*, *Chaetothyriales*, *Hemisphaeriales*, *Lophiostomatales*, *Microthyriales*, *Perisporiales*, *Pleosporales*, *Pseudosphaeriales* and *Trichothyriales*). This proposal has however, rarely been followed. Three existing families, i.e. *Lophiostomataceae*, *Pleosporaceae* and *Venturiaceae* plus 11 other families were accepted in *Pleosporales* as arranged by Barr (1979a) (largely using Luttrell's concepts, Table 1), and she assigned these families to six suborders. The morphology of pseudoparaphyses was given much prominence at the ordinal level in this classification (Barr 1983). In particular the *Melanommatales* was introduced to accommodate taxa with trabeculate pseudoparaphyses (*Sporormia*-type centrum development) (Barr 1983), distinguished from cellular pseudoparaphyses (*Pleospora*-type centrum development) possessed by members of *Pleosporales sensu* Barr. The order *Melanommatales* included *Didymosphaeriaceae*, *Fenestellaceae*, *Massariaceae*, *Melanommataceae*, *Microthyriaceae*, *Mytiliniaceae*, *Platystomaceae* and *Requienellaceae* (Barr 1990a).

*Pleosporales* was formally established by Luttrell and Barr (in Barr 1987b), characterised by perithecioid ascomata, usually with a papillate apex, ostioles with or without paraphyses, presence of cellular pseudoparaphyses, bitunicate asci, and ascospores of various shapes, pigmentation and septation (Table 1). Eighteen families were included, i.e. *Arthopyreniaceae*, *Botryosphaeriaceae*, *Cucurbitariaceae*, *Dacampiaceae*, *Dimeriaceae*, *Hysteriaceae*, *Leptosphaeriaceae*, *Lophiostomataceae*, *Parodiellaceae*, *Phaeosphaeriaceae*, *Phaeotrichaceae*, *Pleomassariaceae*, *Pleosporaceae*, *Polystomellaceae*, *Pyrenophoraceae*, *Micropeltidaceae*, *Tubeufiaceae* and *Venturiaceae*. Recent phylogenetic analysis based on DNA sequence comparisons, however, indicated that separation of the orders (*Pleosporales* and *Melanomma-*

*tales*) based on the *Pleospora* or *Sporormia* centrum type, is not a natural grouping, and *Melanommatales* has therefore been combined under *Pleosporales* (Liew et al. 2000; Lumbsch and Lindemuth 2001; Reynolds 1991). Six more families, i.e. *Cucurbitariaceae*, *Diademaceae*, *Didymosphaeriaceae*, *Mytiliniaceae*, *Testudinaceae* and *Zopfiaceae*, were subsequently added to *Pleosporales* (Lumbsch and Huhndorf 2007). After intensive sampling and multigene phylogenetic studies, 20 families were accepted in *Pleosporales*, namely *Aigialaceae*, *Amniculicolaceae*, *Delitschiaceae*, *Didymellaceae*, *Didymosphaeriaceae*, *Hypsostromataceae*, *Lentitheciaceae*, *Leptosphaeriaceae*, *Lindgomycetaceae*, *Lophiostomataceae*, *Massariaceae*, *Melanommataceae*, *Montagnulaceae*, *Morosphaeriaceae*, *Phaeosphaeriaceae*, *Pleosporaceae*, *Pleomassariaceae*, *Sporormiaceae*, *Tetraplosporiaceae* and *Trematosphaeriaceae* (Boehm et al. 2009a, b; Mugambi and Huhndorf 2009b; Schoch et al. 2009; Shearer et al. 2009; Suetrong et al. 2009; Tanaka et al. 2009; Zhang et al. 2009a) (Table 1). In addition, another five families, i.e. *Arthopyreniaceae*, *Cucurbitariaceae*, *Diademaceae*, *Teichosporaceae* and *Zopfiaceae* are tentatively included (Kruys et al. 2006; Plate 1). In the most recent issue of Myconet, 28 families were included in *Pleosporales* (Lumbsch and Huhndorf 2010).

Species included in *Pleosporales* have different ecological or morphological characters. For instance, members of the *Leptosphaeriaceae* have saprobic or parasitic lifestyles and lightly pigmented, multi-septate ascospores. Members of the *Lophiostomataceae* are mostly saprobic with ascomata that usually possess a compressed apex. Members of *Sporormiaceae* are coprophilous, and are characterized by heavily pigmented, multi-septate ascospores with germ slits, and with or without non-periphysate ostioles. The lack of DNA sequence data for representatives of numerous families means that their inter-relationships are unclear and many genera or species are artificially placed based on morphological classification. The most recent study on *Venturiaceae* indicated that this group had a set of unique morphological and ecological characters, which is distinct and distantly related to other members of *Pleosporales* (Kruys et al. 2006; Zhang et al. unpublished). Molecular phylogenetic results indicated that members of *Venturiaceae* form a robust clade separate from the core members of *Pleosporales*, and the clade of *Venturiaceae* was uncertainly placed but outside of the two currently designated dothideomycetous subclasses, i.e. *Pleosporomycetidae* and *Dothideomycetidae* (Schoch et al. 2009). In addition, phylogenetic analysis of rDNA sequence data indicates that members of *Zopfiaceae* (as *Testudinaceae*) seem to lack affinity with *Pleosporales* (Kodsueb et al. 2006b). Thus, 26 families are temporarily accepted in *Pleosporales* in this study, although some such as *Zopfiaceae*, still require extensive DNA sequence sampling (Table 4).

**Table 1** Major circumscription changes of *Pleosporales* from 1955 to 2011

References	Circumscriptions distinguishing <i>Pleosporales</i> from other orders of <i>Dothideomycetes</i>
Luttrell 1955	<i>Pleospora</i> -type centrum development.
Müller and von Arx 1962	Ascomata perithecioid, with rounded or slit-like ostiole; asci produced within a locule, arranged regularly in a single layer or irregularly scattered, surrounded with filiform pseudoparaphyses, cylindrical, ellipsoidal or sac-like.
Luttrell 1973	Ascocarps perithecioid, immersed, erumpent to superficial on various substrates, asci ovoid to mostly clavate or cylindrical, interspersed with pseudoparaphyses (sometimes form an epithecium) in mostly medium- to large-sized locules.
Barr 1979a	Saprobic, parasitic, lichenized or hypersaprobic. Ascomata perithecioid, rarely cleistothecioid or hysterothecioid, peridium pseudoparenchymatous, pseudoparaphyses cellular, narrow or broad, deliquescing early at times, not forming an epithecium, asci oblong, clavate or cylindrical, interspersed with pseudoparaphyses, ascospores mostly asymmetric.
Barr 1987b	Saprobic, biotrophic or hemibiotrophic. Ascomata globose, subglobose or conical, asci bitunicate, oblong, clavate or cylindrical, cellular pseudoparaphyses, ascospores hyaline or pigmented, asymmetric or symmetric, with or without septa.
Kirk et al. 2001, 2008	Ascomata perithecioid or rarely cleistothecioid, sometimes clypeate, mostly globose, thick-walled, immersed or erumpent, black, sometimes setose, peridium composed of pseudoparenchymatous cells, pseudoparaphyses trabeculate or cellular, asci cylindrical, fissitunicate, with a well-developed ocular chamber, rarely with a poorly defined ring (J-), ascospores hyaline to brown, septate, thin or thick-walled, sometimes muriform, usually with sheath, anamorphs hyphomycetous or coelomycetous.
Boehm et al. 2009a, b; Mugambi and Huhndorf 2009b; Schoch et al. 2009; Shearer et al. 2009; Suetrong et al. 2009; Tanaka et al. 2009; Zhang et al. 2009a	Hemibiotrophic, saprobic, hypersaprobic, or lichenized. Habitats in freshwater, marine or terrestrial environment. Ascomata perithecioid, rarely cleistothecioid, immersed, erumpent to superficial, globose to subglobose, or lenticular to irregular, with or without conspicuous papilla or ostioles. Ostioles with or without periphyses. Peridium usually composed of a few layers of cells with various shapes and structures. Hamathecium persistent, filamentous, very rarely decomposing. Asci bitunicate, fissitunicate, cylindrical, clavate to obclavate, with or without pedicel. Ascospores hyaline or pigmented, ellipsoidal, broadly to narrowly fusoid or filiform, mostly septate.

## Morpho-characters used in taxonomy of *Pleosporales*

### Sexual characters

According to the Linnean classification system, reproductive structures are the most important criteria in plant taxonomy, and this proposal is widely applied in fungal taxonomy (Gäumann 1952). In the classification of *Dothideomycetes*, reproductive characters such as the uni- or multilocular nature and shape of ascomata, presence and shape of ostioles/papillae, shape and apical structures of asci and shape, pigmentation and septation of ascospores play important roles at different ranks (Clements and Shear 1931; Luttrell 1951, 1955, 1973). Besides the common morphological characters possessed by *Dothideomycetes* (bitunicate and fissitunicate asci as well as the perithecioid-like ascostromata), most pleosporalean fungi also have pseudoparaphyses among their well-arranged asci (Zhang et al. 2009a). Currently, classification of *Pleosporales* at the family level focuses mostly on morphological characters of ascomata (such as size, shape of ostiole or papilla), presence or absence of periphyses, characters of centrum (such as asci, pseudoparaphyses and ascospores) as well as on lifestyle or habitat (Barr 1990a; Shearer et al. 2009; Suetrong et al. 2009; Tanaka et al. 2009; Zhang et al. 2009a), whilst relying extensively on DNA sequence comparisons.

### Ascomata

Most species of *Pleosporales* have uniloculate ascomata. The presence (or absence) and forms of papilla and ostiole are the pivotal character of ascomata, which serve as important characteristics in generic or higher rank classification (Clements and Shear 1931). The vertically flattened papilla has recently been shown as an effective criterion for familial level classification, e.g. in the *Amniculicolaceae* and the *Lophiostomataceae* (Zhang et al. 2009a). Papillae and ostioles are present in most species of *Pleosporales*, except in the *Diademaceae* and *Sporormiaceae*. Members of *Diademaceae* have apothecial ascomata, and some genera of *Sporormiaceae* have cleistothecioid ascomata. Another coprophilous pleosporalean family, *Delitschiaceae*, can be distinguished from *Sporormiaceae* by the presence of periphysate ostioles.

### Pseudoparaphyses

Presence of pseudoparaphyses is a characteristic of *Pleosporales* (Kirk et al. 2008; Liew et al. 2000). Although pseudoparaphyses may be deliquescing in some families when the ascomata mature (e.g. in *Didymellaceae*), they are persistent in most of other pleosporalean members. According to the thickness, with or without branching and density of septa, pseudoparaphyses were roughly divided into two types: trabeculate and cellular, and their taxonomic significance need to be re-evaluated (Liew et al. 2000).

## Asci

The asci of *Pleosporales* are bitunicate, usually fissitunicate, mostly cylindrical, clavate or cylindro-clavate, and rarely somewhat obclavate or sphaerical (e.g. *Macroventuria anomochaeta* Aa and *Westerdykella dispersa*). There are ocular chambers in some genera (e.g. *Ammiculicola* and *Asteromassaria*), or sometimes with a large apical ring (J-) (e.g. *Massaria*).

## Ascospores

Ascospores of *Pleosporales* can be hyaline or colored to varying degrees. They may be amerosporous (e.g. species of *Semidelitschia*), phragmosporous (e.g. *Phaeosphaeria* and *Massariosphaeria*), dictyosporous (e.g. most species of *Pleospora* and *Bimuria*), or scolecosporous (e.g. type species of *Cochliobolus*, *Entodesmium* or *Lophionema*). Although ascospore morphology had been regarded as a key factor in differentiating genera under some families, e.g. *Arthopyreniaceae* (Watson 1929) and *Testudinaceae* (Hawksworth 1979), it has been proven variable even within a single species. For instance, two types of ascospores are produced by *Mamillisphaeria dimorphospora*, i.e. one type is large and hyaline, and the other is comparatively smaller and brown. Numerous studies have shown the unreliability of ascospore characters above genus level classification (e.g. Phillips et al. 2008; Zhang et al. 2009a).

## Asexual states of *Pleosporales*

### Anamorphs of pleosporalean families

Anamorphs of *Pleosporales* are mostly coelomycetous, but may also be hyphomycetous. *Phoma* or *Phoma*-like anamorphic stages and its relatives are most common anamorphs of *Pleosporales* (Aveskamp et al. 2010; de Gruyter et al. 2009, 2010; Hyde et al. 2011). Some of the reported teleomorph and anamorph connections (including some listed below) are, however, based on the association rather than single ascospore isolation followed by induction of the other stage in culture (Hyde et al. 2011).

### *Pleosporales* suborder *Pleosporineae*

*Pleosporineae* is a phylogenetically well supported suborder of *Pleosporales*, which temporarily includes seven families, namely *Cucurbitariaceae*, *Didymellaceae*, *Didymosphaeriaceae*, *Dothidotthiaceae*, *Leptosphaeriaceae*, *Phaeosphaeriaceae* and *Pleosporaceae*, and contains many important plant pathogens (de Gruyter et al. 2010; Zhang et al. 2009a). De Gruyter et al. (2009, 2010) systematically analyzed the phylogeny of *Phoma* and its closely related genera, and indicated that their representative species cluster in different subclades of *Pleosporineae*.

**Plate 1** The best scoring likelihood tree of representative *Pleosporales* obtained with RAxML v. 7.2.7 for a concatenated set of nucleotides from LSU, SSU, *RPB2* and *TEF1*. Family and suborder names are indicated where possible. The percentages of nodes present in 250 bootstrap pseudo replicates are shown above branches. Culture and voucher numbers are indicated after species names and the presence of the genes used in the analysis are indicated by pluses in this order: LSU, SSU, *RPB2*, *TEF1*

### *Cucurbitariaceae*

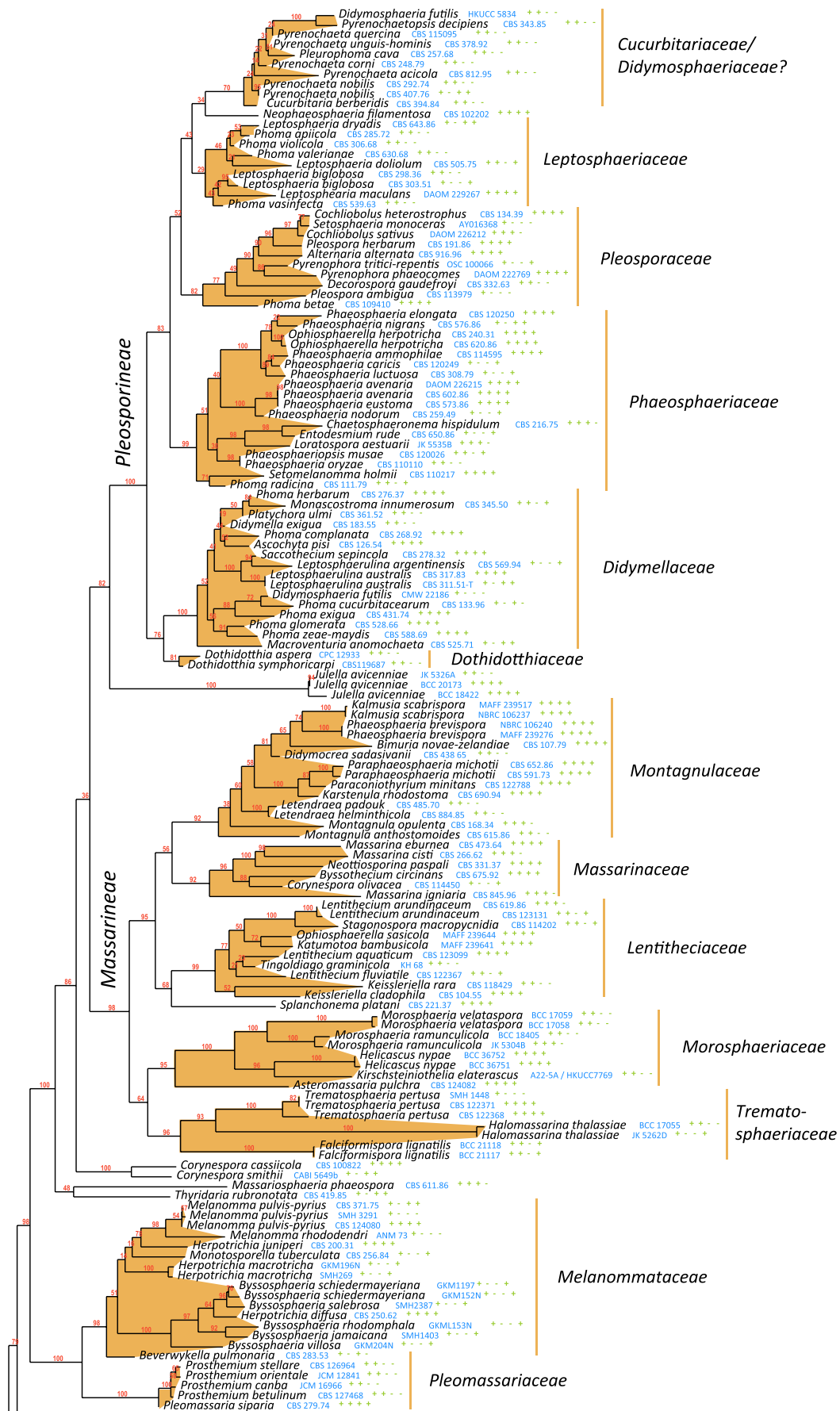
Based on the molecular phylogenetic analysis, some species of *Coniothyrium*, *Pyrenochaeta*, *Phoma*, *Phialophorophoma* and *Pleurophoma* belong to *Cucurbitariaceae* (de Gruyter et al. 2010; Hyde et al. 2011). Other reported anamorphs of *Cucurbitaria* are *Camarosporium*, *Diplodia*-like and *Pleurostromella* (Hyde et al. 2011; Sivanesan 1984). The generic type of *Cucurbitaria* (*C. berberidis* Fuckel) is linked to *Pyrenochaeta berberidis* (Farr et al. 1989). *Curreya* has a *Coniothyrium*-like anamorphic stage (von Arx and van der Aa 1983; Marincowitz et al. 2008). The generic type of *Curreya* is *C. conorum* (Fuckel) Sacc., which is reported to be linked with *Coniothyrium glomerulatum* Sacc. (von Arx and van der Aa 1983). The generic type of *Rhytidiella* (*R. moriformis*, *Cucurbitariaceae*) can cause rough-bark of *Populus balsamifera*, and has a *Phaeoseptoria* anamorphic stage (Zalasky 1968). *Rhytidiella baranyayi* Funk & Zalasky, another species of *Rhytidiella* associated with the cork-bark disease of aspen is linked with *Pseudosporella*-like anamorphs (Funk and Zalasky 1975; Sivanesan 1984).

### *Didymellaceae*, *Didymosphaeriaceae* and *Dothidotthiaceae*

As has been mentioned before, *Phoma sensu lato* species have been proved to be highly polyphyletic, and they cluster in six distinct familial clades within the *Pleosporales* (Aveskamp et al. 2010). Most *Phoma* species, including the generic type (*P. herbarum*), clustered in *Didymellaceae* (Aveskamp et al. 2010). The clade of *Didymellaceae* also comprises other sections, such as *Ampelomyces*, *Boeremia*, *Chaetasbolisia*, *Dactuliochaeta*, *Epicoccum*, *Peyronellaea*, *Phoma*-like, *Piggotia*, *Pithoascus*, as well as the type species of *Ascochyta* and *Microsphaeropsis* (Aveskamp et al. 2010; de Gruyter et al. 2009; Kirk et al. 2008; Sivanesan 1984). *Leptosphaerulina* is another genus of *Didymellaceae*, which has hyphomycetous anamorphs with pigmented and muriform conidia, such as *Pithomyces* (Roux 1986).

The other reported anamorphs of *Didymosphaeria* are *Fusicladiella*-like, *Dendrophoma*, *Phoma*-like (Hyde et al. 2011). Hyphomycetous *Thyrostroma* links to *Dothidotthiaceae* (Phillips et al. 2008).

Some important plant pathogens are included within *Didymellaceae*, such as *Phoma medicaginis* Malbr. & Roum., which is a necrotrophic pathogen on *Medicago truncatula* (Ellwood et al. 2006). *Phoma herbarum* is another plant pathogen, which has potential as a



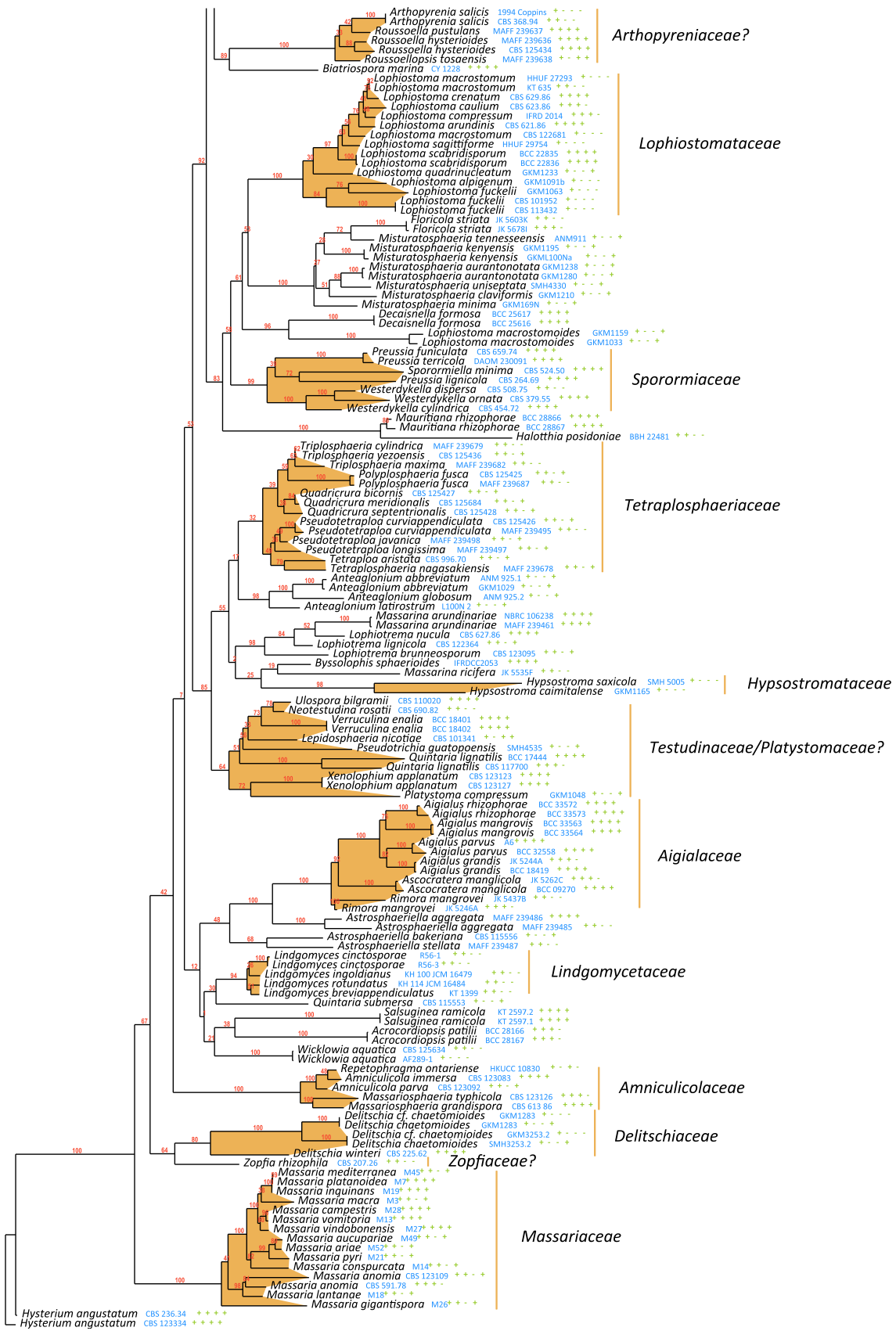


Plate 1 (continued)

biocontrol agent of weeds (Neumann and Boland 2002). *Ascochyta rabiei* is a devastating disease of chickpea in most of the chickpea producing countries (Saxena and Singh 1987).

### **Leptosphaeriaceae**

The anamorphic stages of *Leptosphaeriaceae* can be *Coniothyrium*, *Phoma*, *Plenodomus* and *Pyrenochaeta*. All are coelomycetous anamorphs, and they may have phialidic or annellidic conidiogenous cells. *Phoma heteromorphospora* Aa & Kesteren, the type species of *Phoma* sect. *Heterospora* and *Coniothyrium palmarum*, the generic type of *Coniothyrium*, reside in *Leptosphaeriaceae* (de Gruyter et al. 2009).

### **Pleosporaceae**

Various anamorphic types can occur in *Pleosporaceae*, which can be coelomycetous or hyphomycetous, and the ontogeny of conidiogenous cells can be phialidic, annellidic or sympodial blastic. Both *Ascochyta caulina* and *Phoma betae* belong to *Pleosporaceae* (de Gruyter et al. 2009).

Some species of *Bipolaris* and *Curvularia* are anamorphs of *Cochliobolus*. Many species of these two genera cause plant disease or even infect human beings (Khan et al. 2000). They are hyphomycetous anamorphs with sympodial proliferating conidiogenous cells, and pigmented phragmosporous poroconidia. The generic type of *Lewia* (*L. scrophulariae*) is linked with *Alternaria conjuncta* E.G. Simmons (Simmons 1986), and the generic type of *Pleospora* (*P. herbarum*) is linked with *Stemphylium botryosum* Sacc. (Sivanesan 1984). Both *Alternaria* and *Stemphylium* are hyphomycetous anamorphs characterized by pigmented, muriform conidia that develop at a very restricted site in the apex of distinctive conidiophores (Simmons 2007).

The generic type of *Pleoseptum* (*P. yuccaesedum*) is linked with *Camarosporium yuccaesedum* (Ramaley and Barr 1995), the generic type of *Macrospora* (*M. scirpicola*) with *Nimbya scirpicola* (Fuckel) E.G. Simmons (Simmons 1989), and the generic type of *Setosphaeria* (*S. turcica*) with *Drechslera turcica* (Pass.) Subram. & B.L. Jain (Sivanesan 1984). *Pyrenophora* has the anamorphic stages of *Drechslera*, and the anamorphic stage of *Wettsteinina* can be species of *Stagonospora* (Farr et al. 1989).

Most common anamorphs in *Pleosporaceae* are *Alternaria*, *Bipolaris*, *Phoma*-like and *Stemphylium*, and they can be saprobic or parasitic on various hosts. *Phoma betae* A.B. Frank is a notorious pathogen on sugar beet, which causes zonate leaf spot or Phomopsis of sugar beet. *Alternaria porri* (Ellis) Cif., *Stemphylium solani* G.F. Weber, *S. botryosum* and *S. vesicarium* (Wallr.) E.G. Simmons can cause leaf blight of garlic (Zheng et al. 2009). *Phoma incompta* Sacc. & Martelli is a pathogen on

olive, and *Stemphylium botryosum*, the anamorph of *Pleospora herbarum*, causes leaf disease of olive trees (Malathrakis 1979).

### **Phaeosphaeriaceae**

The type species of *Phoma* sect. *Paraphoma* (*Phoma radicina* (McAlpine) Boerema) as well as several pathogens on Gramineae, i.e. *Stagonospora foliicola* (Bres.) Bubák, *S. neglecta* var. *colorata* and *Wojnowicia hirta* Sacc. belong to *Phaeosphaeriaceae* (de Gruyter et al. 2009). Other anamorphs reported for *Phaeosphaeriaceae* are *Amarenographium*, *Ampelomyces*, *Chaetosphaeronema*, *Coniothyrium*, *Hendersonia*, *Neosetophoma*, *?Parahendersonia*, *Paraphoma*, *Phaeoseptoria*, *Rhabdospora*, *Scolecosporella*, *Setophoma*, *Sphaerellopsis* and *Tiarospora*.

These anamorphic fungi can be saprobic, but mostly pathogenic on herbaceous plants. For instance, *Stagonospora foliicola* and *Coniothyrium concentricum* (Desm.) Sacc. can cause leaf spots on herbaceous plants (Zeiders 1975), and *Ampelomyces quisqualis* Ces. is a hyperparasite of powdery mildews.

### **Pleosporales suborder Massarinaceae**

*Massarinaceae* species are mostly saprobic in terrestrial or aquatic environments. Five families are currently included within *Massarinaceae*, viz. *Lentitheciaceae*, *Massarinaceae*, *Montagnulaceae*, *Morosphaeriaceae* and *Trematosphaeriaceae*. Anamorphs of the five families are summarized as follows.

#### **Lentitheciaceae**

*Stagonospora macropycnidia* Cunnell nests within the clade of *Lentitheciaceae* (Plate 1). A relatively broad genus concept of *Stagonospora* is currently accepted, which comprises parasitic or saprobic taxa. *Keissleriella cladophila* (Niessl) Corbaz is another species nesting within *Lentitheciaceae* (Zhang et al. 2009a), and is linked with *Dendrophoma* sp., which has branching conidiogenous cells, and 1-celled, hyaline conidia (Bose 1961; Sivanesan 1984).

#### **Massarinaceae**

A relatively narrow concept tends to be accepted for *Massarinaceae*, which seems only to comprise limited species such as *Byssothecium circinans*, *Massarina eburnea*, *M. cisti* S.K. Bose, *M. igniaria* (C. Booth) Aptroot (anamorph: *Periconia igniaria* E.W. Mason & M.B. Ellis) and *Neottiosporina paspali* (G.F. Atk.) B. Sutton & Alcorn (Zhang et al. 2009a; Plate 1). Similarly, a relatively narrow generic concept of *Massarina* was accepted, containing only *M. eburnea* and *M. cisti* (Zhang et al. 2009b), and both species have been linked with species of *Ceratophoma* (Sivanesan 1984).



### Montagnulaceae

*Montagnula* has an *Aschersonia* anamorph, and *Kalmusia* and *Paraphaeosphaeria* have *Coniothyrium*-like, *Cytoplea*, *Microsphaeropsis* and *Paraconiothyrium* anamorphs. The generic type of *Paraphaeosphaeria* (*P. michotii*) is linked with *Coniothyrium scirpi* Trail (Webster 1955). The *Coniothyrium* complex is highly polyphyletic, and was subdivided into four groups by Sutton (1980), viz. *Coniothyrium*, *Microsphaeropsis*, *Cyclothyrium* and *Cytoplea*. *Paraconiothyrium* was introduced to accommodate *Coniothyrium minitans* W.A. Campb. and *C. sporulosum* (W. Gams & Domsch) Aa, which are closely related to *Paraphaeosphaeria* based on 18S rDNA sequences phylogeny (Verkley et al. 2004).

### Morosphaeriaceae

Based on the multigene phylogenetic analysis in this study, *Asteromassaria* is tentatively included in *Morosphaeriaceae*. *Asteromassaria macrospora* is linked with *Scolicosporium macrosporium* (Berk.) B. Sutton, which is hyphomycetous. No anamorphic stages have been reported for other species of *Morosphaeriaceae*.

### Trematosphaeriaceae

Three species from three different genera were included in *Trematosphaeriaceae*, i.e. *Falciformispora lignatilis*, *Halomassarina thalassiae* and *Trematosphaeria pertusa* (Suetrong et al. data unpublished; Plate 1). Of these, only *Trematosphaeria pertusa*, the generic type of *Trematosphaeria*, produces hyphopodia-like structures on agar (Zhang et al. 2008a).

### Other families of Pleosporales

#### Amniculicolaceae

Three anamorphic species nested within the clade of *Amniculicolaceae*, i.e. *Anguillospora longissima* (Sacc. & P. Syd.) Ingold, *Repetophragma ontariense* (Matsush.) W. P. Wu and *Spirosphaera cupreorufescens* Voglmayr (Zhang et al. 2009a). Sivanesan (1984, p. 500) described the teleomorphic stage of *Anguillospora longissima* as *Massarina* sp. II, which fits the diagnostic characters of *Amniculicola* well. Thus this taxon may be another species of *Amniculicola*.

#### Hypsostromataceae

A *Pleurophomopsis*-like anamorph is reported in the subiculum of the generic type of *Hypsostroma* (*H. saxicola* Huhndorf) (Huhndorf 1992).

#### Lophiostomataceae

The concept of *Lophiostomataceae* was also narrowed, and presently contains only *Lophiostoma* (Zhang et al.

2009a). Leuchtmann (1985) studied cultures of some *Lophiostoma* species, and noticed that *L. caulium* (Fr.) Ces. & De Not., *L. macrostomum*, *L. semiliberum* (Desm.) Ces. & De Not., *Lophiostoma* sp. and *Lophiotrema nucula* produced *Pleurophomopsis* anamorphic stages, which are similar to those now in *Melanomma* (Chesters 1938), but *Lophiostoma* and *Melanomma* has no proven phylogenetic relationship (Zhang et al. 2009a, b; Plate 1). Species of *Aposphaeria* have also been reported in *Massariosphaeria* (Farr et al. 1989; Leuchtmann 1984), but the polyphyletic nature of *Massariosphaeria* is well documented (Wang et al. 2007).

#### Melanommataceae

The anamorphs of the *Melanommataceae* are mostly coelomycetous and rarely hyphomycetous with various ontogenic structures, such as annellidic or sympodial for hyphomycetes (*Exosporiella* and *Pseudospiropes*) and coelomycetes (*Aposphaeria*-like and *Pyrenochaeta*).

*Herpotrichia* is reported as having a *Pyrenochaeta* anamorphic stage with or without seta on the surface of pycnidia (Sivanesan 1984). *Aposphaeria* and *Phoma*-like have been reported in *Melanomma* species (Chesters 1938; Sivanesan 1984). Similarly, the anamorphs of *Karstenula* are reported as coelomycetous, i.e. *Microdiplodia* (Constantinescu 1993). The anamorphic stage of *Anomalemma* is *Exosporiella* (Sivanesan 1983), and that of *Byssosphaeria* is *Pyrenochaeta* (Barr 1984). *Ohleria brasiliensis* Starbäck has been linked with *Monodictys putredinis* (Wallr.) S. Hughes (Samuels 1980). *Astrosphaeriella* is a contentious genus as its familial status is not determined yet. Here we temporarily assigned it under *Melanommataceae*, which is linked with the anamorph genus *Pleurophomopsis*.

#### Pleomassariaceae

*Shearia* and *Prosthemia* are all anamorphs of *Pleomassaria*, and *Prosthemia betulinum* is linked with the generic type of *Pleomassaria* (*P. siparia*) (Barr 1982b; Sivanesan 1984; Sutton 1980; Tanaka et al. 2010). *Splanchnonema* is a genus of *Pleomassariaceae*, the teleomorphic morphology of which is difficult to distinguish from two other genera, i.e. *Asteromassaria* and *Pleomassaria*, and the reported anamorphs of *Splanchnonema* are *Ceuthodiplospora*, *Myxocycclus* and *Stegonsporium*, which are comparable with those of *Asteromassaria* and *Pleomassaria*.

#### Tetraplophaeriaceae

*Tetraplophaeriaceae* was introduced to accommodate the *Massarina*-like bambusicolous fungi that produce *Tetraploa sensu stricto* anamorphs (Tanaka et al. 2009). *Tetraploa aristata* Berk. & Broome, the generic type of *Tetraploa* is widely distributed, associated with various

substrates and many occur in freshwater or has been isolated from air. The polyphyletic nature of *T. aristata* has been well documented (Tanaka et al. 2009). Anamorphic stages can serve as a diagnostic character for this family.

#### ***Diademaceae, Massariaceae, Sporormiaceae and Teichosporaceae***

The *Sporormiaceae* is coprophilous having *Phoma* or *Phoma*-related anamorphic states (Cannon and Kirk 2007). *Comoclathris* (*Diademaceae*) is linked with *Alternaria*-like anamorphs (Simmons 1952). *Myxocyclus* links to *Massaria* (*Massariaceae*) (Hyde et al. 2011). The anamorphic stage of *Chaetomastia* (*Teichosporaceae*) is *Aposphaeria*- or *Coniothyrium*-like (Barr 1989c).

Generally speaking, the morphologically simple conidiophores are usually considered phylogenetically uninformative (Seifert and Samuels 2000). *Phoma*-like anamorphs commonly occur in *Pleosporales*, while their colorless and unicellular conidia are also not phylogenetically informative (Seifert and Samuels 2000).

All of the above mentioned anamorphic taxa of *Pleosporales* have phialidic, annellidic or sympodial conidiogenous cells, representing apical wall-building type (compared to ring wall-building and diffused wall-building) (Nag Raj 1993), which may indicate that the wall-building type probably has phylogenetic significance.

#### Molecular phylogeny of *Pleosporales*

Numerous genes have been applied in phylogenetic studies of *Pleosporales*, mostly including LSU, SSU, mtSSU and ITS as well as the protein genes, such as *RPB1*, *RPB2*, *TEF1*,  $\beta$ -tubulin (*TUB1*) and actin (*ACT1*). A single gene such as ITS or LSU, has been used to study phylogenetic relationships between *Leptosphaeria* and *Phaeosphaeria* (Câmara et al. 2002) or *Pleosporaceae* and *Tubeufiaceae* (Kodsueb et al. 2006a, b) (Table 2). The use of these phylogenetic markers, although making important contributions, has not been successful in resolving numerous relationships in single gene dendrograms. One exception is the use of SSU sequences to demonstrate the phylogenetic significance of pseudoparaphyses (Liew et al. 2000) whilst rejecting the phylogenetic utility of pseudoparaphyses morphology (cellular or trabeculate). Analyses with combined genes have had more success. For instance combined analyses with LSU and SSU sequence data could be used to define family level classification in a few cases (Dong et al. 1998; de Gruyter et al. 2009; Lumbsch and Lindemuth 2001; Pinnoi et al. 2007; Zhang et al. 2009b) (Table 2). The addition of more than two genes has been used to determine relationships between orders. For instance, genes such as LSU,

SSU and *mtSSU* have been used to analyze ordinal relationships in *Loculoascomycetes* (Lindemuth et al. 2001), and to analyze phylogenetic relationships of coprophilous families in *Pleosporales* (Kruys et al. 2006). *Phaeocryptopus gaeumannii* (T. Rohde) Petr. was shown to belong in *Dothideales* based on LSU, SSU and ITS sequence analysis (Winton et al. 2007), while Schoch et al. (2006) used four genes, i.e. LSU, SSU, *RPB2* and *TEF1* to evaluate the phylogenetic relationships among different orders of the *Dothideomycetes*. Five genes, viz. LSU, SSU, *TEF1*, *RPB1* and *RPB2*, were used to study the phylogenetic relationships of different orders within *Dothideomycetes* (Schoch et al. 2009) and of different families within *Pleosporales* (Zhang et al. 2009a) (Table 2). It is clear that even more genes will be required to address the remaining issues and the promise of genome analyses is within reach ([www.jgi.doe.gov/sequencing/why/dothideomycetes.html](http://www.jgi.doe.gov/sequencing/why/dothideomycetes.html)) for *Dothideomycetes*.

#### The importance of generic type specimens

The type specimen (collection type) is a fundamental element in the current Code of Botanical Nomenclature at familial or lower ranks (Moore 1998). A type specimen fixes the name to an exact specimen at family, genera, species and variety/subspecies rank and is ultimately based on this single specimen, i.e. a family name is based on a genus, the genus name is based on a species, and the species name is based on a specimen (Kirk et al. 2008).

The generic type is of great importance in defining generic circumscriptions in fungal taxonomy. The generic types of *Pleosporales* have been studied previously by many mycologists. For instance, Müller and von Arx (1962) studied the generic types of “*Pyrenomyces*”, and described and illustrated them in detail. Sivanesan (1984) described and illustrated the generic representatives of *Loculoascomycetes* for both their teleomorphs and anamorphs, and their links were emphasized. A large number of pleosporalean genera have been studied by Barr (1990a, b). Almost all of the previous work was conducted more than 20 years ago, when no molecular phylogenetic studies could be carried out and thus had been carried out in a systematic fashion.

#### Aim and outline of present study

The present study had two principal objectives:

1. To explore genera under *Pleosporales* based on the generic types and provide a detailed description and illustration for the type species of selected genera, discuss the study history of those genera, and explore their ordinal, familial, and generic relationships;

**Table 2** List of phylogenetic studies on *Pleosporales*

Year	Author(s)	Loci used	Target fungi	General conclusion
1998	Dong et al.	LSU, SSU	<i>Leptosphaeriaceae</i> , <i>Pleosporaceae</i> and three other families	<i>Leptosphaeriaceae</i> is paraphyletic and <i>Pleosporaceae</i> is monophyletic.
2000	Liew et al.	SSU	<i>Pleosporales</i> and <i>Melanommatales</i>	<i>Pleosporales</i> and <i>Melanommatales</i> are not natural groups.
2001	Lindemuth et al.	LSU, SSU, mtSSU	loculoascomycetes	Loculoascomycetes are not monophyletic.
2001	Lumbsch and Lindemuth	LSU, SSU	<i>Dothideomycetes</i>	Presence of pseudoparaphyses is a major character at order level classification
2002	Câmara et al.	ITS	<i>Leptosphaeria</i> and <i>Phaeosphaeria</i>	Accepted <i>Leptosphaeria sensu stricto</i> .
2006	Kodsueb et al.	LSU	<i>Pleosporaceae</i>	<i>Wettsteinina</i> should be excluded from the <i>Pleosporaceae</i> .
2006	Kodsueb et al.	LSU	<i>Tubeufiaceae</i>	<i>Tubeufiaceae</i> is more closely related to the <i>Venturiaceae</i> .
2006	Kruys et al.	LSU, SSU, mtSSU	coprophilous families of <i>Pleosporales</i>	coprophilous families of <i>Pleosporales</i> form phylogenetic monophyletic groups respectively
2006	Schoch et al.	LSU, SSU, <i>TEF1</i> , <i>RPB2</i>	<i>Dothideomycetes</i>	Proposed the subclasses <i>Pleosporomycetidae</i>
2007	Pinnoi et al.	LSU, SSU	<i>Pleosporales</i>	phylogenetic relationships of different families of <i>Pleosporales</i> , introduced a new fungus— <i>Berkleasium crunisia</i>
2007	Wang et al.	LSU, SSU, <i>RPB2</i>	<i>Massariosphaeria</i>	<i>Massariosphaeria</i> is not monophyletic
2007	Winton et al.	LSU, SSU, ITS	<i>Phaeocryptopus gaeumannii</i>	<i>Phaeocryptopus gaeumannii</i> nested in <i>Dothideales</i> .
2008a	Zhang et al.	LSU, SSU	<i>Melanomma</i> and <i>Trematosphaeria</i>	<i>Melanomma</i> and <i>Trematosphaeria</i> belong to different families
2009	de Gruyter et al.	LSU, SSU;	<i>Phoma</i> and related genera	They are closely related with <i>Didymellaceae</i> , <i>Leptosphaeriaceae</i> , <i>Phaeosphaeriaceae</i> and <i>Pleosporaceae</i>
2009a	Zhang et al.	LSU, SSU, <i>TEF1</i> , <i>RPB1</i> , <i>RPB2</i>	<i>Pleosporales</i>	<i>Amniculicolaceae</i> and <i>Lentitheciaceae</i> were introduced, and <i>Pleosporineae</i> recircumscribed.
2009	Mugambi and Huhndorf	LSU, <i>TEF1</i>	<i>Melanommataceae</i> , <i>Lophiostomataceae</i>	Recircumscribed <i>Melanommataceae</i> and <i>Lophiostomataceae</i> , and reinstated <i>Hypostromataceae</i> .
2009	Nelsen et al.	LSU and mtSSU	lichenized <i>Dothideomycetes</i>	Pyrenocarpous lichens with bitunicate asci are not monophyletic, but belong to at least two classes ( <i>Dothideomycetes</i> and <i>Errotiomycetes</i> ).
2009	Suetrong et al.	LSU, SSU, <i>TEF1</i> , <i>RPB1</i>	marine <i>Dothideomycetes</i>	Two new families are introduced <i>Aigialaceae</i> and <i>Morosphaeriaceae</i> .
2009	Shearer et al.	LSU, SSU	freshwater <i>Dothideomycetes</i>	Freshwater <i>Dothideomycetes</i> are related to terrestrial taxa and have adapted to freshwater habitats numerous times.
2009	Tanaka et al.	LSU, SSU, <i>TEF1</i> , ITS, BT	bambusicolous <i>Pleosporales</i>	Introduced <i>Tetraplophaeriaceae</i> with <i>Tetraploa</i> -like anamorphs.
2009	Kruys and Wedin	ITS-nLSU, mtSSU rDNA and $\beta$ -tubulin	<i>Sporormiaceae</i>	Analyzed the inter-generic relationships as well as evaluated the morphological significance used in this family.
2010	Hirayama et al.	LSU, SSU	<i>Massarina ingoldiana sensu lato</i>	<i>Massarina ingoldiana sensu lato</i> is polyphyletic, and separated into two clades within <i>Pleosporales</i> .
2010	Aveskamp et al.	LSU, SSU, ITS and $\beta$ -tubulin	<i>Phoma</i> and related genera within <i>Didymellaceae</i>	Rejected current Boeremaeian subdivision.
2010	de Gruyter et al.	LSU, SSU	<i>Phoma</i> and related genera within <i>Pleosporineae</i>	Introduced <i>Pyrenochaetopsis</i> , <i>Setophoma</i> and <i>Neosetophoma</i> and reinstated <i>Cucurbitariaceae</i> within <i>Pleosporineae</i>

2. To investigate the phylogeny of *Pleosporales*, its inter-familial relationships, and the morphological circumscription of each family;

In order to clarify morphological characters, the generic types of the majority of teleomorphic pleosporalean genera (> 60%) were studied. Most of them are from the “core families” of *Pleosporales*, i.e. *Delitschiaceae*, *Lophiostomataceae*, *Massariaceae*, *Massarinaceae*, *Melanommataceae*, *Montagnulaceae*, *Phaeosphaeriaceae*, *Phaeotrichaceae*, *Pleomassariaceae*, *Pleosporaceae*, *Sporormiaceae* and *Teichosporaceae*. Notes are given for those where type specimens could not be obtained during the timeframe of this study. A detailed description and illustration of each generic type is provided. Comments, notes and problems that need to be addressed are provided for each genus. Phylogenetic investigation based on five nuclear loci, viz. LSU, SSU, *RPB1*, *RPB2* and *TEF1* was carried out using available strains from numerous genera in *Pleosporales*. In total, 278 pleosporalean taxa are included in the phylogenetic analysis, which form 25 familial clades on the dendrogram (Plate 1). The suborder, *Massarineae*, is emended to accommodate *Lentitheciaceae*, *Massarinaceae*, *Montagnulaceae*, *Morosphaeriaceae* and *Trematosphaeriaceae*.

## Materials and methods

### Molecular phylogeny

Four genes were used in this analysis, the large and small subunits of the nuclear ribosomal RNA genes (LSU, SSU) and two protein coding genes, namely the second largest subunit of RNA polymerase II (*RPB2*) and translation elongation factor-1 alpha (*TEF1*). All sequences were downloaded from GenBank as listed in Table 3. Each of the individual ribosomal genes was aligned in SATé under default settings with at least 20 iterations. The protein coding genes were aligned in BioEdit (Hall 2004) and completed by manual adjustment. Introns were removed and all genes were concatenated in a single nucleotide alignment with 43% missing and gap characters out of a total set of 5081. The alignment had 100% representation for LSU, 75% for SSU, 48% for *RPB2* and 65% for *TEF1*. The final data matrix had 280 taxa including outgroups (Table 3).

Previous results indicated no clear conflict amongst the majority of the data used (Schoch et al. 2009). A phylogenetic analysis of the concatenated alignment was performed on CIPRES webportal (Miller et al. 2009) using RAxML v. 7.2.7 (Stamatakis 2006; Stamatakis et al. 2008) applying unique model parameters for each gene and codon (8 partitions). A general time reversible model (GTR) was applied with a discrete gamma distribution and four rate classes. Fifty

thorough maximum likelihood (ML) tree searches were done in RAxML v. 7.2.7 under the same model, each one starting from a separate randomized tree and the best scoring tree selected with a final likelihood value of  $-95238.628839$ . Two isolates of *Hysterium angustatum* (*Hysteriales*, *Pleosporomycetidae*) were used as outgroups based on earlier work (Boehm et al. 2009a). Bootstrap pseudo-replicates were run with the GTRCAT model approximation, allowing the program to halt bootstraps automatically under the majority rule criterion (Pattengale et al. 2010). The resulting 250 replicates were plotted on to the best scoring tree obtained previously. The phylogram with bootstrap values on the branches is presented in Plate 1 by using graphical options available in TreeDyn v. 198.3 (Chevenet et al. 2006).

### Morphology

Type specimens as well as some other specimens were loaned from the following herbaria: BAFC, BISH, BPI, BR, BRIP, CBS, E, ETH, FFE, FH, G, H, Herb. J. Kohlmeyer, HHUF, IFRD, ILLS, IMI, K(M), L, LPS, M, MA, NY, PAD, PC, PH, RO, S, TNS, TRTC, UB, UBC, UPS and ZT. Attempts were made to trace and borrow all the type specimens from herbaria worldwide, but only some of them could be obtained. Some of the type specimens are in such bad condition that little information could be obtained. In order to obtain the location of specimens, original publications were searched.

Ascostroma and ascomata were examined under an Olympus SZ H10 dissecting microscope. Section of the fruiting structures was carried out by cryotome or by hand-cutting. Measurements and descriptions of sections of the ascomata, hamathecium, asci and ascospores were carried out by immersing ascomata in water or in 10% lactic acid. Microphotography was taken with material mounted in water, cotton blue, Melzer’s reagent or 10–100% lactic acid.

Terminologies are as in Ulloa and Hanlin (2000). In addition, ascomata size is defined as: small-sized: < 300  $\mu\text{m}$  diam., medium-sized: from 300  $\mu\text{m}$  to 600  $\mu\text{m}$  diam., large-sized: > 600  $\mu\text{m}$  diam.

Question mark (“?”) before family (or genus) name means its familial (or generic) status within *Pleosporales* (or some particular family) is uncertain. Other question marks after habitats, latin names or other substantives mean the correctness of their usages need verification.

## Results

### Molecular phylogeny

In total, 278 pleosporalean taxa are included in the phylogenetic analysis. These form 25 familial clades in the dendrogram, i.e. *Aigialaceae*, *Ammiculicolaceae*, *Arthopyreniaceae*,

**Table 3** Taxa used in the phylogenetic analysis and their corresponding GenBank numbers. Culture and voucher abbreviations are indicated where available

Species	Culture/voucher <sup>1</sup>	LSU	SSU	RPB2	TEF1
<i>Acrocardiopsis patilii</i>	BCC 28166	GU479772	GU479736	GU479811	
<i>Acrocardiopsis patilii</i>	BCC 28167	GU479773	GU479737	GU479812	
<i>Aigialus grandis</i>	BCC 18419	GU479774	GU479738	GU479813	GU479838
<i>Aigialus grandis</i>	JK 5244A	GU301793	GU296131	GU371762	
<i>Aigialus mangrovis</i>	BCC 33563	GU479776	GU479741	GU479815	GU479840
<i>Aigialus mangrovis</i>	BCC 33564	GU479777	GU479742	GU479816	GU479841
<i>Aigialus parvus</i>	A6	GU301795	GU296133	GU371771	GU349064
<i>Aigialus parvus</i>	BCC 32558	GU479779	GU479743	GU479818	GU479843
<i>Aigialus rhizophorae</i>	BCC 33572	GU479780	GU479745	GU479819	GU479844
<i>Aigialus rhizophorae</i>	BCC 33573	GU479781	GU479746	GU479820	GU479845
<i>Alternaria alternata</i>	CBS 916.96	DQ678082	DQ678031	DQ677980	DQ677927
<i>Amniculicola immersa</i>	CBS 123083	FJ795498	GU456295	GU456358	GU456273
<i>Amniculicola parva</i>	CBS 123092	FJ795497	GU296134		GU349065
<i>Anteaglonium abbreviatum</i>	ANM 925.1	GQ221877			GQ221924
<i>Anteaglonium abbreviatum</i>	GKM 1029	GQ221878			GQ221915
<i>Anteaglonium globosum</i>	ANM 925.2	GQ221879			GQ221925
<i>Anteaglonium latirostrum</i>	L100N 2	GQ221876			GQ221938
<i>Arthopyrenia salicis</i>	1994 Coppins	AY607730			
<i>Arthopyrenia salicis</i>	CBS 368.94	AY538339	AY538333		
<i>Ascochyta pisi</i>	CBS 126.54	DQ678070	DQ678018	DQ677967	DQ677913
<i>Ascocratera manglicola</i>	BCC 09270	GU479782	GU479747	GU479821	GU479846
<i>Ascocratera manglicola</i>	JK 5262 C	GU301799	GU296136	GU371763	
<i>Asteromassaria pulchra</i>	CBS 124082	GU301800	GU296137	GU371772	GU349066
<i>Astrosphaeriella aggregata</i>	MAFF 239485	AB524590	AB524449		
<i>Astrosphaeriella aggregata</i>	MAFF 239486	AB524591	AB524450	AB539105	AB539092
<i>Astrosphaeriella bakeriana</i>	CBS 115556	GU301801			GU349015
<i>Astrosphaeriella stellata</i>	MAFF 239487	AB524592	AB524451		
<i>Beverwykella pulmonaria</i>	CBS 283.53	GU301804		GU371768	
<i>Biatriospora marina</i>	CY 1228	GQ925848	GQ925835	GU479823	GU479848
<i>Bimuria novae-zelandiae</i>	CBS 107.79	AY016356	AY016338	DQ470917	DQ471087
<i>Byssolophis sphaerioides</i>	IFRDCC2053	GU301805	GU296140	GU456348	GU456263
<i>Byssosphaeria jamaicana</i>	SMH1403	GU385152			GU327746
<i>Byssosphaeria rhodomphala</i>	GKM L153N	GU385157			GU327747
<i>Byssosphaeria salebrosa</i>	SMH2387	GU385162			GU327748
<i>Byssosphaeria schiedermayeriana</i>	GKM1197	GU385161			GU327750
<i>Byssosphaeria schiedermayeriana</i>	GKM152N	GU385168			GU327749
<i>Byssosphaeria villosa</i>	GKM204N	GU385151			GU327751
<i>Byssothecium circinans</i>	CBS 675.92	AY016357	AY016339	DQ767646	GU349061
<i>Chaetosphaeronema hispidulum</i>	CBS 216.75	EU754144	EU754045	GU371777	
<i>Cochliobolus heterostrophus</i>	CBS 134.39	AY544645	AY544727	DQ247790	DQ497603
<i>Cochliobolus sativus</i>	DAOM 226212	DQ678045	DQ677995	DQ677939	
<i>Corynespora cassicola</i>	CBS 100822	GU301808	GU296144	GU371742	GU349052
<i>Corynespora olivacea</i>	CBS 114450	GU301809			GU349014
<i>Corynespora smithii</i>	CABI 5649b	GU323201		GU371783	GU349018
<i>Cucurbitaria berberidis</i>	CBS 394.84	GQ387605	GQ387544		
<i>Decaisnella formosa</i>	BCC 25616	GQ925846	GQ925833	GU479825	GU479851
<i>Decaisnella formosa</i>	BCC 25617	GQ925847	GQ925834	GU479824	GU479850
<i>Decorospora gaudefroyi</i>	CBS 332.63	EF177849	AF394542		

**Table 3** (continued)

Species	Culture/voucher <sup>1</sup>	LSU	SSU	RPB2	TEF1
<i>Delitschia cf. chaetomioides</i>	GKM 1283	GU385172			
<i>Delitschia cf. chaetomioides</i>	GKM 3253.2	GU390656			
<i>Delitschia chaetomioides</i>	GKM1283	GU385172			GU327752
<i>Delitschia chaetomioides</i>	SMH3253.2	GU390656			GU327753
<i>Delitschia winteri</i>	CBS 225.62	DQ678077	DQ678026	DQ677975	DQ677922
<i>Didymella exigua</i>	CBS 183.55	EU754155	EU754056		
<i>Didymocrea sadasivanii</i>	CBS 438 65	DQ384103	DQ384066		
<i>Didymosphaeria futilis</i>	CMW 22186	EU552123			
<i>Didymosphaeria futilis</i>	HKUCC 5834	GU205219	GU205236		
<i>Dothidotthia aspera</i>	CPC 12933	EU673276	EU673228		
<i>Dothidotthia symphoricarpi</i>	CBS119687	EU673273	EU673224		
<i>Entodesmium rude</i>	CBS 650.86	GU301812			GU349012
<i>Falciformispora lignatilis</i>	BCC 21117	GU371826	GU371834		GU371819
<i>Falciformispora lignatilis</i>	BCC 21118	GU371827	GU371835		GU371820
<i>Floricola striata</i>	JK 5603 K	GU479785	GU479751		
<i>Floricola striata</i>	JK 5678I	GU301813	GU296149	GU371758	
<i>Halomassarina thalassiae</i>	BCC 17055	GQ925850	GQ925843		
<i>Halomassarina thalassiae</i>	JK 5262D	GU301816			GU349011
<i>Halothia posidoniae</i>	BBH 22481	GU479786	GU479752		
<i>Helicascus nypae</i>	BCC 36751	GU479788	GU479754	GU479826	GU479854
<i>Helicascus nypae</i>	BCC 36752	GU479789	GU479755	GU479827	GU479855
<i>Herpotrichia diffusa</i>	CBS 250.62	DQ678071	DQ678019	DQ677968	DQ677915
<i>Herpotrichia juniperi</i>	CBS 200.31	DQ678080	DQ678029	DQ677978	DQ677925
<i>Herpotrichia macrotricha</i>	GKM196N	GU385176			GU327755
<i>Herpotrichia macrotricha</i>	SMH269	GU385177			GU327756
<i>Hypsostroma caimitalense</i>	GKM 1165	GU385180			
<i>Hypsostroma saxicola</i>	SMH 5005	GU385181			
<i>Hysterium angustatum</i>	CBS 123334	FJ161207	FJ161167	FJ161129	FJ161111
<i>Hysterium angustatum</i>	CBS 236.34	FJ161180	GU397359	FJ161117	FJ161096
<i>Julella avicenniae</i>	BCC 18422	GU371823	GU371831	GU371787	GU371816
<i>Julella avicenniae</i>	BCC 20173	GU371822	GU371830	GU371786	GU371815
<i>Julella avicenniae</i>	JK 5326A	GU479790	GU479756		
<i>Kalmusia scabrispora</i>	MAFF 239517	AB524593	AB524452	AB539093	AB539106
<i>Kalmusia scabrispora</i>	NBRC 106237	AB524594	AB524453	AB539094	AB539107
<i>Karstenula rhodostoma</i>	CBS 690.94	GU301821	GU296154	GU371788	GU349067
<i>Katumotoa bambusicola</i>	MAFF 239641	AB524595	AB524454	AB539095	AB539108
<i>Keissleriella cladophila</i>	CBS 104.55	GU301822	GU296155	GU371735	GU349043
<i>Keissleriella rara</i>	CBS 118429	GU479791	GU479757		
<i>Kirschsteiniothelia elaterascus</i>	A22-5A/HKUCC7769	AY787934	AF053727		
<i>Lentithecium aquaticum</i>	CBS 123099	GU301823	GU296156	GU371789	GU349068
<i>Lentithecium arundinaceum</i>	CBS 123131	GU456320	GU456298		GU456281
<i>Lentithecium arundinaceum</i>	CBS 619.86	GU301824	GU296157	FJ795473	
<i>Lentithecium fluviatile</i>	CBS 122367	GU301825	GU296158		GU349074
<i>Lepidosphaeria nicotiae</i>	CBS 101341	DQ678067		DQ677963	DQ677910
<i>Leptosphaeria biglobosa</i>	CBS 298.36	GU237980	GU238207		
<i>Leptosphaeria biglobosa</i>	CBS 303.51	GU301826			GU349010
<i>Leptosphaeria doliolum</i>	CBS 505.75	GU301827	GU296159		GU349069
<i>Leptosphaeria dryadis</i>	CBS 643.86	GU301828		GU371733	GU349009
<i>Leptosphaerulina argentinensis</i>	CBS 569.94	GU301829			GU349008

**Table 3** (continued)

Species	Culture/voucher <sup>1</sup>	LSU	SSU	RPB2	TEF1
<i>Leptosphaerulina australis</i>	CBS 311.51-T	FJ795500		GU456357	GU456272
<i>Leptosphaerulina australis</i>	CBS 317.83	GU301830	GU296160	GU371790	GU349070
<i>Leptosphaeria maculans</i>	DAOM 229267	DQ470946	DQ470993	DQ470894	DQ471062
<i>Letendraea helminthicola</i>	CBS 884.85	AY016362	AY016345		
<i>Letendraea padouk</i>	CBS 485.70	AY849951	GU296162		
<i>Lindgomyces breviappendiculatus</i>	KT 1399	AB521749	AB521734		
<i>Lindgomyces cinctosporae</i>	R56-1	AB522431	AB522430		
<i>Lindgomyces cinctosporae</i>	R56-3	GU266245	GU266238		
<i>Lindgomyces ingoldianus</i>	KH 100 JCM 16479	AB521737	AB521720		
<i>Lindgomyces rotundatus</i>	KH 114 JCM 16484	AB521742	AB521725		
<i>Lophiostoma alpigenum</i>	GKM 1091b	GU385193			
<i>Lophiostoma arundinis</i>	CBS 621.86	DQ782384	DQ782383	DQ782386	DQ782387
<i>Lophiostoma caulium</i>	CBS 623.86	GU301833	GU296163	GU371791	
<i>Lophiostoma compressum</i>	IFRD 2014	GU301834	GU296164	FJ795457	
<i>Lophiostoma crenatum</i>	CBS 629.86	DQ678069	DQ678017	DQ677965	DQ677912
<i>Lophiostoma fuckelii</i>	CBS 101952	DQ399531			
<i>Lophiostoma fuckelii</i>	CBS 113432	EU552139			
<i>Lophiostoma fuckelii</i>	GKM 1063	GU385192			
<i>Lophiostoma macrostomum</i>	CBS 122681	EU552141			
<i>Lophiostoma macrostomum</i>	HHUF 27293	AB433274			
<i>Lophiostoma macrostomum</i>	KT 635	AB433273	AB521731		
<i>Lophiostoma quadrinucleatum</i>	GKM1233	GU385184			GU327760
<i>Lophiostoma sagittiforme</i>	HHUF 29754	AB369267			
<i>Lophiotrema brunneosporum</i>	CBS 123095	GU301835	GU296165		GU349071
<i>Lophiotrema lignicola</i>	CBS 122364	GU301836	GU296166		GU349072
<i>Massarina arundinariae</i>	MAFF 239461	AB524596	AB524455	AB539096	AB524817
<i>Massarina arundinariae</i>	NBRC 106238	AB524597	AB524456	AB539097	AB524818
<i>Lophiotrema nucula</i>	CBS 627.86	GU301837	GU296167	GU371792	GU349073
<i>Loratospora aestuarii</i>	JK 5535B	GU301838	GU296168	GU371760	
<i>Macroventuria anomochaeta</i>	CBS 525.71	GU456315		GU456346	GU456262
<i>Massaria anomia</i>	CBS 123109	GU301792	GU296130		GU349062
<i>Massaria anomia</i>	CBS 591.78	GU301839	GU296169	GU371769	
<i>Massaria ariae</i>	M52	HQ599382	HQ599456		HQ599322
<i>Massaria aucupariae</i>	M49	HQ599384	HQ599455		HQ599324
<i>Massaria campestris</i>	M28	HQ599385	HQ599449	HQ599459	HQ599325
<i>Massaria conspurcata</i>	M14	HQ599393	HQ599441		HQ599333
<i>Massaria gigantispora</i>	M26	HQ599397	HQ599447		HQ599337
<i>Massaria inquinans</i>	M19	HQ599402	HQ599444	HQ599460	HQ599342
<i>Massaria lantanae</i>	M18	HQ599406	HQ599443		HQ599346
<i>Massaria macra</i>	M3	HQ599408	HQ599450		HQ599348
<i>Massaria mediterranea</i>	M45	HQ599417	HQ599452		HQ599357
<i>Massaria platanoidea</i>	M7	HQ599420	HQ599457	HQ599462	HQ599359
<i>Massaria pyri</i>	M21	HQ599424	HQ599445		HQ599363
<i>Massaria vindobonensis</i>	M27	HQ599429	HQ599448	HQ599464	HQ599368
<i>Massaria vomitoria</i>	M13	HQ599437	HQ599440	HQ599466	HQ599375
<i>Massarina cisti</i>	CBS 266.62	FJ795447	FJ795490	FJ795464	
<i>Massarina eburnea</i>	CBS 473.64	GU301840	GU296170	GU371732	GU349040
<i>Massarina igniaria</i>	CBS 845.96	GU301841	GU296171	GU371793	
<i>Massarina ricifera</i>	JK 5535 F	GU479793	GU479759		

**Table 3** (continued)

Species	Culture/voucher <sup>1</sup>	LSU	SSU	RPB2	TEF1
<i>Massariosphaeria phaeospora</i>	CBS 611.86	GU301843	GU296173	GU371794	
<i>Mauritiana rhizophorae</i>	BCC 28866	GU371824	GU371832	GU371796	GU371817
<i>Mauritiana rhizophorae</i>	BCC 28867	GU371825	GU371833	GU371797	GU371818
<i>Melanomma pulvis-pyrius</i>	CBS 124080	GU456323	GU456302	GU456350	GU456265
<i>Melanomma pulvis-pyrius</i>	CBS 371.75	GU301845		GU371798	GU349019
<i>Melanomma pulvis-pyrius</i>	SMH 3291	GU385197			
<i>Melanomma rhododendri</i>	ANM 73	GU385198			
<i>Misturatosphaeria aurantonotata</i>	GKM1238	GU385173			GU327761
<i>Misturatosphaeria aurantonotata</i>	GKM1280	GU385174			GU327762
<i>Misturatosphaeria claviformis</i>	GKM1210	GU385212			GU327763
<i>Misturatosphaeria kenyensis</i>	GKM1195	GU385194			GU327767
<i>Misturatosphaeria kenyensis</i>	GKM L100Na	GU385189			GU327766
<i>Misturatosphaeria minima</i>	GKM169N	GU385165			GU327768
<i>Misturatosphaeria tennesseensis</i>	ANM911	GU385207			GU327769
<i>Misturatosphaeria uniseptata</i>	SMH4330	GU385167			GU327770
<i>Monascostroma innumerosum</i>	CBS 345.50	GU301850	GU296179		GU349033
<i>Monotosporella tuberculata</i>	CBS 256.84	GU301851			GU349006
<i>Montagnula anthostomoides</i>	CBS 615.86	GU205223	GU205246		
<i>Montagnula opulenta</i>	CBS 168.34	DQ678086	AF164370	DQ677984	
<i>Morosphaeria ramunculicola</i>	BCC 18405	GQ925854	GQ925839		
<i>Morosphaeria ramunculicola</i>	JK 5304B	GU479794	GU479760	GU479831	
<i>Morosphaeria velatospora</i>	BCC 17059	GQ925852	GQ925841		
<i>Morosphaeria velatospora</i>	BCC 17058	GQ925851	GQ925840		
<i>Massariosphaeria grandispora</i>	CBS 613.86	GU301842	GU296172	GU371725	GU349036
<i>Massariosphaeria typhicola</i>	CBS 123126	GU301844	GU296174	GU371795	
<i>Neophaeosphaeria filamentosa</i>	CBS 102202	GQ387577	GQ387516	GU371773	GU349084
<i>Neotestudina rosatii</i>	CBS 690.82		DQ384069		
<i>Neottiosporina paspali</i>	CBS 331.37	EU754172	EU754073	GU371779	GU349079
<i>Ophiosphaerella herpotricha</i>	CBS 240.31	DQ676765	DQ676765	DQ676765	DQ6767639
<i>Ophiosphaerella herpotricha</i>	CBS 620.86	DQ678062	DQ678010	DQ677958	DQ677905
<i>Ophiosphaerella sasicola</i>	MAFF 239644	AB524599	AB524458	AB539098	AB539111
<i>Paraconiothyrium minitans</i>	CBS 122788	EU754173	EU754074	GU371776	GU349083
<i>Paraphaeosphaeria michotii</i>	CBS 591.73	GU456326	GU456305	GU456352	GU456267
<i>Paraphaeosphaeria michotii</i>	CBS 652.86	GU456325	GU456304	GU456351	GU456266
<i>Phaeosphaeria ammophilae</i>	CBS 114595	GU301859	GU296185	GU371724	GU349035
<i>Phaeosphaeria avenaria</i>	CBS 602.86	AY544684	AY544725	DQ677941	DQ677885
<i>Phaeosphaeria avenaria</i>	DAOM 226215	AY544684	AY544725	DQ677941	DQ677885
<i>Phaeosphaeria brevispora</i>	MAFF 239276	AB524600	AB524459	AB539099	AB539112
<i>Phaeosphaeria brevispora</i>	NBRC 106240	AB524601	AB524460	AB539100	AB539113
<i>Phaeosphaeria caricis</i>	CBS 120249	GU301860			GU349005
<i>Phaeosphaeria elongata</i>	CBS 120250	GU456327	GU456306	GU456345	GU456261
<i>Phaeosphaeria eustoma</i>	CBS 573.86	DQ678063	DQ678011	DQ677959	DQ677906
<i>Phaeosphaeria luctuosa</i>	CBS 308.79	GU301861			GU349004
<i>Phaeosphaeria nigrans</i>	CBS 576.86	GU456331		GU456356	GU456271
<i>Phaeosphaeria nodorum</i>	CBS 259.49	GU456332			GU456285
<i>Phaeosphaeria oryzae</i>	CBS 110110	GQ387591	GQ387530		
<i>Phaeosphaeriopsis musae</i>	CBS 120026	GU301862	GU296186		GU349037
<i>Phoma apiicola</i>	CBS 285.72	GU238040	GU238211		
<i>Phoma betae</i>	CBS 109410	EU754178	EU754079	GU371774	GU349075



**Table 3** (continued)

Species	Culture/voucher <sup>1</sup>	LSU	SSU	RPB2	TEF1
<i>Phoma complanata</i>	CBS 268.92	EU754180	EU754081	GU371778	GU349078
<i>Phoma cucurbitacearum</i>	CBS 133.96	GU301863		GU371767	
<i>Phoma exigua</i>	CBS 431.74	EU754183	EU754084	GU371780	GU349080
<i>Phoma glomerata</i>	CBS 528.66	EU754184	EU754085	GU371781	GU349081
<i>Phoma herbarum</i>	CBS 276.37	DQ678066	DQ678014	DQ677962	DQ677909
<i>Phoma radicina</i>	CBS 111.79	EU754191	EU754092		GU349076
<i>Phoma valerianae</i>	CBS 630.68	GU238150	GU238229		
<i>Phoma vasinfecta</i>	CBS 539.63	GU238151	GU238230		
<i>Phoma violicola</i>	CBS 306.68	GU238156	GU238231		
<i>Phoma zaeae-maydis</i>	CBS 588.69	EU754192	EU754093	GU371782	GU349082
<i>Platychora ulmi</i>	CBS 361.52	EF114702	EF114726		
<i>Lophiostoma compressum</i>	GKM1048	GU385204			GU327772
<i>Lophiostoma scabridisporum</i>	BCC 22836	GQ925845	GQ925832	GU479829	GU479856
<i>Lophiostoma scabridisporum</i>	BCC 22835	GQ925844	GQ925831	GU479830	GU479857
<i>Pleomassaria siparia</i>	CBS 279.74	DQ678078	DQ678027	DQ677976	DQ677923
<i>Pleospora ambigua</i>	CBS 113979	AY787937			
<i>Pleospora herbarum</i>	CBS 191.86	DQ247804	DQ247812	DQ247794	DQ471090
<i>Polyplosphaeria fusca</i>	CBS 125425	AB524607	AB524466		AB524822
<i>Polyplosphaeria fusca</i>	MAFF 239687	AB524606	AB524465		
<i>Preussia funiculata</i>	CBS 659.74	GU301864	GU296187	GU371799	GU349032
<i>Preussia lignicola</i>	CBS 264.69	GU301872	GU296197	GU371765	GU349027
<i>Preussia terricola</i>	DAOM 230091	AY544686	AY544726	DQ470895	DQ471063
<i>Prosthemium betulinum</i>	CBS 127468	AB553754	AB553644		
<i>Prosthemium canba</i>	JCM 16966	AB553760	AB553646		
<i>Prosthemium orientale</i>	JCM 12841	AB553748	AB553641		
<i>Prosthemium stellare</i>	CBS 126964	AB553781	AB553650		
<i>Pseudotetraploa curviappendiculata</i>	CBS 125426	AB524610	AB524469		AB524825
<i>Pseudotetraploa curviappendiculata</i>	MAFF 239495	AB524608	AB524467		
<i>Pseudotetraploa javanica</i>	MAFF 239498	AB524611	AB524470		AB524826
<i>Pseudotetraploa longissima</i>	MAFF 239497	AB524612	AB524471		AB524827
<i>Pseudotrachia guatopoensis</i>	SMH4535	GU385202			GU327774
<i>Pyrenochaeta acicola</i>	CBS 812.95	GQ387602	GQ387541		
<i>Pleurophoma cava</i>	CBS 257.68	EU754199	EU754100		
<i>Pyrenochaeta corn</i>	CBS 248.79	GQ387608	GQ387547		
<i>Pyrenochaeta nobilis</i>	CBS 292.74	GQ387615	GQ387554		
<i>Pyrenochaeta nobilis</i>	CBS 407.76	DQ678096		DQ677991	DQ677936
<i>Pyrenochaeta quercina</i>	CBS 115095	GQ387619	GQ387558		
<i>Pyrenochaeta unguis-hominis</i>	CBS 378.92	GQ387621	GQ387560		
<i>Pyrenochaetopsis decipiens</i>	CBS 343.85	GQ387624	GQ387563		
<i>Pyrenophora phaeocomes</i>	DAOM 222769	DQ499596	DQ499595	DQ497614	DQ497607
<i>Pyrenophora tritici-repentis</i>	OSC 100066	AY544672			DQ677882
<i>Quadricrura bicornis</i>	CBS 125427	AB524613	AB524472		AB524828
<i>Quadricrura meridionalis</i>	CBS 125684	AB524614	AB524473		AB524829
<i>Quadricrura septentrionalis</i>	CBS 125428	AB524617	AB524476		AB524832
<i>Quintaria lignatilis</i>	BCC 17444	GU479797	GU479764	GU479832	GU479859
<i>Quintaria lignatilis</i>	CBS 117700	GU301865	GU296188	GU371761	
<i>Quintaria submersa</i>	CBS 115553	GU301866			GU349003
<i>Repetophragma ontariense</i>	HKUCC 10830	DQ408575		DQ435077	
<i>Rimora mangrovei</i>	JK 5246A	GU301868	GU296193	GU371759	

**Table 3** (continued)

Species	Culture/voucher <sup>1</sup>	LSU	SSU	RPB2	TEF1
<i>Rimora mangrovei</i>	JK 5437B	GU479798	GU479765		
<i>Roussoella hysteroioides</i>	CBS 125434	AB524622	AB524481	AB539102	AB539115
<i>Roussoella hysteroioides</i>	MAFF 239636	AB524621	AB524480	AB539101	AB539114
<i>Roussoella pustulans</i>	MAFF 239637	AB524623	AB524482	AB539103	AB539116
<i>Roussoellopsis tosaensis</i>	MAFF 239638	AB524625		AB539104	AB539117
<i>Saccolothecium sepincola</i>	CBS 278.32	GU301870	GU296195	GU371745	GU349029
<i>Salsuginea ramicola</i>	KT 2597.1	GU479800	GU479767	GU479833	GU479861
<i>Salsuginea ramicola</i>	KT 2597.2	GU479801	GU479768	GU479834	GU479862
<i>Setomelanomma holmii</i>	CBS 110217	GU301871	GU296196	GU371800	GU349028
<i>Setosphaeria monoceras</i>	AY016368	AY016368			
<i>Massaria platani</i>	CBS 221.37	DQ678065	DQ678013	DQ677961	DQ677908
<i>Sporormiella minima</i>	CBS 524.50	DQ678056	DQ678003	DQ677950	DQ677897
<i>Stagonospora macropycnidia</i>	CBS 114202	GU301873	GU296198		GU349026
<i>Tetraploa aristata</i>	CBS 996.70	AB524627	AB524486		AB524836
<i>Tetraploosphaeria nagasakiensis</i>	MAFF 239678	AB524630	AB524489		AB524837
<i>Lophiostoma macrostomoides</i>	GKM1033	GU385190			GU327776
<i>Lophiostoma macrostomoides</i>	GKM1159	GU385185			GU327778
<i>Thyridaria rubronotata</i>	CBS 419.85	GU301875		GU371728	GU349002
<i>Tingoldiogo graminicola</i>	KH 68	AB521743	AB521726		
<i>Trematosphaeria pertusa</i>	CBS 122368	FJ201990	FJ201991	FJ795476	GU456276
<i>Trematosphaeria pertusa</i>	CBS 122371	GU301876	GU348999	GU371801	GU349085
<i>Trematosphaeria pertusa</i>	SMH 1448	GU385213			
<i>Triploosphaeria cylindrica</i>	MAFF 239679	AB524634	AB524493		
<i>Triploosphaeria maxima</i>	MAFF 239682	AB524637	AB524496		
<i>Triploosphaeria yezoensis</i>	CBS 125436	AB524638	AB524497		AB524844
<i>Ulospora bilgramii</i>	CBS 110020	DQ678076	DQ678025	DQ677974	DQ677921
<i>Verruculina enalia</i>	BCC 18401	GU479802	GU479770	GU479835	GU479863
<i>Verruculina enalia</i>	BCC 18402	GU479803	GU479771	GU479836	GU479864
<i>Westerdykella cylindrica</i>	CBS 454.72	AY004343	AY016355	DQ470925	DQ497610
<i>Westerdykella dispersa</i>	CBS 508.75	DQ468050	U42488		
<i>Westerdykella ornata</i>	CBS 379.55	GU301880	GU296208	GU371803	GU349021
<i>Wicklowia aquatica</i>	AF289-1	GU045446			
<i>Wicklowia aquatica</i>	CBS 125634	GU045445	GU266232		
<i>Xenolophium applanatum</i>	CBS 123123	GU456329	GU456312	GU456354	GU456269
<i>Xenolophium applanatum</i>	CBS 123127	GU456330	GU456313	GU456355	GU456270
<i>Zopfia rhizophila</i>	CBS 207.26	DQ384104	L76622		

<sup>1</sup> BCC Belgian Coordinated Collections of Microorganisms; CABI International Mycological Institute, CABI-Bioscience, Egham, Bakenham Lane, U.K.; CBS Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands; DAOM Plant Research Institute, Department of Agriculture (Mycology), Ottawa, Canada; DUKE Duke University Herbarium, Durham, North Carolina, U.S.A.; HHUF Herbarium of Hiroshima University, Japan; IFRDCC Culture Collection, International Fungal Research & Development Centre, Chinese Academy of Forestry, Kunming, China; MAFF Ministry of Agriculture, Forestry and Fisheries, Japan; NBRC NITE Biological Resource Centre, Japan; OSC Oregon State University Herbarium, U.S.A.; UAMH University of Alberta Microfungus Collection and Herbarium, Edmonton, Alberta, Canada; UME Herbarium of the University of Umeå, Umeå, Sweden; Culture and specimen abbreviations: ANM A.N. Miller; CPC; P.W. Crous; EB E.W.A. Boehm; EG E.B.G. Jones; GKM G.K. Mugambi; JK J. Kohlmeier; KT K. Tanaka; SMH S.M. Huhndorf

*Cucurbitariaceae/Didymosphaeriaceae, Delitschiaceae, Didymellaceae, Dothidothiaceae, Hypsostromataceae, Lentitheciaceae, Leptosphaeriaceae, Lindgomycetaceae, Lophiostomataceae, Massariaceae, Massarinaceae, Melanommataceae, Montagnulaceae, Morosphaeriaceae,*

*Phaeosphaeriaceae, Pleomassariaceae, Pleosporaceae, Sporormiaceae, Testudinaceae/Platystomaceae, Tetraploosphaeriaceae, Trematosphaeriaceae and Zopfiaceae (Plate 1). Of these, Lentitheciaceae, Massarinaceae, Montagnulaceae, Morosphaeriaceae and Trematosphaeriaceae form a robust*

clade in the present study and in previous studies (Schoch et al. 2009; Zhang et al. 2009a, b). We thus emended the suborder, *Massarineae*, to accommodate them.

**Pleosporales suborder *Massarineae*** Barr, *Mycologia* 71: 948. (1979a). **emend.**

Habitat freshwater, marine or terrestrial environment, saprobic. *Ascomata* solitary, scattered or gregarious, globose, subglobose, conical to lenticular, immersed, erumpent to superficial, papillate, ostiolate. *Hamathecium* of dense or rarely few, filliform pseudoparaphyses. *Asci* bitunicate, fissitunicate, cylindrical, clavate or broadly clavate, pedicellate. *Ascospores* hyaline, pale brown or brown, 1 to 3 or more transverse septa, rarely muriform, narrowly fusoid, fusoid, broadly fusoid, symmetrical or asymmetrical, with or without sheath.

Accepted genera of *Pleosporales*

*Acrocordiopsis* Borse & K.D. Hyde, *Mycotaxon* 34: 535 (1989). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat marine, saprobic. *Ascomata* seated in blackish stroma, scattered or gregarious, superficial, conical to semiglobose, ostiolate, carbonaceous. *Hamathecium* of dense, long trabeculate pseudoparaphyses. *Asci* 8-spored, cylindrical with pedicels and conspicuous ocular chambers. *Ascospores* hyaline, 1-septate, obovoid to broadly fusoid.

**Anamorphs reported for genus:** none.

**Literature:** Alias et al. 1999; Barr 1987a; Borse and Hyde 1989.

### Type species

*Acrocordiopsis patilii* Borse & K.D. Hyde, *Mycotaxon* 34: 536 (1989). (Fig. 1)

*Ascomata* 1–2 mm high × 1.8–3 mm diam., scattered or gregarious, superficial, conical or semiglobose, with a flattened base not easily removed from the substrate, ostiolate, black, very brittle and carbonaceous and extremely difficult to cut (Fig. 1a and b). *Peridium* 250–310 μm thick, to 600 μm thick near the apex, thinner at the base, comprising three types of cells; outer cells pseudoparenchymatous, small heavily pigmented thick-walled cells of *textura epidermoidea*, cells 0.6–1 × 6–10 μm diam., cell wall 5–9 μm thick; cells near the substrate less pigmented, composed of cells of *textura prismatica*, cell walls 1–3(–5) μm thick; inner cells less pigmented, comprised of hyaline to pale brown thin-walled cells, merging with pseudoparaphyses (Fig. 1c, d and e). *Hamathecium* of dense, long trabeculate pseudoparaphyses, ca. 1 μm broad, embedded in mucilage, hyaline,

**Fig. 1** *Acrocordiopsis patilii* (from IMI 297769, **holotype**). **a** ▶ *Ascomata* on the host surface. **b** Section of an *ascoma*. **c** Section of lateral *peridium*. **d** Section of the apical *peridium*. **e** Section of the basal *peridium*. Note the paler cells of *textura prismatica*. **f** Cylindrical *ascus*. **g** Cylindrical *ascus* in pseudoparaphyses. **h, i** One-septate *ascospores*. Scale bars: **a**=3 mm, **b**=0.5 mm, **c**=200 μm, **d, e**=50 μm, **f–i**=20 μm

anastomosing and sparsely septate. *Asci* 140–220 × 13–17 μm ( $\bar{x}$  = 165.3 × 15.6 μm,  $n$ =10), 8-spored, bitunicate, fissitunicate, cylindrical, with short pedicels, 15–25(–40) μm long, with a large and conspicuous ocular chamber (Fig. 1f and g). *Ascospores* 17.5–25 × 12.5–15(–20) μm ( $\bar{x}$  = 21.5 × 13.6 μm,  $n$ =10), uniseriate to partially overlapping, ovoid or ellipsoidal, hyaline, 1-septate, not constricted at the septum, smooth-walled (Fig. 1h and i).

**Anamorph:** none reported.

**Material examined:** INDIA, Indian Ocean, Malvan (Maharashtra), on intertidal wood of *Avicennia alba* Bl., 30 Oct. 1981 (IMI 297769, **holotype**).

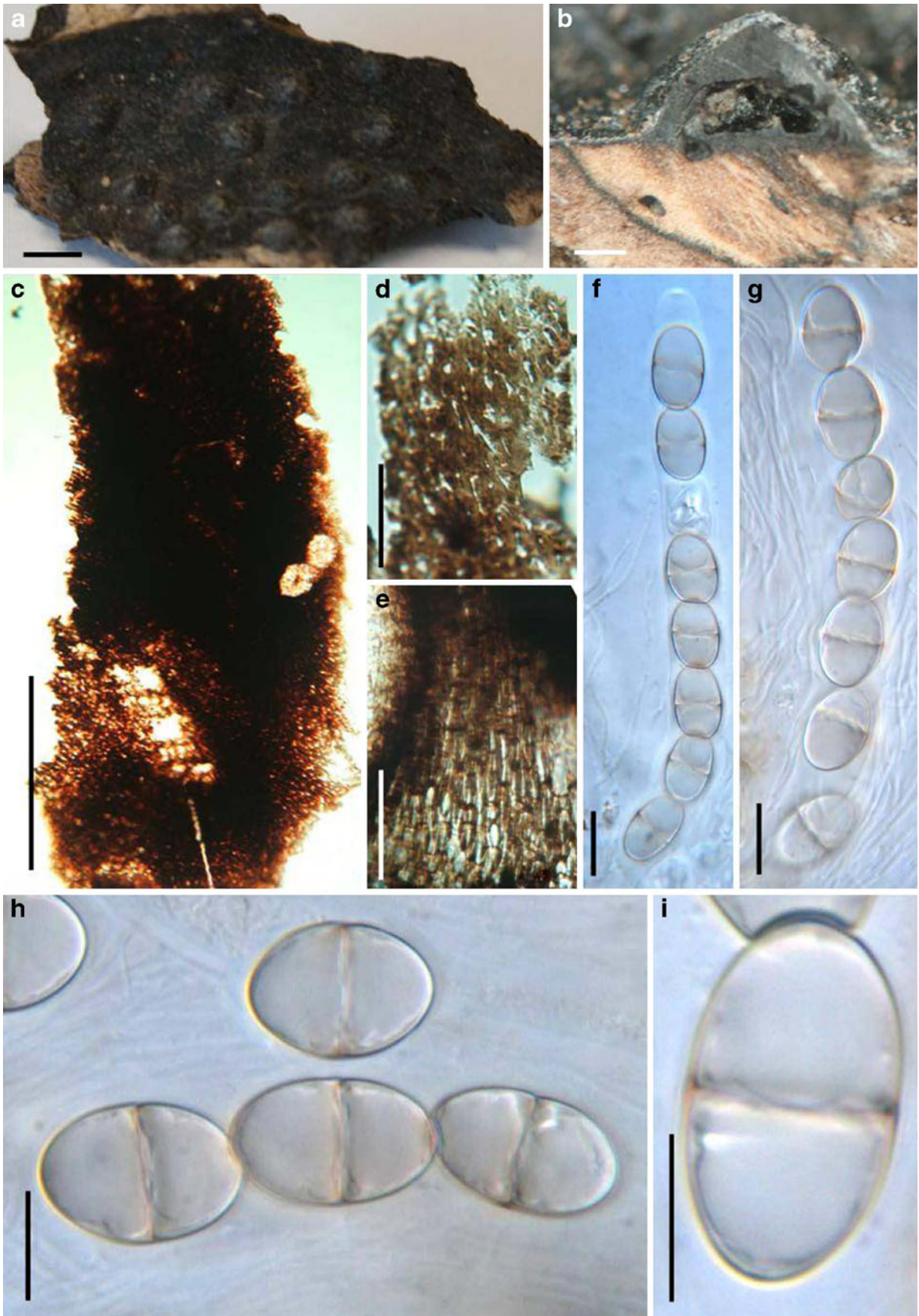
### Notes

### Morphology

*Acrocordiopsis* was formally established by Borse and Hyde (1989) as a monotypic genus represented by *A. patilii* based on its “conical or semiglobose superficial carbonaceous *ascomata*, trabeculate pseudoparaphyses, cylindrical, bitunicate, 8-spored *asci*, and hyaline, 1-septate, obovoid or ellipsoid *ascospores*”. *Acrocordiopsis patilii* was first collected from mangrove wood (Indian Ocean) as a marine fungus, and a second marine *Acrocordiopsis* species was reported subsequently from Philippines (Alias et al. 1999). *Acrocordiopsis* is assigned to *Melanommataceae* (*Melanommatales sensu* Barr 1983) based on its ostiolate *ascomata* and trabeculate pseudoparaphyses (Borse and Hyde 1989). Morphologically, *Acrocordiopsis* is similar to *Astrosphaeriella sensu stricto* based on the conical *ascomata* and the brittle, carbonaceous *peridium* composed of thick-walled black cells with rows of palisade-like parallel cells at the rim area. *Ascospores* of *Astrosphaeriella* are, however, elongate-fusoid, usually brown or reddish brown and surrounded by a gelatinous sheath when young; as such they are readily distinguishable from those of *Acrocordiopsis*. A new family (*Acrocordiaceae*) was introduced by Barr (1987a) to accommodate *Acrocordiopsis*. This proposal, however, has been rarely followed and Jones et al. (2009) assigned *Acrocordiopsis* to *Melanommataceae*.

### Phylogenetic study

*Acrocordiopsis patilii* nested within an unresolved clade within *Pleosporales* (Suetrong et al. 2009). Thus its familial placement is unresolved, but use of the *Acrocordiaceae* could be reconsidered with more data.



### Concluding remarks

*Acrocordiopsis*, *Astrosphaeriella sensu stricto*, *Mamillisphaeria*, *Caryospora* and *Caryosporella* are morphologically similar as all have very thick-walled carbonaceous ascomata, narrow pseudoparaphyses in a gelatinous matrix (trabeculae) and bitunicate, fissitunicate asci. Despite their similarities, the shape of asci and ascospores differs (e.g. *Mamillisphaeria* has sac-like asci and two types of ascospores, brown or hyaline, *Astrosphaeriella* has cylindro-clavate asci and narrowly fusoid ascospores, both *Acrocordiopsis* and *Caryosporella* has cylindrical asci, but ascospores of *Caryosporella* are reddish brown). Therefore, the current familial placement of *Acrocordiopsis* cannot be determined. All generic types of *Astrosphaeriella sensu stricto*, *Mamillisphaeria* and *Caryospora* should be recollected and isolated for phylogenetic study.

*Aigialus* Kohlm. & S. Schatz, Trans. Br. Mycol. Soc. 85: 699 (1985). (*Aigialaceae*)

### Generic description

Habitat marine, saprobic. *Ascomata* mostly subglobose in front view, fusoid in sagittal section, rarely subglobose, scattered, immersed to erumpent, papillate, ostiolate, ostiole rounded or slit-like, periphysate. *Peridium* 2-layered. *Hamathecium* of trabeculate pseudoparaphyses. *Asci* 8-spored, cylindrical, pedicellate, with an ocular chamber and conspicuous apical ring. *Ascospores* ellipsoidal to fusoid, muriform, yellow brown to brown, with terminal appendages.

**Anamorphs reported for genus:** none.

**Literature:** Eriksson 2006; Jones et al. 2009; Kohlmeyer and Schatz 1985; Lumbsch and Huhndorf 2007.

### Type species

*Aigialus grandis* Kohlm. & S. Schatz, Trans. Br. Mycol. Soc. 85: 699 (1985). (Fig. 2)

*Ascomata* 1–1.25 mm high × 1–1.3 mm diam. in front view, 250–400  $\mu\text{m}$  broad in sagittal section, vertically flattened subglobose, laterally compressed, scattered, immersed to semi-immersed, papillate, with an elongated furrow at the top of the papilla, wall black, carbonaceous, ostiolate, ostiole filled with branched or forked septate periphyses (Fig. 2a). *Peridium* 70–100  $\mu\text{m}$  thick laterally, up to 150  $\mu\text{m}$  thick at the apex, thinner at the base, comprising two cell types, outer layer composed of small heavily pigmented thick-walled pseudoparenchymatous cells, cells 1–2  $\mu\text{m}$  diam., cell wall 2–5  $\mu\text{m}$  thick, inner layer thin, composed of small hyaline cells (Fig. 2b). *Hamathecium* of dense, very long trabeculate pseudoparaphyses, 0.8–1.2  $\mu\text{m}$  broad, embedded in mucilage, anastomosing and branching above the asci. *Asci* 450–640 × 22–35  $\mu\text{m}$  ( $\bar{x}$  = 505 × 30  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a long furcate pedicel, 90–180  $\mu\text{m}$  long,

with a low truncate ocular chamber and a refractive apical apparatus (to 12  $\mu\text{m}$  wide × 4  $\mu\text{m}$  high) (Fig. 2e and f). *Ascospores* 75–95 × 15–26  $\mu\text{m}$  ( $\bar{x}$  = 84.3 × 17.5  $\mu\text{m}$ ,  $n$ =10), obliquely uniseriate and partially overlapping, broadly fusoid to fusoid with narrowly rounded ends in front view, flat on one side from side view (14–20  $\mu\text{m}$  thick), yellowish brown, apical cells usually hyaline, muriform, with 14–17(–18) transversal septa, 1–3 longitudinal septa in most cells, slightly constricted at the septa, with a gelatinous cap at each end (Fig. 2c and d).

**Anamorph:** none reported.

**Material examined:** BELIZE, Wee-Wee Cay, on submerged wood of roots and branches of *Rhizophora mangle* L., Mar. 1983, leg. J. Kohlmeyer (NY, J.K. 4332b, **isotype**).

### Notes

### Morphology

*Aigialus* was formally established by Kohlmeyer and Schatz (1985) based on its immersed or semi-immersed ascomata with periphysate ostiole, trabeculate pseudoparaphyses, cylindrical and fissitunicate asci, and distinctive muriform ascospores with gelatinous sheath or caps. There are five accepted species in the genus, namely *A. grandis*, *A. mangrovei* Borse, *A. parvus* S. Schatz & Kohlm., *A. rhizophorae* Borse and *A. striatispora* K.D. Hyde (Jones et al. 2009). *Aigialus* was first assigned to the *Melanommatales*, but its familial status was uncertain (Kohlmeyer and Schatz 1985). Barr (1990b) included *Aigialus* in *Massariaceae* based on its conspicuous apical ring in the asci and ascospore characters, and this has subsequently been widely followed (Eriksson 2006; Hawksworth et al. 1995; Kirk et al. 2001; Lumbsch and Huhndorf 2007).

### Phylogenetic study

The generic type of *Aigialus* (*A. grandis*) together with other three marine species, i.e. *A. mangrovei*, *A. parvus* as well as *A. rhizophorae* form a robust clade on the phylogenetic tree. Thus a new family, *Aigialaceae*, was introduced to accommodate *Aigialus* together with *Ascocratera* and *Rimora* (Suetrong et al. 2009).

### Concluding remarks

The pleosporalean status of *Aigialus* has been phylogenetically verified, and the single branch containing *Aigialus*, *Ascocratera* and *Rimora* represents a familial rank of *Aigialaceae* (Suetrong et al. 2009).

*Amniculicola* Yin. Zhang & K.D. Hyde, Mycol. Res. 112: 1189 (2008). (*Amniculicolaceae*)

### Generic description

Habitat freshwater, saprobic. *Ascomata* solitary, scattered, or in small groups, initially immersed, becoming erumpent,



**Fig. 2** *Aigialus grandis* (from NY, J.K. 4332b, **isotype**). **a** Ascomata on the host surface. Note the longitudinal slit-like furrow which is the ostiole. **b** Section of the peridium. **c**, **d** Released ascospores. **e**

Ascospores in ascus. Note the conspicuous apical ring. **f** Cylindrical ascus with a long pedicel. Scale bars: **a**=1 mm, **b**=200  $\mu$ m, **c**–**f**=20  $\mu$ m

to nearly superficial, globose, subglobose to conical, wall black, roughened; apex well differentiated into two tuberculate flared lips surrounding a slit-like ostiole. *Peridium* thin, 2-layered, outer layer composed of small heavily pigmented thick-walled cells of *textura angularis*, inner layer composed of hyaline thin-walled cells of *textura angularis*. *Hamathecium* of dense, long trabeculate pseudoparaphyses, embedded in mucilage, anastomosing between and above the asci. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical to narrowly fusoid, short pedicellate, with an ocular chamber and a small apical apparatus. *Ascospores* fusoid, hyaline, 1-septate, constricted at the septum, surrounded by an irregular hyaline gelatinous sheath.

**Anamorphs reported for genus:** *Anguillospora longissima*, *Spirosphaera cupreorufescens* and *Repetophragma ontariense* (Zhang et al. 2008c, 2009c).

**Literature:** Zhang et al. 2008c, 2009a, c.

#### Type species

*Amniculicola lignicola* Ying Zhang & K.D. Hyde, Mycol. Res. 112: 1189 (2008). (Fig. 3)

*Ascomata* 350–450  $\mu\text{m}$  high  $\times$  300–500  $\mu\text{m}$  diam., solitary, scattered, or in small groups of 2–3, initially immersed, becoming erumpent, to nearly superficial, with basal wall remaining immersed in host tissue, globose, subglobose, broadly or narrowly conical, often laterally flattened, with a flattened base not easily removed from the substrate, wall black, roughened, often bearing remnants of wood fibers; apex well differentiated into two tuberculate flared lips surrounding a slit-like ostiole, 150–250  $\mu\text{m}$  long, filled with a purplish amorphous matter, oriented in the axis of the wood fibers; underlying wood stained pale purple (Fig. 3a and b). *Peridium* 40–55  $\mu\text{m}$  thick laterally, up to 120  $\mu\text{m}$  thick at the apex, thinner at the base, coriaceous, 2-layered, outer layer composed of small heavily pigmented thick-walled cells of *textura angularis*, cells 4–9  $\mu\text{m}$  diam., cell wall 2–3  $\mu\text{m}$  thick, apex cells smaller and walls thicker, inner layer composed of hyaline thin-walled cells of *textura angularis*, 8–16  $\mu\text{m}$  diam., in places with columns of *textura prismatica*, oriented perpendicular to the ascomatal surface, and larger, paler cells of *textura prismatica* towards the interior and at the base, 10–25  $\mu\text{m}$  (Fig. 3c, d and e). *Hamathecium* of dense, long trabeculate pseudoparaphyses <1  $\mu\text{m}$  broad, embedded in mucilage (Indian ink), anastomosing between and above the asci. *Asci* 140–184  $\times$  9–10  $\mu\text{m}$ , 8-spored, bitunicate, fissitunicate, cylindrical to narrowly fusoid, with a short, narrowed, twisted, furcate pedicel which is 15–25  $\mu\text{m}$  long, with a low truncate ocular chamber and a small inconspicuous apical apparatus barely seen in water (Fig. 3f). *Ascospores* (20.5–)28–32  $\times$  (6–)8(–9)  $\mu\text{m}$ , obliquely uniseriate and partially overlapping, broadly fusoid to fusoid with broadly to narrowly rounded ends, hyaline, 1-septate, deeply constricted at the median septum, the upper cell often

shorter and broader than the lower one, smooth, containing four refractive globules, surrounded by an irregular hyaline gelatinous sheath 4–8.5  $\mu\text{m}$  thick, best seen in India ink, released senescent ascospores are greyish and 3-septate, strongly constricted at all septa (Fig. 3g).

**Anamorph:** none reported.

Colonies slow growing, reaching 4 cm diam. after 70 d growth on Malt Extract Agar (MEA) at 25°C, flat, with irregular to rhizoidal margin, off-white to grey, reverse reddish purple to deep reddish purple, the medium is stained pale yellow.

**Material examined:** FRANCE, Ariège, Prat Communal, Ruisseau de Loumet, 1000 m, on partly submerged wood of *Fraxinus excelsior*, 8 Aug. 2006, leg. Jacques Fournier (PC 0092661, **holotype**); 3 Sept. 2004 (BPI 877774; CBS: H-17932); Rimont, Ruisseau de Peyrau, 400 m, on driftwood of *Alnus glutinosa* (L.) Gaertn., 23 Jul. 2006 (HKU(M) 17515, **isotype**).

#### Notes

#### Morphology

*Amniculicola* is a freshwater genus which stains the woody substrate purple (Zhang et al. 2008c, 2009a, c). This genus appears only to be reported from Europe. A detailed description of the generic type was provided by Zhang et al. (2008c).

#### Phylogenetic study

Three species of *Amniculicola* cluster together with *Anguillospora longissima*, *Spirosphaera cupreorufescens* and *Repetophragma ontariense* as well as *Pleospora rubicunda* Niessl (current name *Murispora rubicunda* (Niessl) Y. Zhang et al. & K.D. Hyde) and *Massariosphaeria typhicola* (P. Karst.) Leuchtm. (current name *Neomassariosphaeria typhicola* (P. Karst.) Yin, Zhang, J. Fourn. & K.D. Hyde). A new family, i.e. *Amniculicolaceae*, was introduced to accommodate these taxa (Zhang et al. 2008c, 2009a, c).

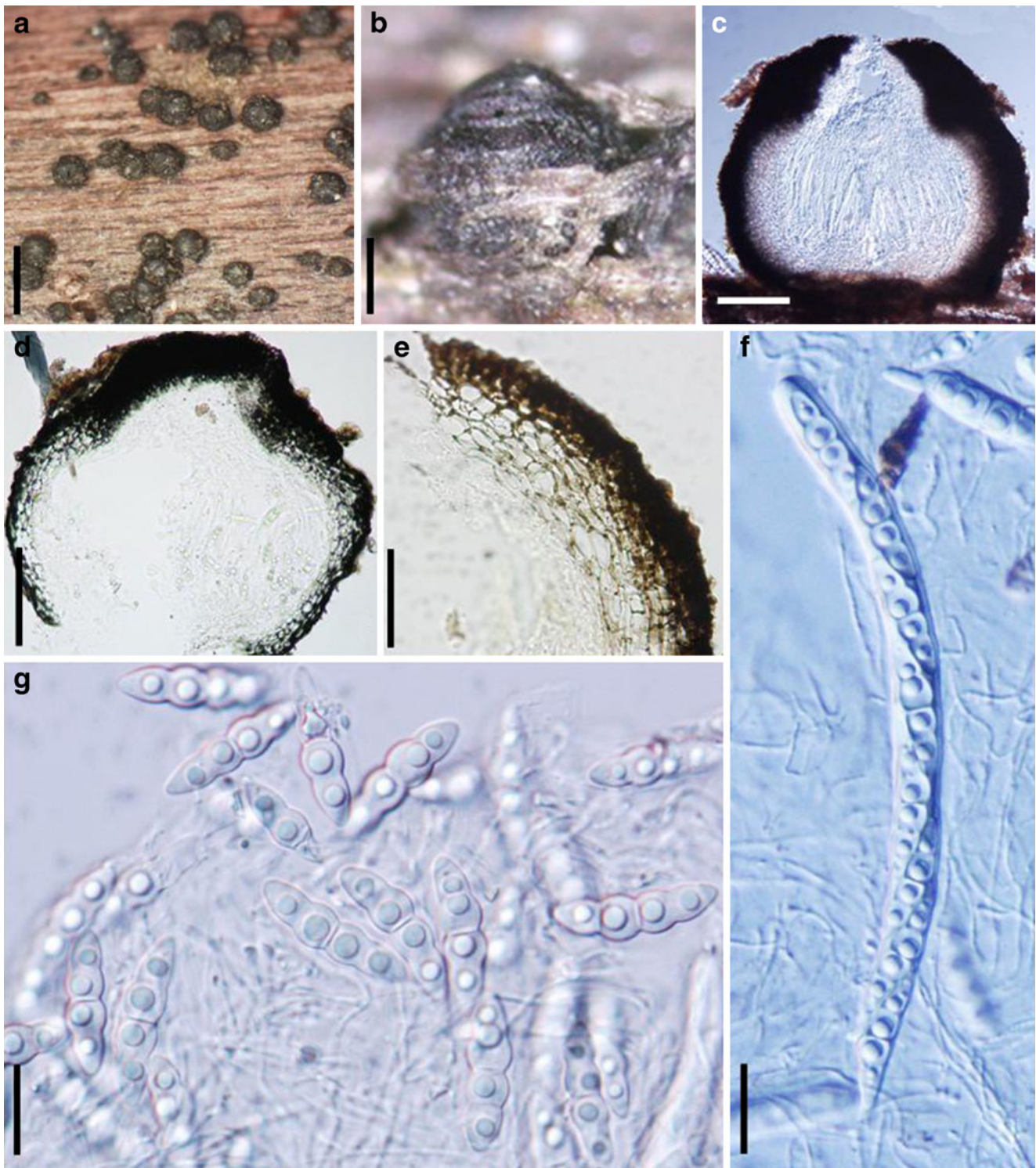
#### Concluding remarks

All of the five teleomorphic taxa within *Amniculicolaceae* are from freshwater in Europe and their ascomata stain the woody substrate purple. Purple staining makes taxa of this family easily recognized in the field.

*Anomalemma* Sivan., Trans. Br. Mycol. Soc. 81: 328 (1983). (?*Melanommataceae*)

#### Generic description

Habitat terrestrial, fungicolous. *Ascomata* gregarious, superficial, papillate, ostiolate. *Peridium* composed cells of pseudoparenchymatous. *Asci* clavate, 8-spored. *Hamathecium* of dense, filliform pseudoparaphyses. *Ascospores*



**Fig. 3** *Amniculicola lignicola* (from PC 0092661, **holotype**). **a** Superficial ascomata gregarious on the host surface. **b** An erumpent ascoma with elongated papilla and slit-like ostiole. **c** Habitat section of a superficial ascoma. **d**, **e** Section of an ascoma and the partial

peridium. **f** Cylindrical 8-spored ascus with a short pedicel. **g** Hyaline, 1-septate broadly fusoid ascospores. Scale bars: **a**=1 mm, **b–d**=100  $\mu$ m, **e**=50  $\mu$ m, **f**, **g**=20  $\mu$ m

1- (rarely 2- to 3-) septate, fusoid, reddish brown, constricted at the main septum.

**Anamorphs reported for genus:** *Exosporiella* (= *Phanero-corynella*) (Sivanesan 1983).





**Fig. 4** *Anomalemma epochnii* (from K(M):143936, **syntype**). **a** Gregarious ascomata on the host surface. **b, c** Bitunicate asci. Note the wide pseudoparaphyses. **d** Section of the apical peridium comprising

thick-walled cells of *textura angularis*. **e–h** Fusoid to broadly fusoid ascospores. Scale bars: **a**=0.5 mm, **b–h**=20  $\mu$ m

**Literature:** Berkeley and Broome 1866; Keissler 1922; Massee 1887; Saccardo 1878a; Sivanesan 1983.

### Type species

*Anomalemma epochnii* (Berk. & Broome) Sivan., Trans. Br. Mycol. Soc. 81: 328 (1983). (Fig. 4)

= *Sphaeria epochnii* Berk. & Broome, Ann. Mag. nat. Hist., Ser. 3 18: 128 (1866).

*Ascomata* 340–500  $\mu\text{m}$  high  $\times$  170–286  $\mu\text{m}$  diam., gregarious on the intertwined hyphae, superficial, papillate, wall black, coriaceous, roughened (Fig. 4a). *Peridium* composed of two types of cells, outer layer 17–22  $\mu\text{m}$  wide, composed of heavily pigmented thick-walled cells of *textura angularis*, cells up to 8  $\times$  13  $\mu\text{m}$  diam., cell wall 1–1.5  $\mu\text{m}$  thick, inner layer 30–34  $\mu\text{m}$  thick, composed of hyaline thin-walled cells (Fig. 4d). *Hamathecium* of dense, long cellular pseudoparaphyses, 2–4  $\mu\text{m}$  broad, septate. *Asci* 75–108  $\times$  9.5–12.5  $\mu\text{m}$  ( $\bar{x}$  = 92.8  $\times$  11.1  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, dehiscence not observed, cylindro-clavate to clavate, with a furcate pedicel up to 6–25  $\mu\text{m}$  long, with a small ocular chamber best seen in immature asci (ca. 2  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 4b and c). *Ascospores* 20–25(–30)  $\times$  5–7.5  $\mu\text{m}$  ( $\bar{x}$  = 23.1  $\times$  6.3  $\mu\text{m}$ ,  $n$ =10), obliquely uniseriate and partially overlapping to biseriate, fusoid to narrowly fusoid with narrowly rounded ends, brown, 1-septate, rarely 2- to 3-septate, deeply constricted at the median septum, smooth (Fig. 4e, f, g and h).

**Anamorph:** *Exosporiella fungorum* (Fr.) P. Karst. (Sivanesan 1983).

= *Epochnium fungorum* Fr., Syst. mycol. 3: 449 (1832).

*Mycelium* composed of branched, septate, pale brown hyphae. *Stroma* none. *Conidiophores* macronematous or semi-macronematous, mononematous, hyaline, smooth, branched towards the apex. *Conidiogenous cells* monoblastic, cylindrical or doliform. *Conidia* cylindrical or ellipsoidal, dry, 3–4-septate, smooth, hyaline or pale brown.

**Material examined:** UK, England, Warleigh near Bath, on fungus on bark (*Epochnium* sp.), Mar. 1866, leg. Warbright? (K(M):143936, **syntype**, ex herb. C.E. Broome).

### Notes

#### Morphology

*Sphaeria epochnii* was first described and illustrated by Berkeley and Broome (1866) from Britain and the anamorphic stage is the hyphomycetous *Epochniella fungorum*. *Sphaeria epochnii* has subsequently been transferred to *Melanomma* (as *M. epochnii* (Berk. & Broome) Sacc.; Saccardo 1878a), *Byssosphaeria* (as *B. epochnii* (Berk. & Broome) Cooke; Massee 1887) and *Chaetosphaeria* (as *C. epochnii* (Berk. & Broome) Keissl.; Keissler 1922). The deposition of *Sphaeria epochnii* in *Chaetosphaeria* is obviously unacceptable, as *Chaetosphaeria* has unitunicate asci. *Melanomma* has been

reported having *Aposphaeria* or *Pseudospiropes* anamorphs, which differs from *Exosporiella* (Sivanesan 1983). In addition, the presence of well developed prosenchymatous stroma in *Sphaeria epochnii* can also readily distinguish it from *Melanomma* (Sivanesan 1983).

The gregarious ascomata and formation of prosenchymatous stroma of *Anomalemma* resembles those of *Cucurbitaria*, but the pleosporaceous dictyosporous ascospores of *Cucurbitaria* readily distinguish it from *Anomalemma epochnii*. In addition, the pseudoparenchymatous peridium, fungicolous habitat and brown 1-septate ascospores, which later becoming 3-septate differ from any other pleosporalean genus. Thus a new genus, *Anomalemma*, was introduced to accommodate it (Sivanesan 1983). *Anomalemma* is presently monotypic.

#### Phylogenetic study

None.

#### Concluding remarks

*Anomalemma epochnii* certainly resembles *Byssosphaeria* in its ascomata clustering together in groups on closely intertwined hyphae and brown ascospores, and may well be included in this genus. Its fungicolous habitat, however, distinguishes it from *Byssosphaeria*.

**Appendispora** K.D. Hyde, Sydowia 46: 29 (1994a). (?*Didymellaceae*)

#### Generic description

Habitat terrestrial, saprobic. *Ascomata* small, clustered, immersed, subglobose or irregularly pyriform. *Peridium* thin. *Hamathecium* of dense, long trabeculate pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, apical rounded with ocular chamber and faint ring, with short pedicels. *Ascospores* uniseriate to partially overlapping, fusoid, brown, 1-septate, slightly constricted at the septum.

**Anamorphs reported for genus:** none.

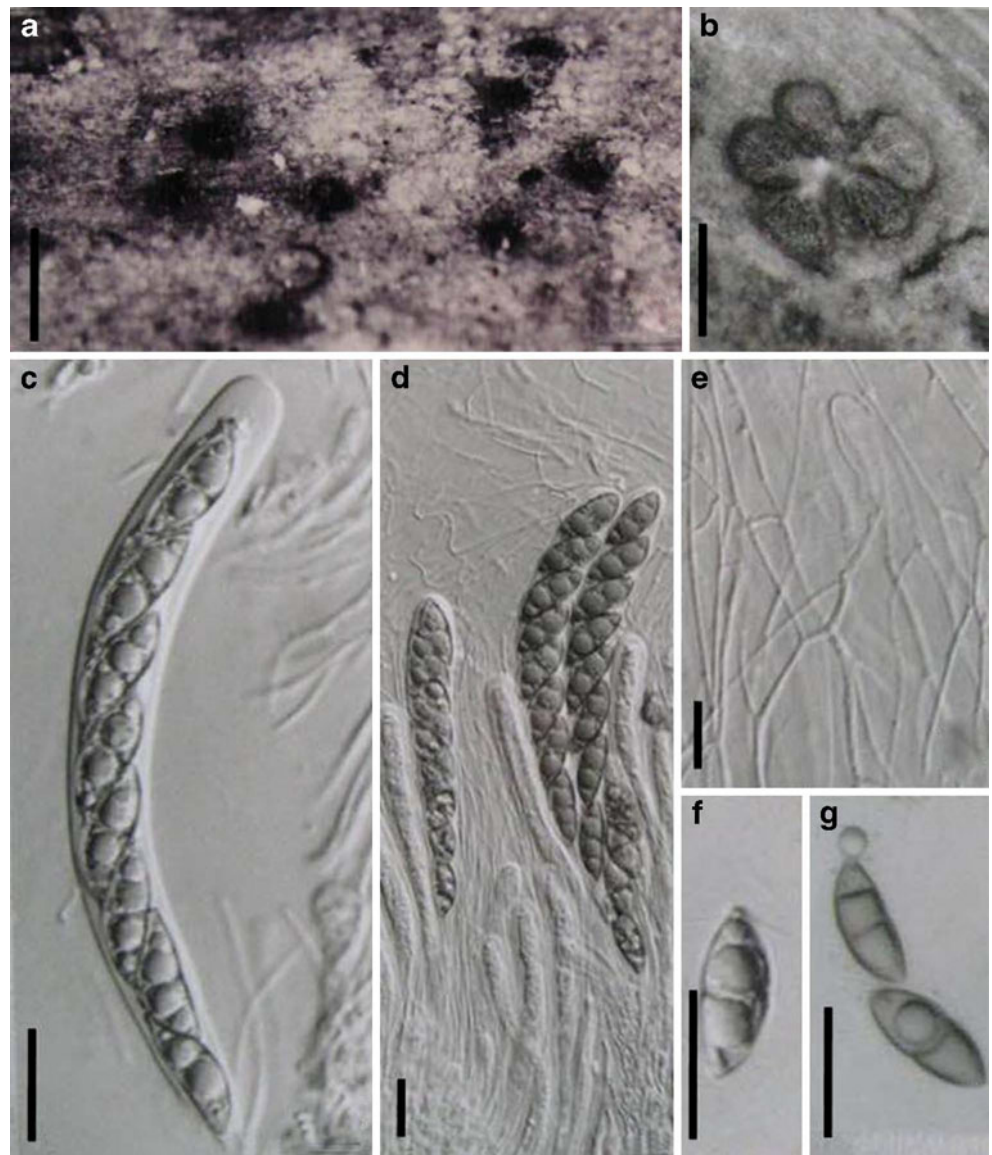
**Literature:** Hyde 1994a.

#### Type species

**Appendispora frondicola** K.D. Hyde, Sydowia 46: 30 (1994a). (Fig. 5)

*Ascomata* 120–280  $\mu\text{m}$  high  $\times$  180–280  $\mu\text{m}$  diam., clustered, immersed with minute ostioles visible through cracks or blackened dots on the host surface, subglobose or irregularly pyriform (Fig. 5a and b). *Peridium* 40  $\mu\text{m}$  thick, comprising two types of cells; outer cells, small heavily pigmented thick-walled cells of *textura angularis*, inner cells compressed, hyaline. *Hamathecium* of dense, very long trabeculate pseudoparaphyses, ca. 1  $\mu\text{m}$  broad, embedded in mucilage, hyaline, anastomosing (Fig. 5e). *Asci* 130–144  $\times$  11–

**Fig. 5** *Appendispora frondicola* (from BRIP 21354, **holotype**). **a** Immersed ascomata on host surface. **b** Valsoid configuration of the ascomata. **c** Cylindrical ascus. **d** Squash showing asci and numerous pseudoparaphyses. **e** Thin strands of anastomosing pseudoparaphyses. **f, g** Ascospores with one or two appendages. Scale bars: **a, b**=0.5 mm, **c–g**=30  $\mu$ m



13  $\mu$ m, 8-spored, bitunicate, fissitunicate, cylindrical, with an ocular chamber and faint ring, with short pedicels (Fig. 5c and d). Ascospores 21–30 $\times$ 7–9  $\mu$ m, uniseriate to partially overlapping, fusoid, brown, 1-septate, slightly constricted at the septum, with an irregular ridged ornamentation and 3–5 narrow appendages at each end (Fig. 5f and g).

**Anamorph:** none reported.

**Material examined:** BRUNEL, Jalan, Muara, Simpang 835, on dead rachis of *Oncosperma horridum* on forest floor, Nov. 1992, K.D. Hyde 1652 (BRIP 21354, **holotype**).

## Notes

## Morphology

*Appendispora* was described as a saprobe of palm, and is characterized by small, immersed ascomata, bitunicate,

fissitunicate asci, trabeculate pseudoparaphyses, brown, 1-septate, appendaged ascospores with irregular wall striations (Hyde 1994a). Based on its trabeculate pseudoparaphyses embedded within gel matrix and its brown ascospores, *Appendispora* was assigned to *Didymosphaeriaceae* (Barr 1987b; Hyde 1994a).

## Phylogenetic study

None.

## Concluding remarks

The saprobic habitat and association with monocots, cylindrical asci, trabeculate pseudoparaphyses as well as its brown, 1-septate ascospores make it difficult to determine a better phylogenetic position than *Didymellaceae*.

*Ascorhombispora* L. Cai & K.D. Hyde, Cryptog. Mycol. 28: 294 (2007). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat freshwater, saprobic. *Ascomata* solitary or gregarious, superficial, globose to subglobose, dark brown to black, short papillate, ostiolate, coriaceous. *Peridium* relatively thin, *textura angularis* in longitudinal section, 2-layered. *Hamathecium* not observed. *Asci* 8-spored, obpyriform, broadly clavate to saccate, pedicellate, bitunicate, apex rounded, persistent. *Ascospores* overlapping 2-3-seriate, broadly fusoid to rhomboid, thick-walled, surrounded by mucilaginous sheath, 3-euseptate, not constricted at septa, median septum wide, forming a darker band, central cells large, trapezoid, dark brown to black, verruculose, polar end cells small and paler.

**Anamorphs reported for genus:** none.

**Literature:** Cai and Hyde 2007.

### Type species

*Ascorhombispora aquatica* L. Cai & K.D. Hyde, Cryptog. Mycol. 28: 295 (2007). (Fig. 6)

*Ascomata* 140–170  $\mu\text{m}$  high  $\times$  150–185  $\mu\text{m}$  diam., solitary or gregarious, superficial, globose to subglobose, dark brown to black, short papillate, ostiolate, ostioles rounded, small, coriaceous. *Peridium* relatively thin, 10–18  $\mu\text{m}$  wide, *textura angularis* in longitudinal section, composed of two layers of angular cells, outer later dark brown to black, relatively thick-walled, inner layer hyaline, relatively thin-walled (Fig. 6a and b). *Hamathecium* not observed. *Asci* 100–198  $\times$  72–102  $\mu\text{m}$  ( $\bar{x}$  = 186  $\times$  88  $\mu\text{m}$ ,  $n$ =15), 8-spored, obpyriform, broadly clavate to saccate, pedicellate, bitunicate, apex rounded, deliquescent (Fig. 6c, d and e). *Ascospores* 30.5–45  $\times$  16–26.5  $\mu\text{m}$  ( $\bar{x}$  = 38.5  $\times$  21  $\mu\text{m}$ ,  $n$ =25), overlapping 2-3-seriate, broadly fusoid to rhomboid, thick-walled, surrounded by mucilaginous sheath, 3-euseptate, not constricted at septa, median septum wide, forming a darker band, central cells large, trapezoid, 11–18  $\mu\text{m}$  long, dark brown to black, verruculose, polar end cells small, hemispherical, 3.5–4  $\mu\text{m}$  long, subhyaline to pale brown, smooth (Fig. 6f).

**Anamorph:** none reported.

**Material examined:** CHINA, Yunnan, Jinghong, on submerged bamboo in a small forest stream, 26 Jan. 2003, leg. det. L. Cai, CAI-1H31 (HKU(M) 10859, **holotype**).

### Notes

### Morphology

*Ascorhombispora* was introduced as a monotypic genus from freshwater by Cai and Hyde (2007), and is characterized by superficial, coriaceous, non-stromatic ascomata, large, saccate asci; lack of interascal filaments

and trapezoid (rhombic), 3-septate, dark brown to black ascospores with smaller end cells which are subhyaline to pale brown. *Ascorhombispora* is most comparable with *Caryospora* and *Zopfia*. But the globose to subglobose ascomata and thin peridium, saccate asci lacking interascal pseudoparaphyses, and the 3-septate, rhomboid ascospores with the paler end cells of *Ascorhombispora* differs from those of *Caryospora* (Cai and Hyde 2007).

### Phylogenetic study

Phylogenetic analysis based on either SSU or LSU rDNA sequences indicated that *Ascorhombispora aquatica* belongs to *Pleosporales*, but its familial placement was left undetermined (Cai and Hyde 2007).

### Concluding remarks

The sac-shaped asci and absence of pseudoparaphyses are uncommon in *Pleosporales*, especially among those from freshwater.

*Asteromassaria* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. I 126: 368 (1917). (?*Morosphaeriaceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium-sized, clustered, at first immersed and then breaking through the host surface and becoming superficial, globose, subglobose, coriaceous. *Peridium* 2-layered, thicker near the base. *Hamathecium* of dense, septate, cellular pseudo-paraphyses which branch and anastomosing frequently between and above asci. *Asci* (4-)8-spored, bitunicate, cylindro-clavate to clavate, with a short truncated pedicel and a small ocular chamber. *Ascospores* obliquely uniseriate and partially overlapping to biseriate, fusoid to fusoid-ellipsoidal, pale brown when mature, 1-septate, some becoming 3-septate when old, constricted at the median septum.

**Anamorphs reported for genus:** *Scolicosporium* (Sivanesan 1984).

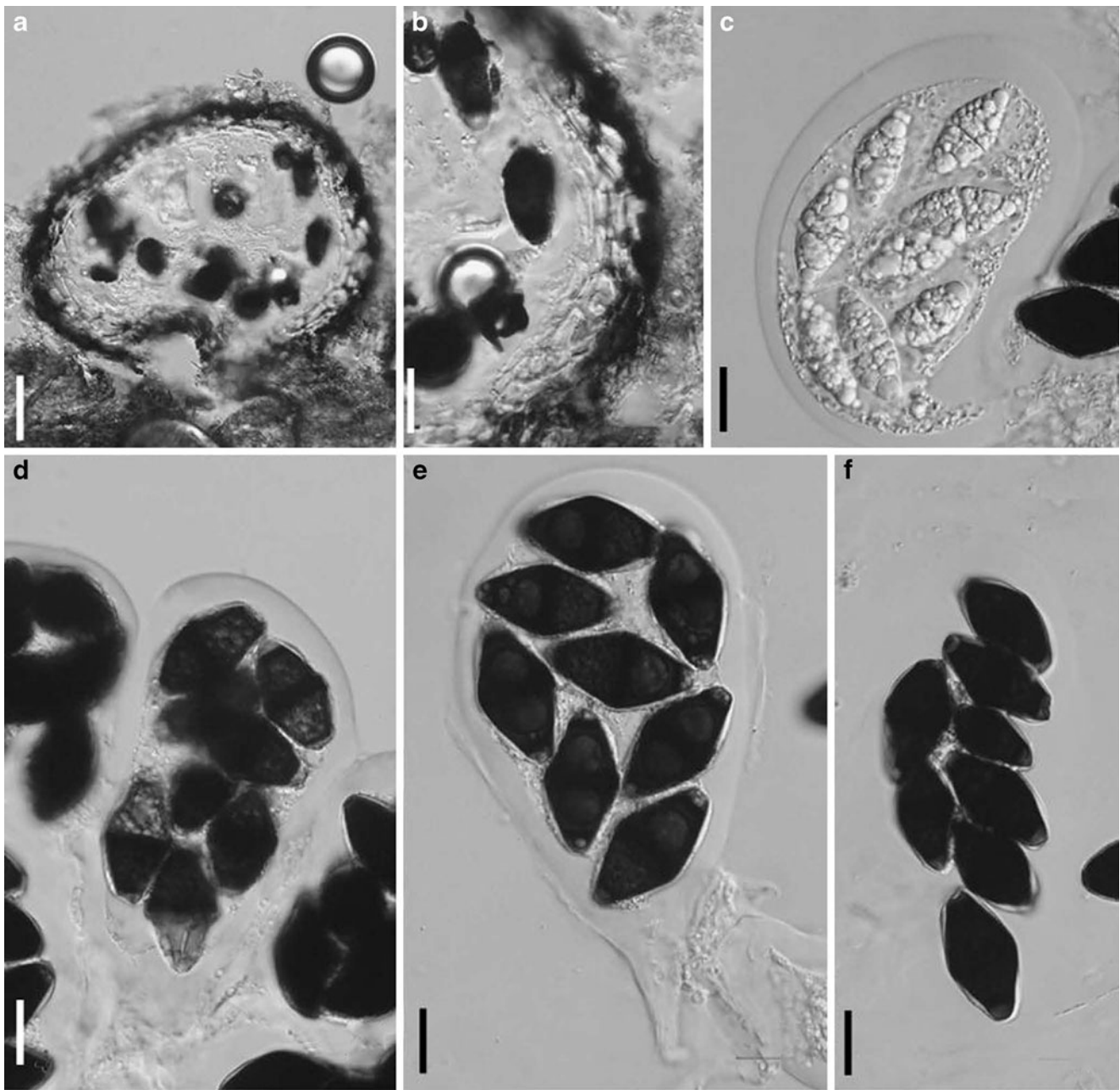
**Literature:** Barr 1982a; b; 1993a; Boise 1985; Shoemaker and LeClair 1975; Sivanesan 1987; Tanaka et al. 2005.

### Type species

*Asteromassaria macrospora* (Desm.) Höhn., F. von, Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. I 126: 368 (1917). (Fig. 7)

$\equiv$  *Sphaeria macrospora* Desm., Ann. Sci. Nat. Bot. 10: 351 (1849).

*Ascomata* 400–600  $\mu\text{m}$  high  $\times$  450–650  $\mu\text{m}$  diam., 4–20 clustered together, at first immersed and then breaking through the host surface and becoming superficial, globose,



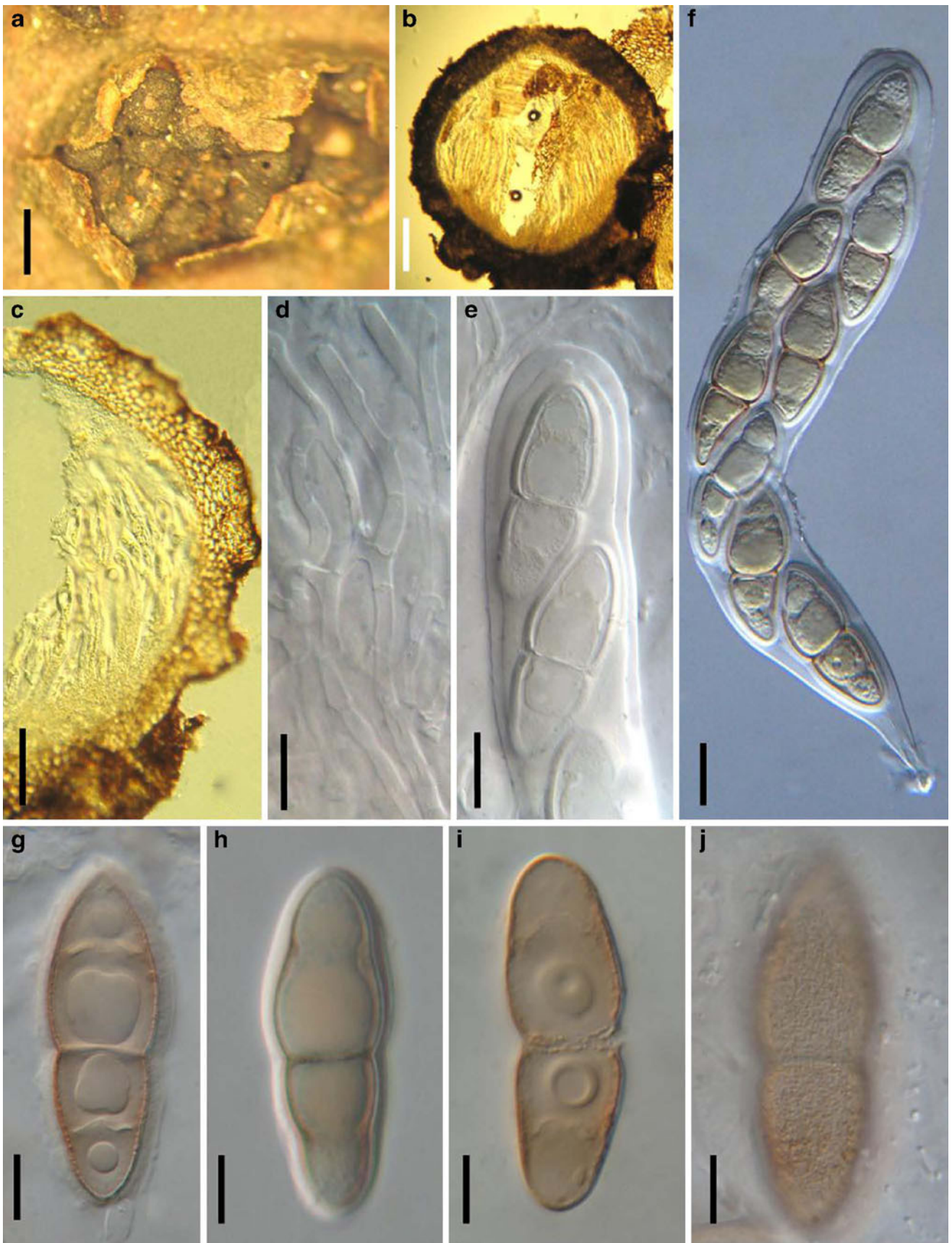
**Fig. 6** *Ascorhombispora aquatica* (from HKU(M) 10859, holotype). **a** Section of an ascoma. **b** Section of a partial peridium. **c** Immature ascus. **d–f** Mature asci with ascospores. Note the deliquescent ascus wall in **f**. Note the wide, dark band in the medium septum of

ascospores in **d** and **e** and the mucilaginous sheath and paler end cells in **e** and **f**. Scale bars: **a**=20  $\mu\text{m}$ , **b–f**=15  $\mu\text{m}$  (figures referred to Cai and Hyde 2007)

subglobose, not easily removed from the substrate, wall black, coriaceous, roughened, apex usually widely porate, with or without papilla (Fig. 7a). Peridium 70–90  $\mu\text{m}$  wide, thicker near the base where it is up to 180  $\mu\text{m}$  wide, comprising two cell types, outer cells composed of heavily pigmented small cells, cells 3–5  $\mu\text{m}$  diam., inner layer composed of less pigmented cells of *textura angularis*, 10–20  $\mu\text{m}$  diam. (Fig. 7b and c). Hamathecium of dense, septate, 2–3  $\mu\text{m}$  broad, pseudoparaphyses which branch and anasto-

mosing frequently between and above asci (Fig. 7d). Asci (180–)200–280 $\times$ 28–43  $\mu\text{m}$  ( $\bar{x}$  = 230  $\times$  35 $\mu\text{m}$ ,  $n$ =10), 8–

**Fig. 7** *Asteromassaria macrospora* (from L, 1004). **a** Ascomata clustered in a group breaking through the host surface. **b** Section of an ascoma. **c** Section of a partial peridium. Note the cells of *textura angularis*. **d** Pseudoparaphyses. Note the branches. **e** Upper part of the ascus illustrating the ocular chamber. **f** Ascus with a short pedicel. **g–j** Ascospores. Note the mucilaginous sheath in **g** and minutely verruculose ornamentation in **j**. Scale bars: **a**=0.5 mm, **b**, **c**=100  $\mu\text{m}$ , **d–j**=10  $\mu\text{m}$



spored (sometimes 4-spored), bitunicate, fissitunicate dehiscence not observed, cylindro-clavate to clavate, with a short truncated pedicel up to 30  $\mu\text{m}$ , with a small ocular chamber (ca. 3  $\mu\text{m}$  wide  $\times$  3  $\mu\text{m}$  high) (Fig. 7e and f). *Ascospores* 50–58  $\times$  (14–)18–21  $\mu\text{m}$  ( $\bar{x}$  = 55.3  $\times$  18.2  $\mu\text{m}$ ,  $n$ =10), obliquely uniseriate and partially overlapping to biseriate, fusoid to fusoid-ellipsoidal, with narrowly rounded ends, lightly brown when mature, 1-septate, some becoming 3-septate when old, constricted at the median septum, the upper cell often broader and longer than the lower one, minutely verrucose (Fig. 7g, h, i and j).

**Anamorph:** *Scolicosporium macrosporium* (Berk.) B. Sutton.

*Acervuli* immersed in bark, brown, discrete, up to 250  $\mu\text{m}$  diam., opening by irregular rupture of the overlying tissues. *Peridium* of thin-walled angular cells. *Conidiophores* cylindrical, 1-2-septate, up to 30  $\mu\text{m}$  long and 3–5  $\mu\text{m}$  wide. *Conidiogenous cells* holoblastic, 1-2-annellate, cylindrical, hyaline. *Conidia* 100–190  $\times$  12–15  $\mu\text{m}$ , fusoid, pale brown with paler or hyaline ends, 7–17 transverse septate, smooth-walled, with a tapered apex and truncate base (adapted from Sivanesan 1984).

**Material examined:** CZECH REPUBLIC, Mährisch-Welbkirchen (Hranice), Wsetin (Vsetin), Berg Čap., on *Fagus sylvatica* L., Aug. 1938, F. Petrak (L, 1004).

## Notes

### Morphology

In this study we were unable to obtain the holotype, so we used a collection of Petrak's. The main morphological characters of *Asteromassaria* are the medium- to large-sized, globose to depressed ascomata opening with a pore, clavate to oblong asci, narrowly cellular pseudoparaphyses, pale to dark brown, bipolar symmetric, mostly fusoid, distoseptate or euseptate ascospores (Barr 1993a). The bipolar symmetric ascospores of *Asteromassaria* can readily be distinguished from other genera of this family (Barr 1993a; Tanaka et al. 2005). Currently, it comprises 12 species (Tanaka et al. 2005; <http://www.mycobank.org>, 28-02-2009).

### Phylogenetic study

*Asteromassaria pulchra* (Harkn.) Shoemaker & P.M. LeClair is basal to *Morosphaeriaceae* in the phylogenetic tree based on four genes, but its placement is influenced by taxon sampling that was different in several analyses.

### Concluding remarks

*Asteromassaria* can be distinguished from other comparable genera, i.e. *Pleomassaria* and *Splanchnonema* by 1-septate and pale brown ascospores, thick-walled *textura*

*angularis* peridium and *Scolicosporium* anamorphic stage (see under *Pleomassaria*).

*Astrosphaeriella* Syd. & P. Syd., Annl. mycol. 11: 260 (1913). (?*Melanommataceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* densely scattered or in small groups, erumpent through the outer layers of the host tissues to nearly superficial, reflexed pieces of the ruptured host tissue usually persisting around the base of the ascomata, often star-like, conical to semiglobose, with a central papilla. *Peridium* upper wall usually comprising a thick dark brittle pseudoparenchymatous layer, base usually flattened and thin-walled. *Hamathecium* of dense, filliform, trabeculate pseudoparaphyses, embedded in mucilage. *Asci* 8-spored, bitunicate, fissitunicate, cylindro-clavate to narrowly fusoid. *Ascospores* narrowly fusoid with acute ends, hyaline, pale brown or brown, 1-3-septate.

**Anamorphs reported for genus:** *Pleurophomopsis* (Hyde et al. 2011).

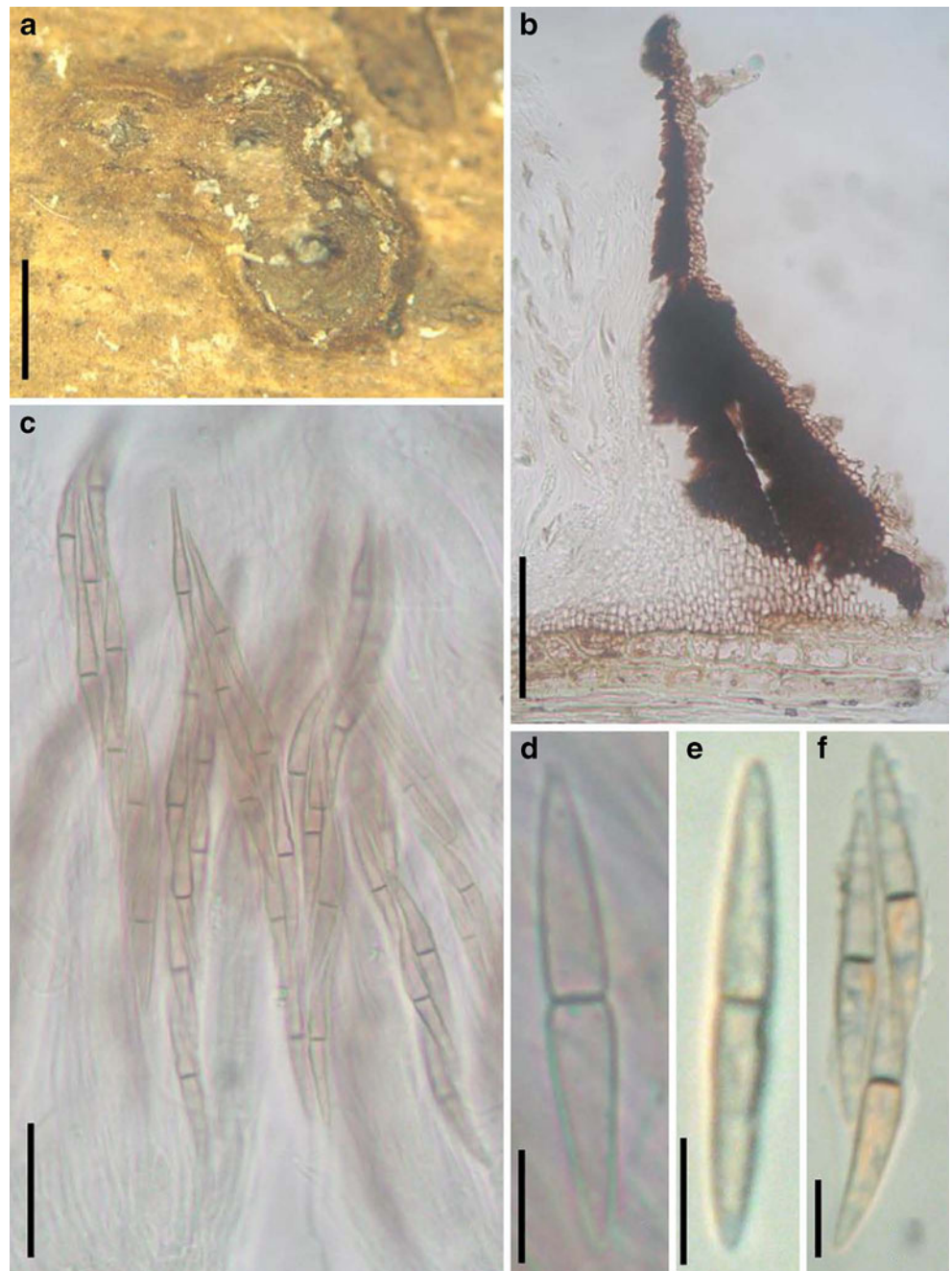
**Literature:** von Arx and Müller 1975; Barr 1990a; Chen and Hsieh 2004; Hawksworth 1981; Hawksworth and Boise 1985; Hyde and Fröhlich 1998; Hyde et al. 2000; Kirk et al. 2001; Sydow and Sydow 1913; Tanaka and Harada 2005a; b; Tanaka et al. 2009.

### Type species

*Astrosphaeriella stellata* Syd. & P. Syd., Annl. mycol. 11: 260 (1913). (Fig. 8)

*Ascomata* 360–570  $\mu\text{m}$  high  $\times$  860–1150  $\mu\text{m}$  diam., densely scattered or in small groups, erumpent through the outer layers of the host tissues to nearly superficial, reflexed pieces of the ruptured host tissue usually persisting around the base of the ascomata, forming star-like flanges around the ascomata from the surface view; ascomata broadly conical, with a flattened base not easily removed from the substrate, wall black; apex with a central papilla which is black and shiny at maturity, scarcely projecting (Fig. 8a). *Peridium* 40–70  $\mu\text{m}$  thick, carbonaceous and crisp, 1-layered, composed of very small dark brown thick-walled pseudoparenchymatous cells, cells 2–5  $\mu\text{m}$  diam., cell wall 2–6  $\mu\text{m}$  thick, in places at the base composed of hyaline cells of *textura prismatica*, cells 5  $\times$  8  $\mu\text{m}$  diam. (Fig. 8b). *Hamathecium* of dense, very long trabeculate pseudoparaphyses, <1  $\mu\text{m}$  broad, embedded in mucilage (Indian ink), anastomosing between and above the asci. *Asci* 130–190  $\times$  11.5–15  $\mu\text{m}$  ( $\bar{x}$  = 161.5  $\times$  12.8  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, cylindro-clavate to narrowly fusoid, with a short, narrowed pedicel which is 10–35  $\mu\text{m}$  long, with a large ocular chamber (Fig. 8c). *Ascospores* 35–50  $\times$  5–7.5  $\mu\text{m}$  ( $\bar{x}$  = 43.4  $\times$  6  $\mu\text{m}$ ,  $n$ =10), biseriate, elongate-fusoid, gradually tapering towards the

**Fig. 8** *Astrosphaeriella fusispora* (BISH 145726). **a** Ascocmata forming a small group on host surface. Note the remains of the host forming flanges around the ascocmata. **b** Section of the partial peridium. Note the black peridium and wedge of palisade cells between the lateral and basal walls. **c** Asci in trabeculate pseudoparaphyses. **d–f** Narrowly fusoid ascospores. Scale bars: **a**=1 mm, **b**=100  $\mu$ m, **c**=50  $\mu$ m, **d**=15  $\mu$ m, **f**=10  $\mu$ m



ends, hyaline, turning pale brown when mature, 1(–3)-septate, constricted at the median septum (Fig. 8d,e and f).

**Anamorph:** none reported.

**Material examined:** USA, Hawaii, Kapano Gulch, in bamboo culms, 5 Jun. 1947, leg. Kopf & Rogers, det. Miller (BISH 145726, as *Astrosphaeriella fusispora* Syd. & P. Syd.).

## Notes

### Morphology

*Astrosphaeriella* has been treated as a synonym of *Microthelia* (von Arx and Müller 1975), but the large conical

ascocmata, numerous trabeculate pseudoparaphyses and 1-septate and elongated ascospores of *Astrosphaeriella* all disagree with those of *Microthelia* (Hawksworth 1981). It was assigned to *Platystomaceae* by Barr (1990a) in *Pleosporales* or *Melanommataceae* by Kirk et al. (2001). Following a systematic study of *Astrosphaeriella*, only four species were accepted, i.e. *A. aosimensis* I. Hino & Katum., *A. stellata*, *A. trochus* (Penz. & Sacc.) D. Hawksw. and *A. venezuelensis* M.E. Barr & D. Hawksw. (Hawksworth 1981), and it was defined as a tropical genus, occurring exclusively on palms or bamboo. *Astrosphaeriella stellata* was selected as the type of *Astrosphaeriella*, and *A. fusispora* was regarded



as a synonym of *A. stellata* (Hawksworth 1981). More taxa were subsequently added (Barr 1990a; Hawksworth and Boise 1985; Hyde and Fröhlich 1998), and the generic concept extended to include three elements: 1. typical semi-immersed to superficial ascomata with flattened base, cylindro-clavate asci with fusoid ascospores and trabeculate pseudoparaphyses, i.e. *Astrosphaeriella sensu stricto* (e.g. *A. fusispora* and *A. vesuvius* (Berk. & Broome) D. Hawksw. & Boise); 2. *Trematosphaeria*-like with rounded ascomata (e.g. *A. africana* D. Hawksw.); and 3. *Massarina*-like species with immersed ascomata (e.g. *A. bakeriana* (Sacc.) K.D. Hyde & J. Fröhl.) (Chen and Hsieh 2004; Tanaka and Harada 2005a; b). Currently, a broad generic concept of *Astrosphaeriella* is accepted, and 47 taxa are included in *Astrosphaeriella*.

### Phylogenetic study

Phylogenetic analysis based on LSU and SSU *nucDNA* sequence data indicates that *Astrosphaeriella* is polyphyletic, and located in the basal region of the *Pleosporales* between *Testudinaceae* and *Zopfiaceae/Delitschiaceae* (Tanaka et al. 2009), or basal to *Aigialaceae* (Schoch et al. 2009). The genus is, however, clearly not related to *Trematosphaeria* as previously understood (Boise 1985).

### Concluding remarks

*Astrosphaeriella* is currently polyphyletic and new collections of the different elements listed above are needed in order to understand the placement of various species. We suggest that some immersed bambusicolous species may belong in *Tetraplospheariaceae*.

*Asymmetricospora* J. Fröhl. & K.D. Hyde, Sydowia 50: 183 (1998). (?*Melanommataceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* solitary or in small groups, immersed, black, lenticular in section, uni- or often multi-locular, with a central ostiole without tissue differentiation. *Upper peridium* carbonaceous, thicker at sides and apex. *Lower peridium* composed of irregular-shaped, hyaline cells. *Hamathecium* of trabeculate pseudoparaphyses, branching and anastomosing between and above asci, embedded in mucilage. *Asci* 8-spored, bitunicate, fissitunicate unknown, clavate, short pedicellate. *Ascospores* 1-septate, hyaline, constricted at the septum, with a broad, spreading mucilaginous sheath.

**Anamorphs reported for genus:** none.

**Literature:** Fröhlich and Hyde 1998.

### Type species

*Asymmetricospora calamicola* J. Fröhl. & K.D. Hyde, Sydowia 50: 184 (1998). (Fig. 9)

*Ascomata* 675–950  $\mu\text{m}$  high  $\times$  875–1500  $\mu\text{m}$  diam., solitary or in small groups of 2–10, immersed and forming slightly protruding domes on the substrate surface, with near-white rim around the central ostiole; in vertical view lenticular, multi- or rarely unilocular, individual locules 175–270  $\mu\text{m}$  high  $\times$  320–400  $\mu\text{m}$  diam., with a flattened base, ostiole a central opening without tissue differentiation (Fig. 9a). *Upper peridium* 32–70  $\mu\text{m}$  wide, carbonaceous, composed of a few layers of black walled cells of *textura angularis*. *Lower peridium* thinner, composed of hyaline cells of *textura globulosa* or *textura prismatica* (Fig. 9b). *Hamathecium* of long trabeculate pseudoparaphyses, 1.2–1.6(–2)  $\mu\text{m}$  wide, branching and anastomosing between and above asci, embedded in mucilage. *Asci* 137.5–207.5  $\times$  26–35  $\mu\text{m}$  ( $\bar{x}$  = 172.8  $\times$  31.5  $\mu\text{m}$ ,  $n=20$ ), 8-spored, bitunicate, fissitunicate dehiscence not observed, clavate, with short pedicel (to 25  $\mu\text{m}$ ), with ocular chambers (ca. 3  $\mu\text{m}$  wide  $\times$  4  $\mu\text{m}$  high) (Fig. 9c and d). *Ascospores* 35–55  $\times$  10.5–15  $\mu\text{m}$  ( $\bar{x}$  = 44.7  $\times$  12.4  $\mu\text{m}$ ,  $n=50$ ), biseriolate, navicular to obovoid, hyaline, becoming pale brown when senescent, straight or usually curved, smooth, asymmetric, 1-septate, the upper cell larger with a rounded end, basal cell with a tapering end, constricted at the septum, with spreading mucilaginous sheath (Fig. 9e, f and g) (data from Fröhlich and Hyde 1998).

**Anamorph:** none reported.

**Material examined:** AUSTRALIA, North Queensland, Palmerston, Palmerston National Park, on dead rattan of *Calamus caryotooides* A.Cunn. ex Mart., Mar. 1994, J. Fröhlich (HKU(M) 7794, **holotype**).

### Notes

### Morphology

*Asymmetricospora* was introduced as a monotypic genus represented by *A. calamicola* based on its “absence of a subiculum, the absence of short dark setae around the papilla and its asymmetric ascospores” (Fröhlich and Hyde 1998). Because of the immersed ascomata, ostiole and peridium morphology, fissitunicate asci and trabeculate pseudoparaphyses, *Asymmetricospora* was assigned to *Melanommataceae* (*sensu* Barr 1990a; Fröhlich and Hyde 1998).

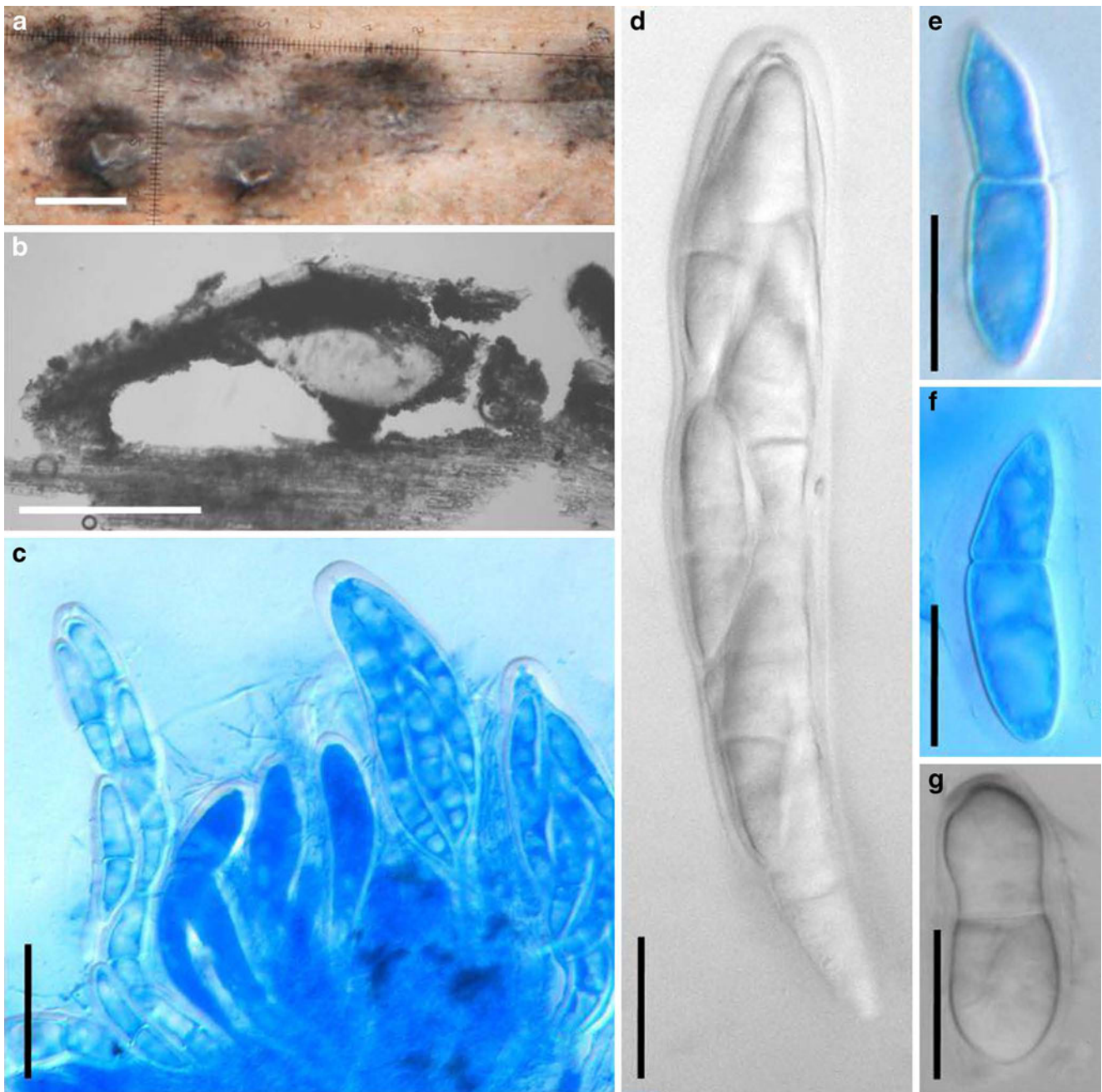
Morphologically *Asymmetricospora* can be distinguished from its most comparable genus, *Astrosphaeriella*, by its ostiole, which is a simple opening without tissue differentiation, asymmetric ascospores, and the usually multi-loculate fruiting body (Fröhlich and Hyde 1998).

### Phylogenetic study

None.

### Concluding remarks

The placement of *Asymmetricospora* under *Melanommataceae* remains to be confirmed.



**Fig. 9** *Asymmetricospora calamicola* (from HKU(M) 7794, **holotype**). **a** Ascomata immersed in the substrate. **b** Section of the peridium. **c** Mature and immature asci in pseudoparaphyses (in *cotton*

*blue*). **d** Clavate ascus with a small ocular chamber. **e–g** Ascospores with sheath. Scale bars: **a, b**=0.5 mm, **c**=50  $\mu\text{m}$ , **d–g**=20  $\mu\text{m}$

*Barria* Z.Q. Yuan, Mycotaxon 51: 313 (1994).  
(*Phaeosphaeriaceae*)

#### Generic description

Habitat terrestrial, parasitic. *Ascomata* small- to medium-sized, solitary or scattered, immersed, globose, subglobose, ostiolate, coriaceous. *Apex* with or without papilla and with a pore-like ostiole. *Peridium* 2-layered. *Hamathecium* of dense, long cellular pseudoparaphyses, septate, embedded in mucilage.

*Asci* bitunicate, fissitunicate, cylindrical to clavate, with a short, furcate pedicel. *Ascospores* ellipsoid, hyaline at first, turning brown at maturity, 1-septate, strongly constricted at the septum.

**Anamorphs reported for genus:** none.

**Literature:** Yuan 1994.

#### Type species

*Barria piceae* Z.Q. Yuan, Mycotaxon 51: 314 (1994). (Fig. 10)

**Fig. 10** *Barria piceae* (from NY 92003, **isotype**). **a** Ascoma on the host surface. Note the wide opening ostiole. **b** Section of the partial peridium with two types of cells. **c, d** Asci with ocular chambers and short pedicels. **e, f** Ellipsoid ascospores which are turning brown with thin sheath around them. Scale bars: **a**=0.5 mm, **b**=50  $\mu\text{m}$ , **c, d**=20  $\mu\text{m}$ , **e, f**=10  $\mu\text{m}$



*Ascomata* 240–370  $\mu\text{m}$  high  $\times$  200–320  $\mu\text{m}$  diam., solitary, scattered, immersed, globose, subglobose, coriaceous, apex with or without papilla and with a pore-like ostiole (Fig. 10a). *Peridium* 20–35  $\mu\text{m}$  thick, comprising two cell types, the outer cells comprising 3–4 layers of brown pseudoparenchymatous cells, cells 4–5  $\mu\text{m}$  diam., cell wall 2–3  $\mu\text{m}$  thick, inner cells comprising 3–4 layers of pale brown compressed cells, cells  $2 \times 16 \mu\text{m}$  diam., cell wall 0.5–1.5  $\mu\text{m}$  thick (Fig. 10b). *Hamathecium* of dense, long cellular pseudoparaphyses, 2–3  $\mu\text{m}$  broad, septate. *Asci* 135–200(–220)  $\times$  14–20  $\mu\text{m}$  ( $\bar{x} = 156 \times 16.6 \mu\text{m}$ ,  $n = 10$ ), 8-spored, bitunicate, fissitunicate, cylindrical to cla-

vate, with a short, furcate pedicel, up to 22  $\mu\text{m}$  long, with a large ocular chamber (ca. 4  $\mu\text{m}$  wide  $\times$  3  $\mu\text{m}$  high) (Fig. 10c and d). *Ascospores* 19–21.5  $\times$  10–12  $\mu\text{m}$  ( $\bar{x} = 20.4 \times 11 \mu\text{m}$ ,  $n = 10$ ), uniseriate to partially overlapping, ellipsoid, hyaline or greenish with numerous small guttules at first and olive green to smoky brown at maturity, 1-septate, strongly constricted at the septum, foveolate, surrounded with sheath (Fig. 10e and f).

**Anamorph:** none reported.

**Material examined:** CHINA, Xinjiang Province, Uygur, Urumqi, Tianshan Mountain, on needles of *Picea schrenkiana*, 1 Jul. 1992, Z.Q. Yuan (NY 92003, **isotype**).

## Notes

### Morphology

*Barria* was established by Yuan (1994) as a monotypic genus represented by *B. piceae* according to its “two-celled, pigmented ascospores, pseudoparenchymatous peridium and narrowly cellular pseudoparaphyses” thus differing in its combination of characters from all of the morphologically related dothideomycetous genera, such as *Didymosphaeria*, *Didymoplella* or *Stegasphaeria*. The taxon was considered to belong in *Phaeosphaeriaceae*. Ascomata and colour or shape of ascospores, however, readily distinguish it from other 1-septate *Phaeosphaeriaceae* genera, i.e. *Didymella*, *Lautitia* and *Metameris* (Yuan 1994). *Barria piceae* causes blight of spruce needles.

### Phylogenetic study

None.

### Concluding remarks

The status of *Barria* with its unusual verrucose ascospores and thick gel coating is uncertain. In many ways it resembles *Belizeana*, with its cylindrical asci, 1-septate, ellipsoid ascospores with sheath and verruculose surface (Kohlmeyer and Volkmann-Kohlmeyer 1987). However, the latter is a marine genus while *Barria* causes leaf blight of terrestrial *Picea* (Yuan 1994). The placement in *Phaeosphaeriaceae* seems logical based on the parasitic life style, thin and simple peridium, wide cellular pseudoparaphyses and brown ascospores. However, molecular data are needed to confirm this.

***Belizeana*** Kohlm. & Volkm.-Kohlm., Bot. Mar. 30: 195 (1987). (*Pleosporales*, genera incertae sedis)

### Generic description

Habitat marine, saprobic. *Ascomata* solitary, scattered, or in small groups, medium-sized, immersed to semi-immersed, subglobose to broadly ampulliform, black, ostiolate, carbonaceous. *Peridium* thin, comprising several layers of brown thin-walled cells of *textura angularis*. *Hamathecium* of dense, filliform pseudoparaphyses, rarely branched. *Asci* 8-spored, bitunicate, fissitunicate, broadly cylindrical to clavate, with a short pedicel and an ocular chamber. *Ascospores* uniseriate, broadly ellipsoidal, hyaline, turn pale brown when senescent, 1-septate, constricted at the septum, thick-walled, 2-layered, mature spores with tuberculate ornamentation between the two layers.

**Anamorphs reported for genus:** *Phoma*-like (Kohlmeyer and Volkmann-Kohlmeyer 1987).

**Literature:** Kohlmeyer and Volkmann-Kohlmeyer 1987.

## Type species

***Belizeana tuberculata*** Kohlm. & Volkm.-Kohlm., Bot. Mar. 30: 196 (1987). (Fig. 11)

*Ascomata* 170–300  $\mu\text{m}$  high  $\times$  160–290  $\mu\text{m}$  diam., solitary, scattered, or in small groups of 2–3, immersed to semi-immersed, subglobose to broadly ampulliform, carbonaceous, black, pale brown on the sides, ostiolate, epapillate or shortly papillate, ostiolar canal filled with a tissue of hyaline cells (Fig. 11a). *Peridium* 25–35  $\mu\text{m}$  wide, comprising several layers thin-walled cells of *textura angularis*, which are hyaline inwardly, near the base composed of a hyaline hyphal mass producing asci, up to 20  $\mu\text{m}$  thick (Fig. 11b, c and e). *Hamathecium* of dense, ca. 2  $\mu\text{m}$  broad, filliform pseudoparaphyses, rarely branched, embedded in mucilage (Fig. 11g). *Asci* 145–170  $\times$  20–30  $\mu\text{m}$  ( $\bar{x}$  = 163  $\times$  25  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate, broadly cylindrical to clavate with a short pedicel, thick-walled, with a small ocular chamber (Fig. 11d, f and h). *Ascospores* 21–26  $\times$  13–18  $\mu\text{m}$  ( $\bar{x}$  = 22  $\times$  15  $\mu\text{m}$ ,  $n$  = 10), uniseriate, broadly ellipsoidal, hyaline, turn pale brown when senescent, 1-septate, constricted at the septum, thick-walled, 2-layered, mature spores with tuberculate ornamentation between the two layers (Fig. 11i and j).

**Anamorph:** *Phoma*-like (Kohlmeyer and Volkmann-Kohlmeyer 1987).

**Material examined:** BELIZE, Twin Cays, on *Laguncularia* sp., 7 Apr. 1983, leg. & det. J. Kohlmeyer (Herb. J. Kohlmeyer No. 4398, **holotype**); AUSTRALIA, Towra Point, New South Wales, trunk of eroded tree with oysters and shipworms, intertidal zone, Botany Bay, 23 Aug. 1981 (Herb. J. Kohlmeyer No. 4209, **paratype**).

## Notes

### Morphology

*Belizeana* was formally established to accommodate *B. tuberculata*, an obligate marine fungus, which is characterized by verrucose ascospores (Kohlmeyer and Volkmann-Kohlmeyer 1987). *Belizeana tuberculata* can be assigned to *Pleosporaceae* (*Pleosporales*) according to Luttrell's (1973) treatment and keys of von Arx and Müller (1975), but cannot resolve a proper family based on Barr (1979a, 1983). The unique morphology together with obligate marine habitat makes *B. tuberculata* readily distinguishable from all other taxa of *Pleosporaceae*.

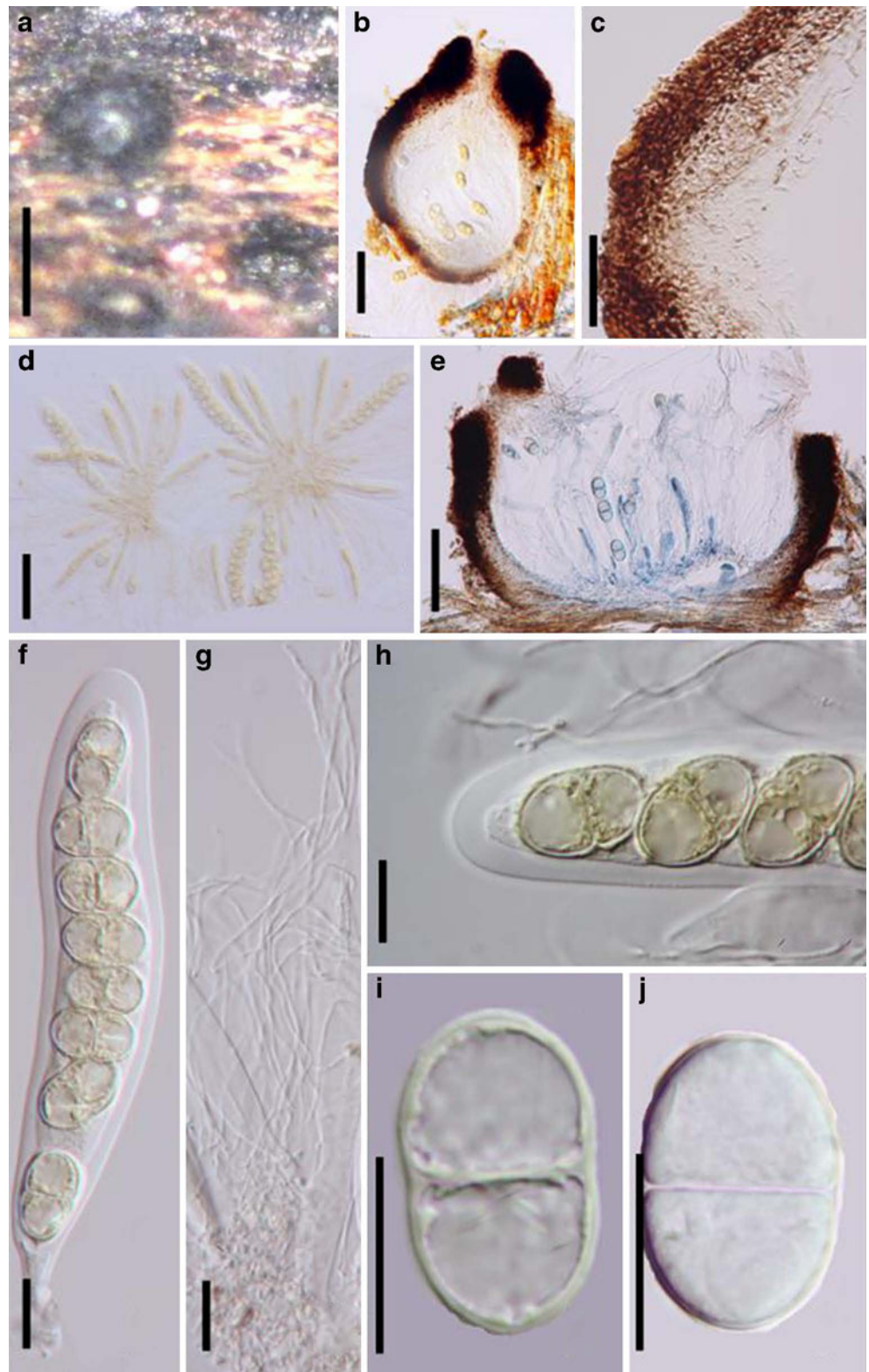
### Phylogenetic study

None.

### Concluding remarks

The ascospores of *Belizeana tuberculata* are most comparable with those of *Acrocordiopsis patilii*, but the superficial

**Fig. 11** *Belizeana tuberculata* (from Herb. J. Kohlmeyer No. 4398, **holotype**). **a** Immersed to semi-immersed ascomata. **b, e** Vertical section of an ascoma. **c** Section of a partial peridium. **d** Squash mounts with a large number of asci. **f** Broadly cylindrical ascus with a large ocular chamber. **g** Filiform pseudoparaphyses. **h** Apical part of an ascus. Note the large ocular chamber. **i, j** One-septate ascospores. Scale bars: **a**=0.3 mm, **b**=100  $\mu\text{m}$ , **c**=20  $\mu\text{m}$ , **d, e**=50  $\mu\text{m}$ , **f–j**=10  $\mu\text{m}$



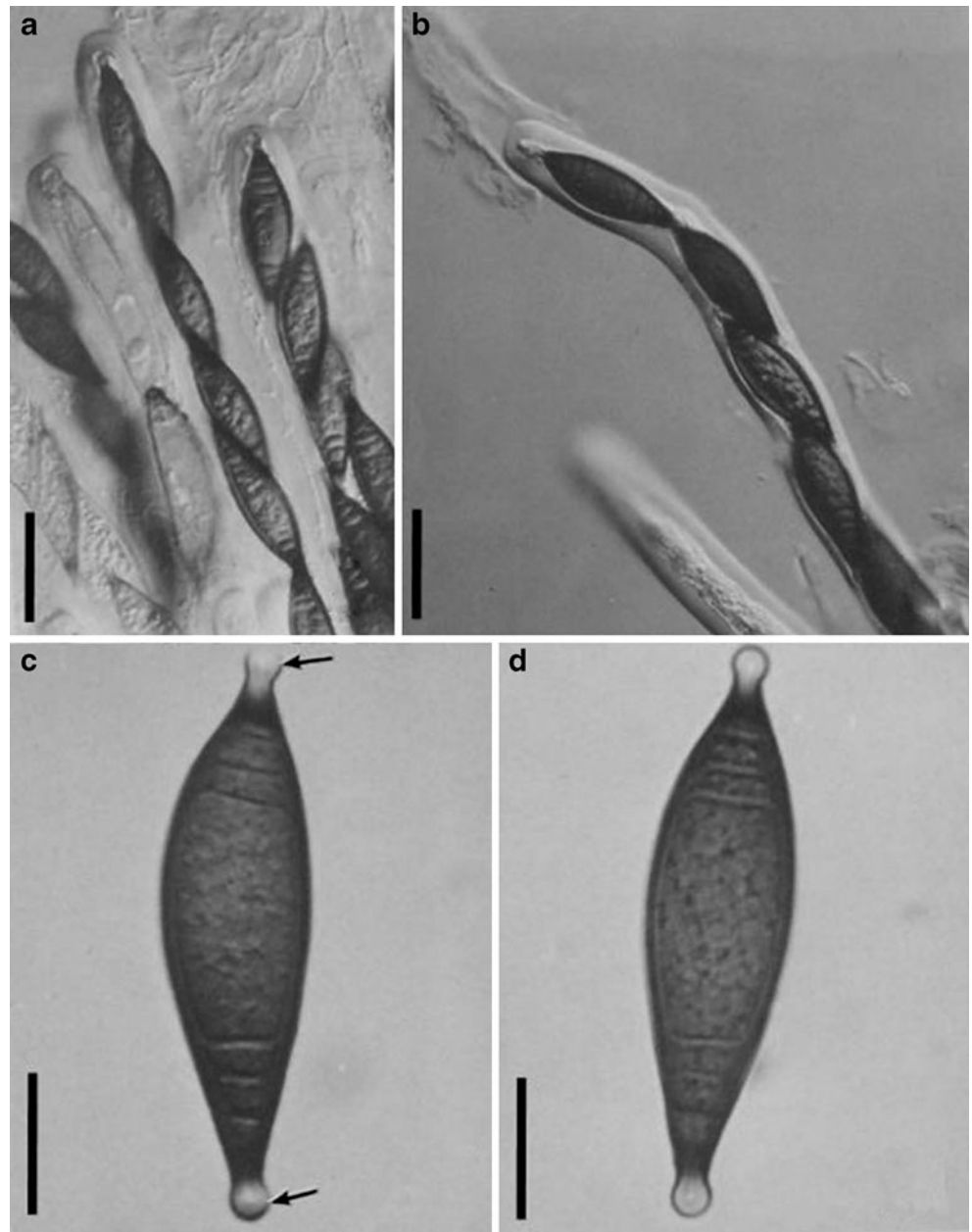
conical ascomata of *A. patilii* are distinct from *B. tuberculata*. Thus, the familial placement of *Belizeana* is still undetermined.

*Biatriospora* K.D. Hyde & Borse, Mycotaxon 26: 263 (1986). (*Pleosporales*, genera *incertae sedis*)

## Generic description

Habitat marine, saprobic. *Ascomata* large, solitary or gregarious, immersed, subglobose to pyriform, ostiolate, papillate, periphysate, black, branching, carbonaceous. *Hamathecium* of dense, long trabeculate pseudoparaphyses, embedded in mucilage. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, with apical apparatus. *Ascospores* uniseriate to partially overlapping, fusoid, hyaline when young, becoming brown to dark brown at maturity, multi-septate towards each end, with a hyaline, globose refractive chamber or appendage at each end, not constricted at the septum.

**Fig. 12 1** *Biatriospora marina* (from IMI 297768, **holotype**). **a**, **b** Cylindrical asci. Note the mucilage pseudoparaphyses in (**a**) and the conspicuous ocular chamber in (**b**). **c**, **d** Ascospores with hyaline end chambers (arrowed). Scale bars: **a**, **b**=50  $\mu\text{m}$ , **c**, **d**=20  $\mu\text{m}$ . **2** Line drawings of *Biatriospora marina* (based on **holotype**). **a** Section through ascocarp showing asci and pseudoparaphyses. **b** Asci and pseudoparaphyses. **c** Ascospores. Scale bars: **a**=200  $\mu\text{m}$ , **b**=40  $\mu\text{m}$ , **c**=30  $\mu\text{m}$  (figure with permission from Hyde and Borse 1986)



**Anamorphs reported for genus:** none.

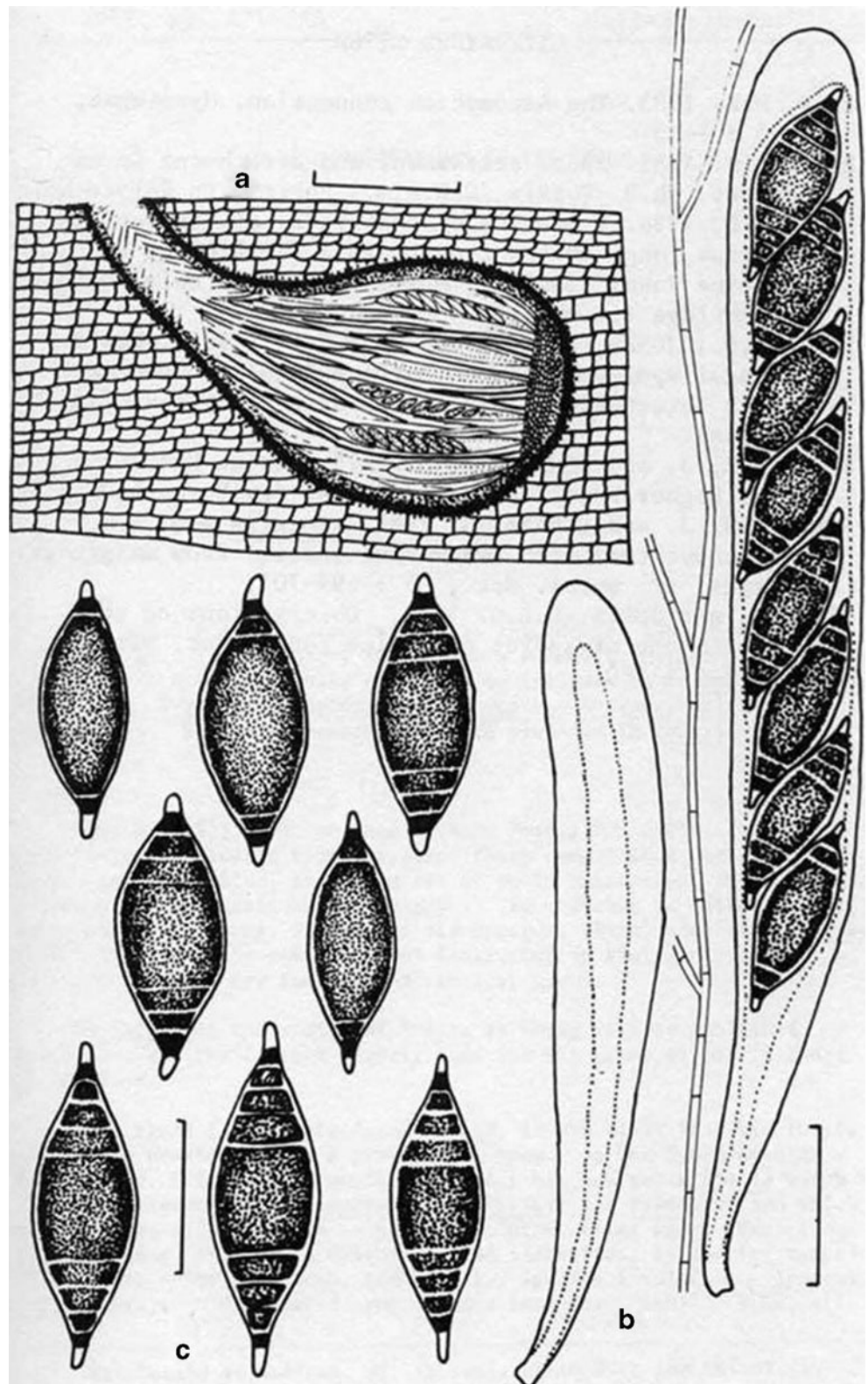
**Literature:** Hyde and Borse 1986; Suetrong et al. 2009.

## Type species

*Biatriospora marina* K.D. Hyde & Borse, Mycotaxon 26: 264 (1986). (Fig. 12)

*Ascomata* 650–860  $\mu\text{m}$  high  $\times$  350–510  $\mu\text{m}$  diam., solitary or gregarious, immersed, subglobose to pyriform, ostiolate, papillate, periphysate, black, carbonaceous (Fig. 12.2a). *Hamathecium* of dense, long trabeculate pseudoparaphyses, 1–1.5  $\mu\text{m}$  broad, branching, embedded in mucilage. *Asci* 175–

Fig. 12 2 (continued)



$400 \times 22\text{--}40 \mu\text{m}$ , 8-spored, bitunicate, fissitunicate, cylindrical, with long pedicels and apical apparatus (Fig. 12.1a, b, 2b). *Ascospores*  $55\text{--}82 \times 16\text{--}25 \mu\text{m}$ , uniseriate to partially overlapping, fusoid, hyaline when young, becoming brown to

dark brown at maturity, 2-4-septate towards each end, and with a hyaline, globose refractive chamber or appendage at each end,  $6\text{--}8 \times 4\text{--}6 \mu\text{m}$  diam., not constricted at the septum (Fig. 12.1c, d, 2c).

**Anamorph:** none reported.

**Material examined:** SEYCHELLES, 2 Jan. 1984 (Herb. IMI 297768 **holotype**).

## Notes

### Morphology

*Biatriospora* was introduced to accommodate a marine fungus *B. marina*, which is characterized by horizontal ascomata and ascospores with polar, globose refractive chambers and polar septa (Hyde and Borse 1986). Polar refractive chambers can also occur in other marine fungi, such as *Lulworthia* and *Aigialus*. The chambers have been proposed as important for spore attachment to substrates in a liquid environment (Hyde and Borse 1986).

### Phylogenetic study

Multigene phylogenetic analysis indicated that *Biatriospora marina* forms a separate branch, sister to other families of *Pleosporales* (Suetrong et al. 2009), and maybe related to species in *Roussoella* (Plate 1).

### Concluding remarks

The familial status of *Biatriospora* can not be determined.

*Bicrouania* Kohlm. & Volkm.-Kohlm., Mycol. Res. 94: 685 (1990). (?*Melanommataceae*)

### Generic description

Habitat marine, saprobic. *Ascomata* immersed gregarious, erumpent to superficial, globose to subglobose, black, periphysate, coriaceous, epapillate or papillate, ostiolate. *Peridium* thin, 2-layered. *Hamathecium* of dense, long trabeculate pseudoparaphyses, branching and anastomosing between and above the asci. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, with a thick, furcate pedicel lacking ocular chamber. *Ascospores* obliquely uniseriate and partially overlapping, ellipsoidal with broadly rounded ends, reddish brown, 1-septate, thick-walled, constricted at the septum.

**Anamorphs reported for genus:** none.

**Literature:** Jones et al. 2009; Kohlmeyer and Volkmann-Kohlmeyer 1990.

### Type species

*Bicrouania maritima* (P. Crouan & H. Crouan) Kohlm. & Volkm.-Kohlm., Mycol. Res. 94: 685 (1990). (Fig. 13)

≡ *Sphaeria maritima* P. Crouan & H. Crouan, Florule du Finistère, Paris: 27 (1867) non *Sphaeria maritima* Cooke & Plowright, Grevillia 5: 120 (1877).

*Ascomata* 320–440  $\mu\text{m}$  high  $\times$  370–460  $\mu\text{m}$  diam., gregarious, immersed, mostly erumpent to superficial, globose to subglobose, black, coriaceous, with a rough surface, papillate or epapillate, ostiolate, periphysate (Fig. 13a). *Peridium* 40–50  $\mu\text{m}$  thick laterally, up to 75  $\mu\text{m}$  thick at the apex, thinner at the base, 2-layered, outer layer composed of small heavily pigmented pseudoparenchymatous cells, inner layer very thin, composed of hyaline thin-walled small cells, merging into pseudoparaphyses (Fig. 13a and b). *Hamathecium* of dense, very long trabeculate pseudoparaphyses, 0.8–1.2  $\mu\text{m}$  broad, branching and anastomosing between and above the asci. *Asci* 170–225  $\times$  17.5–22.5  $\mu\text{m}$  ( $\bar{x}$  = 199.6  $\times$  20  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate, cylindrical, with a thick, furcate pedicel which is up to 70  $\mu\text{m}$  long, lacking ocular chamber (Fig. 13c, d and e). *Ascospores* 22–26  $\times$  12–15  $\mu\text{m}$  ( $\bar{x}$  = 24.5  $\times$  13.3  $\mu\text{m}$ ,  $n$  = 10), obliquely uniseriate and partially overlapping, ellipsoidal with broadly rounded ends, reddish brown, 1-septate, slightly constricted at the septum, thick-walled, with a thick darkened band around the septum, smooth (Fig. 13c, d and e).

**Anamorph:** none reported.

**Material examined:** FRANCE, Finistère, on *Halimone portulacoides* (IMI 330806, **isotype**, as *Sphaeria maritima*).

## Notes

### Morphology

When Kohlmeyer and Volkmann-Kohlmeyer (1990) studied the four marine *Didymosphaeria* species, the monotypic *Bicrouania* was established to accommodate *B. maritima* (as *Didymosphaeria maritima* (P. Crouan & H. Crouan) Sacc.), which could be distinguished from *Didymosphaeria* by its superficial ascomata lacking a clypeus, thick-walled asci and its association with algae (Kohlmeyer and Volkmann-Kohlmeyer 1990). Jones et al. (2009) agreed that it cannot be placed in *Didymosphaeria* based on its superficial ascomata, but that it does have many similarities with *Didymosphaeria*. Molecular data are required to determine its relationship with *Didymosphaeria* and to resolve its higher level placement.

### Phylogenetic study

None.

### Concluding remarks

Besides the morphological differences, its marine and substrate habitats also differ from *Didymosphaeria*.

*Bimuria* D. Hawksw., Chea & Sheridan, N. Z. J. Bot. 17: 268 (1979). (*Montagnulaceae*)



**Fig. 13** *Bicrouania maritima* (from IMI 330806, **isotype**). **a** Section of an ascoma. **b** Section of papilla. Note the periphyses. **c–e** Eight-spored asci. Note the furcated pedicel. Scale bars: **a**, **b**=100  $\mu\text{m}$ , **c–e**=20  $\mu\text{m}$



### Generic description

Habitat terrestrial, saprobic. *Ascomata* solitary, superficial, globose, dark brown, epapillate, ostiolate. *Peridium* thin, pseudoparenchymatous. *Hamathecium* of few, cellular pseudoparaphyses, embedded in mucilage, rarely anastomosing and branching. *Asci* bitunicate, fissionate, broadly clavate with short pedicels, 2-3-spored. *Ascospores* muriform, broadly ellipsoid, dark brown with subhyaline end cells, verrucose.

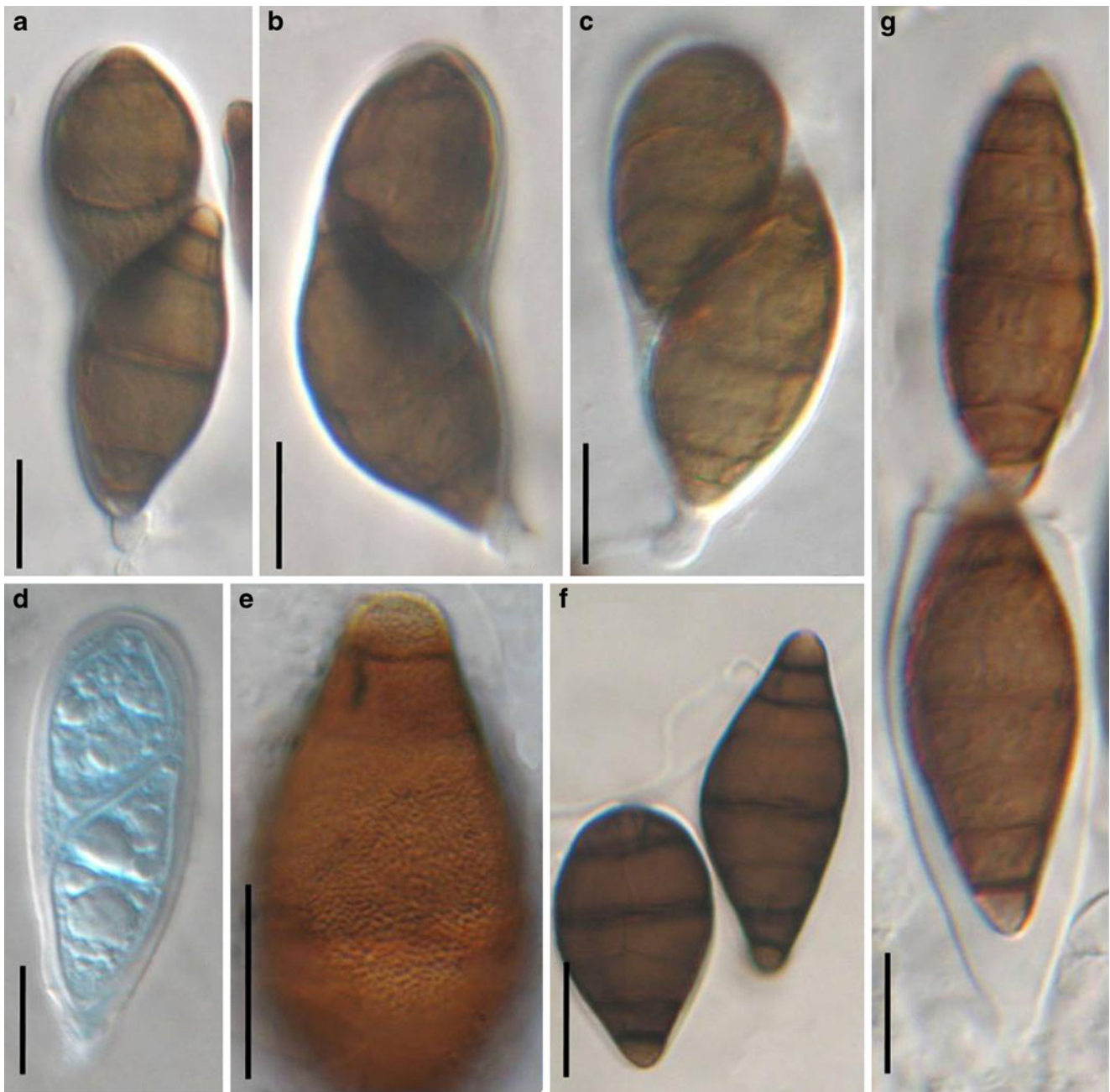
**Anamorphs reported for genus:** none.

**Literature:** Barr 1987b; Hawksworth et al. 1979; Lumbsch and Huhndorf 2007.

### Type species

*Bimuria novae-zelandiae* Hawksworth, Chea & Sheridan, N. Z. J. Bot. 17: 268 (1979). (Fig. 14)

*Ascomata* (185-)200×310(-330)  $\mu\text{m}$  diam., solitary, scattered, semi-immersed or superficial, globose, hyaline when



**Fig. 14** *Bimuria novae-zelandiae* (from CBS 107.79, isotype). **a–c** Asci with a short pedicel and small ocular chamber. **d** Immature ascus (in cotton blue). **e** Partial ascospore. Note the convex verrucae on the

ascospore surface. **f** Released ascospores. Note the lighter end cells, germ pore and the longiseptum (arrowed). **g** Fission-tunicate ascus dehiscent. Scale bars: **a–g**=20  $\mu\text{m}$

young, turning dark brown to black when mature, ostiolate, the ostiole more or less sessile or raised into a very short neck. *Peridium* 5–8(–12)  $\mu\text{m}$  thick, comprising 2–3 layers of radically compressed pseudoparenchymatous cells, cells 10–15  $\mu\text{m}$  diam. in surface view, cell wall 2–3  $\mu\text{m}$  thick. *Hamathecium* consisting of few, 2.5–4  $\mu\text{m}$  broad cellular pseudoparaphyses, embedded in mucilage, rarely anastomosing and branching, septate, 7–13  $\mu\text{m}$  long between two septa. *Asci* (65–)80–95 $\times$ 20–32.5  $\mu\text{m}$  ( $\bar{x}$  = 75.6 $\times$

29.4 $\mu\text{m}$ ,  $n=10$ ), (1–)2(–3)-spored, bitunicate, fission-tunicate, broadly clavate, with a short and small knob-like pedicel which is up to 13  $\mu\text{m}$  long, ocular chamber best seen in immature asci (Fig. 14a, b, c, d and g). *Ascospores* accumulating in a subglobose black shiny mass adhering together outside the ostiole, 55–68 $\times$ 25–28  $\mu\text{m}$  ( $\bar{x}$  = 59 $\times$ 26 $\mu\text{m}$ ,  $n=10$ ), broadly ellipsoid but becoming narrowed towards the poles, muriform with (5–)7 transverse septa, cells with (0–)1(–2) longitudinal septa in each cell, no constriction

at the septa, dark brown, the apical cells paler with no longitudinal septa, verruculose (Fig. 14e and f).

**Anamorph:** none reported.

**Material examined:** NEW ZEALAND, North Island, Wairarapa District, Nutty Farm, isolated from soil, 3 Mar. 1978, Chea Chark Yen & J.E. Sheridan (CBS 107.79, **isotype**).

## Notes

### Morphology

*Bimuria novae-zelandiae* was first isolated from soil of a barley field in New Zealand (Hawksworth et al. 1979). Based on *B. novae-zelandiae*, the genus is characterized by a very thin peridium, mostly 2-spored and fissitunicate asci as well as the muriform, dark brown, verrucose ascospores (Hawksworth et al. 1979). Because of its unique morphological characters, the familial placement of this genus has been debatable and it has been placed in *Pleosporaceae* (Hawksworth et al. 1979), in *Phaeosphaeriaceae* (Barr 1987b) and in *Melanommataceae* (Lumbsch and Huhndorf 2007).

Morphologically, *Bimuria* is most comparable with some superficially similar or allied genera, in particular *Montagnula* (Hawksworth et al. 1979). However, the thick carbonaceous peridium distinguishes *Montagnula* from that of *Bimuria* (Hawksworth et al. 1979). In addition, the ascospores of *Montagnula* are discharged forcibly through the ostiole instead of forming a mass outside of the ostiole as in *Bimuria* (Hawksworth et al. 1979). *Ascomauritiana lignicola* V.M. Ranghoo & K.D. Hyde has somewhat similar ascospores in 4-spored asci, but this taxon has unitunicate asci (Ranghoo and Hyde 1999). The morphological characters of *Bimuria*, such as ascospore release and large, thick-walled ascospores may be an adaptation to its soil-borne habitat (Hawksworth et al. 1979).

### Phylogenetic study

*Bimuria novae-zelandiae* was found to be closely related to *Phaeodothis winterti* (Niessl) Aptroot (syn. *Didymosphaerella opulenta* (De Not.) Checa & M.E. Barr) and *Montagnula opulenta* (De Not.) Aptroot in analysis of combined sequences, i.e. SSU rDNA, LSU rDNA, *RPB2* and *TEF1* sequences (Schoch et al. 2006, 2009). These two species had been included by Barr (2001) in her new family *Montagnulaceae*.

### Concluding remarks

We agree with Barr (2001) and include the genus in *Montagnulaceae* based on both morphological and phylogenetic characters.

***Bricookea*** M.E. Barr, Mycotaxon 15: 346 (1982). (?*Phaeosphaeriaceae*)

## Generic description

Habitat terrestrial, saprobic (or parasitic?). *Ascomata* small- to medium-sized, solitary, scattered, or in small groups, immersed, erumpent to superficial, depressed globose, papillate, ostiolate. *Peridium* thin. *Hamathecium* filliform, cellular pseudoparaphyses, embedded in mucilage, anastomosing, septate. *Asci* bitunicate, fissitunicate, cylindrical, cylindro-clavate or slightly obclavate, with a short knob-like pedicel, with an ocular chamber. *Ascospores* hyaline, ellipsoid to narrowly obovoid, 3-septate, constricted at each septum.

**Anamorphs reported for genus:** none.

**Literature:** Barr 1982a; Berlese 1896; Holm 1957; Shoemaker and Babcock 1989a.

## Type species

***Bricookea sepalorum*** (Vleugel) M.E. Barr, Mycotaxon 15: 346 (1982). (Fig. 15).

≡ *Metasphaeria sepalorum* Vleugel, Svensk bot. Tidskr. 2: 369 (1908).

*Ascomata* 120–250  $\mu\text{m}$  high  $\times$  170–440  $\mu\text{m}$  diam., solitary, scattered, or in small groups, or forming locules in massive stromatic tissues, initially immersed, becoming erumpent, to nearly superficial, depressed globose, black, membranous, roughened; apex rounded, sometimes very short and almost inconspicuous, with a somewhat slit-like or Y-shaped ostiole (Fig. 15a). *Peridium* 16–30  $\mu\text{m}$  wide, comprising two types of cells, outer cells heavily pigmented thick-walled *textura angularis*, cells 4.5–8  $\mu\text{m}$  diam., cell wall 1–1.5  $\mu\text{m}$  thick, inner cells of subhyaline thin-walled *textura angularis*, cells larger than outer cells (Fig. 15b). *Hamathecium* of long cellular pseudoparaphyses, 1.5–2  $\mu\text{m}$  broad, embedded in mucilage, anastomosing, septate. *Asci* 63–83  $\times$  9.5–11  $\mu\text{m}$  ( $\bar{x}$  = 73.8  $\times$  10.8  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, oblong, cylindro-clavate or slightly obclavate, with a short knob-like pedicel which is 5–13  $\mu\text{m}$  long, with an ocular chamber (Fig. 15c, d and e). *Ascospores* (14-)15.5–19  $\times$  5–7  $\mu\text{m}$  ( $\bar{x}$  = 16.9  $\times$  5.9  $\mu\text{m}$ ,  $n=10$ ), obliquely uniseriate and partially overlapping to biseriate, ellipsoid to narrowly obovoid, hyaline, 3-septate, constricted at each septum, the cells above central septum often broader than the lower ones, smooth (Fig. 15f, g, h, i and j).

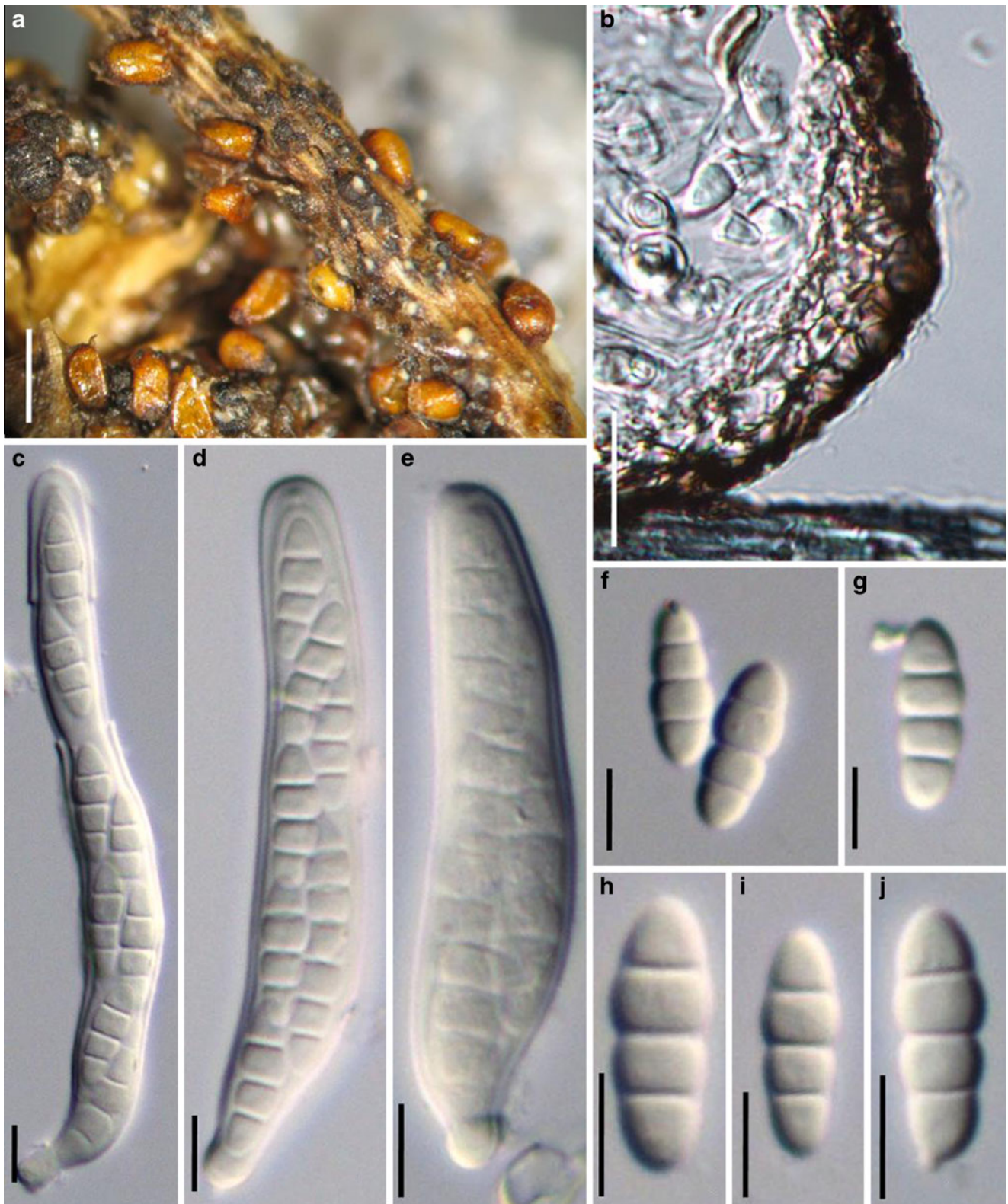
**Anamorph:** none reported.

**Material examined:** SWEDEN, on *Juncus filliformis*, Stockholm, J. Vleugel. Jul. 1907 (S, **type** as *Metasphaeria sepalorum* Vleugel).

## Notes

### Morphology

*Bricookea* was formally established by Barr (1982a) as a monotypic genus represented by *B. sepalorum* based on its



**Fig. 15** *Bricookea sepalarum* (from S, type). **a** Ascomata on host surface (arrowed). **b** Section of partial peridium. Note thick-walled out layer and thin-walled inner layer. **c–e** Cylindrical to slightly

obclavate asci with short knob-like pedicels. **f–j** Hyaline, 3-septate smooth-walled ascospores. Scale bars: **a**=0.5 mm, **b**=50  $\mu$ m, **c–j**=10  $\mu$ m

“globose to depressed ascomata, slit-like ostiole with labial cells, bitunicate asci, cellular pseudoparaphyses, and hyaline septate ascospores”. *Bricookea* was morphologically assigned to *Phaeosphaeriaceae*. Holm (1957) checked the authentic collections from North America and type material from Europe, and observed that the ascospores of collections from North America were significantly larger than those from the type material from Sweden. Thus, Shoemaker and Babcock (1989a) considered that the collections from North America represented a new species, which they introduced as *B. barrae* Shoemaker & C.E. Babc. Although the short slit-like ostiole has previously been reported (Shoemaker and Babcock 1989a), it is inconspicuous in the type specimen from Sweden. Currently, only two species are accommodated in this genus.

### Phylogenetic study

None.

### Concluding remarks

The knob-shaped pedicel, slit-like ostiole, hyaline ascospores as well as the herbaceous substrate all disagree with any current pleosporalean family. Thus, we temporarily retain this genus under *Phaeosphaeriaceae* until DNA sequence comparisons can be carried out.

*Byssolophis* Clem., in Clements & Shear, Gen. fung., Edn 2 (Minneapolis): 286 (1931). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium-sized, gregarious, semi-immersed to erumpent, coriaceous, ovoid, with a conspicuous elongate slit-like ostiole on the top. *Peridium* not observed. *Hamathecium* of dense, long pseudoparaphyses, anastomosing and branching between and above the asci. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical or cylindro-clavate, with a furcate pedicel. *Ascospores* fusoid, hyaline, turning faintly brown when old, 1-septate, with a short terminal appendage at each end.

**Anamorphs reported for genus:** none.

**Literature:** Clements and Shear 1931; Holm 1986; Müller and von Arx 1962.

### Type species

*Byssolophis byssiseda* (Flageolet & Chenant.) Clem., Gen. Fung. (Minneapolis): 286 (1931). (Fig. 16)

≡ *Schizostoma byssisedum* Flageolet & Chenant., in Chenantaise, Bull. Soc. mycol. Fr. 35: 125 (1919).

*Ascomata* 300–450  $\mu\text{m}$  high  $\times$  600–750  $\mu\text{m}$  long  $\times$  350–420  $\mu\text{m}$  broad, gregarious, semi-immersed to

erumpent, coriaceous, ovoid with a flattened base and apex with a elongate slit-like ostiole, up to 700  $\mu\text{m}$  long and 200  $\mu\text{m}$  wide (Fig. 16a). *Peridium* not observed. *Hamathecium* of dense, long pseudoparaphyses, up to 1.5–2.5  $\mu\text{m}$  broad, anastomosing and branching between and above the asci (Fig. 16b). *Asci* 80–105  $\times$  (5–)7.5–10  $\mu\text{m}$  ( $\bar{x}$  = 91  $\times$  8  $\mu\text{m}$ ;  $n=10$ ), 8-spored, bitunicate, fissitunicate, cylindrical or cylindro-clavate, with a furcate pedicel and a small ocular chamber (J-) (Fig. 16d). *Ascospores* 18–20 (–28)  $\times$  4.5–6 (–7.5)  $\mu\text{m}$  ( $\bar{x}$  = 20.8  $\times$  5.7  $\mu\text{m}$ ,  $n=10$ ), uniseriate to biseriate, fusoid, hyaline, turning faintly brown when old, 1-septate, with 1–2 distinct oil drops in each cell and usually with a short terminal appendage at each end (Fig. 16c).

**Anamorph:** none reported.

**Material examined:** on decaying wood (K(M):164030, *isotype*).

### Notes

### Morphology

*Byssolophis* was introduced as a monotypic genus based on *B. byssiseda*, which is characterized by its semi-immersed, gregarious, ovoid ascomata, with a conspicuous central apical ostiolar slit (Holm 1986). Subsequently, two more species were introduced, viz. *B. ampla* (Berk. & Broome) L. Holm and *B. sphaerioides* (P. Karst.) E. Müll. (Holm 1986; Müller and von Arx 1962).

### Phylogenetic study

The current phylogeny places *Byssolophis sphaerioides* in proximity of *Hypsostromataceae* without resolving any sister taxa (Plate 1).

### Concluding remarks

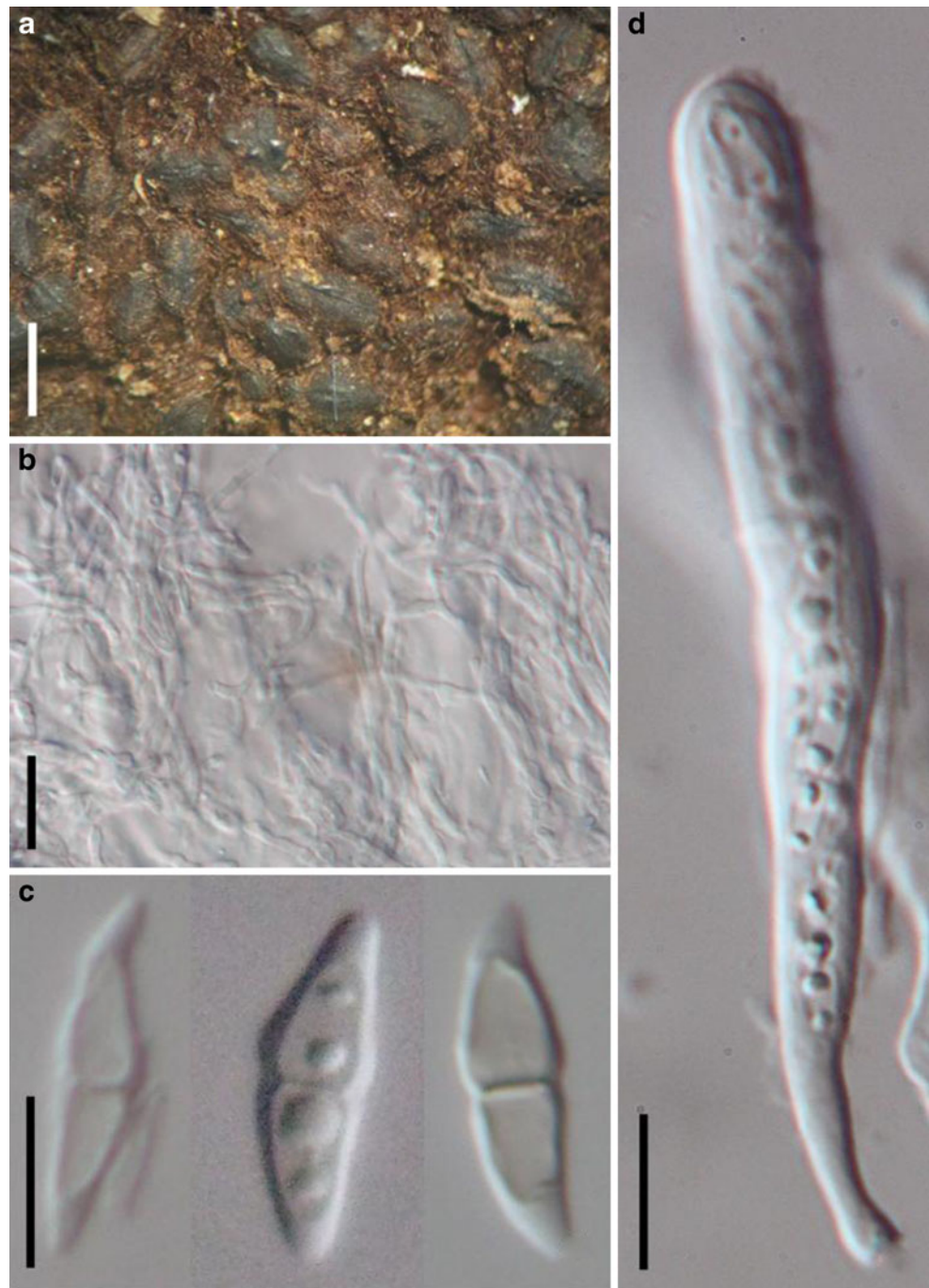
The slit-like ostiole, cylindrical asci, hyaline and 1-septate ascospores as well as the form of pseudoparaphyses are similar to species in *Lophiostoma*. Thus, *Byssolophis* may be a synonym of *Lophiostoma*.

*Byssosphaeria* Cooke, Grevillea 7: 84 (1879). (*Melanommataceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium-sized, scattered to gregarious, superficial, globose, subglobose to turbinate, non papillate with white, orange, red or green ostiolar region, wall black. *Hamathecium* of dense, long trabeculate pseudoparaphyses, embedded in mucilage, anastomosing between and above the asci. *Asci* bitunicate, fissitunicate, clavate to nearly cylindrical, with a furcate pedicel. *Ascospores* fusoid with narrow

**Fig. 16** *Byssolophis byssiseda* (from K(M):164030, **isotype**). **a** Ascomata gregarious on the host surface. **b** Numerous pseudo-paraphyses. **c** Fusoid ascospores with or without terminal appendages. **d** Clavate ascus with a short furcate pedicel. Scale bars: **a**=1 mm, **b–d**=10  $\mu\text{m}$



ends, straight or slightly curved, brown, 1-septate when young.

**Anamorphs reported for genus:** *Pyrenochaeta* or *Chaetophoma*-like (Barr 1984; Hawksworth et al. 1995; Samuels and Müller 1978).

**Literature:** von Arx and Müller 1975; Barr 1984; Boise 1984; Bose 1961; Chen and Hsieh 2004; Cooke and Plowright 1879; Hyde et al. 2000; Luttrell 1973; Mugambi and Huhndorf 2009b; Müller and von Arx 1962; Samuels and Müller 1978.

#### Type species

*Byssosphaeria keitii* (Berk. & Broome) Cooke [as '*Byssosphaeria keithii*'], (1879). (Fig. 17)

≡ *Sphaeria keitii* Berk. & Broome [as '*Sphaeria keithii*'], Ann. Mag. Nat. Hist., IV 17: 144 (1876).

*Ascomata* 360–500(–600)  $\mu\text{m}$  high  $\times$  420–640  $\mu\text{m}$  diam., scattered or in small groups, superficial with basal subiculum anchoring on the substrate, globose, subglobose to turbinate, non-papillate with pore-like



**Fig. 17** *Byssosphaeria schiedermayriana* (from K(M):108784, holotype). **a** Superficial ascomata on the host surface. **b** Brown, 1-septate ascospores. **c** Section of the lateral peridium. Note the outer

*textura angularis* and inner *textura epidermoidea* cells. **d, e** Furcate asci with a long pedicel. **f** Dehiscent ascus. Scale bars: **a**=0.5 mm, **c**=50  $\mu$ m, **b, d–f**=15  $\mu$ m

ostiole, ostiolar region sometimes with orange and greenish tint, wall black, roughened, coriaceous (Fig. 17a). *Peridium* 55–85  $\mu$ m thick, peridium outside of the substrate comprising two cell types, outer layer composed of brown thick-walled cells of *textura epidermoidea*, cells 1–3  $\mu$ m diam., inner layer composed of small hyaline cells, cells 3–5  $\mu$ m diam., merging into pseudoparaphyses; peridium inside the substrate one layer, composed of large pale brown cells of *textura angularis*, cells 6–13  $\mu$ m diam. (Fig. 17c). *Hamathecium* of dense, long trabeculate pseudoparaphyses, 1–2  $\mu$ m broad, embedded in mucilage, anastomosing between and above the asci. *Asci* 90–120(–148)  $\times$  10–14  $\mu$ m, 8-spored, bitunicate, fissitunicate, cylindro-clavate to clavate, biseriata above and uniseriate below, pedicel 15–20 (–53)  $\mu$ m long, the immature asci usually with longer

and furcate pedicel (–68  $\mu$ m) (Fig. 17d,e and f). *Ascospores* 29–34(–38)  $\times$  5.5–8(–10)  $\mu$ m, fusoid with narrow ends, mostly straight, sometimes slightly curved, smooth, pale brown, 1-septate, becoming 3-septate after discharge, with hyaline appendages at each acute to subacute end; in some mature spores the appendage may be absent (Fig. 17b).

**Anamorph:** *Pyrenochaeta* sp. (Barr 1984; Samuels and Müller 1978).

*Pycnidia* 70–500  $\mu$ m diam. *Conidiogenous cells* phialidic, lining cavity, 5–8  $\times$  4–6  $\mu$ m to 5–10  $\times$  3–6  $\mu$ m. *Conidia* 2.5–3.5(–4)  $\times$  1.5–2(–3)  $\mu$ m, hyaline, ellipsoid or subglobose (Barr 1984).

**Material examined:** ERIE, Dublin, Glasnevin Botanic Garden, on old rope, Jun. 1872, W. Keit (K(M):108784, holotype, as *Sphaeria keitii* Berk. & Broome).

## Notes

### Morphology

*Byssosphaeria* was introduced by Cooke and Plowright (1879) based on its superficial ascomata seated on a “tomentose subiculum of interwoven threads”, which includes various species in *Sphaeria* and *Byssisedae*, and was validly typified by *B. keitii* (Cooke 1878). *Byssosphaeria keitii* was treated as a synonym of *B. schiedermayeriana* (Fuckel) M.E. Barr by Sivanesan (1971), and *B. schiedermayeriana* exclusively occurs in tropical regions or greenhouse environments in temperate regions (Barr 1984). Morphologically, *B. keitii* is characterized by its large ascomata with orange to reddish plain apices, and is closely related to *B. rhodomphala* (Berk.) Cooke (Barr 1984).

For a long time, *Byssosphaeria* was assigned to *Herpotrichia sensu lato*, and *Byssosphaeria schiedermayeriana* was renamed as *H. schiedermayeriana* Fuckel (von Arx and Müller 1975; Bose 1961; Luttrell 1973; Müller and von Arx 1962; Sivanesan 1971). After studying *Herpotrichia* in North America, Barr (1984) accepted a relatively narrow generic concept, *Herpotrichia sensu stricto*, and revived *Byssosphaeria*; this proposal is supported by phylogenetic study (Mugambi and Huhndorf 2009b). Currently *Byssosphaeria* comprises 32 species (<http://www.mycobank.org>, 08-01-2009).

### Phylogenetic study

The monophyletic nature of *Byssosphaeria* is well demonstrated, as well as its familial status in *Melanommataceae* (Mugambi and Huhndorf 2009b).

### Concluding remarks

Orange and greenish plain apices exist in the specimen we examined, which is different from records as “orange, bright or dull reddish plain apices” by Barr (1984). This might be because different specimens have different colours, or there may be a variation of apical colour within a single species, as both orange and green can coexist on the same ascoma (see Fig. 17a). The coloured apical rim, together with the trabeculate pseudoparaphyses as well as the presence of subiculum make *Byssosphaeria* readily distinguishable from other morphologically comparable genera, e.g. *Herpotrichia* and *Keissleriella* (Hyde et al. 2000).

*Calyptronectria* Speg., Anal. Mus. nac. Hist. nat. B. Aires 19: 412 (1909). (*Melanommataceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* small- to medium-sized, solitary, scattered, or in small groups, immersed,

lenticular to subglobose, papillate, ostiolate. *Hamathecium* of long, filliform pseudoparaphyses, branching and anastomosing, embedded in mucilage. *Asci* 4- to 8-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a short, furcate pedicel. *Ascospores* muriform, broadly fusoid to fusoid with broadly to narrowly rounded ends, hyaline.

**Anamorphs reported for genus:** none.

**Literature:** Barr 1983; Rossman et al. 1999; Spegazzini 1909.

### Type species

*Calyptronectria platensis* Speg., Anal. Mus. nac. Hist. nat. B. Aires 19: 412 (1909). (Fig. 18)

*Ascomata* 120–270  $\mu\text{m}$  high  $\times$  170–400  $\mu\text{m}$  diam., solitary, scattered, immersed, lenticular to subglobose, papillate, ostiolate (Fig. 18a and b). *Apex* with a small and slightly protruding papilla. *Peridium* 18–30  $\mu\text{m}$  wide, comprising two types of cells, outer layer composed of pseudoparenchymatous cells, cells 3–6  $\mu\text{m}$  diam., cell wall 1–2  $\mu\text{m}$  thick, inner layer comprising less pigmented cells, merging with pseudoparaphyses (Fig. 18b and c). *Hamathecium* of long, filliform pseudoparaphyses, 1–2  $\mu\text{m}$  broad, branching and anastomosing, embedded in mucilage. *Asci* 98–140  $\times$  12.5–20  $\mu\text{m}$  ( $\bar{x}$  = 107  $\times$  15.4  $\mu\text{m}$ ,  $n$ =10), 8-spored, sometimes 4-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a short, furcate pedicel, 12–20  $\mu\text{m}$  long, with an ocular chamber (to 4  $\mu\text{m}$  wide  $\times$  3  $\mu\text{m}$  high) (Fig. 18e and f). *Ascospores* 17–22.5  $\mu\text{m}$   $\times$  (6.3–)7.5–10  $\mu\text{m}$  ( $\bar{x}$  = 19.8  $\times$  7.6  $\mu\text{m}$ ,  $n$ =10), biseriate above and uniseriate below, ellipsoid to broadly fusoid with broadly to narrowly rounded ends, hyaline, usually with (3–)5 transverse septa, with or without 1–3 longitudinal septa in the central cells, constricted at the median septum, the upper cell often broader than the lower one, smooth, surrounded by an irregular hyaline gelatinous sheath up to 3  $\mu\text{m}$  thick (in dry specimen) (Fig. 18d).

**Anamorph:** none reported.

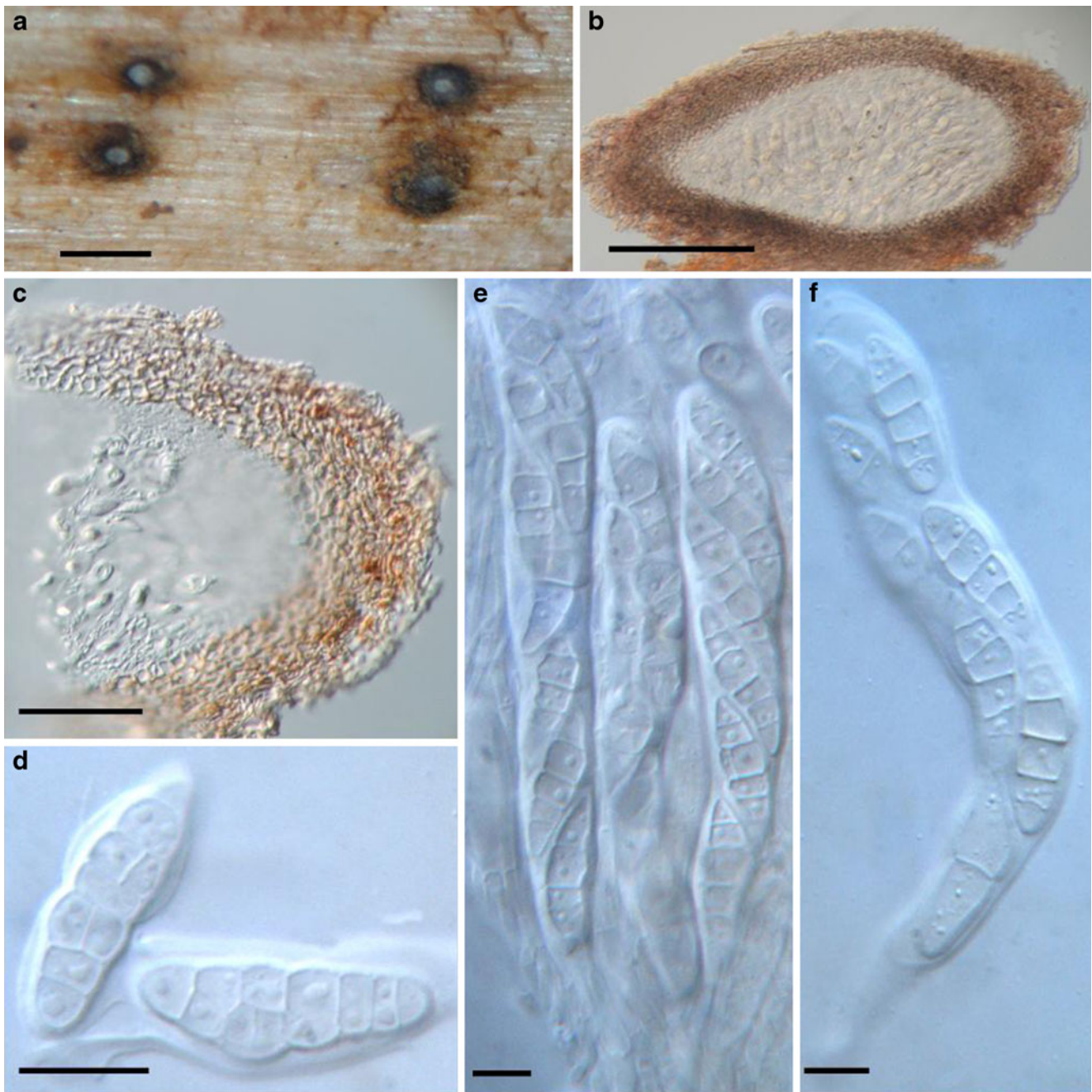
**Material examined:** ARGENTINA, La Plata, on decaying branches of *Manihot carthaginensis* (Jacq.) Müll., Sept. 1906, Spegazzini (LPS 1209, **holotype**).

## Notes

### Morphology

*Calyptronectria* is a relatively poorly studied genus, which was formally established based on *C. argentinensis* Speg. and *C. platensis*, with *C. platensis* being chosen as the generic type (Spegazzini 1909). Morphologically, *Calyptronectria* is characterized by its immersed ascomata,





**Fig. 18** *Calyptronectria platensis* (from LPS 1209, holotype). **a** Appearance of ascomata scattered in the substrate (after removing the out layer of the substrate). Note the protruding papilla. **b** Section of an ascoma. **c** Section of the partial peridium. Note the lightly pigmented

pseudoparenchymatous cells. **d** Released ascospores with mucilaginous sheath. **e** Eight-spored asci in hamathecium and embedded in gel matrix. **f** Ascus with a short pedicel. Scale bars: **a**=0.5 mm, **b**=100  $\mu$ m, **c**=50  $\mu$ m, **d**–**f**=10  $\mu$ m

trabeculate pseudoparaphyses and hyaline, muriform ascospores as well as its peridium that turns reddish brown in KOH (Rossman et al. 1999) (not shown here). Subsequently, *C. indica* Dhaware was introduced from India, and Barr (1983) transferred *Teichospora ohiensis* Ellis & Everh. to *Calyptronectria* as *C. ohiensis* (Ellis & Everh.) M.E. Barr. However, this proposal is inappropriate as the type specimen of *T. ohiensis* is “unitunicate” (Barr 1983; Rossman et al. 1999). Subsequently, Rossman et al. (1999) transferred

*Calyptronectria ohiensis* to *Thyridium* (as *T. ohiense* (Ellis & Everh.) Rossman & Samuels).

#### Phylogenetic study

None.

#### Concluding remarks

The immersed ascomata, trabeculate pseudoparaphyses, bitunicate asci, hyaline and muriform ascospores as well as

the reaction of peridium to KOH (turns reddish brown) make it distinguishable from all other reported genera (Rossman et al. 1999). Thus *Calyptronectria* is a morphologically well defined genus.

***Carinispora*** K.D. Hyde, J. Linn. Soc., Bot. 110: 97 (1992). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat marine, saprobic. One or two ascomata per stroma. *Ascomata* scattered or in small groups, developing beneath the host epidermis, erumpent, lenticular, ostiolate, lacking periphyses. *Peridium* pale brown, composed of thin-walled elongated cells at the sides and thick-walled cells of *textura epidermoidea* at the base. *Hamathecium* of dense, long filliform pseudoparaphyses, embedded in mucilage, anastomosing between and above the asci, rarely septate. *Asci* 8-spored, bitunicate, fissitunicate, clavate to cylindrical, with a short furcate pedicel, apex with an ocular chamber and apical ring. *Ascospores* biserial, narrowly fusoid, yellow to pale brown, multi-septate, constricted at the septa, the two central cells being the largest, surrounded by a gelatinous sheath.

**Anamorphs reported for genus:** none.

**Literature:** Hyde 1992a, 1994b.

### Type species

***Carinispora nypae*** K.D. Hyde, J. Linn. Soc., Bot. 110: 99 (1992). (Fig. 19)

One or two ascomata per stroma. *Ascomata* up to 0.8 mm diam., scattered or in small groups, developing beneath the host epidermis, crust-like, as circular spots, wall brown, with a small central ostiole, in section 225–285  $\mu\text{m}$  high  $\times$  510–750  $\mu\text{m}$  diam., lenticular, ostiolar canal lacking periphyses (Fig. 19a and b). *Peridium* 35–45  $\mu\text{m}$  wide at sides, pale brown, at sides composed of a thin layer of thin-walled elongate cells, fusing with the stromatic tissue and host cells, at the base composed of thick-walled cells, forming a *textura epidermoidea* and fusing with host cells. A wedge of pale brown hyphae forming a *textura porrecta* is present at the rim (Fig. 19c). *Hamathecium* of dense, long filliform pseudoparaphyses 1–3  $\mu\text{m}$  broad, embedded in mucilage, anastomosing between and above the asci, rarely septate. *Asci* 142–207  $\times$  14.2–19.8  $\mu\text{m}$ , 8-spored, bitunicate, fissitunicate, clavate to cylindrical, with a furcate pedicel, up to 40  $\mu\text{m}$  long, apex with an ocular chamber and apical ring (to 2  $\mu\text{m}$  wide  $\times$  3  $\mu\text{m}$  high, J-), developing from ascogenous tissue at the base of the ascocarp (Fig. 19d, e, f, g and h). *Ascospores* 42–66  $\times$  7–10.6  $\mu\text{m}$ , biserial, narrowly fusoid with broadly to narrowly rounded ends, somewhat curved,

yellow to pale brown, yellow in mass, 7–8-septate, constricted at the septa, the two central cells being the largest, surrounded by a gelatinous sheath; the sheath has a central “spine” and curved polar extrusions (Fig. 19i and j).

**Anamorph:** none reported.

**Material examined:** BRUNEI DARUSSALAM, Tungit Api Api mangrove, from decaying intertidal fronds of *Nypa fruticans* Wurmb., 14 Apr. 1987, K.D. Hyde (BRIP 17106, holotype).

### Notes

### Morphology

*Carinispora* is distinguished from *Phaeosphaeria* by its saprobic life style and lenticular ascomata formed under the host epidermis, peridium structure and sheath surrounding the ascospores (Hyde 1992a, 1994b). Two species were reported, i.e. *C. nypae* and *C. velatispora* K.D. Hyde.

### Phylogenetic study

Suetrong et al. (2009) could not resolve *Carinispora nypae* in a phylogeny based on four genes.

### Concluding remarks

Both *Carinispora nypae* and *C. velatispora* are reported as marine fungi, which should be taken into consideration for their familial placement.

***Caryospora*** Kohlm., Proc. Indian Acad. Sci., Pl. Sci. 94: 355 (1985). (?*Melanommataceae*)

### Generic description

Habitat marine, saprobic. *Ascomata* densely scattered or gregarious, superficial, subglobose, black, papillate, ostiolate, periphysate, carbonaceous. *Peridium* carbonaceous. *Hamathecium* of dense, long trabeculate pseudoparaphyses, anastomosing and branching above the asci. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical. *Ascospores* ellipsoidal to broadly fusoid with narrowly hyaline rounded ends, deep reddish brown, thick-walled, 1-septate with hyaline germ pore at each end.

**Anamorphs reported for genus:** suspected spermatia (Kohlmeyer 1985).

**Literature:** Eriksson 2006; Kohlmeyer 1985; Lumbsch and Huhndorf 2007.

### Type species

***Caryospora rhizophorae*** Kohlm., Proc. Indian Acad. Sci., Pl. Sci. 94: 356 (1985). (Fig. 20)

*Ascomata* 0.8–1.1 mm high  $\times$  0.9–1.2 mm diam., densely scattered or gregarious, superficial with a flattened base, not easily removed from the host surface, subglobose, black, short

papillate, ostiolate, periphysate, carbonaceous (Fig. 20a and b). *Peridium* 120–150  $\mu\text{m}$  thick at sides, up to 200  $\mu\text{m}$  thick at the apex, thinner at the base, 3-layered, outer layer composed of golden-yellow, very thick-walled cells of *textura epidermoidea*, mixed with subglobose, large cells near the surface, cells 7–15  $\mu\text{m}$  diam., middle layer composed of deep brown, very thick-walled cells of *textura epidermoidea*, inner layer composed of hyaline, thin-walled cells of *textura prismatica*, up to 50 $\times$ 5  $\mu\text{m}$  diam., merging with pseudoparaphyses (Fig. 20b, c and d). *Hamathecium* of dense, long trabeculate pseudoparaphyses, 1.5–2  $\mu\text{m}$  wide, anastomosing and branching above the asci. *Asci* 225–250 (–275) $\times$ 14–17  $\mu\text{m}$  ( $\bar{x}$  = 137  $\times$  16.3 $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissionate, cylindrical, with a long, narrowed, pedicel which is up to 75  $\mu\text{m}$  long, apical characters not observed (Fig. 20e). *Ascospores* 25–28 (–30) $\times$ 9–13  $\mu\text{m}$  ( $\bar{x}$  = 26.8  $\times$  11 $\mu\text{m}$ ,  $n$ =10), uniseriate to partially overlapping, ellipsoidal to broadly fusoid with narrow hyaline rounded ends, deep reddish brown, thick-walled, 1-septate with hyaline germ pore at each end, slightly constricted at the septum, verruculose, sometimes with “net”-like ridged ornamentations (Fig. 20f and g).

**Anamorph:** suspected spermatia (Kohlmeyer 1985).

**Material examined:** BELIZE, Twin Cays, tip of prop root of *Rhizophora mangle*, 18 Mar. 1984, J. Kohlmeyer (NY. Herb. J. Kohlmeyer No. 4532a, **holotype**).

## Notes

### Morphology

*Caryospora* was formally established by Kohlmeyer (1985) based on the obligate marine fungus, *C. rhizophorae*, which is characterized by its superficial ascomata, 3-layered peridium, filliform trabeculate pseudoparaphyses, and brown, 1-septate ascospores. *Caryospora* was originally assigned to *Massariaceae* despite several major differences, such as the superficial ascomata, reddish brown ascospores (Kohlmeyer 1985). Subsequently, *Caryospora* was assigned to *Melanommataceae* (Eriksson 2006; Lumbsch and Huhndorf 2007).

### Phylogenetic study

Suetrong et al. (2009) showed that a single isolate of *Caryospora rhizophorae* does not reside in *Pleosporales*, but is related to *Lineolata rhizophorae* (Kohlm. & E. Kohlm.) Kohlm. & Volkm.-Kohlm. and placed in *Dothiomyces* *incertae sedis*.

### Concluding remarks

As an obligate marine fungus, the familial placement of *Caryospora rhizophorae* is uncertain but it may not belong to *Pleosporales*.

**Fig. 19** *Carinispora nypae* (from BRIP 17106, **holotype**). **a** Ascomata on the host surface. **b** Section of an ascoma. **c** Section of a partial peridium. **d, e, g, h** Asci with ocular chambers and short pedicels. **f** The ocular chamber and apical ring of ascus. **i–j** Narrowly fusoid ascospores. Scale bars: **a**=1 mm, **b, c**=100  $\mu\text{m}$ , **d, g, h**=50  $\mu\text{m}$ , **e, f, i, j**=10  $\mu\text{m}$

*Chaetomastia* (Sacc.) Berl., Icon. fung. (Abellini) 1: 38 (1890). (*Teichosporaceae*)

≡ *Melanomma* subgen. *Chaetomastia* Sacc., Syll. fung. (Abellini) 2: 113 (1883).

### Generic description

Habitat terrestrial, saprobic. *Ascomata* relatively small, scattered, or in small groups, superficial, globose or subglobose, black, papillate, ostiolate, coriaceous. *Peridium* relatively thin, 1-layered, composed of heavily pigmented cells of *textura angularis*. *Hamathecium* of dense, long cellular pseudoparaphyses, embedded in mucilage. *Asci* mostly 4-spored, bitunicate, fissionate, broadly cylindrical with a furcate pedicel, with a large ocular chamber, especially apparent in immature asci. *Ascospores* ellipsoid to broadly fusoid with broadly to narrowly rounded ends, brown, 3-septate, constricted at all septa.

**Anamorphs reported for genus:** coelomycetous where known: conidia hyaline or brown, aseptate or 1-septate (*Aposphaeria*- or *Coniothyrium*-like) (Barr 1989c).

**Literature:** Barr 1987b, 1989c; 1993a; b; 2002; Berlese 1890; Clements and Shear 1931; Eriksson 1999; Eriksson and Hawksworth 1987, 1998; Holm 1957; Leuchtmann 1985; Saccardo 1883.

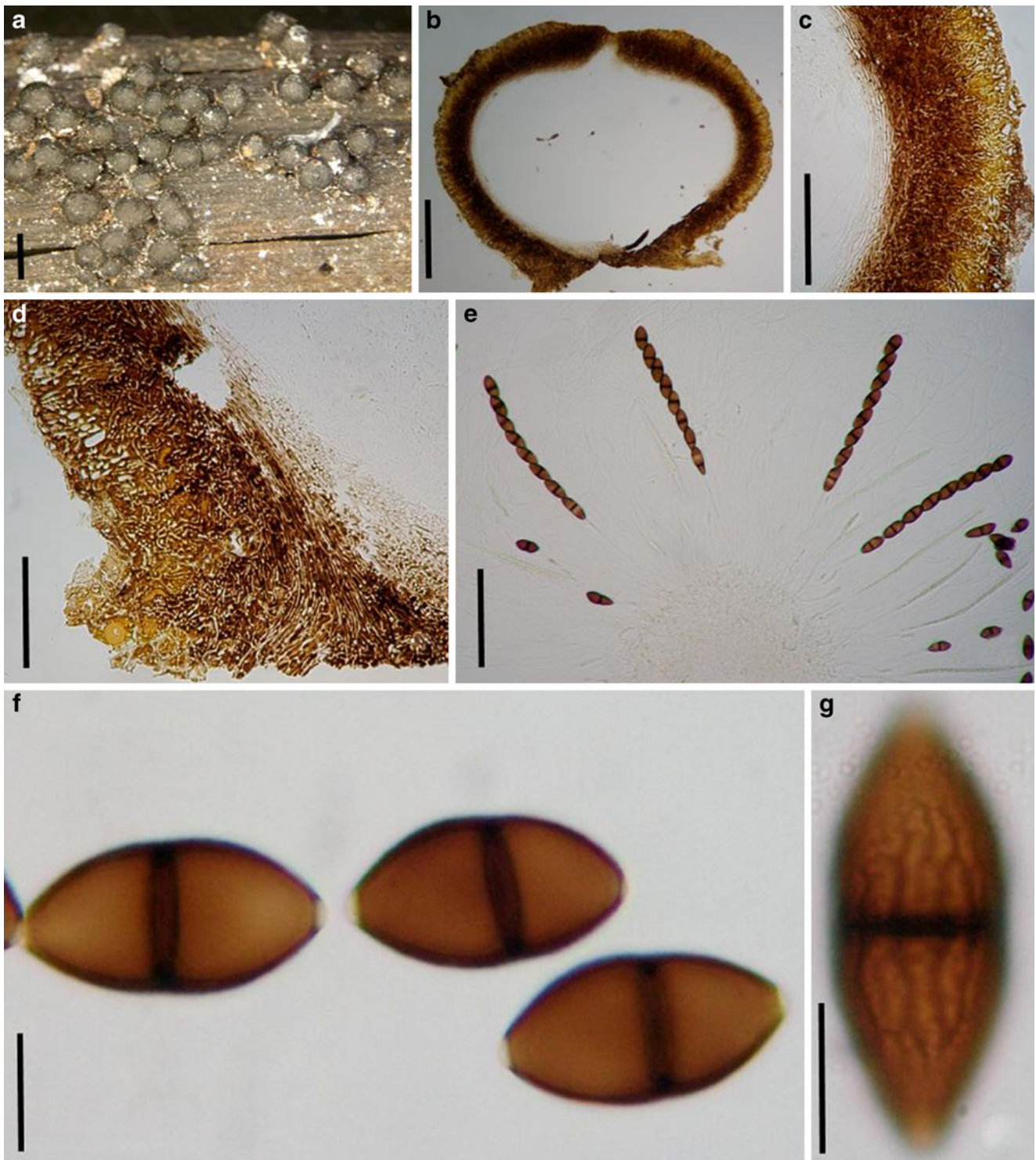
### Type species

*Chaetomastia hirtula* (P. Karst.) Berl., Icon. fung. (Abellini) 1: 38 (1890). (Fig. 21)

≡ *Sphaeria hirtula* P. Karst., Fungi Fenn. Exs. N. 825 (1869).

*Ascomata* 214–286  $\mu\text{m}$  high $\times$ 210–258  $\mu\text{m}$  diam., scattered or in groups, superficial, globose, wall black; apex often opening with a broad pore within slightly raised papilla, up to 30  $\mu\text{m}$  diam., coriaceous (Fig. 21a). *Peridium* 20–26  $\mu\text{m}$  thick, 1-layered, composed of heavily pigmented cells of *textura angularis*, cells up to 5 $\times$ 15  $\mu\text{m}$  diam., cell wall up to 3.5  $\mu\text{m}$  thick (Fig. 21b). *Hamathecium* of dense, long cellular pseudoparaphyses, embedded in mucilage. *Asci* 90–130 $\times$ 12.5–17.5(–22.5)  $\mu\text{m}$  ( $\bar{x}$  = 111  $\times$  16.3 $\mu\text{m}$ ,  $n$ =10), mostly 4-spored, bitunicate, fissionate, broadly cylindrical, with a furcate pedicel, 18–48  $\mu\text{m}$  long, with a large ocular chamber best seen in immature asci (to 3  $\mu\text{m}$  wide $\times$ 3  $\mu\text{m}$  high) (Fig. 21c and d). *Ascospores* 20.5–27 $\times$ 7–10  $\mu\text{m}$





**Fig. 20** *Caryosporella rhizophoriae* (from NY. Herb. J. Kohlmeyer No. 4532a, **holotype**). **a** Gregarious ascomata on host surface. **b** Section of an ascoma. **c, d** Section of partial peridium at sides (**c**) and base (**d**). Note the three layers. **e** Asci with long peduncles in

pseudoparaphyses. **f, g** Ascospores. Note the “net”-like ridged ornamentation of spore surface and hyaline germ pores. Scale bars: **a**=1 mm, **b**=200  $\mu\text{m}$ , **c–e**=100  $\mu\text{m}$ , **f, g**=10  $\mu\text{m}$

( $\bar{x}$  = 23.5  $\times$  8.2  $\mu\text{m}$ ,  $n$ =10), uniseriate to partially overlapping, ellipsoid to broadly fusoid with broadly to narrowly rounded ends, brown, 3-septate, verruculose,

constricted at all septa, constricted at the median septum, the cell above the central septum often broader than the others (Fig. 21e and f).



**Fig. 21** *Chaetomastia hirtula* (from H, FFE 825, **kleptotype**). **a** Superficial ascomata gregarious on the host surface. **b** Section of a partial peridium. Note the cells of *textura angularis* with relatively

thick wall. **c, d** Cylindrical asci with long and furcate pedicels. **e, f** Brown, 3-septate ascospores. Scale bars: **a**=0.5 mm, **b**=50  $\mu$ m, **c–f**=15  $\mu$ m

**Anamorph:** none reported.

**Material examined:** FINLAND, ETELÄ-HÄME (EH/Ta), Tammela, Mustiala, På *Rub. id.*, 8 May 1866. P.A. Karsten (H, FFE 825, **kleptotype**).

#### Notes

#### Morphology

*Chaetomastia* was introduced by Saccardo (1883) as a subgenus of *Melanomma*, and five species were includ-

ed, i.e. *M. canescens* Speg., *M. cucurbitarioides* Speg., *M. hirtulum* (P. Karst.) Sacc., *M. hispidulum* Sacc. and *M. pilosellum* P. Karst. Berlese (1890) promoted it to genus rank. Subsequently, *Chaetomastia hirtula* (P. Karst.) Berl. was selected as the lectotype species of the genus (Clements and Shear 1931). *Chaetomastia* has been regarded as having unitunicate asci (Eriksson and Hawksworth 1986, 1998; Eriksson 1999). However its bitunicate status was confirmed by Holm (1957). Holm (1957) treated *C. hirtula* as *Melanomma hirtulum* (P.

Karst.) Sacc., and Leuchtman (1985) transferred this species to *Montagnula sensu lato* based on the ascospore morphology and the hyphae surrounding the ascomata. Barr (1987b) suggested that ascoma, peridium structure and ascospore characters pointed *Montagnula sensu stricto* to *Phaeosphaeriaceae*, while the characters of ascomata and peridium structure of *Chaetomastia* were thought to fit the definition of *Dacampiaceae* (Barr 1987b). In particular, the peridium and ascospore characters of *C. hirtula* are comparable with those of the generic type of *Massariosphaeria* (*M. phaeospora*). Thus, Barr (1989c) accepted *Massariosphaeria sensu stricto* and assigned the phragmosporous species of *Massariosphaeria sensu lato* to *Chaetomastia*.

Barr (2002) later assigned *Chaetomastia* to *Teichosporaceae* based on its saprobic or hypersaprobic lifestyle, occurring on woody stems and peridium structure, and this is widely followed (Eriksson 2006; Lumbsch and Huhndorf 2007). Currently, 11 species are accepted in this genus (<http://www.indexfungorum.org/>).

#### Phylogenetic study

None.

#### Concluding remarks

Familial placement of *Chaetomastia* is undetermined currently but has been included in the *Teichosporaceae* by authoritative sources (Eriksson 2006; Lumbsch and Huhndorf 2007) or the *Dacampiaceae* (<http://www.indexfungorum.org/>).

*Chaetoplea* (Sacc.) Clem., Gen. Fung. (Minneapolis): 275 (1931). (?*Phaeosphaeriaceae*)

≡ *Pyrenophora* subgen. *Chaetoplea* Sacc., Syll. fung. (Abellini) 2: 279 (1883).

#### Generic description

Habitat terrestrial, saprobic. *Ascomata* small to medium, immersed, erumpent to superficial, globose to subglobose, papillate, ostiolate. *Peridium* not examined. *Hamathecium* of dense, long, narrowly cellular pseudoparaphyses. *Asci* 8-spored or 4-spored, bitunicate, fissitunicate, cylindro-clavate, with a thick, furcate pedicel. *Ascospores* ellipsoid or fusoid, pale brown to brown, phragmosporous or muriform.

**Anamorphs reported for genus:** *Microdiplodia*-like (Barr 1990b).

**Literature:** Barr 1981; 1987a; b; 1990b; Clements and Shear 1931; Ramaley and Barr 1995; Yuan and Barr 1994.

**Fig. 22** *Chaetoplea calvescens* (from FH-81113, **isotype**). **a, b** Four-spored and 8-spored asci. **c** Released ascospores. Scale bars: **a–c** = 10  $\mu\text{m}$

#### Type species

*Chaetoplea calvescens* (Fr.) Clem., Gen. Fung. (Minneapolis): 275 (1931). (Fig. 22)

≡ *Sphaeria calvescens* Fr. Scleromyc. Suecicae 401.

*Ascomata* not examined. *Peridium* not examined. *Hamathecium* of dense, long, narrow cellular pseudoparaphyses, 2–3  $\mu\text{m}$  broad, septate, branching and anastomosing. *Asci* 90–110×10–12  $\mu\text{m}$ , 8-spored, rarely 4-spored, bitunicate, fissitunicate, cylindro-clavate, with a thick, furcate pedicel which is up to 30  $\mu\text{m}$  long (Fig. 22a and b). *Ascospores* 13–18×5.5–7  $\mu\text{m}$ , obliquely uniseriate and partially overlapping, broadly fusoid to oblong with broadly rounded ends, pale brown, 2-3-septate, constricted at the septa, containing four refractive globules (Fig. 22c).

Note: The specimen is only a slide, and no peridium or ascomata information could be obtained.

**Anamorph:** coelomycetous, *conidia* yellowish, 1-septate, 9–13×4–5(–8)  $\mu\text{m}$  (Webster and Lucas 1959); *Microdiplodia henningsii* Staritz=*Chaetodiplodia caudina* Karst. (Sutton 1980) (referred to Barr 1990b (p50)).

**Material examined:** SWEDEN, sub-collection: Curtis Herbarium, verified by R.A. Shoemaker, leg. E.M. Fries 401 (FH-81113, **isotype**, microscope slide).

#### Notes

#### Morphology

*Chaetoplea* was introduced based on *C. calvescens*, which has been regarded as similar to *Pleospora* or *Leptosphaeria* (Eriksson and Hawksworth 1987; Wehmeyer 1961; von Arx and Müller 1975). Based on the differences in ascomata, peridium structure, pseudoparaphyses as well as its anamorphic stage, *Chaetoplea* was maintained as a separate genus (Barr 1990b; Yuan and Barr 1994). *Chaetoplea sensu lato* was accepted by Barr (1990b), which included some species of *Teichospora* as well as the subgenus *Pleospora* subg. *Cylindrosporeae*.

The following is from the label of specimen.

“*Sphaeria calvescens*, Scler. Suecicae (Ed. 2) 401. No specimen of Scler. Suecicae 401 is now at Uppsala according to R. Santesson 1966. This Curtis Herbarium specimen in the Farlow Herbarium is isotype. Wehmeyer (1961) in his *Pleospora* monograph did not study any portion of the Scler. Suecicae exsiccatus





401, nor did Webster & Lucas in the taxonomic and life-history study (Trans. Brit. Myc. Soc. 42, 332–342. 1959) of this species.

The specimen has most of the features described by Webster & Lucas including the presence of the conidial state *Microdiplodia henningsii* Staritz. I did not see vertical septa in the ascospores. Webster & Lucas note that vertical septa may be occasionally be lacking. The fungus is otherwise as they describe it although some perithecia collapse and appear cupulate.”—by R.A. Shoemaker.

### Phylogenetic study

None.

### Concluding remarks

The substrate of *Chaetoplea sensu* Barr (1990b) can be herbaceous stalks, decorticated wood or periderm, or old cotton cloth and string, which may indicate its heterogeneous nature. The ascospores seem very much like *Phaeosphaeria* which may be an earlier name; more details concerning the ascomatal, peridial and hamathecial structures are needed to make any conclusion.

*Cilioplea* Munk, Dansk botanisk Arkiv 15: 113 (1953). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* small- to medium-sized, solitary, scattered or in small groups, immersed, globose or subglobose, papilla covered with short and blackish setae, coriaceous. *Peridium* thin, comprising small heavily pigmented thick-walled cells of *textura angularis*. *Hamathecium* of cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, broadly clavate, with a short, furcate pedicel, and small ocular chamber. *Ascospores* fusoid to narrowly fusoid with narrowly rounded ends, pale brown to reddish brown, multi-transverse septa, usually with one longitudinal septum in some central cells, constricted at the primary septum.

**Anamorphs reported for genus:** none.

**Literature:** Barr 1990b, 1992b; Crivelli 1983; Lumbsch and Huhndorf 2007; Müller 1951; Munk 1953, 1957.

### Type species

*Cilioplea coronata* (Niessl) Munk, Dansk botanisk Arkiv 15: 113 (1953). (Fig. 23)

≡ *Pleospora coronata* Niessl, Notiz. Pyr.: 16 (1876).

*Ascomata* 170–290  $\mu\text{m}$  high  $\times$  200–410  $\mu\text{m}$  diam., solitary, scattered, or in small groups, immersed, globose or subglobose, wall black, papilla raised, 50–80  $\mu\text{m}$  high, with short and blackish setae, coriaceous (Fig. 23a). *Peridium* 9–15  $\mu\text{m}$

thick laterally, up to 28  $\mu\text{m}$  thick at the apex, thinner at the base, 1-layered, composed of small heavily pigmented thick-walled cells of *textura angularis*, cells up to  $4 \times 2.5$   $\mu\text{m}$  diam., cell wall 2–3  $\mu\text{m}$  thick, apex cells smaller and walls thicker (Fig. 23b). *Hamathecium* of long cellular pseudoparaphyses, 2–3  $\mu\text{m}$  broad. *Asci* (60–)80–108  $\times$  10–15  $\mu\text{m}$  ( $\bar{x}$  = 85.3  $\times$  12.1  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, broadly clavate, with a short, thick, furcate pedicel, 5–15  $\mu\text{m}$  long, and a small ocular chamber (to 3  $\mu\text{m}$  wide  $\times$  2  $\mu\text{m}$  high) (Fig. 23c and d). *Ascospores* 21–27.5  $\times$  5.5–7.5  $\mu\text{m}$  ( $\bar{x}$  = 24  $\times$  6.7  $\mu\text{m}$ ,  $n=10$ ), biseriate to uniseriate at base, fusoid to narrowly fusoid with narrowly rounded ends, pale reddish brown, 5–7 transverse septa (mostly 5), usually with one longitudinal septum in some central cells, deeply constricted at the median septum, the part above the primary septum shorter and broader, smooth-walled.

**Anamorph:** none reported.

**Material examined:** GERMANY, Hadiberg, on *Reseda lutea* Hadiberg, 20 Sept. 1875, Niessl (M 175-89-290, **lectotype**; M 175-89-291, **type**).

### Notes

### Morphology

*Cilioplea* was introduced by Müller (1951) as a subgenus of *Pleospora*, and this was followed by Munk (1957), who had earlier proposed it as a separate genus typified by *C. coronata* based on its hairy papilla, clavate asci as well as its “perfectly paraphysoid” (see Munk 1953). A relatively narrow concept of *Pleospora* was accepted by Crivelli (1983), and four species was assigned under the separate genus *Cilioplea*, viz. *C. coronata*, *C. genisticola* (Fautrey & Lambotte) Crivelli, *C. kansensis* (Ellis & Everh.) Crivelli and *C. nivalis* (Niessl) Crivelli. Subsequently, another six species were added (Barr 1990b, 1992b). Currently, ten species are included under *Cilioplea*.

### Phylogenetic study

None.

### Concluding remarks

The most striking character of *Cilioplea* is its setose papilla, which has been shown to have no phylogenetic significance in *Lentitheciaceae* (Zhang et al. 2009a). *Cilioplea* was assigned under *Lophiostomataceae* (Lumbsch and Huhndorf 2007), but there is little morphological similarity with the *Lophiostomataceae sensu stricto* (Zhang et al. 2009a). Thus its familial placement needs further study.

**Crivellia** Shoemaker & Inderb., in Inderbitzin, Shoemaker, O’Neill, Turgeon & Berbee, Can. J. Bot. 84: 1308 (2006). (*Pleosporaceae*)



**Fig. 23** *Cilioplea coronata* (M 175-89-290, lectotype). **a** Immersed ascomata in small groups on the host surface (the covering host tissue was removed). **b** Section of a partial ascoma. Note the thin peridium. **c**

Clavate asci within pseudoparaphyses. **d** Ascus with a small ocular chamber. Scale bars: **a**=0.5 mm, **b**=100  $\mu\text{m}$ , **c**=50  $\mu\text{m}$ , **d**=10  $\mu\text{m}$

### Generic description

Habitat terrestrial, hemibiotrophic or parasitic. *Ascomata* small- to medium-sized, scattered, immersed, erumpent to nearly superficial, papillate, ostiolate. *Peridium* thin, composed of two cells types, outer cells of thick walled and *textura angularis*, inner cells thin-walled, yellow. *Hamathecium* of dense, long and thin pseudoparaphyses. *Asci* (4-) 8-spored, bitunicate, fissitunicate dehiscence not observed, broadly cylindrical to cylindrical, with a short, furcate pedicel and an ocular chamber. *Ascospores* fusoid to broadly fusoid, pale brown, septate, sometimes with one or two vertical septa in the middle cells, constricted at the septa.

**Anamorphs reported for genus:** *Brachycladium* (Inderbitzin et al. 2006).

**Literature:** Inderbitzin et al. 2006.

### Type species

*Crivellia papaveracea* (De Not.) Shoemaker & Inderb., Can. J. Bot. 84: 1308 (2006). (Fig. 24)

≡ *Cucurbitaria papaveracea* De Not., Sfer. Ital.: 62 (1863).

*Ascomata* 210–260  $\mu\text{m}$  high  $\times$  300–380  $\mu\text{m}$  diam., densely scattered, immersed, erumpent to nearly superficial, flattened globose, dark brown, papillate, ostiolate (Fig. 24a). *Peridium* 25–30  $\mu\text{m}$  thick, thicker near the apex and thinner at the base, composed of two cell types, outer cells of thick-walled and *textura angularis*, cells up to  $10 \times 5$   $\mu\text{m}$  diam., cell wall 2–4  $\mu\text{m}$  thick, inner cells thin-walled, yellow (Fig. 24b). *Hamathecium* of dense, long, 1–2  $\mu\text{m}$

broad, rarely septate pseudoparaphyses. *Asci* 85–125×10–13  $\mu\text{m}$  ( $\bar{x}$  = 106×11 $\mu\text{m}$ ,  $n$ =10), (4-)8-spored, bitunicate, fissitunicate dehiscence not observed, broadly cylindrical to cylindrical, with a short, furcate pedicel, with a relatively large ocular chamber (Fig. 24c and d). *Ascospores* (16-)19–24×5–7.5  $\mu\text{m}$  ( $\bar{x}$  = 20.4×6.3 $\mu\text{m}$ ,  $n$ =10), overlapping uniseriate to rarely biseriata, fusoid to broadly fusoid, pale brown, 3-septate, sometimes with one or two vertical septa in the middle cells, constricted at the septa, the upper cell often broader than the lower one, smooth-walled.

**Anamorph:** *Brachycladium penicillatum* (Corda) Fr. (Inderbitzin et al. 2006).

**Material examined:** AUSTRIA, Vienna, on decaying stems of *Papaver rhoeas* L., 28 Oct. 2001, W. Jaklitsch (UBC F14995, **epitype**).

#### Notes

#### Morphology

*Crivellia* was separated from *Pleospora* and introduced as a new genus by Inderbitzin et al. (2006) based on their differences in ascospore morphology and anamorphic stages. *Crivellia* is characterized by having small- to medium-sized ascomata, and yellow, 3-septate ascospores

**Fig. 24** *Crivellia papaveracea* (from UBC F14995, **epitype**).

**a** Gregarious ascomata immersed within the host surface. **b** Section of an ascoma. **c** Asci within pseudoparaphyses. **d** Cylindrical ascus with a short pedicel. Scale bars: **a**=1 mm, **b**=100  $\mu\text{m}$ , **c**, **d**=30  $\mu\text{m}$



with one or two vertical septa in central cells. Its *Brachycladium* anamorphic stage with phragmosporous conidia also differs from that of *Stemphylium*, which is the anamorphic stage of *Pleospora* (Inderbitzin et al. 2006). Currently, two species are included within *Crivellia*, i.e. *C. homothallica* Inderb. & Shoemaker and *C. papaveracea*.

### Phylogenetic study

*Crivellia papaveracea* was shown to be closely related to some species of *Alternaria*, and its pleosporaceous status was confirmed following molecular studies (Inderbitzin et al. 2006).

### Concluding remarks

*Crivellia* seems to belong to *Pleosporaceae*, and may be closely related to *Pleospora*.

***Decaisnella*** Fabre, Annl. Sci. Nat., Bot., sér. 6 9:112 (1878). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium to large, immersed to erumpent, clypeate, papillate, ostiolate. *Hamathecium* of dense, long, cellular pseudoparaphyses, rarely septate, embedded in mucilage. *Asci* mostly 4- or 8-spored, rarely 2-spored, cylindrical to cylindro-clavate, with a furcate pedicel. *Ascospores* muriform, dark brown, oblong with broadly rounded ends.

**Anamorphs reported for genus:** none.

**Literature:** Barr 1986; 1990a; b; Fabre 1878; Saccardo 1883.

### Type species

***Decaisnella spectabilis*** Fabre, Annl. Sci. Nat., Bot., sér. 6 9: 112 (1879). (Fig. 25)

*Ascomata* 520–680  $\mu\text{m}$  high  $\times$  430–600  $\mu\text{m}$  diam., solitary, scattered, or in small groups of 2–3, immersed to erumpent, clypeate, globose or subglobose, black, roughened, with a blunt papilla up to 170  $\mu\text{m}$  high, apex with a round ostiole, coriaceous (Fig. 25a). *Peridium* 70–90  $\mu\text{m}$  thick at sides, thicker near the apex, comprising two types of cells; part immersed in host tissue, outer layer pseudoparenchymatous, 55–65  $\mu\text{m}$  thick, pigmented, inner layer composed of lightly pigmented to hyaline thin-walled compressed cells, 15–23  $\mu\text{m}$  thick, cells 3.5–7  $\mu\text{m}$  diam., part above host tissue heavily pigmented covered by clypeus tissues (Fig. 25b). *Hamathecium* of dense, long, cellular pseudoparaphyses, 1.5–3  $\mu\text{m}$  broad, rarely septate, embedded in mucilage. *Asci* 150–200  $\times$  15–25 (–33)  $\mu\text{m}$  ( $\bar{x}$  = 181  $\times$  20.6  $\mu\text{m}$ ,  $n$ =10), (2-)4-spored, bitunicate, fissionate, broadly cylindrical, with a short, thick, furcate

pedicel which is 20–40  $\mu\text{m}$  long, no apical apparatus observed (Fig. 25e). *Ascospores* 37–45  $\times$  12–17  $\mu\text{m}$  ( $\bar{x}$  = 43  $\times$  15  $\mu\text{m}$ ,  $n$ =10), uniseriate and sometimes slightly overlapping, oblong with broadly rounded ends, dark brown, verrucose or smooth, 7–9 transverse septa and 1–3 longitudinal septa in some of the cells, no constriction at the septa (Fig. 25c and d).

**Anamorph:** none reported.

**Material examined:** GERMANY, Valsalpe in der Ramsau, Bayer, Alpen, on *Rhamnus pumila* Turra., Jul. 1913, Karl Arnold (NY2082, **syntype** as *Teichospora megalocarpa* Rehm).

### Notes

### Morphology

*Decaisnella* was formally established by Fabre (1879), but was treated as a synonym of *Teichospora* by Saccardo (1883). This was followed by several mycologists over a long time. The main morphological differences between *Decaisnella* and *Teichospora* include the size and septation of ascospores, shape of ascomata, structure of peridium and type of pseudoparaphyses (Barr 1986). Thus Barr (1986) revived *Decaisnella* and assigned it to *Massariaceae* based on the shape of ascomata and large, distoseptate ascospores. Currently, 15 species are accepted under *Decaisnella* (<http://www.mycobank.org/MycoTaxo.aspx>). Neither the size of ascomata nor the ascospore characters have proven sufficient to place taxa at the family level in *Pleosporales* (Zhang et al. 2009a), and therefore familial placement of *Decaisnella* remains uncertain.

### Phylogenetic study

*Decaisnella formosa* resided in the clade of *Lophiostomataceae* and in proximity to *Lophiostoma macrostomoides* De Not. (Plate 1).

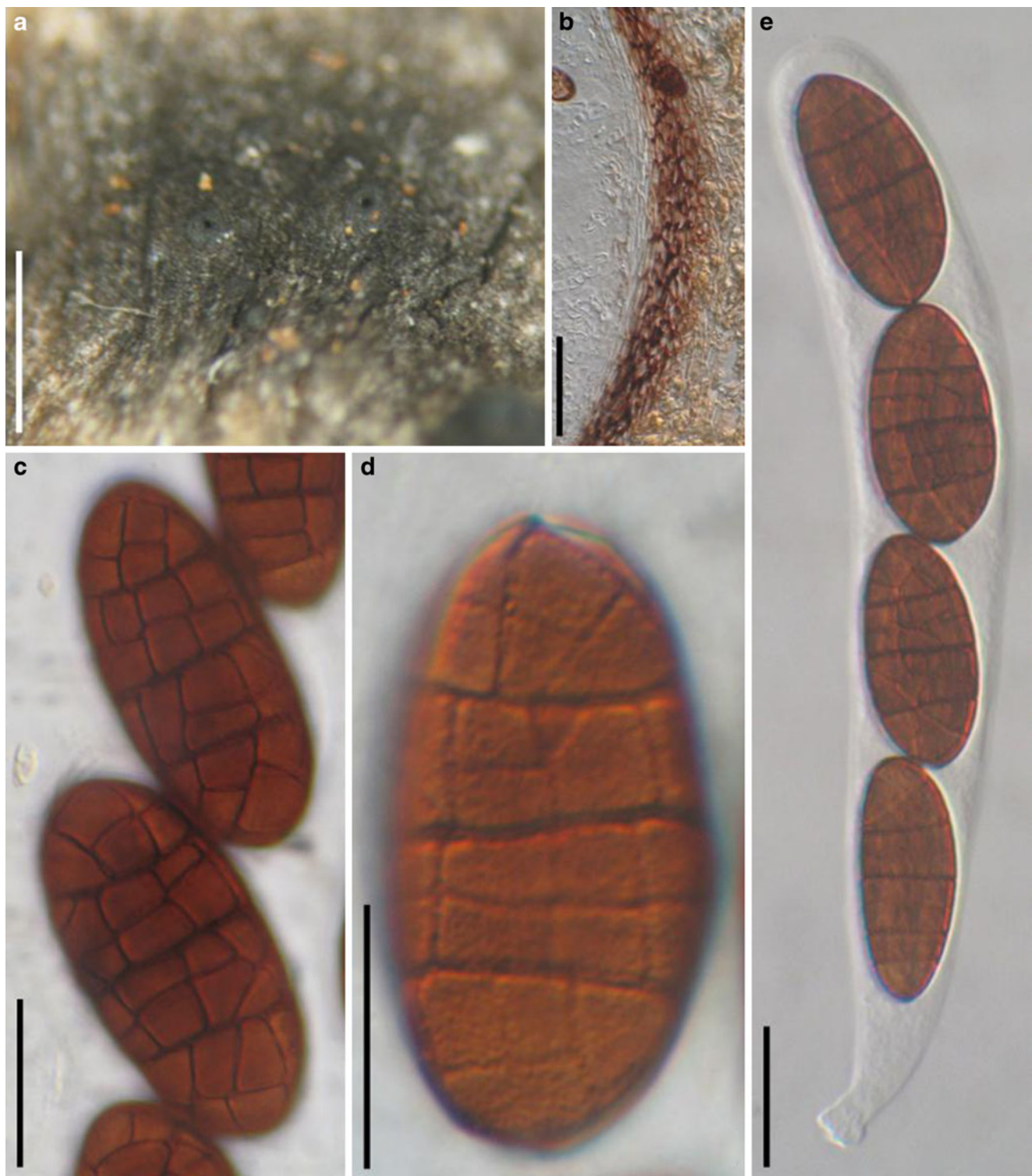
### Concluding remarks

The muriform ascospores, saprobic life style and 4-spored asci point *Decaisnella spectabilis* to *Montagnulaceae*, but this can only be confirmed following a molecular phylogenetic study.

***Delitschia*** Auersw., Hedwigia 5: 49 (1866). (*Delitschiaceae*)

### Generic description

Habitat terrestrial, saprobic (coprophilous). *Ascomata* medium- to large-sized, solitary or scattered, immersed to erumpent, globose or subglobose, apex with or without papilla, ostiolate. *Peridium* thin, composed of compressed cells. *Hamathecium* of dense, long pseudoparaphyses, anastomosing and branching. *Asci* 8-spored, cylindrical to cylindro-clavate, with short pedicel. *Ascospores* uni-



**Fig. 25** *Decaisnella spectabilis* (NY2082, syntype). **a** Appearance of ascomata on the host surface. **b** Section of a partial peridium (immersed in the substrate). Note the pseudoparenchymatous out

layer. **c**, **d** Muriform ascospores. Note the minutely verrucose ornamentation. **e** Ascus with a short pedicel. Scale bars: **a**=0.5 mm, **b**=100  $\mu$ m, **c**–**e**=20  $\mu$ m

triseriate, pale to dark brown, ellipsoid, 1-septate, usually constricted at the septum, smooth, with a full length germ slit in each cell.

**Anamorphs reported for genus:** none.

**Literature:** Auerswald 1866; Barr 2000; Cain 1934; Dennis 1968; Eriksson 2006; Griffiths 1901; Hyde and Steinke 1996; Kirschstein 1911; Krays et al. 2006; Luck-Allen and Cain 1975; Lumbsch and Huhndorf 2007;

Moreau 1953; Munk 1957; Romero and Samuels 1991; Schoch et al. 2006; Winter 1887.

### Type species

*Delitschia didyma* Auersw., Hedwigia 5: 49 (1866). (Fig. 26)

*Ascomata* 400–800  $\mu\text{m}$  diam., solitary or scattered, immersed, globose or subglobose, black, papilla short, 70–130  $\mu\text{m}$  broad, central, with a wide opening, coriaceous (Fig. 26a). *Peridium* ca. 15  $\mu\text{m}$  thick laterally, up to 35  $\mu\text{m}$  thick at the apex, up to 30  $\mu\text{m}$  at the base, comprising a single layer of small lightly pigmented thin-walled cells of *textura angularis*, cells 4–10  $\mu\text{m}$  diam., cell wall <1  $\mu\text{m}$  thick, apex cells smaller and wall thicker (Fig. 26b). *Hamathecium* of dense, very long pseudoparaphyses, 1.5–2  $\mu\text{m}$  broad, anastomosing and branching. *Asci* 290–380  $\times$  35–45  $\mu\text{m}$  ( $\bar{x}$  = 357.5  $\times$  40.6  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with short, narrowed pedicels which are rounded at the base, 25–60  $\mu\text{m}$  long, apex with a wide ocular chamber (Fig. 26d and e). *Ascospores* 50–58  $\times$  20–22.5  $\mu\text{m}$  ( $\bar{x}$  = 54  $\times$  21.3  $\mu\text{m}$ ,  $n$ =10), obliquely uniseriate and partially overlapping, ellipsoid with narrowly rounded ends, reddish brown, 1-septate, slightly constricted at the septum, smooth-walled, each cell with a full length germ slit (Fig. 26c).

**Anamorph:** none reported.

**Material examined:** GERMANY, Near Königstein, in forest, rare, Oct. 1904, W. Krieger (L, 1950).

### Notes

#### Morphology

*Delitschia* was established by Auerswald (1866), and assigned to *Sphaeriaceae*. It was considered to be closely related to *Sordariaceae* and *Amphisphaeriaceae*. Winter (1887) assigned *Delitschia* under *Sordariaceae*, and this placement is followed in several subsequent studies (Griffiths 1901; Kirschstein 1911). Cain (1934) suggested that *Delitschia* might belong in *Pleosporaceae*, and this proposal was supported by Moreau (1953) and Dennis (1968). Finally, Munk (1957) established *Sporormiaceae* (*Pseudosphaeriales*), and *Delitschia* was assigned therein. Luck-Allen and Cain (1975) reviewed and redefined the genus as having bitunicate asci, pigmented and 1-septate ascospores with an elongated germ slit in each cell and surrounded by a gelatinous sheath, and in particular, the coprophilous habitat. Luck-Allen and Cain (1975) accepted 46 species. Subsequently, some wood-inhabiting species were also described (Hyde and Steinke 1996; Romero and Samuels 1991). Three genera, i.e. *Delitschia*, *Ohleriella* and *Semidelitschia* were separated from *Spor-*

*ormiaceae*, and a new family, *Delitschiaceae*, was introduced by Barr (2000) to accommodate them. *Delitschiaceae* is characterized by a periphysate ostiole, wide endotunicate asci with a wide ocular chamber and ascospores having cells with germ slits. *Delitschiaceae* has been subsequently accepted (Eriksson 2006; Lumbsch and Huhndorf 2007).

The genus comprises 83 names (Index Fungorum) and is estimated to comprise 51 species (Kirk et al. 2008). Keys to *Delitschia* can be found in Luck-Allen and Cain (1975) and Hyde and Steinke (1996).

#### Phylogenetic study

*Delitschia didyma* and *D. winteri* (W. Phillips & Plowr.) Sacc. form a robust phylogenetic clade within *Delitschiaceae*, which is basal to other members of *Pleosporales* (Kruys et al. 2006; Schoch et al. 2006) except for *Massariaceae* (Voglmayr and Jaklitsch 2011). This might indicate its early derivation (Zhang et al. 2009a).

#### Concluding remarks

Morphologically, *Delitschia* is a well defined genus, and each cell of the ascospore has a full length germ slit. Currently, most species of this genus are coprophilous, although a few species are reported from wood (Hyde and Steinke 1996; Luck-Allen and Cain 1975). Whether the lignicolous habitat is an important character that might separate these taxa from the main coprophilous group, needs to be addressed, however, the morphological characters are similar.

*Didymosphaeria* Fuckel, Jb. Nassau. Ver. Naturk. 22–23: 140 (1870). (*Didymosphaeriaceae*)

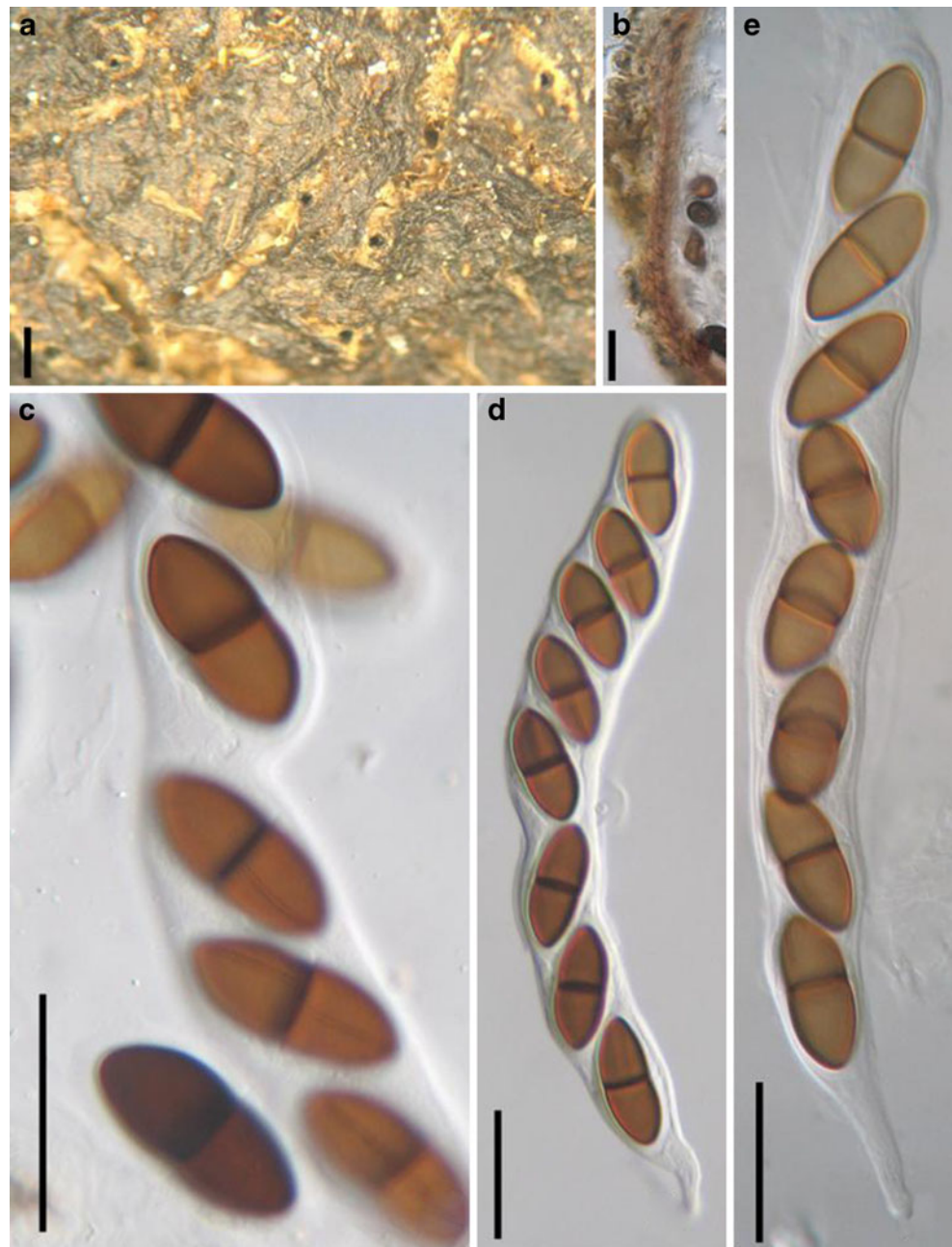
#### Generic description

Habitat terrestrial, saprobic or parasitic. *Ascomata* solitary, scattered, or in small groups, immersed to erumpent, globose to ovoid, papillate, ostiolate, periphysate. *Ostiole* with a pore-like opening. *Peridium* 1-layered, thin, composed of brown pseudoparenchymatous cells of *textura angularis*. *Hamathecium* of dense, trabeculate, anastomosing mostly above the asci. *Asci* (2-)4-spored or 8-spored, bitunicate, cylindrical, with a furcate pedicel. *Ascospores* uniseriate, ellipsoid, brown, 1-distoseptate.

**Anamorphs reported for genus:** *Dendrophoma*, *Fusicladiella* and *Phoma* (Aptroot 1995).

**Literature:** Aptroot 1995; Barr 1989a, b, 1990a, 1992a, b; 1993a; b; Fuckel 1870; Hawksworth 1985a, b; Hawksworth and Boise 1985; Hawksworth and Diederich 1988; Hyde et al. 2000; Lumbsch and Huhndorf 2007; Saccardo 1882; Scheinpflug 1958; Sivanesan 1984.

**Fig. 26** *Delitschia didyma* (from L, 1950). **a** Ascomata on the substrate surface. Note the ostiolar opening. **b** Section of peridium. Note the small cells of *textura angularis*. **c** Released and unreleased ascospores. Note the germ slit in each cell. **d, e** Asci with ascospores and short pedicels with rounded ends. Scale bars: **a**=0.5 mm, **b** =30  $\mu\text{m}$ , **c–e**=70  $\mu\text{m}$



### Type species

*Didymosphaeria futilis* (Berk. & Broome) Rehm, Hedwigia 18: 167 (1879). (Fig. 27)

≡ *Sphaeria futilis* Berk. & Broome, Ann. Mag. nat. Hist., Ser. 2 9: 326 (1852).

*Ascomata* 190–230  $\mu\text{m}$  high  $\times$  240–340  $\mu\text{m}$  diam., scattered, or in small groups, immersed to slightly erumpent, subglobose to ovoid, membranous, near-hyaline, under clypeus, papillate, periphysate (Fig. 27a and c). *Papilla* central, up to 100  $\mu\text{m}$  high, black, with a pore-like ostiole (Fig. 27a and c). *Peridium* 30–40  $\mu\text{m}$  wide upper part, 6–23  $\mu\text{m}$  wide near the base, 1-layered, composed of brown

pseudoparenchymatous cells of *textura angularis*, cell wall 2–3  $\mu\text{m}$  thick (Fig. 27b). *Hamathecium* of dense, long trabeculate pseudoparaphyses, 0.8–1.5  $\mu\text{m}$  broad, anastomosing mostly above the asci, embedded in mucilage (Fig. 27d). *Asci* 90–110  $\times$  7.5–10  $\mu\text{m}$  ( $\bar{x}$  = 97  $\times$  9  $\mu\text{m}$ ,  $n$ =10), 2–4-spored, rarely 8-spored, bitunicate, fissitunicate, cylindrical, with a furcate pedicel, 17.5–27.5  $\mu\text{m}$  long, with a large ocular (to 2.5  $\mu\text{m}$  wide  $\times$  4  $\mu\text{m}$  high) (Fig. 27d, e and f). *Ascospores* 14–15.5  $\times$  (5.5–) 6–7.5  $\mu\text{m}$  ( $\bar{x}$  = 14.8  $\times$  6.9  $\mu\text{m}$ ,  $n$ =10), uniseriate, ellipsoid with obtuse ends, brown, 1-septate, distoseptate, slightly to not constricted, capitate (Fig. 27g).

**Anamorph:** *Dendrophoma* sp., *Fusicladiella* sp. vel aff. (Sivanesan 1984).

**Material examined:** UK, England, Norfolk, King's Cliffe; on dead stem (in ramis emortuis) *Rosa* sp., Mar. 1850, M.J. Berkeley (K(M): 147683, **holotype**).

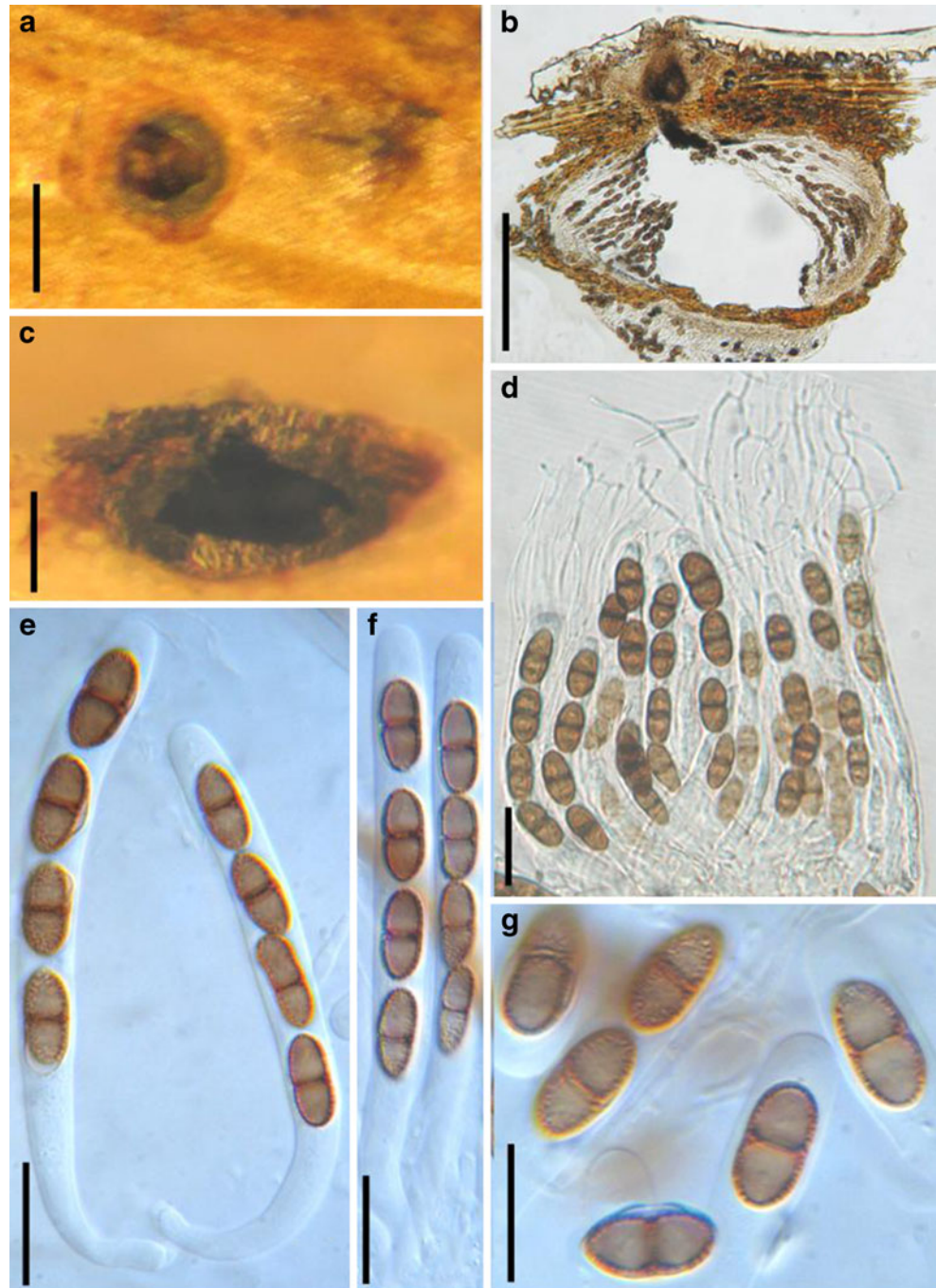
## Notes

### Morphology

*Didymosphaeria* is a widely distributed genus with wide host range (Aptroot 1995). *Didymosphaeria* was formally established by Fuckel (1870) based on six ascomycetous species, and *D. epidermidis* (Fries) Fuckel (or *D. peltigerae*

Fuckel) has been chosen as the lectotype species (see comments by Aptroot 1995). Hawksworth and David (1989: 494) proposed to conserve the genus with a lectotype specimen, *Fungi Rhenani* 1770. The genus had been considered as a depository to accommodate all types of didymosporous pyrenocarpous ascomycetes. Many workers have tried to redefine the genus and excluded some species. Saccardo (1882) restricted the genus to brown-spored species, and about 100 species have been excluded subsequently (Barr 1989a, b, 1990a, 1992a, b, 1993b; Hawksworth 1985a, b; Hawksworth and Boise 1985; Hawksworth and Diederich

**Fig. 27** *Didymosphaeria futilis* (from K(M): 147683, **holotype**). **a** Two immersed ascomata on the host surface (one of them is cut horizontally). **b** Section of an ascoma. Note the thin peridium. **c** Hand cut portion of ascoma showing habitat in wood. **d** Asci in pseudoparaphyses. Note the trabeculate pseudoparaphyses anastomosing above the asci. **e, f** Four-spored asci with long pedicels which are rounded at their bases. **g** Brown, 1-septate ascospores with spinulose ornamentation. Scale bars: **a**=0.3 mm, **b, c**=100  $\mu$ m, **d–g**=10  $\mu$ m





1988; Scheinflug 1958). Over 400 epithets of *Didymosphaeria* were included until the monograph of Aptroot (1995).

Aptroot (1995) examined more than 3000 specimens under the name *Didymosphaeria*. The type specimen of *Didymosphaeria* (Fungi Rhenani 1770) represents the widespread and common *D. futilis* (Aptroot 1995). In this study, we did not get the lectotype specimen, but described the type of *D. futilis* (*Sphaeria futilis*). Using a narrow concept (ignoring differences of host or country of origin), Aptroot (1995) accepted only seven species, which were closely related with the generic type of *Didymosphaeria* with over 100 synonyms distributed among them. Many taxa were found to belong to other groups, i.e. *Aaosphaeria*, *Amphisphaeria*, *Astrosphaeriella*, *Dothidotthia*, *Flagellosphaeria*, *Kirschsteiniotelia*, *Megalotremis*, *Montagnula*, *Munkovalsaria*, *Mycomicrothelia*, *Parapyrenis* or *Phaeodothis*. *Didymosphaeria* is mainly characterized by a peridium consisting of flattened or irregular cells or completely hyphae; a hamathecium consisting of narrow, trabeculate paraphyses or paraphyses, richly anastomosing above the asci; and brown thinly distoseptate ascospores. *Didymosphaeriaceae* was maintained as a separated family within *Pleosporales* by Aptroot (1995) because of the distoseptate ascospores and trabeculate pseudoparaphyses mainly anastomosing above the asci. This proposal, however, has not received much support (Lumbsch and Huhndorf 2007).

### Phylogenetic study

There have been few molecular investigations of *Didymosphaeria* when compared to the morphological studies. *Didymosphaeria futilis* resided in the clade of *Cucurbitariaceae* (or *Didymosphaeriaceae*) (Plate 1). The correct identification of the *Didymosphaeria* strain used for sequencing, however, has not been verified.

### Concluding remarks

*Didymosphaeria* is a well established genus represented by *D. futilis*. Of particular significance are the narrow pseudoparaphyses which anastomose above the asci and brown 1-septate ascospores with indistinct distosepta. Familial placement of *Didymosphaeria* is unclear yet because of insufficient molecular data.

***Dothidotthia*** Höhn., Ber. Deutsch. Bot. Ges. 36: 312 (1918). (*Didymellaceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium-sized, solitary, clustered or somewhat gregarious, erumpent, subglobose, apex somewhat papillate to depressed, coriaceous. *Peridium* composed of a few layers of dark brown cells of *textura angularis*, and giving rise dark brown, thick-walled hyphae in the basal region, 2-layered. *Hamathecium* septate pseudopar-

aphyses branched in upper part above asci. *Asci* 8-spored, bitunicate, clavate, straight to curved. *Ascospores* biseriate to obliquely uniseriate, ellipsoid, pale brown, 1-septate.

**Anamorphs reported for genus:** *Dothiorella* and *Thyrostroma* (Hyde et al. 2011; Phillips et al. 2008).

**Literature:** Barr 1989b; Phillips et al. 2008.

### Type species

***Dothidotthia symphoricarpi*** (Rehm) Höhn., Ber. Deutsch. Bot. Ges. 36: 312 (1918). (Fig. 28)

≡ *Pseudotthia symphoricarpi* Rehm, Ann. Mycol. 11: 169 (1913).

*Ascomata* up to 500  $\mu\text{m}$  high  $\times$  550  $\mu\text{m}$  diam., gregarious clustered, rarely solitary, erumpent, subglobose, apex somewhat papillate to depressed, coriaceous (Fig. 28a). *Peridium* 20–80  $\mu\text{m}$  thick, composed of 3–6 layers of dark brown cells of *textura angularis*, giving rise dark brown, thick-walled hyphae in the basal region, 2-layered, outer layer wall thicker and inner layer wall thinner (Fig. 28b). *Hamathecium* hyaline, septate pseudoparaphyses, 2–3  $\mu\text{m}$  wide, branched in upper part above asci. *Asci* 70–120  $\times$  15–22  $\mu\text{m}$ , 8-spored, bitunicate, clavate, straight to curved (Fig. 28c, d and e). *Ascospores* (20–)22–23 (–26)  $\times$  (8–)9–10(–11)  $\mu\text{m}$ , biseriate to obliquely uniseriate and partially overlapping, ellipsoid tapering towards subacutely rounded ends, pale brown, 1-septate, constricted at the septum, smooth (Fig. 28f) (description referred to Phillips et al. 2008).

**Anamorph:** *Thyrostroma negundinis* (Phillips et al. 2008).

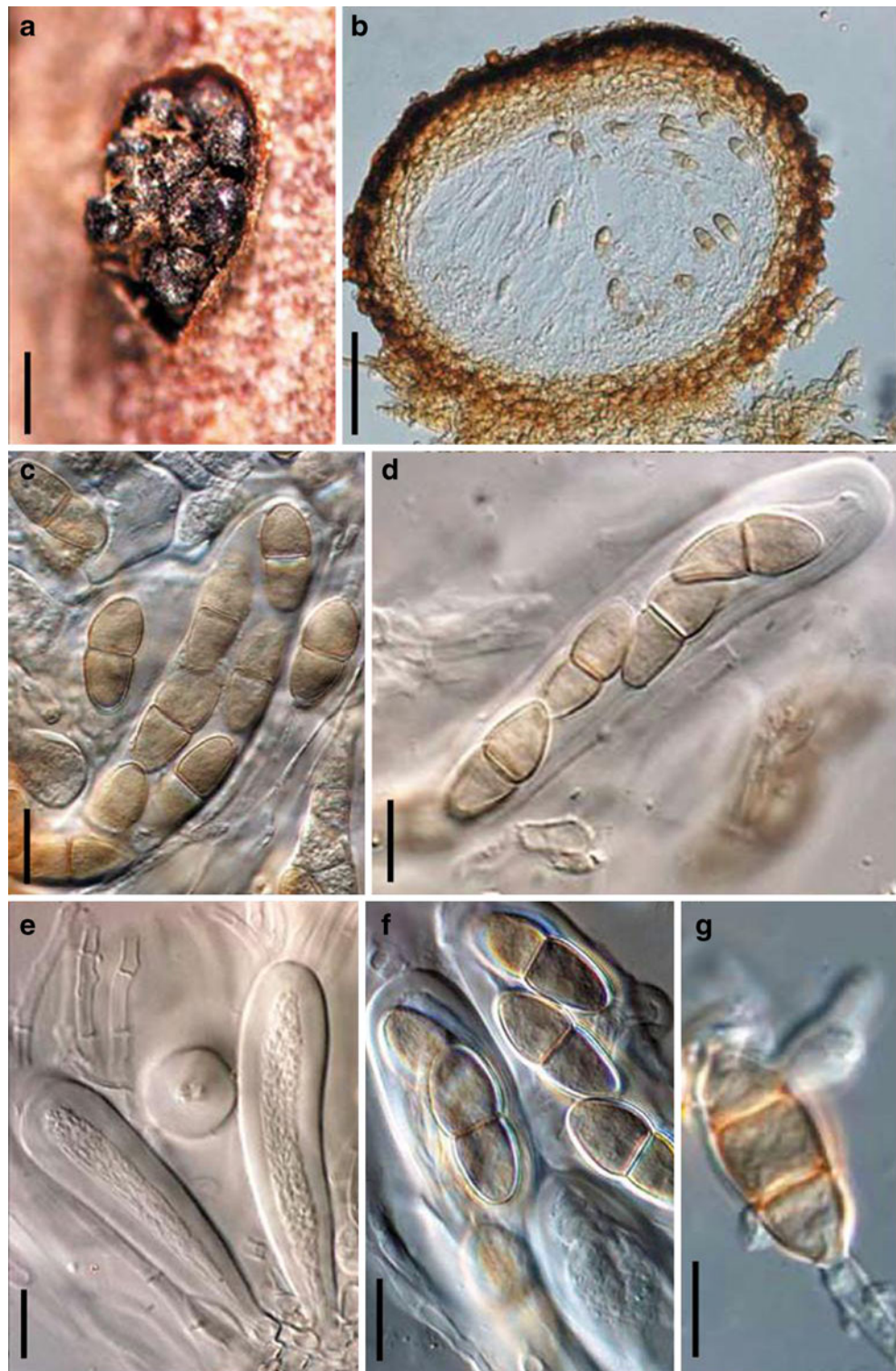
**Material examined:** USA, North Dakota, on branches of *Symphoricarpos occidentalis* Hook. (NY, **holotype**); Colorado, San Juan Co, c. 0.5 mile up Engineer Mountain Trail from turnoff at mile 52.5, Hwy 550, dead twigs of *Symphoricarpos rotundifolius* A. Gray, 24 Jun. 2004, A.W. Ramaley 0410 (BPI 871823, **epitype**).

### Notes

#### Morphology

*Dothidotthia* was formally established to accommodate *Pseudotthia symphoricarpi* (*Montagnellaceae*, *Dothideales*) (von Höhnelt 1918a). Many mycologists considered *Dothidotthia* closely related to a genus of *Venturiaceae* such as *Dibotryon* by Petrak (1927), or *Gibbera* by von Arx and Müller (1954) and Müller and von Arx (1962). *Dothidotthia* had been treated as a synonym of *Gibbera* (von Arx 1954; Müller and von Arx 1962), which was followed by Shoemaker (1963) and Eriksson and Hawksworth (1987). Based on the coelomycetous anamorphic stage and peridium structure, shape of asci, as well as morphology of pseudoparaphyses, Barr (1987b, 1989b) retrieved *Dothidotthia*, and considered it closely related to *Botryosphaeria* (*Botryosphaeriaceae*). Currently, 11 species are included within *Dothidotthia* (<http://www.mycobank.org>, 01–2011).

**Fig. 28** *Dothidotthia symphoricarpi* (from NY, holotype). **a** Clustered ascomata on the host substrate. **b** Longitudinal section through an ascoma. **c, d** Asci with pale brown, 1-septate ascospores. **e** Immature asci. **f** Pale brown, 1-septate ascospores within asci. **g** Conidia of *Thyrostroma* anamorph in association with ascomata. Scale bars: **a**=0.5 mm, **b**=100  $\mu$ m, **c–g**=10  $\mu$ m. (figure with permission from Phillips et al. 2008)



### Phylogenetic study

Based on a multi-gene phylogenetic analysis, *Dothidotthia* formed a separate familial clade (Phillips et al. 2008). Thus *Dothidotthiaceae* was introduced to accommodate it (Phillips et al. 2008).

### Concluding remarks

By comparing the morphological characters and phylogenetic dendrograms by Phillips et al. (2008) and de Gruyter et al. (2009), *Dothidotthia* seems closely related to *Didymellaceae*, but *Dothidotthiaceae* should still be treated as a separate family.

*Dubitatio* Speg., Anal. Soc. cient. argent. 12: 212 (1881). (*Arthopyreniaceae* (or *Massariaceae*))

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium-sized, solitary, densely scattered, or in small groups of 2–4, immersed, covered with white crystalline rim, papillate, ostiolate. *Hamathecium* of dense pseudoparaphyses, long, 2–3  $\mu\text{m}$  broad, branching and anastomosing. *Asci* cylindrical, pedicellate, with furcate pedicel. *Ascospores* 1-septate, asymmetrical, reddish to dark brown.

**Anamorphs reported for genus:** *Aplosporella*-like (Rossman et al. 1999).

**Literature:** Barr 1979b, 1987b; Müller and von Arx 1962; Rossman et al. 1999; Spegazzini 1881.

### Type species

*Dubitatio dubitationum* Speg., Anal. Soc. cient. argent. 12: 212 (1881). (Fig. 29)

*Ascomata* 350–530  $\mu\text{m}$  high  $\times$  550–700  $\mu\text{m}$  diam., solitary, densely scattered, or in small groups of 2–4, immersed, with a protruding papilla, 110–160  $\mu\text{m}$  high, 160–250  $\mu\text{m}$  diam., globose or subglobose, black, covered with white crystalline material which becomes hyaline and gel-like in water, ostiolate (Fig. 29a and b). *Peridium* 18–25  $\mu\text{m}$  thick laterally (excluding the rim), up to 35  $\mu\text{m}$  thick at the apex, thinner at the base, 1-layered, composed of small pale brown thin-walled cells of *textura prismatica*, cells 5–12  $\times$  3–5  $\mu\text{m}$  diam., cell wall up to 1  $\mu\text{m}$  thick, apex cells smaller and walls thicker (Fig. 29b). *Hamathecium* of dense, long pseudoparaphyses, 2–3  $\mu\text{m}$  broad, branching and anastomosing between and above the asci. *Asci* 150–190(–230)  $\times$  12.5–15  $\mu\text{m}$  ( $\bar{x}$  = 172.5  $\times$  13.4  $\mu\text{m}$ ,  $n$  = 10), (6–)8-spored, rarely 4-spored, bitunicate, fissitunicate, cylindrical, with a furcate pedicel which is up to 40  $\mu\text{m}$  long, ocular chamber not observed (Fig. 29c, d and e). *Ascospores* 19–22.5  $\times$  10–12  $\mu\text{m}$  ( $\bar{x}$  = 20.2  $\times$  11.4  $\mu\text{m}$ ,  $n$  = 10), uniseriate to obliquely uniseriate and partially overlapping, broadly ellipsoid with broadly to narrowly rounded ends, reddish brown, 1-septate, constricted at septum, asymmetric with a larger upper cell, thick-walled, possibly distoseptate (Fig. 29f, g and h).

**Anamorph:** *Aplosporella*-like (for detailed description see Rossman et al. 1999).

*Conidiomata* globose, ca. 300  $\mu\text{m}$  diam. *Conidia* holoblastic, broadly fusoid, 13–15  $\times$  7–10  $\mu\text{m}$ , dark brown, finely spinulose (Rossman et al. 1999).

**Material examined:** ARGENTINA, Buenos Aires, Tuyu, on *Celtis tala* Gill., Jan. 1881, leg. det. C. Spegazzini (NY, **isotype**; LPS, **holotype**).

### Notes

#### Morphology

When established *Dubitatio*, Spegazzini (1881) considered it as intermediate between *Sphaeriaceae* and *Nectriaceae* as has been mentioned by Rossman et al. (1999). Müller and von Arx (1962) treated *Dubitatio* as a synonym of *Passerinula*, while the differences of ascomata and ascospores could easily distinguish these two genera (Rossman et al. 1999). After checking the type specimen, *Dubitatio* was assigned to *Dothideomycetes*, and considered closely related to *Dothivalsaria* in the *Massariaceae* (Barr 1979b, 1987b). *Dubitatio chondrospora* was assigned to *Pseudomassaria* (as *P. chondrospora* (Ces.) Jacz.) (Barr 1964; Müller and von Arx 1962).

#### Phylogenetic study

None.

#### Concluding remarks

The black ascomata with white crystalline covering and central white ostiolar region as well as the asymmetrical reddish brown ascospores are striking characters of *Dubitatio dubitationum*. The genus cannot be assigned to any family with certainty based on morphological characters and fresh collections are needed for sequencing.

*Entodesmium* Reiss, Hedwigia 1: 28 (1854). (*Phaeosphaeriaceae*)

#### Generic description

Habitat terrestrial, saprobic (or parasitic?). *Ascomata* scattered or in small groups, immersed, papillate, ostiolate, periphysate. *Peridium* thin, comprising one cell type of pigmented pseudoparenchymatous cells. *Hamathecium* of dense, long pseudoparaphyses, septate, embedded in mucilage. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, with furcate pedicel. *Ascospores* ellipsoid to filliform, multi-septate, deeply constricted at the primary septum (usually near apex), breaking into partspores.

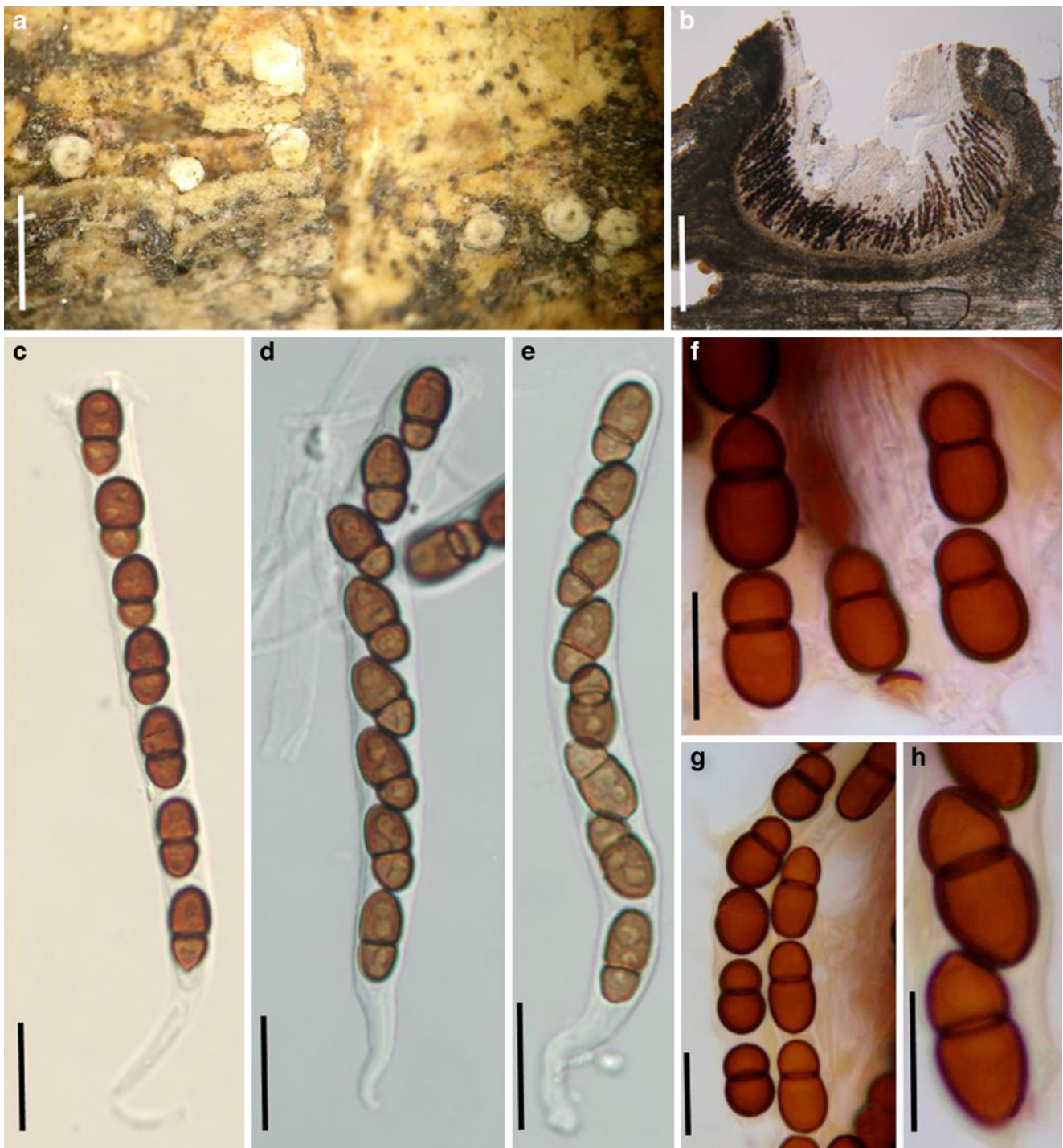
**Anamorphs reported for genus:** none.

**Literature:** von Arx and Müller 1975; Barr 1992b; Eriksson 1967a; b; Holm 1957; Liew et al. 2000; Shoemaker 1984a, b.

#### Type species

*Entodesmium rude* Reiss, Hedwigia 1: 28 (1854). (Fig. 30)

*Ascomata* 160–250  $\mu\text{m}$  high  $\times$  150–300  $\mu\text{m}$  diam., in groups, immersed with long and protruding cylindrical papilla, globose to subglobose, black, coriaceous (Fig. 30a). *Papilla* 100–220  $\mu\text{m}$  long, 70–120  $\mu\text{m}$  broad, cylindrical, with periphysate ostiole. *Peridium* 25–33  $\mu\text{m}$  wide, comprising pseudoparenchymatous cells, cells up to 10  $\times$  7.5  $\mu\text{m}$  diam., cell wall up to 2  $\mu\text{m}$  thick, beak cells smaller and wall thicker



**Fig. 29** *Dubitatio dubitationum* (from NY, isotype; LPS, holotype). **a** Appearance of ascomata scattered on the host surface. Note the exposed white covering around the ostioles. **b, c** Section of an ascoma.

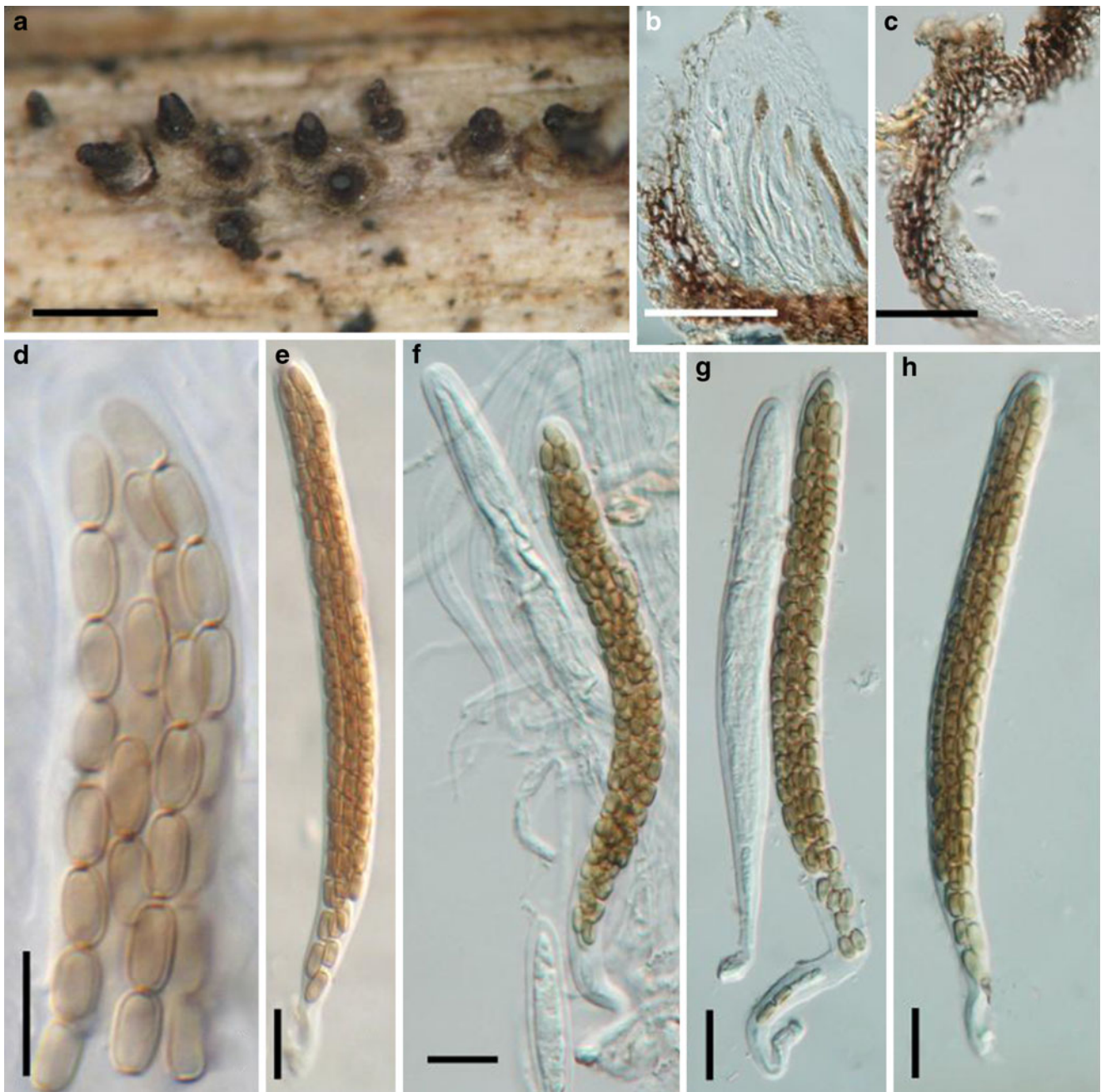
(Fig. 30b and c). *Hamathecium* of dense, long pseudoparaphyses, septate, 2–3  $\mu\text{m}$  wide, embedded in mucilage. *Asci* 100–175  $\times$  8–13  $\mu\text{m}$  ( $\bar{x}$  = 147.5  $\times$  11.3  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissionitunicate, cylindrical, with a furcate pedicel which is 18–50  $\mu\text{m}$  long, and with a low ocular chamber (ca. 1  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 30e, f, g and h).

Note the white covering (see arrow). **d–f** Cylindrical asci with short furcate pedicels. **g, h** Asymmetrical, 1-septate reddish-brown ascospores. Scale bars: **a**=1 mm, **b**=100  $\mu\text{m}$ , **c–e**=50  $\mu\text{m}$ , **f–h**=20  $\mu\text{m}$

*Ascospores* 108–138  $\times$  3–3.5  $\mu\text{m}$  ( $\bar{x}$  = 123  $\times$  3.2  $\mu\text{m}$ ,  $n$ =10), filliform, brown, multi-septate, breaking into 22–28 part-spores, 5–7  $\times$  3–3.5  $\mu\text{m}$  diam. (Fig. 30d).

**Anamorph:** none reported.

**Material examined:** GERMANY, Königstein, on stems of *Coronilla varia* L., 20 May 1895, W. Krieger (H, Krieger 1070).



**Fig. 30** *Entodesmium rude* (from H, Krieger 1070). **a** Ascomata in groups on the host surface. Note the erumpent papilla which is cylindrical and has an inconspicuous ostiole. **b** Section of part of an ascoma. Note the arrangement of asci and pseudoparaphyses. **c** Section

of the peridium comprising cells of *textura angularis*. **d** Part-spores inside the ascus. **e** Relatively immature ascus with filliform ascospores and low ocular chamber. **f–h** Mature and immature asci with pedicels. Scale bars: **a**=0.5 mm, **b**, **c**=50  $\mu$ m, **d–h**=10  $\mu$ m

## Notes

### Morphology

*Entodesmium* is characterized by having immersed ascomata dark cylindrical, periphysate papillae, numerous clavate to cylindrical asci surrounded by narrowly cellular pseudoparaphyses, and ellipsoidal to filliform multi-septate ascospores (Barr 1992b; Shoemaker 1984b). Currently, five species, viz. *Entodesmium elias-*

*sonii* L. Holm, *E. lapponicum* (L. Holm) L. Holm, *E. mayorii* (E. Müll.) L. Holm, *E. niessleanum* (Rabenh. ex Niessl) L. Holm and *E. rude* are accepted in this genus (Holm 1957; Shoemaker 1984b). Von Arx and Müller (1975) assigned *Entodesmium* to the *Pleosporaceae sensu lato*, and Shoemaker (1976) assigned *E. rude* (as *Ophiobolus rudis*) to *Ophiobolus sensu lato* based on the fragmenting filliform ascospores. According to the short, blackish beak and periphysate ostiole, Barr (1992b)

assigned *Entodesmium* to *Lophiostomataceae*. The hosts of *Entodesmium* are restricted to stems of legumes (Barr 1992b; Shoemaker 1984b).

### Phylogenetic study

Limited phylogenetic studies indicate that *Entodesmium rude* may have affinities to *Phaeosphaeriaceae* (Liew et al. 2000; Plate 1).

### Concluding remarks

Species of *Entodesmium* share several morphological characters, such as immersed, papillate ascomata, periphysate ostioles, pale yellow to light yellowish brown, multi-septate ( $\geq 3$ ), narrowly fusoid to filliform ascospores, and are specific to legumes. All of the above similarities indicate a close relationship among members of *Entodesmium*. We do not agree with Barr (1992b) who assigned *Entodesmium* to *Lophiostomataceae* because the ascomata are immersed, the papilla are not laterally compressed and the peridium comprises a single type of cells of *textura angularis*. These characters plus multi-septate, lightly pigmented ascospores, which break up into partspores and host specificity to legumes support inclusion in *Phaeosphaeriaceae*. *Entodesmium multiseptatum* (G. Winter) L. Holm and *E. niessleanum* were originally described as *Leptosphaeria* species (Shoemaker 1984b) indicating their similarity to *Phaeosphaeria* with which *Leptosphaeria* is commonly confused (Shoemaker 1984a; Shoemaker and Babcock 1989b). Phylogenetic study has also shown that *Entodesmium rude* is related to members of *Phaeosphaeriaceae* (Liew et al. 2000). Thus we assign *Entodesmium* to *Phaeosphaeriaceae* as a separate genus until further phylogenetic analysis is carried out on verified specimens.

*Eudarluka* Speg., Revta Mus. La Plata 15: 22 (1908). (?*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, parasitic. *Ascomata* small, solitary, scattered, immersed to erumpent, subglobose, ostiolate, papillate. *Peridium* thin, composed of a few layers cells of *textura prismatica*. *Hamathecium* of dense, cellular pseudoparaphyses, septate. *Asci* 8-spored, bitunicate, fissionate, cylindrical to fusoid, with a furcate pedicel. *Ascospores* broadly fusoid to fusoid, hyaline to pale yellow, rarely 1- or 3- septate, mostly 2-septate, constricted at the primary septum.

**Anamorphs reported for genus:** *Sphaerellopsis* (Sivanesan 1984).

**Literature:** Bayon et al. 2006; Eriksson 1966; Katumoto 1986; Ramakrishnan 1951; Spegazzini 1908.

### Type species

*Eudarluka australis* Speg., Revta Mus. La Plata 15: 22 (1908). (Fig. 31)

*Ascomata* 160–190  $\mu\text{m}$  high  $\times$  180–290  $\mu\text{m}$  diam., solitary, scattered, or in small groups, semi-immersed to erumpent, subglobose to broadly ellipsoid, wall black, ostiolate, apex with a short papilla, 40–70  $\mu\text{m}$  broad (Fig. 31a and b). *Peridium*  $< 10 \mu\text{m}$  wide laterally, up to 25  $\mu\text{m}$  thick at the apex, thinner at the base, composed of lightly pigmented thin-walled cells of *textura prismatica*, cells up to  $12 \times 4 \mu\text{m}$  diam., cell wall  $< 1 \mu\text{m}$  thick, apex cells heavily pigmented, smaller and walls thicker (Fig. 31b and c). *Hamathecium* of dense, long cellular pseudoparaphyses, 1.5–2.5  $\mu\text{m}$  broad, septate. *Asci* 50–70  $\times$  7.5–10  $\mu\text{m}$  ( $\bar{x} = 61.4 \times 8.4 \mu\text{m}$ ,  $n=10$ ), 8-spored, with a short, thick, furcate pedicel, up to 12.5  $\mu\text{m}$  long, bitunicate, fissionate, cylindrical to fusoid, no obvious ocular chamber (Fig. 31d, e, f and g). *Ascospores* 16–20  $\times$  4–6  $\mu\text{m}$  ( $\bar{x} = 17.3 \times 5 \mu\text{m}$ ,  $n=10$ ), obliquely uniseriate and partially overlapping to biseriate, broadly fusoid to fusoid, hyaline to pale yellow, 2-septate, sometimes 1- or 3-septate, constricted at the two main septa, the medium cell often broader than the others, smooth (Fig. 31h).

**Anamorph:** *Sphaerellopsis filum* (Biv.) B. Sutton (Sivanesan 1984).

**Material examined:** BRAZIL, Sao Paulo, on leaves of *Canna* sp., 1905, leg. Usteri, nro; det. Ove Eriksson (LPS 5.415, type).

### Notes

#### Morphology

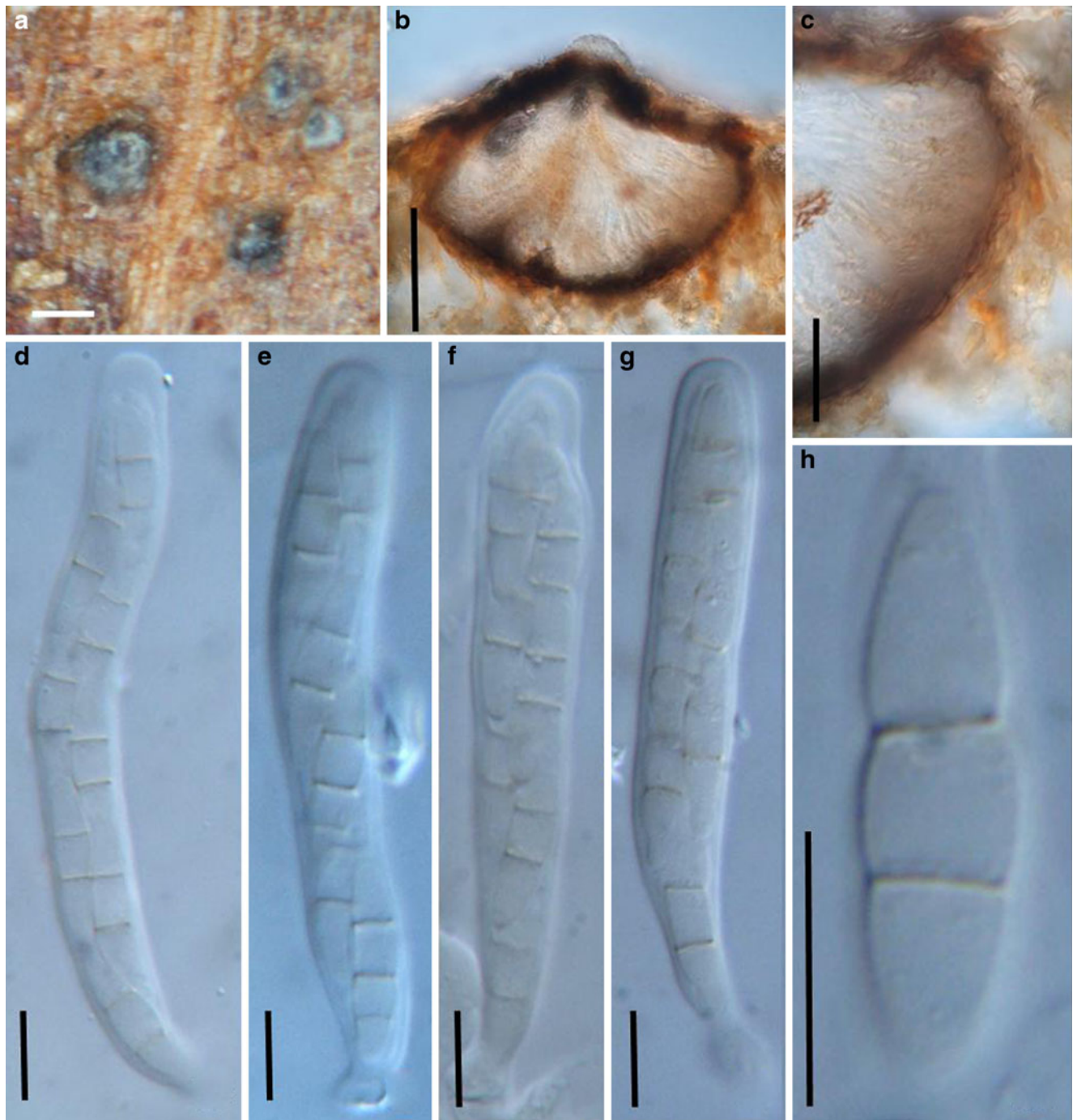
*Eudarluka* was introduced based on *E. australis* (Spegazzini 1908), and *E. australis* was subsequently treated as a synonym of *E. caricis* (Biv.) O.E. Erikss. (Eriksson 1966). The most striking character of *E. australis* is its 2-septate ascospores, which is quite rare in *Pleosporales*. *Sphaerellopsis filum*, anamorph of *E. caricis*, is a cosmopolitan hyperparasite associated with a large number of rust species (Płachecka 2005).

#### Phylogenetic study

A detailed phylogenetic study was conducted on *Sphaerellopsis filum*, the anamorphic stage of *Eudarluka australis* based on both AFLP and ITS sequences, and only limited variation between different isolates was detected (Bayon et al. 2006).

#### Concluding remarks

By blasting within GenBank, ITS sequences of *E. caricis* (= *E. australis*, strain MullMK, GB, access AY836374) are most comparable with species in *Leptosphaeria* and *Phoma*. Thus *Eudarluka* appears to be related to *Leptosphaeriaceae* pending further study.



**Fig. 31** *Eudarlucula australis* (from LPS 5.415, **type**). **a** Ascomata on the host surface. **b** Section of an ascoma. **c** Section of a partial peridium. Note the thin peridium with cells of *textura angularis*. **d–g**

Asci with short pedicels. **h** Ascospores. Note the 2-septate hyaline ascospore. Scale bars: **a, b**=100  $\mu\text{m}$ , **c**=50  $\mu\text{m}$ , **d–h**=10  $\mu\text{m}$

*Falciformispora* K.D. Hyde, Mycol. Res. 96: 26 (1992). (*Trematosphaeriaceae*)

#### Generic description

Habitat freshwater, saprobic. *Ascomata* small, scattered to gregarious, erumpent to nearly superficial, depressed

globose to ovoid, black, ostiolate, epapillate, coriaceous. *Peridium* thin, comprising two cell types, outer layer composed of thick-walled cells of *textura angularis*, inner layer composed of hyaline compressed cells. *Hamathecium* long and cellular pseudoparaphyses, septate, embedded in mucilage. *Asci* 8-spored, bitunicate, fissitunicate, broadly clavate to fusoid, with a short, thick pedicel. *Ascospores*

fusoid to somewhat clavate, hyaline, usually slightly curved, multi-septate.

**Anamorphs reported for genus:** none.

**Literature:** Hyde 1992b; Raja and Shearer 2008.

### Type species

*Falciformispora lignatilis* K.D. Hyde, Mycol. Res. 96: 27 (1992). (Fig. 32)

*Ascomata* 180–270  $\mu\text{m}$  high  $\times$  250–340  $\mu\text{m}$  diam., scattered to gregarious, erumpent and eventually superficial, depressed globose to ovoid, black, ostiolate, epapillate, coriaceous (Fig. 32a). *Peridium* up to 35  $\mu\text{m}$  wide, comprising two cell types, outer layer composed of thick-walled cells of *textura angularis*, up to 8  $\mu\text{m}$  diam., cell wall up to 5  $\mu\text{m}$  thick, inner layer composed of hyaline compressed cells, cells 12  $\times$  3  $\mu\text{m}$  diam., cell wall 1–1.5  $\mu\text{m}$  thick (Fig. 32a). *Hamathecium* long and cellular pseudoparaphyses, 2–3  $\mu\text{m}$  broad, septate, embedded in mucilage. *Asci* 115–130  $\times$  23–31  $\mu\text{m}$ , 8-spored, bitunicate, fissitunicate, broadly clavate to fusoid, with a short, thick pedicel, 8–15  $\mu\text{m}$  long, with an ocular chamber (to 5  $\mu\text{m}$  wide  $\times$  3  $\mu\text{m}$  high) (Fig. 32b and c). *Ascospores* 42–50  $\times$  8–10  $\mu\text{m}$ , 2–3 seriate, fusoid to somewhat clavate, hyaline, usually slightly curved, 6–8-septate, mostly 7-septate, slightly constricted at all septa, smooth-walled, surrounded by a thin mucilaginous sheath which is longer at the base (up to 20–30  $\mu\text{m}$ ) (Fig. 32d, e and f).

**Anamorph:** none reported.

**Material examined:** MEXICO, Nova Hispania, mangrove near Boca de Pascuales, saprobic on immersed intertidal mangrove wood, Mar. 1988, K.D. Hyde (BRIP 16972, **holotype**).

### Notes

#### Morphology

*Falciformispora* was formally established by Hyde (1992b) as a monotypic genus and was assigned to *Pleosporaceae* by comparing with *Setosphaeria*, but *Setosphaeria* has the anamorphic stage of *Exserohilum* and is exclusively parasitic on *Gramineae* unlike *Falciformispora*. The setae on the ascomata of *Setosphaeria* could also serve as a distinguishing character from *Falciformispora*. Raja and Shearer (2008) also collected this species from freshwater in Florida. They considered that the species was more closely related to *Chaetomastia* than *Setosphaeria*, but that *Falciformispora* differed in having hyaline ascospores.

#### Phylogenetic study

Phylogenetic analyses in Schoch et al. (2009) and Suetrong et al. (2009) placed *Falciformispora lignatilis* in *Trematosphaeriaceae* in proximity to another marine species associated with mangroves, *Halomassarina thalassiae*.

### Concluding remarks

Phylogenetic work confirmed that the saprobic habitat of *Falciformispora* is inconsistent with most other members of *Pleosporaceae*. The hyaline multi-septate ascospores with a mucilaginous sheath indicate affinities to *Lophiostomataceae* but this is not supported in DNA sequence comparisons. *Carinispora* is also similar and may be related.

*Hadrospora* Boise, Mem. N. Y. bot. Gdn 49: 310 (1989). (?*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial (or freshwater?), saprobic. *Ascomata* small- to medium-sized, solitary, scattered, or in groups, immersed to nearly superficial, globose to subglobose, papillate. *Peridium* thin, comprising pseudoparenchymatous cells. *Hamathecium* dense, narrowly cellular, embedded in mucilage. *Asci* bitunicate, fissitunicate, oblong to ovoid, with a short pedicel. *Ascospores* ellipsoid to broadly fusoid with narrow ends, reddish brown, multi-septate, constricted at the primary septum.

**Anamorphs reported for genus:** *Zalerion* (Tanaka and Harada 2003a).

**Literature:** Boise 1984, 1989; Fisher and Webster 1992; Shearer and Crane 1971; Tanaka and Harada 2003a; Webster 1993.

### Type species

*Hadrospora fallax* (Mouton) Boise, Mem. N. Y. bot. Gdn 49: 310 (1989). (Fig. 33)

$\equiv$  *Trematosphaeria fallax* Mouton, Bull. Soc. R. Bot. Belg. 25: 155, (1886).

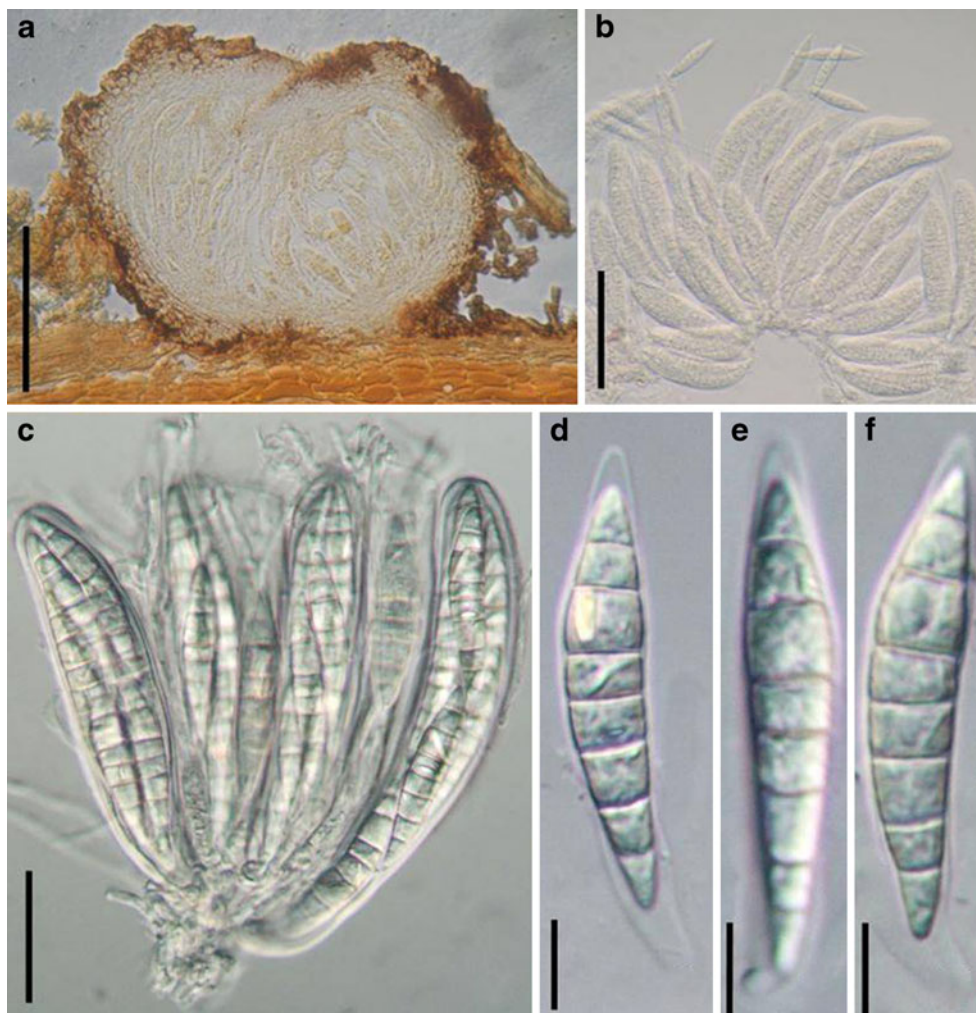
*Ascomata* 130–240  $\mu\text{m}$  high  $\times$  200–330  $\mu\text{m}$  diam., solitary, scattered or in groups, initially immersed, becoming erumpent to nearly superficial, with basal wall remaining immersed in host tissue, not easily removed from the substrate, globose or subglobose, roughened, papillate, coriaceous (Fig. 33a). *Peridium* 30–45  $\mu\text{m}$  wide, comprising cells of pseudoparenchymatous, up to 12.5  $\times$  9  $\mu\text{m}$  diam. (Fig. 33b and c). *Hamathecium* of dense, narrowly cellular pseudoparaphyses, 1–2  $\mu\text{m}$  broad, embedded in mucilage. *Asci* 150–200  $\times$  40–60  $\mu\text{m}$  ( $\bar{x}$  = 171.5  $\times$  48  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, oblong to ovoid, with a short pedicel, 10–24  $\mu\text{m}$  long, with an ocular chamber (to 5  $\mu\text{m}$  wide  $\times$  6  $\mu\text{m}$  high) (Fig. 33d). *Ascospores* 55–80  $\times$  16–22  $\mu\text{m}$  ( $\bar{x}$  = 67.1  $\times$  18.1  $\mu\text{m}$ ,  $n=10$ ), biseriate to 4-seriate, ellipsoid to broadly fusoid with narrow ends, reddish brown with paler end cells, 8-septate, constricted at the primary septum, smooth-walled (Fig. 33e, f, g, h and i).

**Anamorph:** *Zalerion* sp. (Tanaka and Harada 2003a).

**Material examined:** BELGIUM, Beaufays, on cut off, still hard wood. Oct. 1922, V. Mouton (BR, Capsa: K 7534,



**Fig. 32** *Falciformispora lignatilis* (from BRIP 16972, **holotype**). **a** Section of a superficial ascoma. The peridium comprises two layers. **b, c** Squash mounts showing asci with wide pseudoparaphyses. The asci are cylindro-clavate with very short pedicels. **d–f** Hyaline multiseptate ascospores. Note the elongated appendage at the base (arrow head). Scale bars: **a, b**=100  $\mu\text{m}$ , **c**=50  $\mu\text{m}$ , **d–f**=10  $\mu\text{m}$



**holotype**). (Note: The specimen is not in good condition, only a few ascomata left).

#### Notes

#### Morphology

Boise (1989) formally established *Hadrospora* to accommodate *Trematosphaeria fallax* and *T. clarkia* (Sivan.) Boise, and *Hadrospora fallax* (syn. *T. fallax*) was selected as the generic type. *Hadrospora* is a widely distributed species that has been reported from Belgium, China, Italy, Japan, Switzerland and the United States (Boise 1989; Fisher and Webster 1992; Shearer and Crane 1971; Tanaka and Harada 2003a; Webster 1993). *Hadrospora* was temporarily assigned to *Phaeosphaeriaceae* based on its “small, thin-walled ascomata and narrow cellular pseudoparaphyses” (Boise 1989), which is distinguished from other genera of *Phaeosphaeriaceae* by its “large, stout ascospores that form within oblong-ovoid asci” (Boise 1989). Currently, *Hadrospora* includes two species, i.e. *H. fallax* and *H. clarkii* (Sivan.) Boise differentiated by ascospore size.

#### Phylogenetic study

None.

#### Concluding remarks

*Hadrospora* seems not closely related to *Phaeosphaeriaceae*.

*Halothia* Kohlm., Nova Hedwigia 6: 9 (1963). (?*Zopfiaceae*)

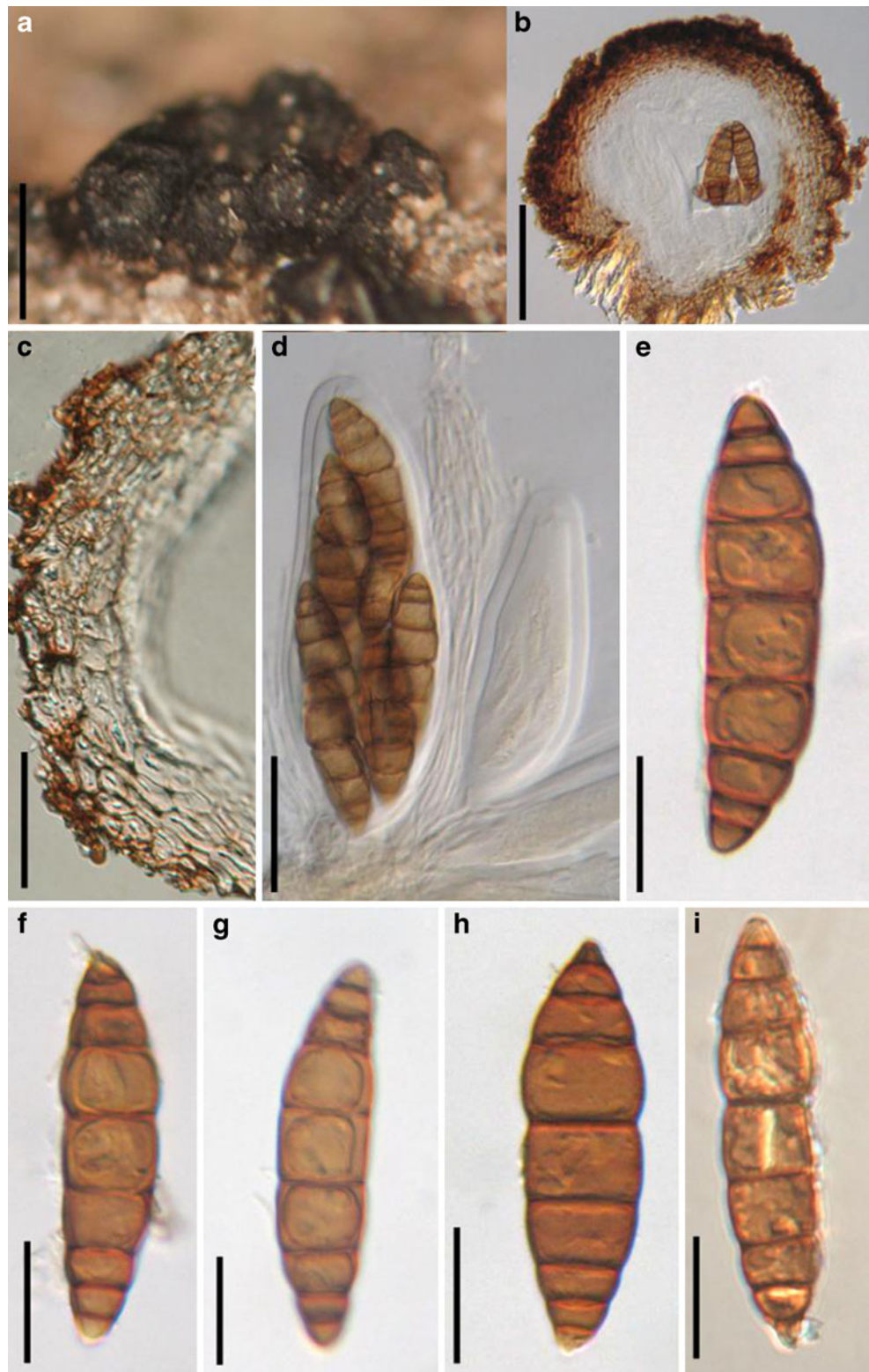
#### Generic description

Habitat marine, saprobic. *Ascomata* large, solitary, gregarious or confluent, broadly conical to subglobose, flattened at the base, carbonaceous, immersed to erumpent, ostiolate, epapillate. *Peridium* plectenchymatous. *Hamathecium* of dense, long, cellular pseudoparaphyses, septate, branching. *Asci* 8-spored, bitunicate, cylindrical, with a short pedicel. *Ascospores* uniseriate, ellipsoidal, subcylindrical or obtuse-fusoid, dark brown, 1-septate, constricted at the septum.

**Anamorphs reported for genus:** none.

**Literature:** Kohlmeyer 1963; Suetrong et al. 2009.

**Fig. 33** *Hadrospora fallax* (from BR, Capsa: K 7534, **holotype**). **a** Ascomata forming a cluster on the host surface. **b** Section of an ascoma. Note the peridium structure. **c** Section of a partial peridium. Note the pseudoparenchymatous cells. **d** Asci in pseudoparaphyses. **e–i** Reddish brown multiseptate ascospores. Scale bars: **a**= 0.5 mm, **b**=100  $\mu\text{m}$ , **c**, **d**= 50  $\mu\text{m}$ , **e–i**=20  $\mu\text{m}$



#### Type species

*Halotthia posidoniae* (Durieu & Mont.) Kohlm., Nova Hedwigia 6: 9 (1963). (Fig. 34)

≡ *Sphaeria posidoniae* Durieu & Mont. Exploration scientifique de l'Algérie, pp. 502–503, Taf. 25, Abb. 8a–i, 1849.

*Ascomata* 0.8–1.1 mm high  $\times$  1.5–2.1 mm diam., solitary, gregarious or confluent, broadly conical to subglobose, flattened at the base, carbonaceous, immersed to erumpent, ostiolate, epapillate (Fig. 34a). *Peridium* 165–275  $\mu\text{m}$  thick at sides, thicker near the apex, plectenchymatous. *Hamathecium* of dense, long cellular pseudo-

paraphyses, 1.5–2  $\mu\text{m}$  broad, septate, branching. *Asci* 275–290 $\times$ 25–35  $\mu\text{m}$ , 8-spored, bitunicate, cylindrical, with a short pedicel (Fig. 34b, c and d). *Ascospores* 37–60.5 $\times$ 16.5–26  $\mu\text{m}$ , uniseriate, ellipsoidal, subcylindrical or obtuse-fusoid, dark brown, 1-septate, constricted at the septum (Fig. 34e, f, g and h) (adapted from Kohlmeyer and Kohlmeyer 1979).

**Anamorph:** none reported.

**Material examined:** ITALY, in rhizomes of *Posidonia oceanica* (*Posidoniaceae*), 1861, Caldesi (S, **isotype** of *Sphaeria posidoniae*)

## Notes

### Morphology

*Halothia* was introduced to accommodate the marine fungus, *H. posidoniae* (as *Sphaeria posidoniae*), which is characterized by immersed to erumpent, large, carbonaceous ascomata, thick peridium, bitunicate, 8-spored, cylindrical asci, ellipsoidal, 1-septate, and dark brown ascospores (Kohlmeyer 1963). Morphologically, *Halothia* is most comparable with *Bicrouania maritima*, but the conical ascomata with flattened base of *H. posidoniae* can be readily distinguished from *B. maritima*.

### Phylogenetic study

Phylogenetically, *Halothia posidoniae*, *Pontoporeia biturbinata* and *Mauritiana rhizophorae* form a robust clade, which may represent a potential family (Suetrong et al. 2009).

### Concluding remarks

Currently the familial status of *Halothia* is unresolved (Suetrong et al. 2009).

***Helicascus*** Kohlm., Can. J. Bot. 47: 1471 (1969). (*Morosphaeriaceae*)

### Generic description

Habitat marine, saprobic. *Ascostromata* lenticular, immersed, black, carbonaceous, enclosing several loculi, pseudoclypeus composed of host cells enclosed in black stromatic fungus material. *Ascomata* depressed ampulliform, horizontally arranged under a black pseudoclypeus, ostiolate, torselloid ostioles, papillate. *Peridium* absent, partitions between loculi formed of brown, isodiametric or elongated cells of the stroma. *Hamathecium* of dense, long pseudoparaphyses. *Asci* 8-spored, bitunicate, subcylindrical to oblong clavate, with a short pedicel and conspicuous apical ring. *Ascospores* uniseriate, obovoid, brown, 1-septate, at each end with a germ pore, surrounded with dissolving sheath.

**Anamorphs reported for genus:** none.

**Literature:** Kohlmeyer 1969; Kohlmeyer and Kohlmeyer 1979; Suetrong et al. 2009.

### Type species

***Helicascus kanaloanus*** Kohlm., Can. J. Bot. 47: 1471 (1969). (Fig. 35)

*Ascostromata* 0.6–0.78 mm high $\times$ 1.25–2.75 mm diam., lenticular, immersed, black, carbonaceous, enclosing 3–4(–5) loculi, pseudoclypeus composed of host cells enclosed in black stromatic fungus material (Fig. 35a). *Ascomata* 235–370  $\mu\text{m}$  high $\times$ 440–800  $\mu\text{m}$  diam., depressed ampulliform, horizontally arranged under a black pseudoclypeus, ostioles 70–170  $\mu\text{m}$  diam., torselloid ostiole (Adams et al. 2005), papilla slightly rising over the surface of the pseudoclypeus, subconical, canal filled with thick, bright orange to yellowish periphyses, 270–435  $\mu\text{m}$  high, 255–300  $\mu\text{m}$  diam. *Peridium* absent, partitions between loculi formed of brown, isodiametric or elongated cells of the stroma. *Hamathecium* of dense, very long pseudoparaphyses. *Asci* 250–335 $\times$ 25–30  $\mu\text{m}$ , 8-spored, subcylindrical, finally oblong-clavate (400–480  $\mu\text{m}$  long), with a short pedicel, bitunicate, thick-walled, physoclastic, apically multi-layered and annulate, ectoascus forming a third, thin permeable outer layer around the base, endoascus swelling in water and becoming coiled at maturity, finally stretching and pushing the ascus into the ostiolar canal (Fig. 35b). *Ascospores* 36.5–48.5 $\times$ 18–22.5  $\mu\text{m}$ , uniseriate, obovoid, brown, 1-septate, at each end with a germ pore, surrounded with dissolving sheath, 2.7–5.4  $\mu\text{m}$  thick, with funnel-shaped, apical indentations (Fig. 35c and d) (adapted from Kohlmeyer and Kohlmeyer 1979).

**Anamorph:** none reported.

**Material examined:** USA, Hawaii, Oahu, Kaneohe Bay, Heeia Swamp, on *Rhizophora mangle*, 4 Jun. 1968 (Herb. J. Kohlmeyer No. 2566, **holotype**; No. 2565, 2567, **paratype**).

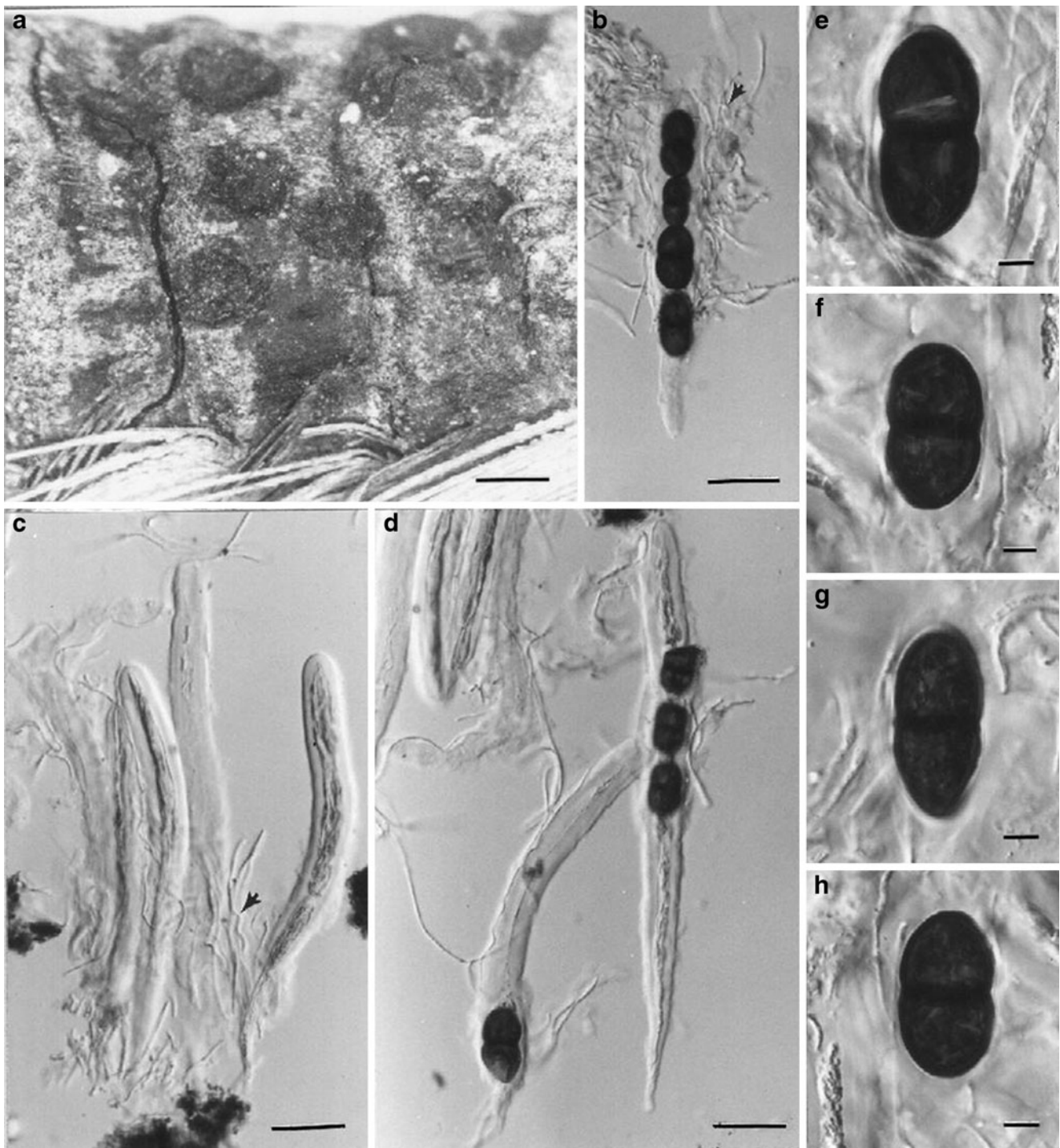
## Notes

### Morphology

*Helicascus* is another marine genus, which is characterized by its thin additional sheath around the base of the asci, the coiling and stretching mechanism of the basal part of the endoascus and its conspicuous apical apparatus which is not that common in bitunicate asci (Kohlmeyer 1969). The immersed stroma comprising several loculi sharing one common ostiole is another striking character of *Helicascus*.

### Phylogenetic study

Multigene phylogenetic analysis indicated that both *Helicascus kanaloanus* and *H. nypae* K.D. Hyde nested within *Morosphaeriaceae* (Suetrong et al. 2009).



**Fig. 34** *Halothia posidoniae* (from S, isotype of *Sphaeria posidoniae*). **a** Ascomata gregarious on the host surface. **b–d** Mature or immature cylindrical asci. **e–h** Ellipsoidal, dark-brown, 1-septate ascospores. Scale bars: **a**=1 mm, **b–d**=50  $\mu$ m, **e–h**=5  $\mu$ m

### Concluding remarks

*Helicascus* is a well defined marine genus.

***Herpotrichia*** Fuckel, Fungi rhenani exsic.: no. 2171 (1868). (*Melanommataceae*)

### Generic description

Habitat terrestrial, parasitic, hyperparasitic or saprobic. *Ascomata* medium-sized, immersed, erumpent to nearly superficial, scattered to gregarious, globose to subglobose

**Fig. 35** *Helicascus kanaloanus* (from Herb. J. Kohlmeyer No. 2566, **holotype**). **a** Section of ascostroma immersed in the host tissue. Note the torselloid ostiole. **b** One-septate, brown, asymmetrical ascospores within the asci. **c, d** Released thick-walled ascospores. Note the germ pore at the lower end of the ascospores. Scale bars: **a**=0.5 mm, **b–d**=20  $\mu\text{m}$



with a broad pore. *Peridium* composed of pseudoparenchymatous cells. *Hamathecium* of dense, long pseudoparaphyses, embedded in mucilage, septate, branching. *Asci* cylindrical to cylindro-clavate, with a furcated pedicel. *Ascospores* fusoid, ellipsoid or oblong with broadly to narrowly round ends, 1-septate, constricted at the septum, uni- to biseriata.

**Anamorphs reported for genus:** *Pyrenochaeta* or *Pyrenochaeta*-like (Sivanesan 1984).

**Literature:** von Arx and Müller 1975; Barr 1984; Cannon 1982; Freyer and van der Aa 1975; Mugambi and Huhndorf 2009b; Samuels 1973; Samuels and Müller 1978; Sivanesan 1971, 1984.

### Type species

*Herpotrichia rubi* Fuckel, Fungi rhenani exsic 2171. (1868). (Fig. 36)

*Ascomata* 220–430  $\mu\text{m}$  high  $\times$  240–390(–530)  $\mu\text{m}$  diam., scattered to gregarious, immersed to erumpent, rarely superficial, globose to subglobose, wall black, coriaceous, apex with a small sometimes inconspicuous papilla, usually with a pore, lacking periphyses (Fig. 36a and b). *Peridium* 32–45  $\mu\text{m}$  wide at the sides, up to 60  $\mu\text{m}$

wide at the apex, basal wall thinner, all walls comprising cells of *textura angularis*, cells 2.5–4  $\mu\text{m}$  diam., cell wall 2–4(–7)  $\mu\text{m}$  thick, exterior cells more thick-walled and pigmented, inner cells thin-walled and less pigmented, comprising thin-walled cells up to 9  $\mu\text{m}$  diam., apex cells smaller and walls thicker (Fig. 36b and c). *Hamathecium* of dense, long pseudoparaphyses, 2–3  $\mu\text{m}$  broad, embedded in mucilage, septate, branching (Fig. 36e). *Asci* 105–150  $\times$  12.5–15  $\mu\text{m}$  ( $\bar{x}$  = 137.5  $\times$  13.8  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a furcate pedicel that is 20–42.5  $\mu\text{m}$  long, and ocular chamber up to 2.5  $\mu\text{m}$  wide  $\times$  2.5  $\mu\text{m}$  high (Fig. 36d and f). *Ascospores* 17.5–25  $\times$  (5.5–)6.3–9  $\mu\text{m}$  ( $\bar{x}$  = 20.5  $\times$  7.3  $\mu\text{m}$ ,  $n=10$ ), biseriata to partially overlapping uniseriate near the base, fusoid with narrowly rounded ends, hyaline when immature and becoming pale brown, 1-septate, deeply constricted at the septum, the upper cell often broader than the lower one, verruculose (Fig. 36g and h).

**Anamorph:** *Pyrenochaeta rhenana* Sacc. (Sivanesan 1984).

**Material examined:** AUSTRIA, on *Rubus idaeus* L., very rarely in the spring, in the Oestreicher meadow forest (G, F. rh. 2171, **type**).

## Notes

### Morphology

*Herpotrichia* was established by Fuckel (1868) comprising two species *H. rhenana* Fuckel and *H. rubi* Fuckel, but no generic type was assigned. Bose (1961) designated *H. rhenana* as the lectotype species with *H. rubi* as a synonym. This proposal was followed by Müller and von Arx (1962) and Sivanesan (1971). *Herpotrichia rubi* was later assigned as the generic type (Holm 1979) as it was found to be validly published 2 years earlier than *H. rhenana*, thus having priority (Cannon 1982). However, Cannon (1982) reported that *Sphaeria herpotrichoides* Fuckel (1864, cited as a synonym of *H. rhenana*) was the earliest name. Thus he made a new combination as *H. herpotrichoides* (Fuckel) P.F. Cannon and cited *H. rubi* as the synonym. *Herpotrichia rubi* is maintained as the type of the genus (Holm 1979; Cannon 1982), but the current name is *H. herpotrichoides*.

*Herpotrichia* is a morphologically well studied genus (Barr 1984; Bose 1961; Müller and von Arx 1962; Pirozynski 1972; Samuels and Müller 1978; Sivanesan 1971, 1984), and *Herpotrichia sensu lato* is characterized by having subglobose, pyriform to obpyriform ascomata and a peridium of *textura angularis* or comprising thick-walled polygonal cells with thin-walled hyaline cells towards the centre. Asci are clavate to cylindrical, 4–8-spored and ascospores are hyaline at first, becoming pale to dark brown, one to many septate, constricted or not at the septa and often surrounded by a mucilaginous sheath. Several morphologically distinct genera were synonymized under *Herpotrichia* using the above broad circumscription (Barr 1984; Müller and von Arx 1962; Sivanesan 1984). In particular, Barr kept *Lojkania* as a separate genus after studying its type material (Barr 1984, 1990a). Sivanesan (1984) was also of the opinion that *Lojkania* and *Neopeckia* were distinct genera as several of their characters differed. *Byssosphaeria* and *Pseudotrichia* have subsequently been assigned to *Melanommataceae*, *Lojkania* to *Fenestellaceae* and *Neopeckia* to *Coccoideaceae* (Barr 1984). *Herpotrichia sensu stricto* is represented by *H. rubi* and has erumpent to superficial ascomata or immersed in a subiculum, clavate to cylindrical, 4–8-spored, stalked asci with a conspicuous apical “nasse”, hyaline, 1-septate ascospores, usually becoming pale brown and several septate, constricted or not constricted at septa, usually surrounded by sheath (Sivanesan 1984). Currently, about 90 species are included in this genus (<http://www.indexfungorum.org/>, 12/01/2009).

### Phylogenetic study

*Herpotrichia diffusa* (Schwein.) Ellis & Everh., *H. juniperi* (Duby) Petr., *H. herpotrichoides* and *H. macrotricha* have been shown to have phylogenetic affinity with the generic types of *Byssosphaeria schiedermayeriana*,

*Melanomma pulvis-pyrius* and *Pleomassaria siparia*, which had been assigned under *Melanommataceae* (Kruys et al. 2006; Mugambi and Huhndorf 2009b; Schoch et al. 2006, 2009; Zhang et al. 2009a). In this study, *Pleomassaria siparia* together with its closely related species of *Prosthemium* is kept in a separate family, viz *Pleomassariaceae*.

### Concluding remarks

Even species under *Herpotrichia sensu stricto* (according to Sivanesan 1984) have diverse hosts (such as gymnosperms (*H. coulteri* (Peck) S.K. Bose and *H. parasitica* (R. Hartig) Rostr.) and angiosperms (*H. diffusa* and *H. villosa* Samuels & E. Müll.) or substrates (like dead or living leaves, bark or decorticated wood) (Sivanesan 1984). Species of *Herpotrichia sensu stricto* are also reported from various locations such as Europe, Asia or America, and they have various life styles, e.g. parasitic, hyperparasitic or saprobic (Sivanesan 1984). Additional factors (like hosts or locations) may need to be considered in order to get a natural concept for *Herpotrichia*.

***Immotthia*** M.E. Barr, Mycotaxon 29: 504 (1987). (*Teichosporaceae*)

### Generic description

Habitat terrestrial, hyperparasitic. *Ascomata* gregarious, globose, superficial, ostiolate, periphysate. *Hamathecium* of cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, cylindrical, with a short pedicel. *Ascospores* 1-seriate, ellipsoidal, brown to reddish brown, 1-septate, constricted at the septum, smooth.

**Anamorphs reported for genus:** none.

**Literature:** Barr 1987a, 2002; Wang et al. 2004.

### Type species

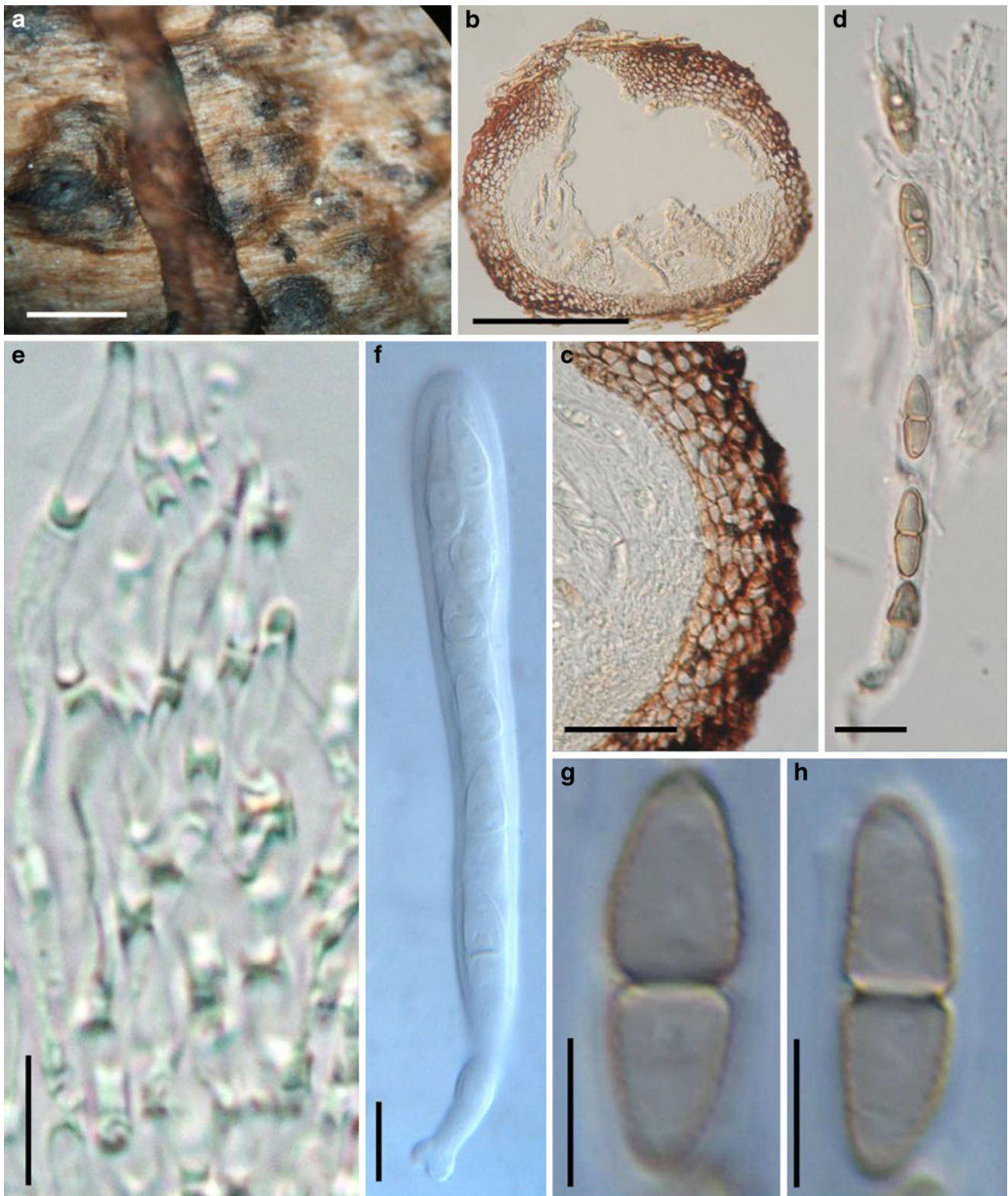
***Immotthia hypoxylon*** (Ellis & Everh.) M.E. Barr, Mycotaxon 29: 504 (1987). (Fig. 37)

≡ *Amphisphaeria hypoxylon* Ellis & Everh., J. Mycol. 2: 41 (1886).

*Ascomata* gregarious, globose, superficial, ostiolate, periphysate, papillate (Fig. 37a). *Hamathecium* of cellular pseudoparaphyses, 2–2.5  $\mu\text{m}$  broad, septate. *Asci* 60–82  $\times$  7–9  $\mu\text{m}$ , 8-spored, bitunicate, cylindrical, with a short pedicel (Fig. 37b, c and d). *Ascospores* 10–13  $\times$  4.4–5.4  $\mu\text{m}$ , 1-seriate, ellipsoidal, brown to reddish brown, 1-septate, constricted at the septum, smooth (Fig. 37f, g and h) (adapted from Wang et al. 2004).

**Anamorph:** none reported.

**Material examined:** USA, Louisiana, Pointe a la Hache, on decaying wood, a branch of *Carya oliviformis* (*Juglandaceae*) lying on the ground in grass (parasitic on



**Fig. 36** *Herpotrichia rubi* (from g. f. rh. 2171, type). **a** Numerous ascomata gregariously immersed in the host tissue. **b** Section of an ascoma. Note the central ostiole and peridium structure and also note the arrangement of asci and pseudoparaphyses. **c** Section of partial lateral peridium which comprises cells of *textura angularis*. **d** Part of a

mature squashed ascus. **e** Relatively wide, septate pseudoparaphyses. **f** Immature ascus. Note the furcate pedicel. **g–h** One-septate ascospores. Note the verruculose ornamentation which is visible at the sides. Scale bars: **a**=0.5 mm, **b**=100  $\mu\text{m}$ , **c**=50  $\mu\text{m}$ , **d**=20  $\mu\text{m}$ , **e–h**=10  $\mu\text{m}$

some effused *Hypoxylon*), 30 Dec. 1885, A.B. Langlois, No. 138 (NY, **holotype** of *Amphisphaeria hypoxylon* Ellis & Everh.).

## Notes

### Morphology

*Immotitia* was introduced to accommodate a species of *Amphisphaeria* (*A. hypoxylon*), which has bitunicate asci, and is characterized by superficial, ostiolate, periphysate, papillate ascomata, cellular pseudoparaphyses, bitunicate, 8-spored, cylindrical asci, ellipsoid, smooth, brown to reddish brown, 1-septate ascospores (Barr 1987a; Wang et al. 2004).

### Phylogenetic study

None.

### Concluding remarks

It seems that those *Amphisphaeria* species with bitunicate asci should be assigned to *Pleosporales*. Morphologically, *Immotitia* is somewhat comparable with *Herpotrichia*.

*Isthmosporella* Shearer & J.L. Crane, Mycologia 91: 141 (1999). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat freshwater, saprobic. *Ascomata* small- to medium-sized, scattered, immersed, erumpent to superficial, globose, papillate, ostiolate, periphysate, membranous. *Peridium* 2-layered, outer layer composed of brown, pseudoparenchymatic, fusoid-cylindric cells, inner layer composed of fusoid, subhyaline to pale brown, compressed cells. *Hamathecium* of rare, broad, septate, interascal pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, oblong to clavate, with a short pedicel, ocular chamber not observed. Ascospores 3–4 seriate, cylindrical to fusoid, isthmoid at centre, constricted at septa, isthmus 1-septate, surrounded by a gelatinous sheath.

**Anamorphs reported for genus:** none.

**Literature:** Shearer and Crane 1999.

### Type species

*Isthmosporella pulchra* Shearer & J.L. Crane, Mycologia 91: 142 (1999). (Fig. 38)

*Ascomata* 240–330  $\mu\text{m}$  diam., scattered on decorticated wood, immersed, erumpent to superficial, globose, black, papillate, papilla short, cylindrical, 60  $\mu\text{m}$  long  $\times$  55  $\mu\text{m}$  wide, ostiolate, periphysate, membranous (Fig. 38a). *Peridium* 2-layered, outer 3–4 cell layers composed of brown, pseudoparenchymatic, fusoid-cylindric cells, 2–6.5  $\mu\text{m}$  long; inner layer composed of 5–7 rows of fusoid, subhyaline to pale brown compressed cells, 11–20  $\times$  2–3.5  $\mu\text{m}$  diam. (Fig. 38a and b). *Hamathecium* of rare, broad,

septate, interascal pseudoparaphyses (Fig. 38f). *Asci* (95–) 135–160(–175)  $\times$  (25–) 30–45(–60)  $\mu\text{m}$ , 8-spored, bitunicate, fissitunicate, oblong to clavate, with a short pedicel, ocular chamber not observed (Fig. 38c, d and e). *Ascospores* 80–105(–110)  $\times$  (7–) 8–10  $\mu\text{m}$ , 3–4-seriate, cylindrical to fusoid, isthmoid at centre, sometimes bent at isthmus and becoming u- or v- shaped, end cells tapering, 12–17-phragmo-septate, constricted at septa, isthmus 1-septate, 2–5.5  $\times$  2–4.5  $\mu\text{m}$  diam., hyaline, frequently fragmenting to form partspores; filled with lipid droplets that merge to form large guttules; surrounded by a gelatinous sheath with a dense region near the isthmus, sheath greatly enlarging in water (Fig. 38g, h, i and j).

**Anamorph:** none reported.

*Colonies* on yeast soluble starch agar containing balsa wood sticks effuse, white. *Hyphae* hyaline, septate.

**Material examined:** USA, New York, Adirondack Park. Piercesfield. Tupper Lake at public boat launch from Rt. 30, UTM Zone 18, 539840 mE, 4892100mN; 44°10'59"N, 80°31'6"W, on submerged, decorticated wood, 7 Jul. 1994, J.L. Crane & C.A. Shearer A-254-1 (ILLS 53086, **holotype**).

## Notes

### Morphology

*Isthmosporella* was described as a freshwater genus typified by *I. pulchra*, and is characterized by globose, pseudoparenchymatous ascomata, sparse, septate pseudoparaphyses, fissitunicate asci and hyaline, cylindrical to fusoid, phragmo-septate, isthmoid ascospores surrounded with a gelatinous sheath (Shearer and Crane 1999). Based on the morphological characters, i.e. small, globose ascomata, peridium with small pseudoparenchymatous cells and sparse pseudoparaphyses, *Isthmosporella* was assigned to the *Phaeosphaeriaceae* (Shearer and Crane 1999). The aquatic habitat of *Isthmosporella*, however, disagree with the *Phaeosphaeriaceae*. *Isthmosporella* seems less likely to belong to *Pleosporineae*.

### Phylogenetic study

None.

### Concluding remarks

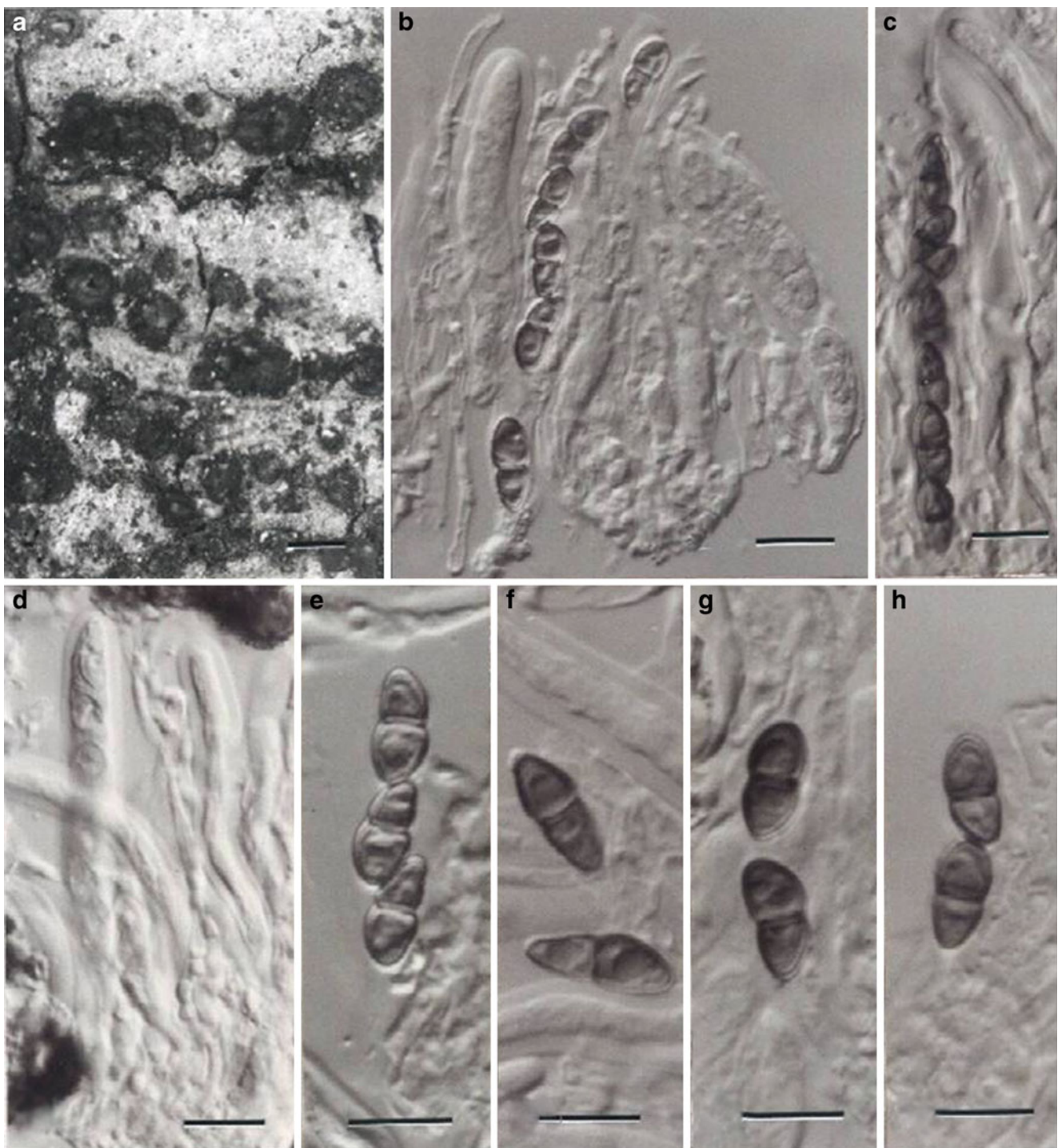
Molecular phylogenetic studies should be conducted to explore its familial placement within *Pleosporales*.

*Kalmusia* Niessl, Verh. nat. Ver. Brünn 10: 204 (1872). (*Montagnulaceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* small- to medium-sized, solitary, scattered or in small groups, immersed to





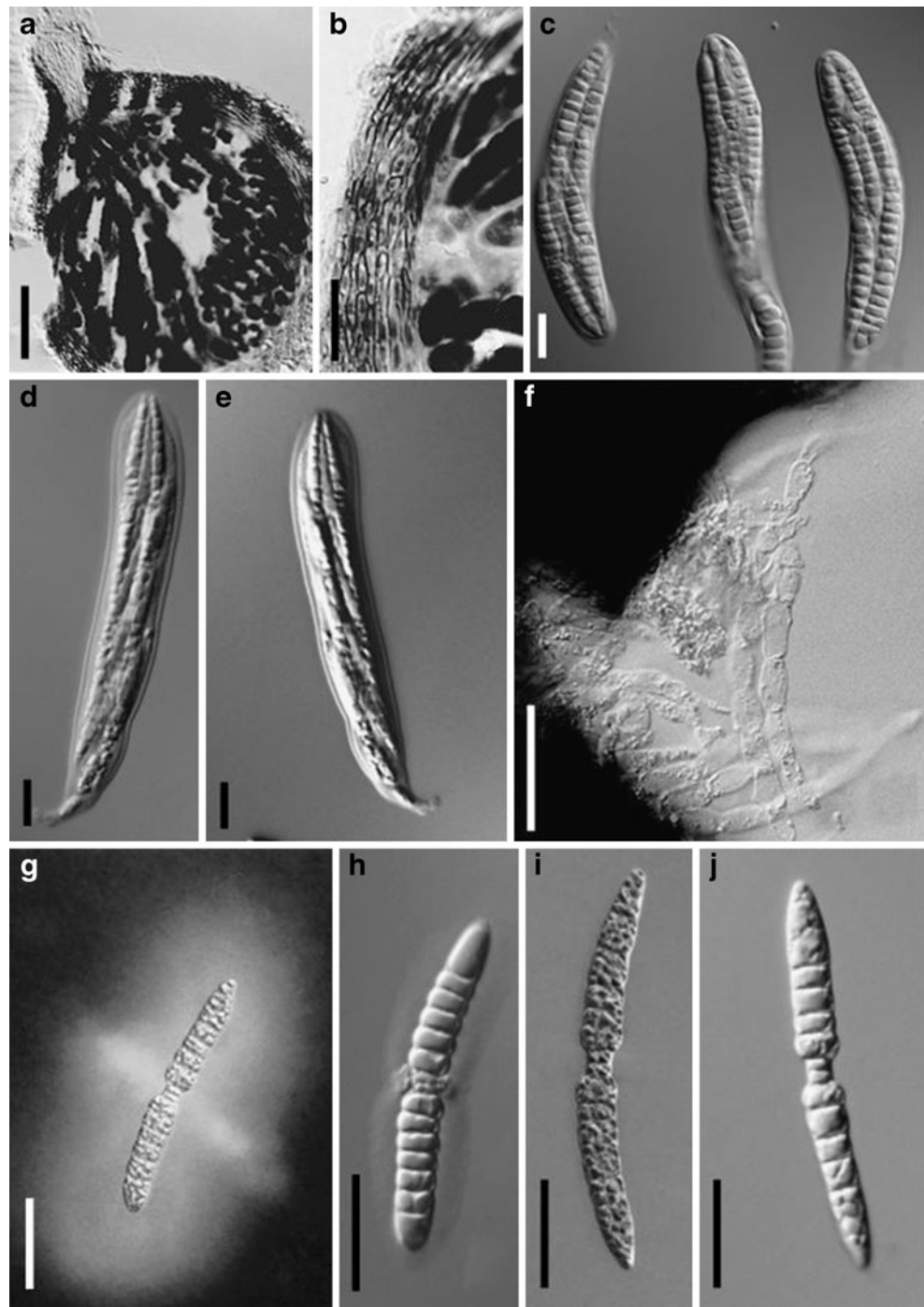
**Fig. 37** *Immotthia hypoxylon* (from holotype of *Amphisphaeria hypoxylon*). **a** Ascomata gregarious on host surface. **b–d** Bitunicate asci. **e–h** Released 1-septate ascospores. Scale bars: **a**=0.5 mm; **b–h**=10  $\mu$ m

erumpent, globose or subglobose, often laterally flattened, coriaceous, wall black, with or without papilla. *Hamathecium* of dense, filliform, delicate, septate pseudoparaphyses, branching and anastomosing between and above asci, embedded in mucilage. *Asci* bitunicate,

fissitunicate unknown, clavate, with a long, furcate pedicel. *Ascospores* narrowly ovoid to clavate, pale brown, 3-septate, distoseptate.

**Anamorphs reported for genus:** *Cytoplea* (Petraik and Sydow 1926).

**Fig. 38** *Isthmosporella pulchra* (from ILLS 53086, **holotype**). **a** Section of an ascoma. **b** Section of a partial peridium. **c–e** Broadly clavate asci with short pedicels. **f** Pseudoparaphyses. **g–j** Ascospores. Note the 2-celled isthmus in J and mucilaginous sheath in G and H. Scale bars: **a**=50  $\mu\text{m}$ , **b–j**=20  $\mu\text{m}$  (figure with permission from [http://fungi.life.illinois.edu/search/fwa\\_lit\\_refs](http://fungi.life.illinois.edu/search/fwa_lit_refs))



**Literature:** Barr 1987b, 1990a, 1992a; Lindau 1897; von Niessl 1872.

#### Type species

*Kalmusia ebuli* Niessl, Verh. nat. Ver. Brünn 10: 204 (1872). (Fig. 39)

Ascomata 290–360  $\mu\text{m}$  high  $\times$  300–520  $\mu\text{m}$  diam., solitary, scattered, or in small groups, immersed to erumpent, globose or subglobose, coriaceous, wall black, with or

without papilla, ostiolate (Fig. 39a). *Papilla* small, up to 100  $\mu\text{m}$  high, with small ostioles (Fig. 39a). *Peridium* 15–40  $\mu\text{m}$  wide, comprising one cell type of small, pigmented, thick-walled cells of *textura prismatica* to *textura angularis*, cells ca. 5  $\times$  3  $\mu\text{m}$  diam., cell wall 2–3  $\mu\text{m}$  thick (Fig. 39b and c). *Hamathecium* of dense, delicate pseudoparaphyses, 1–1.5  $\mu\text{m}$  broad, septate, branching and anastomosing between and above asci, embedded in mucilage. *Asci* 75–125  $\times$  10–15  $\mu\text{m}$  ( $\bar{x}$  = 90.5  $\times$  12  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissionic unknown, clavate, with a long, narrowed, furcate

pedicel which is up to 45  $\mu\text{m}$  long, and a low ocular chamber (ca. 2  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 39d, e and f). *Ascospores* 15–18  $\times$  5.5–6.5  $\mu\text{m}$  ( $\bar{x}$  = 16.3  $\times$  5.8  $\mu\text{m}$ ,  $n=10$ ), biseriate, narrowly ovoid to clavate, pale brown, 3-distoseptate, without constriction, smooth-walled (Fig. 39g, h and i).

**Anamorph:** none reported.

**Material examined:** BELGIUM, Dolembreux, on branchlets and pieces of stumps of *Sarothamnus scoparius* from woodland, Oct. 1922, V. Mouton (BR 101525–63, **holotype**).

## Notes

### Morphology

*Kalmusia* was formally established by von Niessl (1872), and is mainly characterized as “immersed, sphaeroid ascoma with central, stout papilla, surrounded by hyphae in the substrate, stipitate asci with septate pseudoparaphyses, and brown, 3-septate, inequilateral ascospores” (Barr 1992a).

The most morphologically comparable genus to *Kalmusia* is *Thyridaria*, which had been treated as a subgenus under *Kalmusia* (Lindau 1897), and was subsequently transferred to *Platystomaceae* in *Melanommatales* (Barr 1987b, 1990a). Compared to *Thyridaria*, *Kalmusia* has sphaeroid ascomata, a peridium of small pseudoparenchymatous cells, basal asci and very thin pseudoparaphyses, thus it was assigned to *Phaeosphaeriaceae* of the *Pleosporales* by Barr (1990a), and the genus is utilized to accommodate both *K. ebuli* and *K. clivensis* (Berk. & Broome) M.E. Barr, as well as closely related species, i.e. *K. utahensis* (Ellis & Everh.) Huhndorf & M.E. Barr and *K. coniothyrium* (Fuckel) Huhndorf (Barr 1992a). But this proposal is questionable, as the clavate, distoseptate ascospores, as well as the clavate asci with very long pedicels are uncommon in *Phaeosphaeriaceae*, and most recent phylogenetic study indicated that some species of *Kalmusia* reside outside of *Phaeosphaeriaceae* (Zhang et al. 2009a).

### Phylogenetic study

Both *Kalmusia scabrispora* Teng Kaz. Tanaka, Y. Harada & M.E. Barr and *K. brevispora* (Nagas. & Y. Otani) Yin. Zhang, Kaz. Tanaka & C.L. Schoch reside in the clade of *Montagnulaceae* (Zhang et al. 2009a). Familial placement of *Kalmusia* can only be verified after the DNA sequences of the generic type (*K. ebuli*) are obtained.

### Concluding remarks

*Kalmusia* is distinct amongst the *Pleosporales* as it has pale brown ascospores with indistinct distosepta and clavate asci with long pedicels. Although both *K. scabrispora* and *K. brevispora* reside in the clade of *Montagnulaceae*, they both lack the distoseptate ascospores that are possessed by the generic type (*K. ebuli*). Thus, the familial placement of *Kalmusia* is still undetermined.

*Karstenula* Sp., *Decades Mycologicae Italicae* ad no. 94 (in sched.) (1879). (*Montagnulaceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* rarely small-, usually medium-sized, immersed usually under thin clypeus, scattered to gregarious, with flattened top and rounded pore-like ostiole, coriaceous. *Peridium* 2-layered, outer layer composed of reddish brown to dark brown small cells, inner layer of pale compressed cells. *Hamathecium* of dense, cellular pseudoparaphyses. *Asci* cylindrical to cylindro-clavate with short furcate pedicel. *Ascospores* muriform, ellipsoid to fusoid, reddish brown to dark brown.

**Anamorphs reported for the genus:** *Microdiplodia* (Constantinescu 1993).

**Literature:** Barr 1990a; Eriksson and Hawksworth 1991; Kodsueb et al. 2006a; Munk 1957; Zhang et al. 2009a.

### Type species

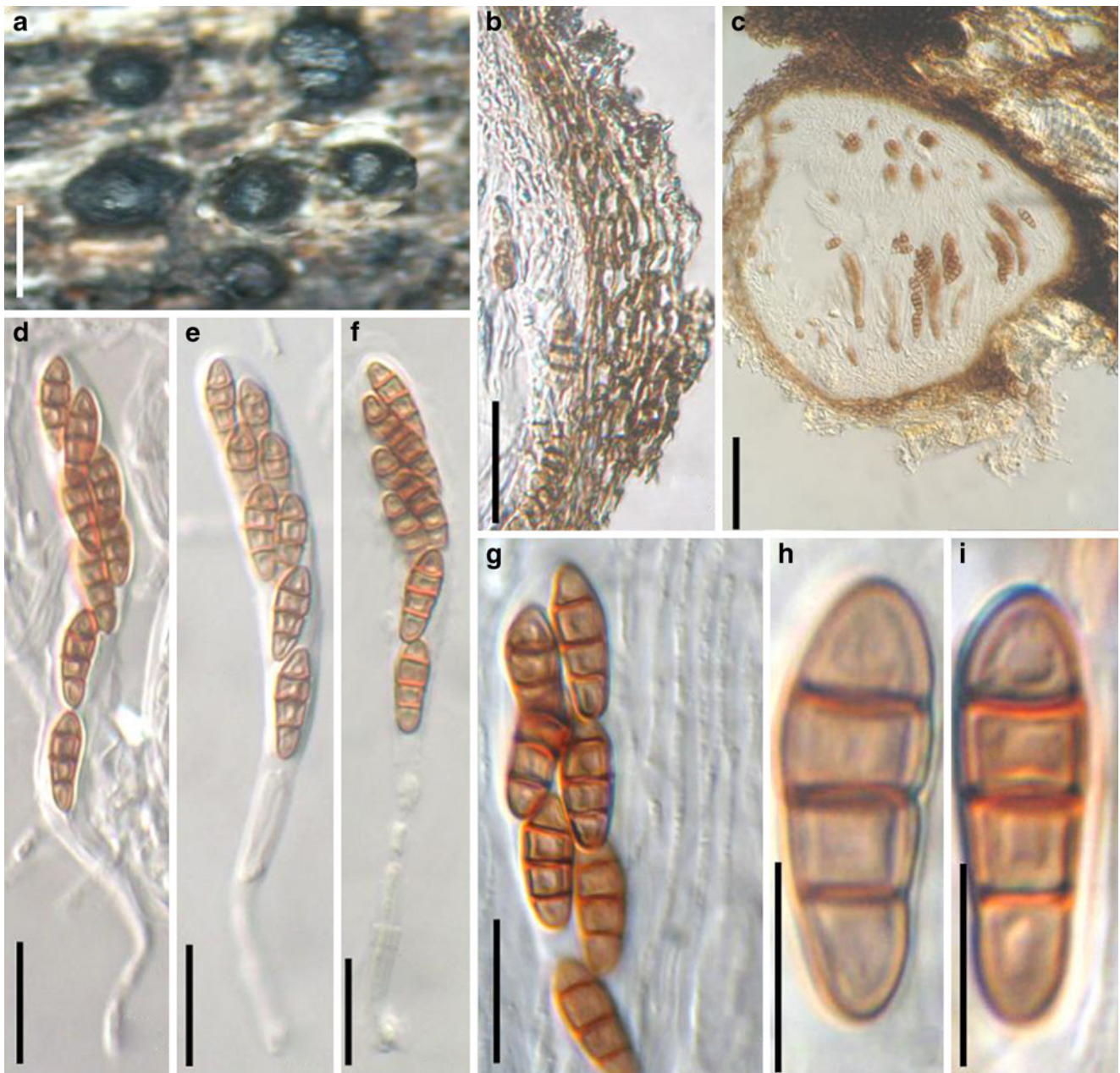
*Karstenula rhodostoma* (Alb. & Schwein.) Sp., *Decades Mycologicae Italicae* no. 94. (1879). (Fig. 40)

$\equiv$  *Sphaeria rhodostoma* Alb. & Schwein., *Consp. fung.* (Leipzig): 43 (1805).

*Ascomata* 250–430  $\mu\text{m}$  high  $\times$  450–650  $\mu\text{m}$  diam., scattered or gregarious, immersed in the subiculum which sometimes sloths off, globose or subglobose, black, flattened top often white or reddish and sometimes slightly protruding out of the substrate surface, usually with a wide opening ostiole after removing the cover, coriaceous (Fig. 40a and b). *Peridium* 30–40  $\mu\text{m}$  wide, comprising two cell types, outer region 1-layered, composed of relatively small heavily pigmented thick-walled compressed cells, cells 2–4  $\times$  5–10  $\mu\text{m}$  diam., cell wall 2–4  $\mu\text{m}$  thick, inner layer cells larger and wall thinner, comprising cells of *textura angularis*, merging with pseudoparaphyses (Fig. 40c and d). *Hamathecium* of dense, long cellular pseudoparaphyses 2–3.5  $\mu\text{m}$  broad, septate, branching or anastomosing not observed. *Asci* 150–210  $\times$  12.5–15  $\mu\text{m}$  ( $\bar{x}$  = 182  $\times$  13.1  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, cylindrical, with a broad, furcate pedicel which is 12–35  $\mu\text{m}$  long, and with an ocular chamber (to 4  $\mu\text{m}$  wide  $\times$  3  $\mu\text{m}$  high) (Fig. 40e and f). *Ascospores* 20–26  $\times$  7.5–10  $\mu\text{m}$  ( $\bar{x}$  = 22.4  $\times$  8  $\mu\text{m}$ ,  $n=10$ ), obliquely uniseriate and partially overlapping, ellipsoid, reddish brown, with 3 transverse septa and a vertical septum in one or two central cells, constricted at the septa, verruculose (Fig. 40g, h and i).

**Anamorph:** *Microdiplodia frangulae* Allesch. (Constantinescu 1993).

*Conidiomata* globose to subglobose, 330–495  $\mu\text{m}$  diam., in subiculum. *Conidia* 9–13  $\times$  4–5  $\mu\text{m}$ , reddish brown, 1-septate (information obtained from Barr 1990a).



**Fig. 39** *Kalmusia ebuli* (from BR 101525–63, **holotype**). **a** Immersed to erumpent ascomata scattered on the host surface. **b** Section of a partial peridium. Note the compressed peridium cells. **c** Section of

an ascoma. **d–f** Eight-spored asci with long pedicels. **g** Partial ascus in pseudoparaphyses. **h, i** Ascospores with 3 thick-walled septa. Scale bars: **a**=0.5 mm, **b**=50  $\mu$ m, **c**=100  $\mu$ m, **d–g**=20  $\mu$ m, **h, i**=10  $\mu$ m

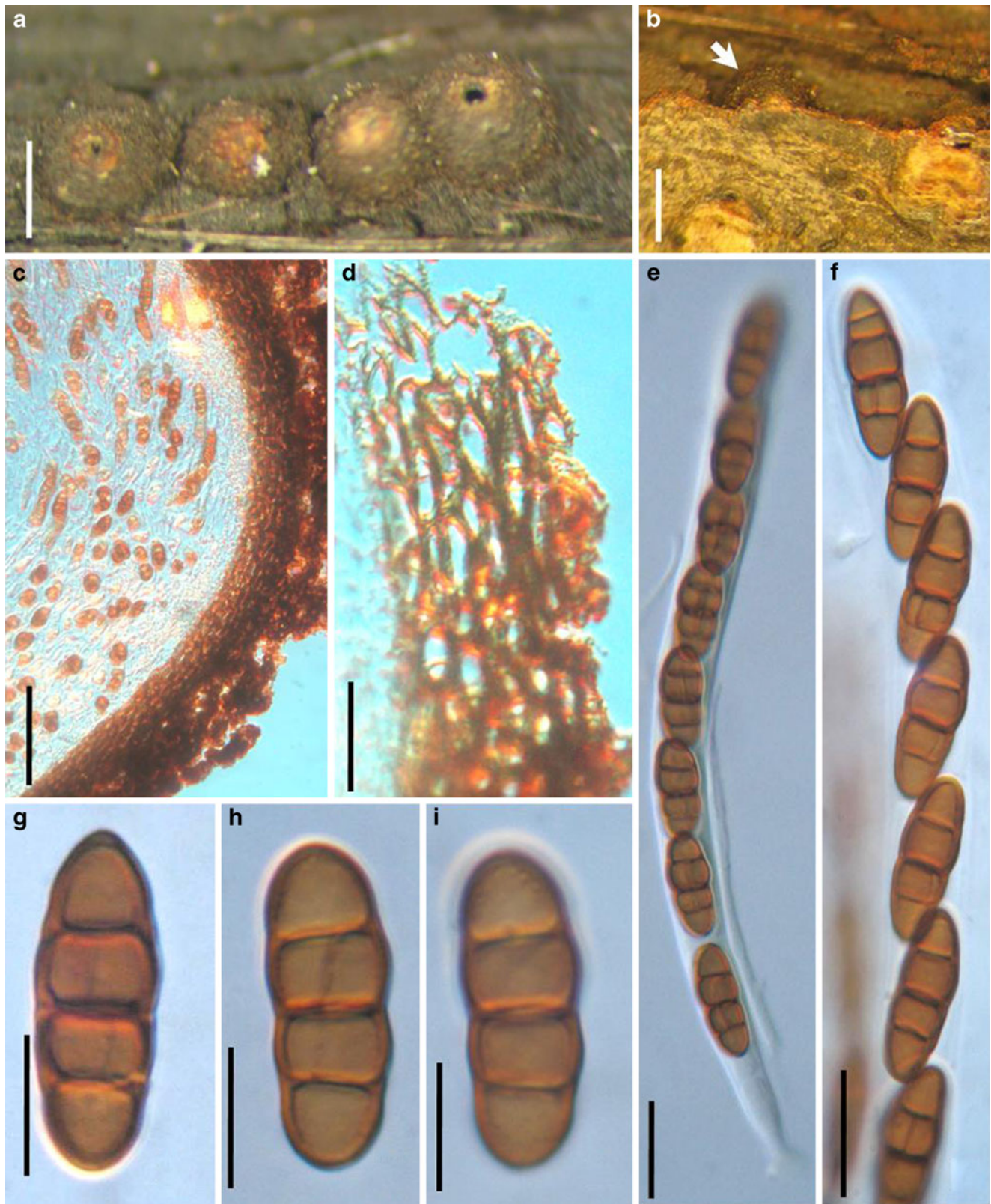
**Material examined:** Fries, Suecia (received by herbarium in 1834) (PH 01048835, **type**, as *Sphaeria rhodostoma* Alb. & Schwein.).

#### Notes

#### Morphology

*Karstenula* is an ambiguous genus, which has been synonymized under *Pleomassaria* (Lindau 1897; Winter 1885). Some of the ascomata characters are even compa-

rable with those of *Didymosphaeria*, such as ascomata seated in subiculum or beneath a clypeal thickening, the development of apex vary in a large degree, even to the occasional formation of a blackened internal clypeus, and sometimes apical cells become reddish or orange-brown (Barr 1990a). Barr (1990a) redefined the concept of *Karstenula* (*sensu lato*), which encompasses some species of *Thyridium*. In her concept, however, Barr (1990a) treated *Karstenula* as having trabeculate pseudoparaphyses and this is clearly not the case. In most cases the



**Fig. 40** *Karstenula rhodostoma* (from PH 01048835, type). **a** Line of ascomata on host surface (after remove the decaying cover). Note the wide ostiolar opening and light colored region around the ostiole. **b** Immersed ascoma under the decaying cover (see arrow). **c, d** Section of the peridium. The peridium comprises small thick-walled

cells in the outer layer. The outside comprises defuse hyphae which is probably part of the subiculum. **e** Ascus with a short furcate pedicel. **f** Partial ascus showing arrangement of ascospores. **g–i** Released ascospores. Note the transverse and rarely vertical septa. Scale bars: **a, b**=0.5 mm, **c–f**=20  $\mu\text{m}$ , **g–i**=10  $\mu\text{m}$

ascospores were brown with transverse septa and sparse longitudinal septa.

The ascomata of this species are similar to those found in *Byssosphaeria* and *Herpotrichia*, especially in the paler area around the ostiole and even in peridial structure and development under a subiculum. The numerous wide cellular pseudoparaphyses and cylindrical asci (in *Herpotrichia*) are also similar. The main difference of *Karstenula* from other two genera are the 3-septate ascospores with rare longitudinal septa (1-septate in *Byssosphaeria* and *Herpotrichia*).

### Phylogenetic study

*Karstenula* forms a robust phylogenetic clade with *Phaeodothis winterti* (Niessl) Aptroot, *Didymocrea sadasivanii*, *Bimuria novae-zelandiae*, *Montagnula opulenta*, *Curreya pityophila* (J.C. Schmidt & Kunze) Arx & E. Müll. and some species of *Letendreaea* and *Paraphaeosphaeria* (Kod-sueb et al. 2006a; Zhang et al. 2009a). Consequently, *Karstenula* might be included in *Montagnulaceae*.

### Concluding remarks

The description of the type of *Karstenula* here clearly excludes it from *Melanommataceae* as it has wide pseudoparaphyses. But its *Montagnulaceae* status can only be confirmed by more phylogenetic work including sequencing the generic type of *Karstenula* (*K. rhodostoma*).

***Katumotoa*** Kaz. Tanaka & Y. Harada, Mycoscience 46: 313 (2005). (*Lentitheciaceae*)

### Generic description

Habitat terrestrial or freshwater, saprobic. *Ascomata* small- to medium-sized, scattered or in small groups, immersed to erumpent, with a central protruding hairy papilla, subglobose. *Peridium* thin, comprising several layers of thin-walled compressed cells. *Hamathecium* of dense, cellular, filliform, embedded in mucilage, branching and anastomosing. *Asci* 8-spored, bitunicate, fissitunicate, clavate with short furcate pedicels. *Ascospores* apiosporous and hyaline when young, becoming 2-septate with reddish brown echinate central cell at maturity, with long gelatinous terminal appendages.

**Anamorphs reported for genus:** none.

**Literature:** Tanaka and Harada 2005b; Tanaka et al. 2009; Zhang et al. 2009a.

### Type species

***Katumotoa bambusicola*** Kaz. Tanaka & Y. Harada, Mycoscience 46: 313 (2005). (Fig. 41)

Some information for the following description is from Tanaka and Harada (2005).

*Ascomata* 240–330  $\mu\text{m}$  high  $\times$  260–420  $\mu\text{m}$  diam., scattered or in small groups, immersed, becoming erumpent, with a slightly protruding papilla covered with brown hyphae, subglobose (Fig. 41a). *Peridium* 13–30  $\mu\text{m}$  thick, composed of a few layers of lightly pigmented, depressed cells. *Hamathecium* of dense, long cellular pseudoparaphyses, 1.5–3  $\mu\text{m}$  broad, embedded in mucilage, branching and anastomosing. *Asci* 110–160  $\times$  17.5–24  $\mu\text{m}$  ( $\bar{x}$  = 139  $\times$  21  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, cylindro-clavate with a short furcate pedicel which is up to 25  $\mu\text{m}$  long (Fig. 41b and d). *Ascospores* 39–50(–57)  $\times$  7–10  $\mu\text{m}$  ( $\bar{x}$  = 45.8  $\times$  8.2  $\mu\text{m}$ ,  $n$ =10), biserial, fusoid to narrowly fusoid with acute ends, usually curved, apiosporous and hyaline when young, constricted at the primary septum, the upper cell longer and broader than the lower one, smooth, surrounded by a bipolar sheath which is up to 15  $\mu\text{m}$  long, best seen in India ink, senescent ascospores yellowish brown, 2–4-septate (Fig. 41c).

**Anamorph:** none reported.

**Material examined:** JAPAN, Mt. Iwate, near Yakebashiri, Hirakasa, Nishine, Iwate, on culms of *Oryza sativa* L., 19 Oct. 2003, K. Tanaka (HHUF 28663, **holotype**).

### Notes

### Morphology

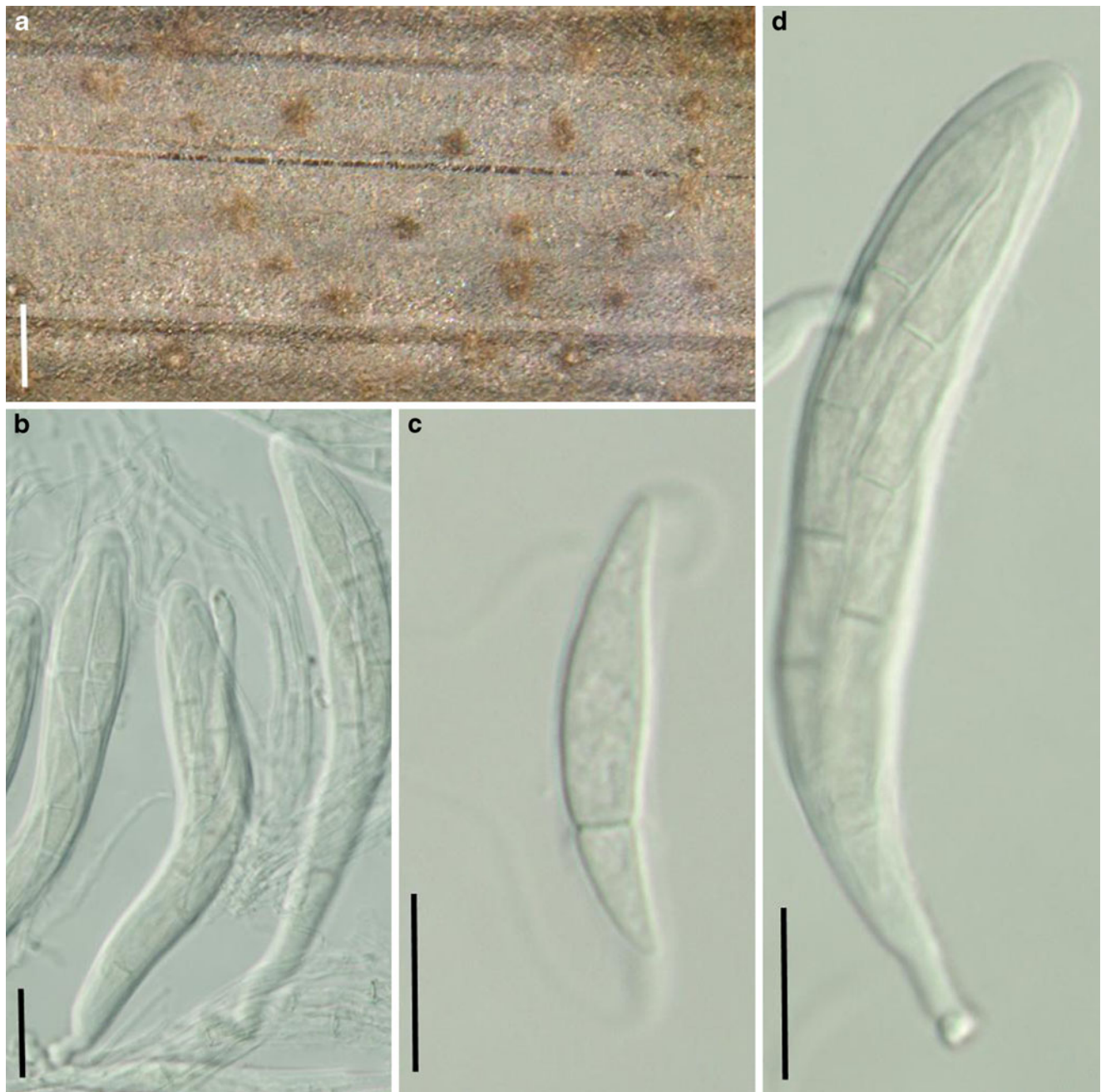
*Katumotoa* was formally established by Tanaka and Harada (2005b) to accommodate the monotypic species, *K. bambusicola*, which is characterized by immersed ascomata with a thin peridium comprising thin-walled compressed cells, cellular pseudoparaphyses, cylindro-clavate and fissitunicate asci and fusoid ascospores with an elongated bipolar mucilaginous sheath. Based on its immersed ascomata, pseudoparenchymatous peridium cells and cellular pseudoparaphyses, *Katumotoa* was assigned to *Phaeosphaeriaceae* (Tanaka and Harada 2005b; Tanaka et al. 2009), but this classification has been shown to be incorrect in subsequent phylogenetic studies (Tanaka et al. 2009; Zhang et al. 2009a).

### Phylogenetic study

Phylogenetic analysis based on five genes (LSU, SSU, *RPB1*, *RPB2* and *EF1*) indicates that *Katumotoa bambusicola* resides in *Lentitheciaceae*, and this receives high bootstrap support (Zhang et al. 2009a). In particular, *K. bambusicola* forms a robust clade with *Ophiosphaerella sasicola* (Nagas. & Y. Otani) Shoemaker & C.E. Babcock, which has filliform ascospores (Shoemaker and Babcock 1989b).

### Concluding remarks

The hyaline, apiosporous ascospores which become 2–4-celled with central reddish brown cells and large



**Fig. 41** *Katumotoa bambusicola* (from HHUF 28663, **holotype**). **a** Ascomata scattered on the host surface. **b** Asci in pseudoparaphyses. **c** Hyaline ascospore with long terminal appendages. **d** Clavate ascus with a short pedicel. Scale bars: **a**=0.5 mm. **b–d**=20  $\mu$ m

unraveling appendages are the most striking features of this species and readily distinguish it from other pleosporalean taxa. Both *Katumotoa bambusicola* and *Ophiosphaerella sasicola* are associated with bambusicolous hosts, which might indicate that host spectrum in this case, has greater phylogenetic significance than some morphological characters (Zhang et al. 2009a).

*Keissleriella* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 128: 582 (1919). (*Lentitheciaceae*)

### Generic description

Habitat terrestrial or freshwater, saprobic. *Ascomata* small- to medium-sized, immersed, erumpent to nearly superficial, globose, papillate, ostiolate. *Papilla* covered by dark setae or small blackened cells. *Peridium* thick, composed of cells of pseudoparenchymatous and inner layer composed of pale cells. *Hamathecium* of dense, long pseudoparaphyses, rarely septate, anastomosing and branching. *Asci* 4- or 8-spored, bitunicate, fissitunicate, cylindro-clavate, with a

furcate pedicel and a small ocular chamber. *Ascospores* hyaline to pale brown, ellipsoid to fusoid, 1-septate, constricted at the septum (Barr 1990a).

**Anamorphs reported for genus:** *Dendrophoma* (Bose 1961).

**Literature:** von Arx and Müller 1975; Bose 1961; Barr 1990a; Dennis 1978; Eriksson 1967a; von Höhnelt 1919; Luttrell 1973; Munk 1957; Zhang et al. 2009a.

### Type species

*Keissleriella aesculi* (Höhn.) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 128: 582 (1919). (Fig. 42) = *Pyrenochaeta aesculi* Höhn., Ber. dt. bot. Ges. 35: 249 (1917).

*Ascomata* ca. 250  $\mu\text{m}$  high  $\times$  450  $\mu\text{m}$  diam., gregarious, immersed to erumpent, globose or subglobose, with a small black papilla, ca. 75  $\mu\text{m}$  high and 110  $\mu\text{m}$  broad, with short black external setae (Fig. 42a). *Peridium* ca. 25–40  $\mu\text{m}$  wide laterally, up to 70  $\mu\text{m}$  near the apex, thinner at the base, comprising two types of cells which merge in the middle; outer cells composed of small heavily pigmented thick-walled cells, cells ca. 4  $\mu\text{m}$  diam., cell wall up to 4  $\mu\text{m}$  thick, and thick near the apex and thinner laterally and absent in the immersed part of the ascoma, inner cells less pigmented, comprising lightly pigmented to hyaline cells, 5–7  $\mu\text{m}$  thick (Fig. 42a). *Hamathecium* of dense, long pseudoparaphyses, 0.8–1.2  $\mu\text{m}$  broad, rarely septate, anastomosing and branching, thicker near the base, ca. 2  $\mu\text{m}$ , constricted near the septum (Fig. 42b). *Asci* 80–120  $\times$  6–11  $\mu\text{m}$  ( $\bar{x}$  = 101  $\times$  8.5  $\mu\text{m}$ ,  $n$  = 10), 4- or 8-spored, bitunicate, fissitunicate, cylindro-clavate, with a furcate pedicel which is up to 20–40  $\mu\text{m}$  long, with a small ocular chamber (Fig. 42e and f). *Ascospores* 13–18  $\times$  4–5.5  $\mu\text{m}$  ( $\bar{x}$  = 14.5  $\times$  4.8  $\mu\text{m}$ ,  $n$  = 10), obliquely uniseriate and partially overlapping, fusoid with narrowly rounded ends, hyaline, 1-septate, constricted at the septum, smooth (Fig. 42c and d).

**Anamorph:** none reported.

**Material examined:** AUSTRIA, Brentenmaistal in the Viennese forest, *Aesculus hippocastanum* L., 1916, Höhnelt (FH, **holotype** of *Othiella aesculi*). (Note: only two slides; setae cannot be seen from the slides but could be seen from the drawings on the cover).

### Notes

### Morphology

*Keissleriella* is characterized by ascomata with setae in and over the papilla, asci are cylindrical and ascospores are hyaline, 1-septate. Based on the morphological characters, *K. aesculi* was regarded as conspecific with *K. sambucina*; as an earlier epithet, *K. sambucina* typifies the genus (see

comments by Barr 1990a). Munk (1957) placed *Trichometasphaeria* and *Keissleriella* in *Massarinaceae*, and distinguished them by their substrates (*Trichometasphaeria* occurs on herbaceous plants and *Keissleriella* on woody substrates). Bose (1961) combined *Trichometasphaeria* under *Keissleriella*, which was followed by some workers (von Arx and Müller 1975; Dennis 1978; Eriksson 1967a; Luttrell 1973). Barr (1990a), however, maintained these as distinct genera based on the differences of peridium structure and pseudoparaphyses.

### Phylogenetic study

The phylogeny of *Keissleriella* is poorly studied. Limited phylogenetic information indicates that *K. cladophila* forms a robust clade with other species of *Lentitheciaceae* (Zhang et al. 2009a).

### Concluding remarks

The presence of black setae on the surface of papilla is a striking character of *Keissleriella*, but phylogenetic significance of setae is undetermined yet.

***Lentithecium*** K.D. Hyde, J. Fourn. & Yin. Zhang, Fungal Divers. 38: 234 (2009). (*Lentitheciaceae*)

= *Tingoldiagio* K. Hirayama & Kaz. Tanaka, Mycologia 102: 740 (2010) **syn. nov.**

### Generic description

Habitat freshwater, saprobic. *Ascomata* small, scattered or gregarious, immersed, slightly erumpent, depressed spherical to lenticular, ostiolate, papillate or epapillate. *Peridium* thin. *Hamathecium* of cellular pseudoparaphyses. *Asci* 8-ascospored, bitunicate, fissitunicate, clavate, short-stipitate. *Ascospores* broadly fusoid with broadly rounded ends, 1-septate, constricted, hyaline, usually with sheath.

**Anamorphs reported for genus:** none.

**Literature:** Shearer et al. 2009; Zhang et al. 2009a, b.

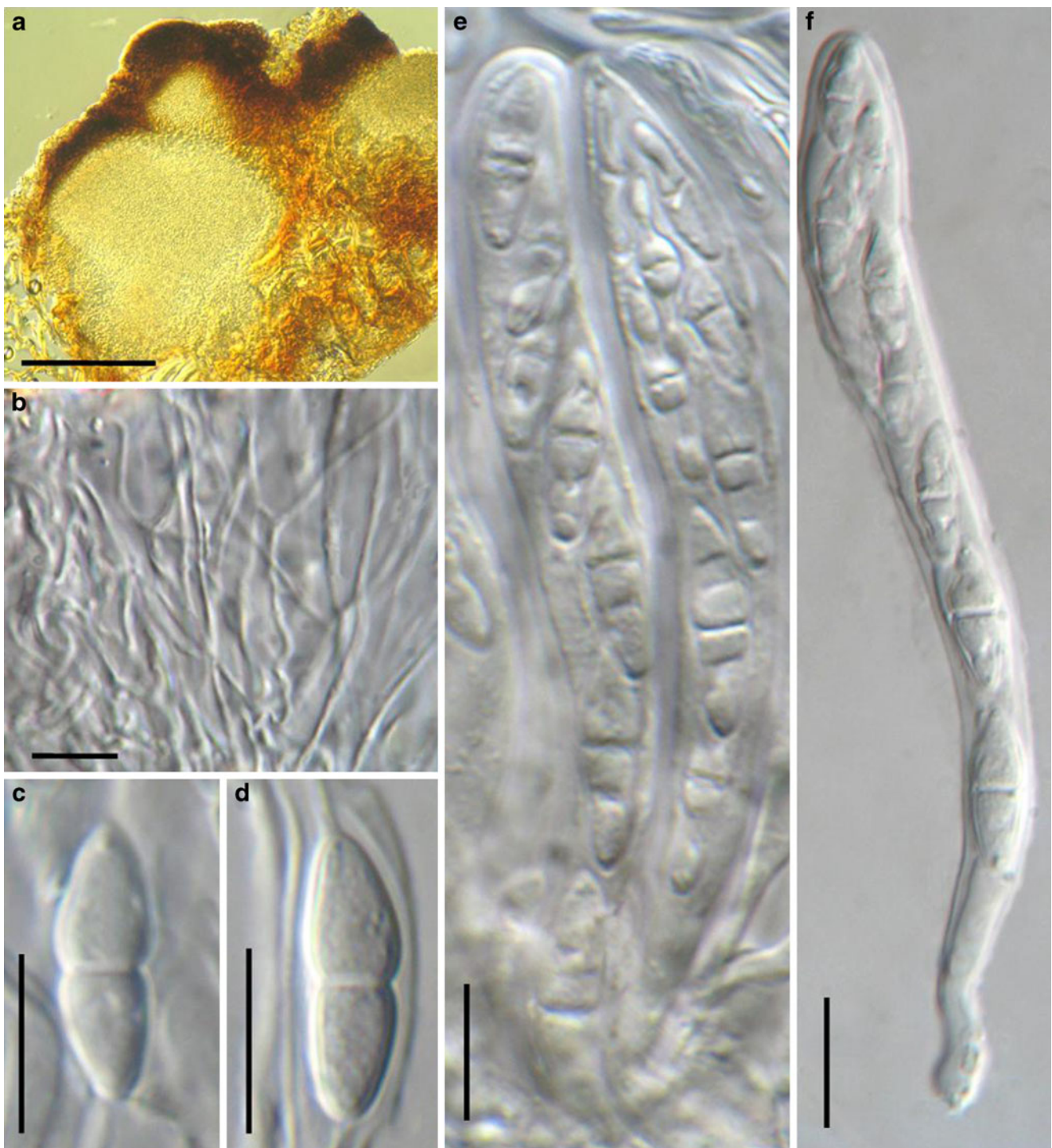
### Type species

***Lentithecium fluviatile*** (Aptroot & Van Ryck.) K.D. Hyde, J. Fourn. & Yin. Zhang, Fungal Divers. 38: 234 (2009). (Fig. 43)

= *Massarina fluviatilis* Aptroot & Van Ryck., Nova Hedwigia 73: 162 (2001).

*Ascomata* 230–260  $\mu\text{m}$  high  $\times$  280–325  $\mu\text{m}$  diam., scattered or gregarious, immersed, slightly erumpent, subglobose to depressed spherical, under a small black pseudostroma originating from the apical part of the peridium, apex slightly papillate, ostiole rounded, 60–70  $\mu\text{m}$  diam. (Fig. 43a and b). *Peridium* 15–20  $\mu\text{m}$  thick at sides and at base, comprising 4–5 layers of angular cells more thick-walled outwards, 50–55  $\mu\text{m}$





**Fig. 42** *Keissleriella sambucina* (from FH, holotype of *Othiella aesculi*). **a** Section of an ascoma. **b** Pseudoparaphyses which are narrow (less than  $1.5\ \mu\text{m}$ ) and branch and anastomosing as

trabeculate. **c, d** Hyaline ascospores with distinct constrictions at the septa. **e** Asci amongst narrow pseudoparaphyses. **f** Ascus with a pedicel and ocular chamber. Scale bars: **a**= $100\ \mu\text{m}$ , **b–f**= $10\ \mu\text{m}$

thick at apex, of small very thick-walled cells. *Hamathecium* of cellular pseudoparaphyses,  $2\text{--}2.5\ \mu\text{m}$  broad (Fig. 43c and d). Asci  $89\text{--}100\times 19\text{--}21\ \mu\text{m}$ , 8-spored, bitunicate, fissitunicate, clavate, bumpy, short-stipitate, apex without obvious apical chamber (Fig. 43e). *Ascospores*  $27\text{--}35\times 8.5\text{--}9.4\ \mu\text{m}$ , 2-

3-seriate, broadly fusoid with broadly rounded ends, straight to slightly curved, 1-septate, slightly constricted, with four large guttules, hyaline, smooth-walled, a very thin mucilaginous sheath can be occasionally observed in India ink but in most cases no sheath can be observed (Fig. 43f and g).

**Anamorph:** none reported.

**Material examined:** FRANCE, Haute Garonne: Avignonnet, Lac de Rosel, artificial lake, on bark and wood of a submerged branch *Populus* sp., 23 Nov. 2006, leg. Michel Delpont, det. Jacques Fournier (IFRD 2039, **holotype**).

## Notes

### Morphology

*Lentithecium* was introduced to accommodate some freshwater fungi previously assigned under *Massarina*, such as *M. arundinacea* (Sowerby) Leuchtm. and *M. fluviatilis* (Zhang et al. 2009a). It is characterized by its immersed and lenticular ascomata, thin peridium which is almost equal in thickness, short pedicellate asci and fusoid or filiform, hyaline or rarely lightly pigmented, 1- to multi-septate ascospores (Zhang et al. 2009b). *Lentitheciaceae* was introduced to accommodate *Lentithecium* and some other related taxa (Zhang et al. 2009a).

### Phylogenetic study

The clade of *Lentitheciaceae* comprises the generic type *Lentithecium fluviatile*, as well as *L. arundinaceum* (Sowerby) K.D. Hyde, J. Fourn. & Yin. Zhang, *Stagonospora macropycnidia*, *Wettsteinina lacustris* (Fuckel) Shoemaker & C.E. Babco., *Keissleriella cladophila*, and the bambusicolous species *Katumotoa bambusicola* and *Ophiosphaerella sasicola*, which receive high bootstrap support (Zhang et al. 2009a).

### Concluding remarks

*Tingoldiogo graminicola* K. Hirayama & Kaz. Tanaka form a robust clade with species of *Lentithecium* (Shearer et al. 2009). *Tingoldiogo* has lenticular immersed to erumpent ascomata, numerous and septate pseudoparaphyses, cylindro-clavate asci and hyaline, 1-septate ascospores with sheath. All of these characters fit *Lentithecium* well. We treat *Tingoldiogo* as a synonym of *Lentithecium*.

***Leptosphaeria*** Ces. & De Not., Comm. Soc. crittog. Ital. 1: 234 (1863). (*Leptosphaeriaceae*)

### Generic description

Habitat terrestrial, saprobic or parasitic. *Ascomata* small- to medium-sized, solitary, scattered or in small groups, erumpent to superficial, subglobose, broadly or narrowly conical, papillate, ostiolate. *Peridium* thick, comprising layers of cells of *textura angularis*. *Hamathecium* of dense cellular pseudoparaphyses, embedded in mucilage, anastomosing and branching. *Asci* 8-spored, bitunicate, fissitunicate unknown, cylindrical with a furcate pedicel and a large ocular chamber. *Ascospores* fusoid or narrowly fusoid,

brown or reddish brown, 3-septate, constricted at each septum.

**Anamorphs reported for genus:** *Coniothyrium* and *Phoma* (Hyde et al. 2011; Sivanesan 1984).

**Literature:** von Arx and Müller 1975; Barr 1987a, b; Cesati and de Notaris 1863; Crane and Shearer 1991; Dong et al. 1998; Eriksson 1967a; Eriksson and Hawksworth 1986, 1991; de Greuter et al. 1988; Hedjaroude 1969; von Höhnell 1907; Holm 1957, 1975; Huhndorf et al. 1990; Luttrell 1973; Müller 1950; Munk 1957; Saccardo 1878b, 1883, 1891, 1895; Schoch et al. 2009; Shearer 1993; Shearer et al. 1990; Shoemaker 1984a; Sivanesan 1984; Zhang et al. 2009a.

### Type species

***Leptosphaeria doliolum*** Ces. & De Not., Comm. Soc. crittog. Ital. 1: 234 (1863). (Fig. 44)

≡ *Sphaeria doliolum* Pers., Icon. Desc. Fung. Min. Cognit. (Leipzig) 2: 39 (1800).

*Ascomata* 340–450  $\mu\text{m}$  high  $\times$  380–500  $\mu\text{m}$  diam., solitary, scattered or in small groups, superficial, subglobose, broadly or narrowly conical, with a flattened base on the host surface, black, usually with 2–4 ring-like ridges surrounding the ascomata surface, apex with a conical, usually shiny papilla (Fig. 44a). *Peridium* 85–110  $\mu\text{m}$  wide at sides, thinner at the apex, comprising two types of cells, outer layer composed of small thick-walled cells of *textura angularis*, cells  $< 2 \mu\text{m}$  diam., cell wall up to 8  $\mu\text{m}$  thick, surface heavily pigmented and inner lightly pigmented, apex cells smaller, walls thicker, and cells more heavily pigmented, inner layer composed of subhyaline relatively thin-walled cells of *textura angularis*, 3–6  $\mu\text{m}$  diam., wall up to 5  $\mu\text{m}$ , cells near the base larger and wall thinner and paler (Fig. 44b). *Hamathecium* of dense, long cellular pseudoparaphyses, 1.5–3  $\mu\text{m}$  broad, embedded in mucilage, anastomosing and branching. *Asci* 110–150  $\times$  7–9(–10)  $\mu\text{m}$  ( $\bar{x} = 130.6 \times 8.5 \mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate unknown, cylindrical, furcate pedicel which is usually less than 25  $\mu\text{m}$  long, with a large ocular chamber (Fig. 44c, d and e). *Ascospores* 25–31  $\times$  4.5–6  $\mu\text{m}$  ( $\bar{x} = 27.7 \times 5.3 \mu\text{m}$ ,  $n=10$ ), uniseriate and somewhat partially overlapping, narrowly fusoid with sharp to narrowly rounded ends, reddish brown, 3-septate, constricted at each septum, smooth (Fig. 44f).

**Anamorph:** *Phoma hoehnelii* (Sivanesan 1984).

**Material examined:** Herb., Persoon 910270–650 (L, **lectotype**).

## Notes

### Morphology

*Leptosphaeria* was first established by Cesati and de Notaris (1863) with 26 species included; *L. doliolum* (Pers.: Fr.) Ces. & De Not. was subsequently selected as the

lectotype species (de Greuter et al. 1988; Holm 1975; Shearer et al. 1990). *Leptosphaeria* was originally defined based mainly on the characters of ascospores being ellipsoid or fusoid, one to many septa, hyaline to dark brown. These few common characters meant that *Leptosphaeria* comprised many species, and some of them should be assigned to either *Euascomycetes* or *Loculoascomycetes* (Crane and Shearer 1991). *Leptosphaeria* had been divided based on host and habitat (Saccardo 1878b, 1891, 1895) as well as the pseudothecium (glabrous, hairy, setose) and ascospore septation (see comments by Crane and Shearer 1991). von Höhnelt (1907) used centrum structure in the classification of *Leptosphaeria*, and divided *Leptosphaeria* into three genera, viz. *Leptosphaeria*, *Scleroplella* and *Nodulosphaeria*. Müller (1950) subdivided *Leptosphaeria* into four sections based on pseudothecial and centrum structure as well as ascospore characters. This classification was modified by Munk (1957), who named these four sections as section I (*Eu-Leptosphaeria*), section II (*Para-Leptosphaeria*), section III (*Scleroplella*) and section IV (*Nodulosphaeria*). Holm (1957) used a relatively narrow concept for *Leptosphaeria*, which included species closely related to the generic type, *L. doliolum*. This viewpoint was accepted by some workers (Eriksson 1967a; Hedjaroude 1969; Shoemaker 1984a). Nevertheless, it still seems a heterogeneous group of fungi (see comments by Crane and Shearer 1991). Its position among the *Loculoascomycetes* is also debated. It has been placed in the *Pleosporaceae* (von Arx and Müller 1975; Luttrell 1973; Sivanesan 1984) or *Leptosphaeriaceae* (Barr 1987a, b; Eriksson and Hawksworth 1991) or *Phaeosphaeriaceae* (Eriksson and Hawksworth 1986).

### Phylogenetic study

Molecular phylogenetic analysis based on multigenes indicated that species of *Leptosphaeria* (including the generic type *L. doliolum*) and *Neophaeosphaeria* form a paraphyletic clade with moderate bootstrap support (Dong et al. 1998; Schoch et al. 2009; Zhang et al. 2009a), which is sister to other families of *Pleosporales* (Zhang et al. 2009a). Thus the familial rank of the *Leptosphaeriaceae* could be temporarily verified, but further molecular phylogenetic study is needed in which more related taxa should be included.

### Concluding remarks

Morphologically, *Leptosphaeria* is mostly comparable with *Amarenomyces*, *Bricookea*, *Diaplella*, *Entodesmium*, *Melanomma*, *Nodulosphaeria*, *Paraphaeosphaeria*, *Passeriniella*, *Phaeosphaeria* and *Trematosphaeria*. While it prefers non-woody parts of dicotyledonous hosts, its cylindrical ascus with short pedicel and smooth, fusoid

**Fig. 43** *Lentithecium fluviatile* (from IFRD 2039). **a** Erumpent ascomata scattering on the host surface. **b** Habitat section of the immersed ascomata. **c, d** Section of an ascoma and a partial peridium. Note the peridium cells of *textura angularis*. **e** Clavate 8-spored ascus with a short pedicel. **f, g** Hyaline, 1-septate broadly fusoid ascospores. Scale bars: **a, b**=0.5 mm, **c**=100  $\mu\text{m}$ , **d**=50  $\mu\text{m}$ , **e–g**=20  $\mu\text{m}$

and multi-septate ascospores make it readily distinguishable from all other genera (Shoemaker 1984a).

***Leptosphaerulina*** McAlpine, Fungus diseases of stone-fruit trees in Australia and their treatment: 103 (1902). (*Didymellaceae*)

### Generic description

Habitat terrestrial, parasitic or saprobic. *Ascomata* small, scattered, immersed, globose to subglobose, with a small, slightly protruding papilla, ostiolate. *Peridium* thin. *Hamathecium* of rare or decomposing cellular pseudoparaphyses. *Asci* bitunicate, obpyriform. *Ascospores* broadly clavate or cylindrical, hyaline, turning pale brown when old, asymmetrical, multi-septate, smooth-walled.

**Anamorphs reported for genus:** *Pithoascus* and *Pithomyces* (Hyde et al. 2011).

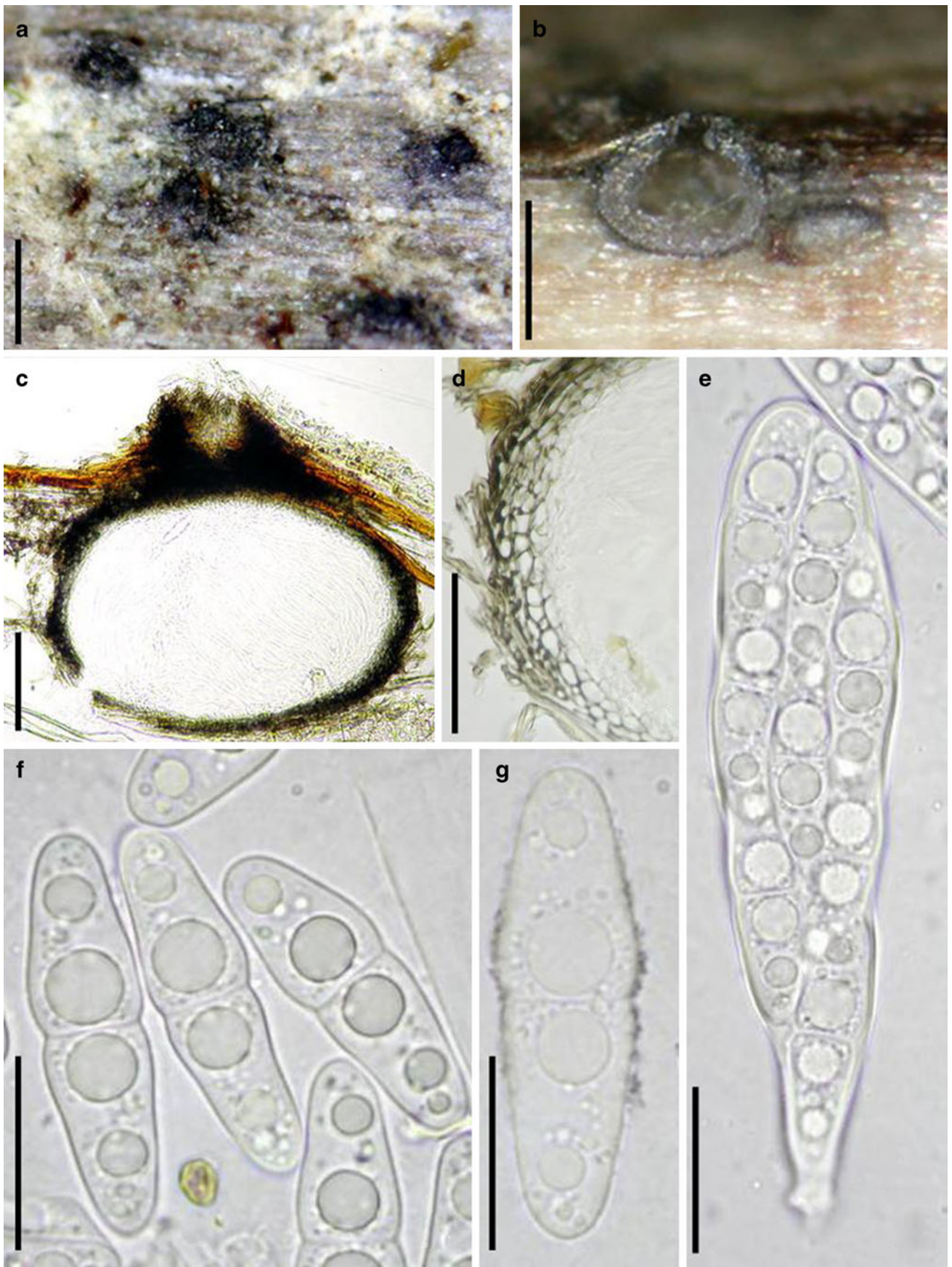
**Literature:** Barr 1972; Chlebicki 2002; Crivelli 1983; Kodsueb et al. 2006a; Zhang et al. 2009a.

### Type species

***Leptosphaerulina australis*** McAlpine, Fungus diseases of stone-fruit trees in Australia and their treatment: 103 (1902). (Fig. 45)

*Ascomata* 140–170  $\mu\text{m}$  diam., scattered, immersed, globose to subglobose, with a small slightly protruding papilla, ostiolate (Fig. 45a). *Peridium* thin, composed of one or two layers of large cells of *textura angularis*, pale brown (Fig. 45a). *Hamathecium* of rare or decomposing cellular pseudoparaphyses, up to 5  $\mu\text{m}$  broad, filling the gaps between the asci. *Asci* 38–53 $\times$ 55–75  $\mu\text{m}$  ( $\bar{x}$  = 67.5  $\times$  43.3  $\mu\text{m}$ ,  $n$ =10), 8-spored, without pedicel, bitunicate, fissitunicate dehiscence not observed, obpyriform, with a large ocular chamber and apical ring (Fig. 45b and c). *Ascospores* 30–40(–47) $\times$ 11–14  $\mu\text{m}$  ( $\bar{x}$  = 36.5  $\times$  13  $\mu\text{m}$ ,  $n$ =10), broadly clavate, hyaline, turning pale brown when old, asymmetrical, upper hemisphere usually with one transverse septum and with a somewhat narrowly rounded end, lower hemisphere usually with two transverse septa and with broadly rounded ends, slightly constricted at the primary septum, mostly with one vertical septum in each central cell, smooth, with thin gelatinous sheath when young, 2–3  $\mu\text{m}$  thick (Fig. 45d and e).

**Anamorph:** none reported.





**Fig. 44** *Leptosphaeria doliolum* (from L, lectotype). **a** Ascomata on the host surface. Note the shiny black surface. **b** Section of the partial peridium. Note the uneven thickness. **c–e** Asci with a short pedicel. **f** Three ascospores in ascus. Scale bars: **a**=0.5 mm, **b**=100  $\mu$ m, **c–f**=20  $\mu$ m

**Material examined:** USA, Kansas, Kansas State College, on *Poa pratensis* L. Grass plots, 2 Jul. 1953, leg. T. Rogerson, det. L.E. Wehmeyer (NY, C.T. Rogerson 3836).

### Notes

### Morphology

*Leptosphaerulina*, introduced by McAlpine (1902), is characterized by small immersed ascomata, obpyriform asci with a large ocular chamber and apical ring as well as muriformly septate ascospores which may be hyaline or pigmented. Species of *Leptosphaerulina* may occur on monocotyledons or dicotyledons. *Leptosphaerulina* is most comparable with *Pleospora*, and the only difference between them is that *Leptosphaerulina* has smaller ascomata and hyaline ascospores that only become pigmented after discharge, whereas the ascospores of *Pleospora* become brown within the asci. Currently, about 60 names are accepted in this genus, and some even reported from marine environments, e.g. *L. mangrovei* (Inderbitzin et al. 2000).

### Phylogenetic study

Based on multigene phylogenetic analysis, two putative strains of *Leptosphaerulina australis*, the generic type of *Leptosphaerulina*, from Switzerland (CBS 311.51) and Indonesia (CBS 317.83) resided within *Didymellaceae* (de Gruyter et al. 2009; Zhang et al. 2009a).

### Concluding remarks

Because of its morphological confusion with *Pleospora* and the diversity of habitats within the genus, *Leptosphaerulina sensu lato* is likely to be polyphyletic. Fresh collections of this species are needed from Australia to epitypify this taxon and define the genus in a strict sense. The specimen described here is a collection from USA and therefore may not represent the type.

**Lewia** M.E. Barr & E.G. Simmons, Mycotaxon 25: 289 (1986). (*Pleosporaceae*)

### Generic description

Habitat terrestrial, parasitic or saprobic? *Ascomata* small, scattered, erumpent to nearly superficial at maturity, subglobose to globose, black, smooth, papillate, ostiolate. *Papilla* short, blunt. *Peridium* thin. *Hamathecium* of pseudoparaphyses. *Asci* (4–6-)8-spored, bitunicate, fissionate, cylindrical to cylindro-clavate, with a short, furcate pedicel. *Ascospores* muriform, ellipsoid to fusoid.

**Anamorphs reported for genus:** *Alternaria* (Simmons 1986).

**Literature:** Kwasna and Kosiak 2003; Kwasna et al. 2006; Simmons 1986, 2007; Vieira and Barreto 2006.

### Type species

***Lewia scrophulariae*** (Desm.) M.E. Barr & E.G. Simmons, Mycotaxon 25: 294 (1986). (Fig. 46)

≡ *Sphaeria scrophulariae* Desm., *Plantes cryptogames du Nord de la France*, ed. 1 fasc. 15: no. 718 (1834).

*Ascomata* ca. 150–200  $\mu\text{m}$  diam., scattered, erumpent to nearly superficial at maturity, subglobose to globose, black, smooth, papillate. *Papilla* short, blunt. *Peridium* thin. *Hamathecium* of septate pseudoparaphyses, ca. 2–2.5  $\mu\text{m}$  broad, anastomosing or branching not observed. *Asci* 100–140 $\times$ 13–17  $\mu\text{m}$ , (4–6-)8-spored, bitunicate, fissionate, cylindrical to cylindro-clavate, with a short, furcate pedicel, ocular chamber unknown (Fig. 46a). *Ascospores* ellipsoid, 5 (rarely 6 or 7) transversal septa and one longitudinal septum mostly through the central cells, yellowish brown to gold-brown, 20–24 $\times$ 8–10  $\mu\text{m}$  ( $\bar{x}$  = 21.5  $\times$  9.1  $\mu\text{m}$ ,  $n$ =10), constricted at median septum, smooth or verruculose (Fig. 46b, e and f).

**Anamorph:** *Alternaria conjuncta* (Simmons 1986).

Primary conidiophore simple with a single conidiogenous locus; conidia produced in chains, the first conidia in chain is larger, 30–45 $\times$ 10–12  $\mu\text{m}$ , 7 transverse septa, 1–2 longitudinal or oblique septa in lower cells. Secondary conidiophore with 5–7 conidiogenous loci, sometimes branched; sporulation in chains, rarely branched.

**Material examined:** (FH, slide from lectotype).

Note: The specimen contains only a slide, so limited structures could be observed e.g. ascospores. The information about ascomata, peridium and whole asci is referred to Simmons (1986).

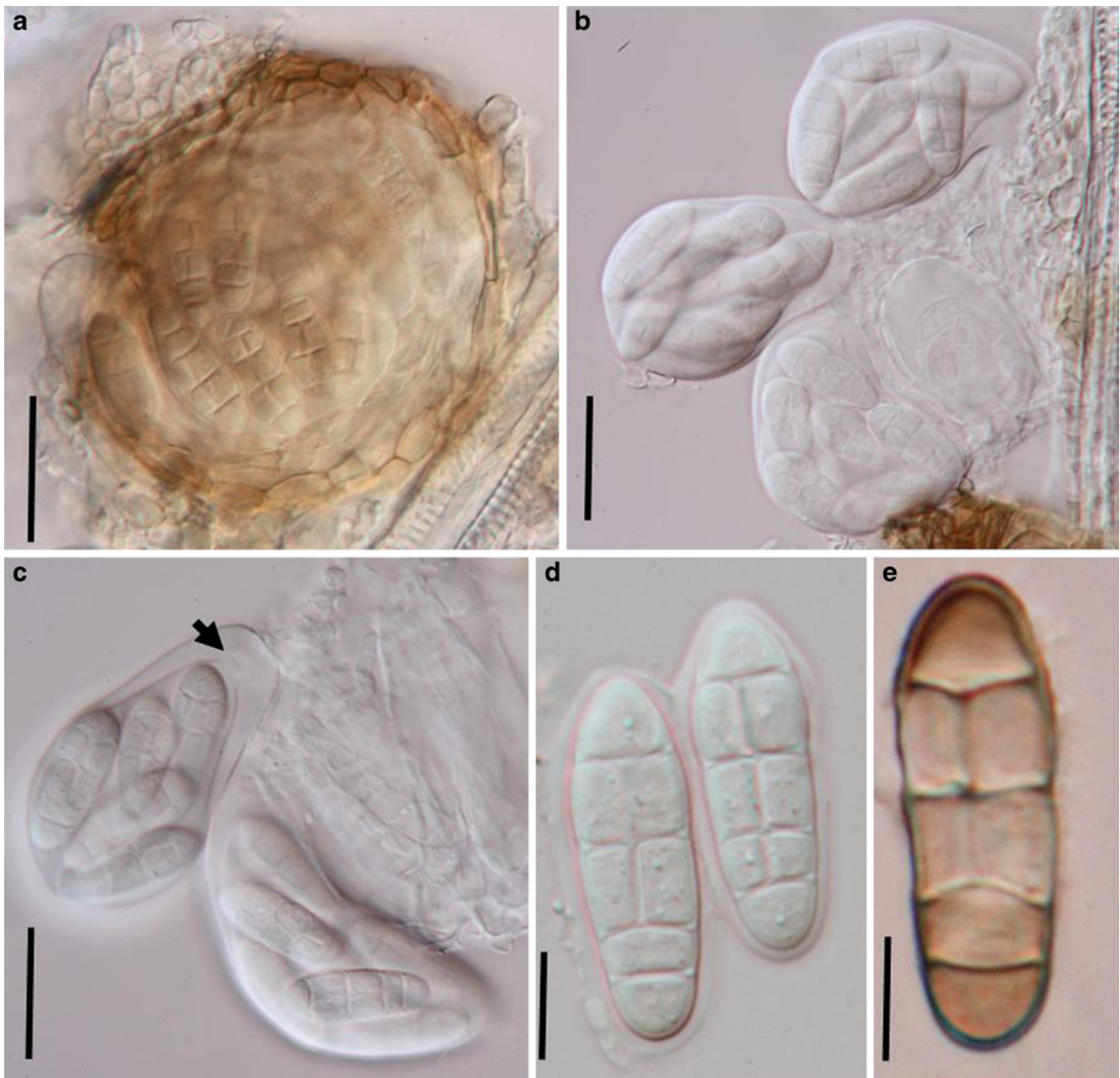
### Notes

### Morphology

*Lewia* has “*Pleospora*-like” teleomorphs, while it has *Alternaria* anamorphs, which are characterized by the beakless conidia connected together with secondary conidiophore (Simmons 1986). Based on these characters, more species under this genus were subsequently reported, i.e. *Lewia avenicola* Kosiak & Kwaśna (Kwasna and Kosiak 2003); *L. chlamidosporiformans* B.S. Vieira & R. W. Barreto (Vieira and Barreto 2006); *L. alternarina* (M. D. Whitehead & J.G. Dicks.) E.G. Simmons and *L. daucicaulis* E.G. Simmons (Simmons 2007). Currently *Lewia* comprises 15 species (<http://www.mycobank.org>, 24-02-2009).

### Phylogenetic study

Phylogenetic analysis based either on SSU rDNA sequences or on multigenes indicated that *Lewia* species



**Fig. 45** *Leptosphaerulina australis* (from NY, C.T. Rogerson 3836). **a.** Compressed ascoma. Note the obpyriform asci within the ascoma and the thin peridium. **b, c.** Eight-spored asci released from the

ascomata. Note the apical apparatus (*arrowed*). **d.** Ascospores with thin sheath. **e.** An old pale brown ascospore. Scale bars: **a–c**=50  $\mu\text{m}$ , **d, e**=10  $\mu\text{m}$

(*Allewia eureka* (E.G. Simmons) E.G. Simmons=*L. eureka*) form a robust clade with other members of *Pleosporaceae* (Schoch et al. 2006; Schoch et al. 2009; Zhang et al. 2009a).

#### Concluding remarks

Its position in *Pleosporaceae* is confirmed.

*Lichenopyrenis* Calat., Sanz & Aptroot, Mycol. Res. 105: 634 (2001). (?*Pleomassariaceae*)

#### Generic description

Habitat terrestrial, parasitic on lichens. *Ascomata* medium-sized, globose or subglobose. *Hamathecium* of dense, filliform, branching, septate pseudoparaphyses. *Asci* bitunicate, fissitunicate, clavate, with a short sometimes furcate pedicel. *Ascospores* ellipsoidal with broadly rounded ends, pale orange-brown, 1-distoseptate.

**Anamorphs reported for genus:** see below.

**Literature:** Calatayud et al. 2001.

**Fig. 46** *Lewia scrophulariae* (from FH, slide from lectotype). **a** Cylindrical ascus with a short pedicel. **b** Ascospores in asci. **c–f** Released muriform brown ascospores. Scale bars: **a**=20  $\mu\text{m}$ , **b–f**=10  $\mu\text{m}$



### Type species

*Lichenopyrenis galligena* Calat., Sanz & Aptroot, Mycol. Res. 105: 636 (2001). (Fig. 47)

Ascomata 140–260  $\mu\text{m}$  high  $\times$  140–250  $\mu\text{m}$  diam., gregarious, initially immersed in galls, later becoming erumpent, globose or subglobose, black, roughened (Fig. 47a and b).

*Peridium* 18–25  $\mu\text{m}$  wide, composed of 2–5 layers of heavily pigmented cells of *textura angularis* to compressed, cells 6–11  $\mu\text{m}$  diam., cell wall 1–3  $\mu\text{m}$  thick (Fig. 47c, d and e). *Hamathecium* of dense, long filamentous pseudoparaphyses, 2.5–4  $\mu\text{m}$  broad, branching, septate. *Asci* 65–85  $\times$  15–20  $\mu\text{m}$  ( $\bar{x}$  = 74  $\times$  18  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissionitunicate, broadly clavate, with a short, thick, some-



times furcate pedicel, up to 13  $\mu\text{m}$  long, ocular chamber not observed (Fig. 47f, g, h and k). *Ascospores* 16–20 $\times$ 9–11  $\mu\text{m}$  ( $\bar{x}$  = 18  $\times$  10 $\mu\text{m}$ ,  $n$ =10), biseriata, ellipsoidal, pale orange-brown, 1-distoseptate, with prominent swelling at the septum, containing refractive globules, smooth (Fig. 47i, j and l).

**Anamorph:** The following description is from Calatayud et al. (2001).

*Conidiomata* pycnidial, arising in galls together with the ascomata, immersed, ca. 100–200  $\mu\text{m}$  diam.; wall dark brown throughout, composed of 2–5 layers of angular to laterally compressed cells; cells relatively large, ca. 8–16  $\mu\text{m}$  diam. in superficial view. *Conidiophores* formed by 1–3 cells, frequently branched and with the uppermost cells bearing 1–4 conidiogenous cells; cells=cylindrical, hyaline except at the base, which are sometimes pale brown, 7–15 $\times$ 3–4  $\mu\text{m}$ . *Conidiogenous cells* tapered towards the apex, 14–18 $\times$ 3–4  $\mu\text{m}$ . *Conidia* 5–7 $\times$ 1.5–2  $\mu\text{m}$ . *Vegetative hyphae* hyaline.

**Material examined:** SPAIN, Andalucía, Province, Jaén, Andújar, lichenicolous on *Leptochidium albociliatum* (Desm.) M. Choisy on acid volcanic rock, 19 Apr. 2000, V. Calatayud (MA-Lichen 12715, **holotype**).

## Notes

### Morphology

*Lichenopyrenis* was formally established by Calatayud et al. (2001) based on its “perithecioid ascomata with peridium comprising compressed cells, fissitunicate and J- asci, wide hamathecium filaments, and 1-septate pale orange-brown ascospores with distoseptate thickenings at maturity”, and is monotypic with *L. galligena*. The genus was temporarily assigned to *Pleomassariaceae*. *Lichenopyrenis galligena* is a parasite of lichens, occurring in galls in the thallus of the host (Calatayud et al. 2001).

### Phylogenetic study

None.

### Concluding remarks

This is one of the few species that are parasitic on lichens. The most comparable species are *Parapyrenis lichenicola* Aptroot & Diederich and *Lacrymospora parasitica* Aptroot (both in *Requienellaceae*, *Pyrenulales*) as well as some species from *Dacampiaceae*. The peridium structure, cellular pseudoparaphyses, distoseptate and smooth, orange-brown ascospores as well as the anamorphic stage of *Lichenopyrenis* can easily distinguish from all of them (Calatayud et al. 2001).

***Lineolata*** Kohlm. & Volkm.-Kohlm., Mycol. Res. 94: 687 (1990). (*Pleosporales*, genera *incertae sedis*)

## Generic description

Habitat marine, saprobic (or perthophytic?). *Ascomata* medium-sized, gregarious, immersed to erumpent, obpyriform, ostiolate, papillate. *Peridium* thin, comprising two types of cells; outer cells thick stratum pseudostromatic, inner stratum thin, composed of a few layers of hyaline cells of *textura angularis*. *Hamathecium* of dense, long trabeculate pseudoparaphyses, embedded in mucilage, anastomosing and septate. *Asci* 8-spored, bitunicate, cylindrical, with short pedicels, with an ocular chamber. *Ascospores* uniseriate to partially overlapping, ellipsoidal, dark brown, 1-septate.

**Anamorphs reported for genus:** none.

**Literature:** Kohlmeyer and Kohlmeyer 1966; Kohlmeyer and Volkmann-Kohlmeyer 1990.

## Type species

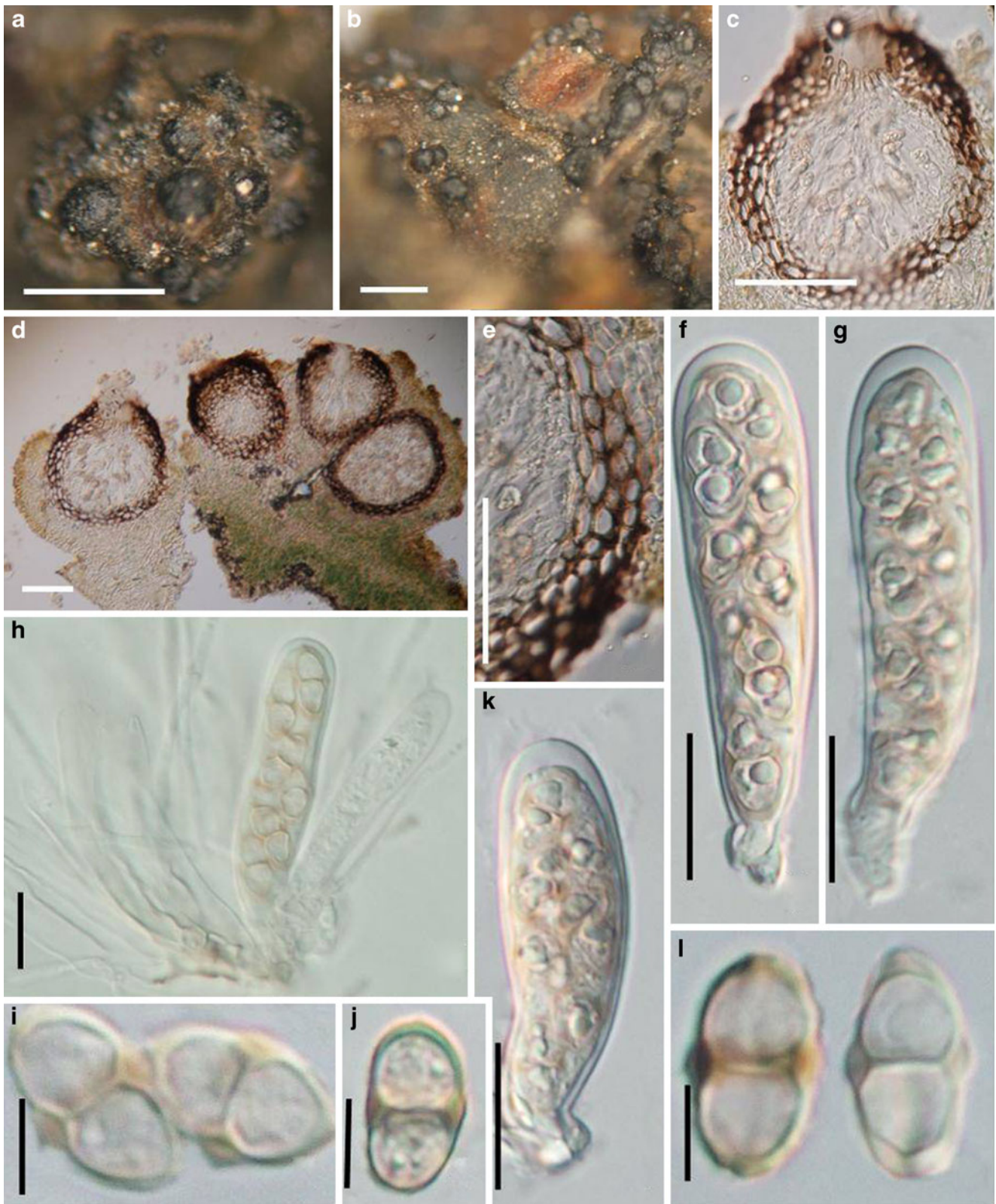
***Lineolata rhizophorae*** (Kohlm. & E. Kohlm.) Kohlm. & Volkm.-Kohlm., Mycol. Res. 94: 688 (1990). (Fig. 48)

≡ *Didymosphaeria rhizophorae* Kohlm. & E. Kohlm. Icones Fungorum Maris (Lehre) 4 & 5: tab. 62a (1967).

*Ascomata* 300–490  $\mu\text{m}$  high $\times$ 200–360  $\mu\text{m}$  diam., gregarious, immersed to erumpent, obpyriform, ostiolate, papillate, subcarbonaceous to subcoriaceous, blackish brown (Fig. 48a). *Peridium* 37–45  $\mu\text{m}$  thick, comprising two types of cells; outer cells thick stratum pseudostromatic, composed of irregular or roundish, dark brown cells, on the outside with a more or less recognizable hyphal structure, enclosing some decaying cells of the host, inner stratum thin, composed of four or five layers of hyaline, polygonal, elongate, thin-walled cells with large lumina, merging into the pseudoparaphyses. *Hamathecium* of dense, long trabeculate pseudoparaphyses, 1–1.5  $\mu\text{m}$  broad, embedded in mucilage, anastomosing and septate. *Asci* 150–175 $\times$ 14–17.5  $\mu\text{m}$ , 8-spored, bitunicate, cylindrical, with short pedicels, with an ocular chamber (Fig. 48b). *Ascospores* 23–32(–33) $\times$ 9–12  $\mu\text{m}$ , uniseriate to partially overlapping, ellipsoid, dark brown, 1-septate, not or slightly constricted at the septum, striate by delicate costae that run parallel or in a slight angle to the longitudinal axis of the ascospore (Fig. 48c, d, e and f) (adapted from Kohlmeyer and Kohlmeyer 1979).

**Anamorph:** none reported.

**Material examined:** US, Florida, Middle Torch Key, on *Rhizophora mangle*, 21 Nov. 1965, J. Kohlmeyer (Herb. J. Kohlmeyer No. 2390b, **isotype**); Pirate Grove Key, on *R. mangle*, 5 Jan. 1964 (Herb. J. Kohlmeyer No. 1721 **paratype**); Florida, Virginia Key, on *R. mangle*, 1 Jan. 1964, leg. E. Kohlmeyer (Herb. J. Kohlmeyer No. 1751 **paratype**); Florida, Torch Key, on *R. mangle*, 20 Nov. 1965, leg. J. Kohlmeyer (Herb. J. Kohlmeyer No. 2423 **paratype**).



**Fig. 47** *Lichenopyrenis galligena* (from MA-Lichen 12715, **holotype**). **a, b** Ascomata forming in the host tissues. **c, d** Sections of ascomata. **e** Section of a partial peridium. **f–h, k** Broadly clavate asci.

Note the short rounded pedicel. **i, j, l** Ascospores. Note the small swellings at the septa. Scale bars: **a, b**=0.5 mm, **c, d**=100  $\mu\text{m}$ , **e**=50  $\mu\text{m}$ , **f–h, k**=20  $\mu\text{m}$ , **i, j, l**=10  $\mu\text{m}$

## Notes

### Morphology

*Lineolata* was monotypified by *L. rhizophorae*, which was originally introduced by Kohlmeyer and Kohlmeyer (1966) as a species of *Didymosphaeria* (as *D. rhizophorae*). Based on the morphology of ascomata and asci, Barr (1990a) assigned it under *Lojkania* (as *L. rhizophorae*). Kohlmeyer and Volkmann-Kohlmeyer (1990) restudied this species and noticed that the absence of clypeus, almost superficial ascomata, coloured peridium, a hamathecium with gelatinous matrix, asci with apical ring-like structure and the ornamented ascospores are quite different from the modified concept of *Didymosphaeria*.

Thus they introduced *Lineolata* to accommodate *D. rhizophorae* (Kohlmeyer and Volkmann-Kohlmeyer 1990).

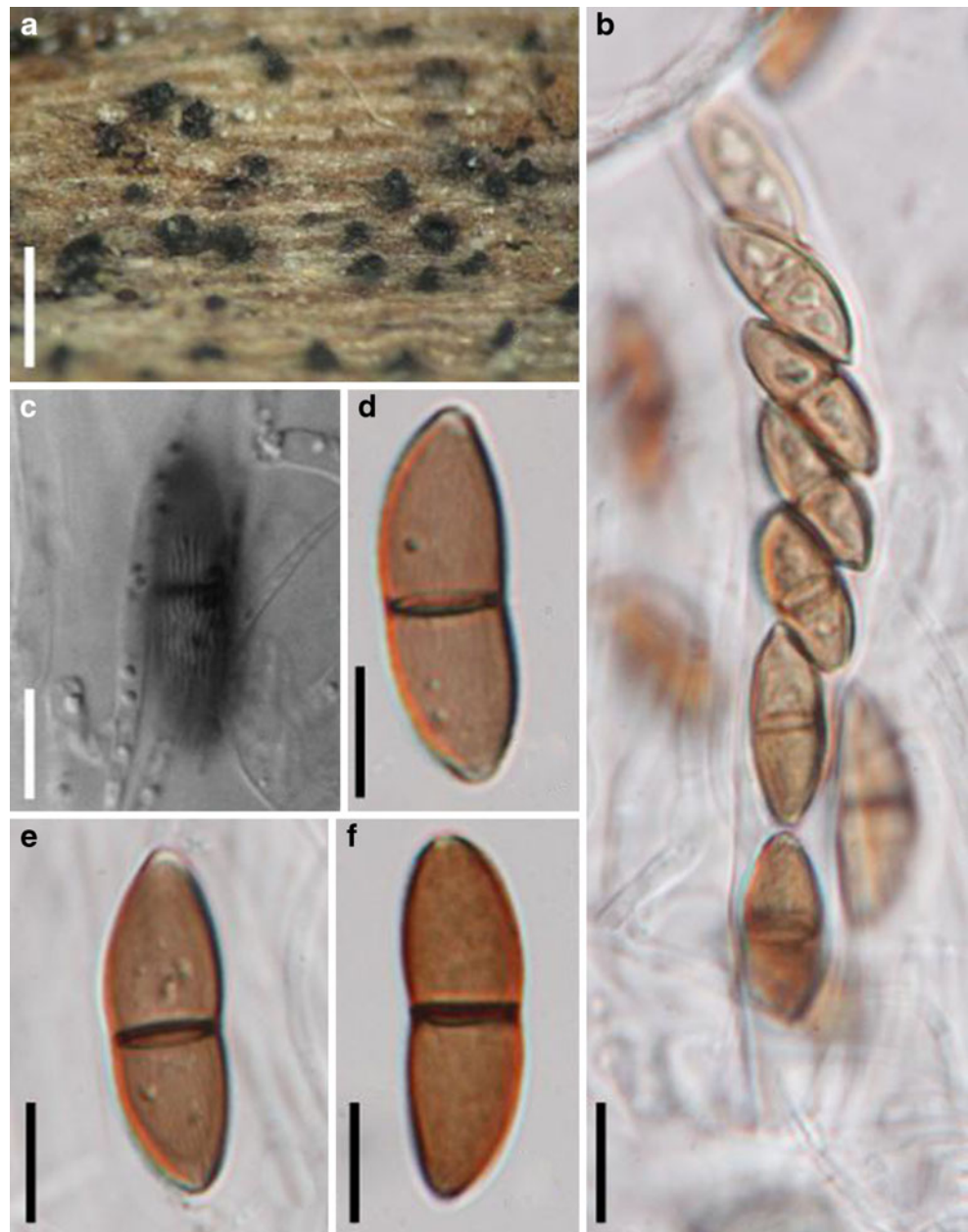
### Phylogenetic study

Three isolates of *Lineolata rhizophorae* from varied geographic localities were analyzed by Suetrong et al. (2009) and shown to be related to *Caryospora rhizophorae* in *Dothideomycetidae* and excluded from *Pleosporomycetidae* and *Pleosporales*.

### Concluding remarks

Based on initial molecular work it is likely that this species does not belong to *Pleosporales* in spite of its dense pseudoparaphyses and other characters shared with the order.

**Fig. 48** *Lineolata rhizophorae* (from Herb. J. Kohlmeyer No. 2390b, **isotype** of *Didymosphaeria rhizophorae*). **a** Ascomata immersed in the host substrate with protruding papilla. **b** Ascospores within an ascus. Note the ascospore arrangement. **c–f** One-septate ascospores. Note the striate ornamentation in (c). Scale bars: **a**=100  $\mu\text{m}$ , **a**, **b**=20  $\mu\text{m}$ , **c–f**=10  $\mu\text{m}$



*Loculohypoxylon* M.E. Barr, Mycotaxon 3: 326 (1976). (Teichosporaceae)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* relatively small, gregarious, immersed to erumpent, globose or subglobose, forming under a clypeus, papillate, ostiolate. *Peridium* thin, a single layer comprising hyaline thin-walled cells of *textura angularis* or *textura prismatica*. *Hamathecium* of septate pseudoparaphyses. *Asci* (2–4-)8-spored, bitunicate, cylindrical to cylindro-clavate, with a short, furcate pedicel, and wide ocular chamber. *Ascospores* broadly elliptic to subglobose, often apiculate at both ends, pale to dark brown, aseptate, with a germ slit.

**Anamorphs reported for genus:** none.

**Literature:** von Arx and Müller 1975; Barr 1976.

### Type species

*Loculohypoxylon grandineum* (Berk. & Rav.) Barr, Mycotaxon 3: 326 (1976). (Fig. 49)

≡ *Diatrype grandinea* Berk. & Rav., in Berkeley, Grevillea 4: 95 (1876).

*Ascomata* 85–130  $\mu\text{m}$  high  $\times$  75–145  $\mu\text{m}$  diam., gregarious, immersed to widely erumpent, globose or subglobose, under a reddish brown to black clypeus, papillate, ostiolate (Fig. 49a and b). *Peridium* 18–30  $\mu\text{m}$  thick laterally, 1-layered, composed of hyaline thin-walled cells of *textura angularis* to *prismatica*, cells up to 5  $\times$  9  $\mu\text{m}$  diam., cell wall 0.5–1  $\mu\text{m}$  thick, apex cells smaller and walls thicker (Fig. 49c). *Hamathecium* comprising 2–3  $\mu\text{m}$  broad, septate pseudoparaphyses. *Asci* 70–90  $\times$  10–12.5  $\mu\text{m}$  ( $\bar{x}$  = 76.5  $\times$  10.9  $\mu\text{m}$ ,  $n$ =10), (2–4-)8-spored, bitunicate, cylindrical to cylindro-clavate, with a short, furcate pedicel, up to 25  $\mu\text{m}$  long, with a wide ocular chamber (Fig. 49f, g, and h). *Ascospores* 7.5–10  $\times$  5–7  $\mu\text{m}$  ( $\bar{x}$  = 8.3  $\times$  5.9  $\mu\text{m}$ ,  $n$ =10), uniseriate to partially overlapping at the upper part, broadly elliptic to subglobose, often apiculate at both ends, pale to dark brown, aseptate, with a germ slit (Fig. 49d and e).

**Anamorph:** none reported.

**Material examined:** USA, New Jersey, Newfield, on bark of *Quercus coccinea*, Sept. 1878, as *Diatrype grandinea*, Ellis N.A.F. 494 (NY, MASS); on *Quercus* sp. wood, Nov. 1893, as *Anthostoma grandinea* B. & Rav., Ellis & Everhart, N.A.F. 494 (NY); Newfield, Oct. 1881, as *Diatrype grandinea* (NY); Newfield, Jan. 1882, on *Quercus coccinea*, as *Diatrype grandinea* B. & Rav., Ex Herb Ellis (NY); Newfield, Nov. 1893, as *Anthostoma grandinea*, on bark of fallen trunks of *Quercus coccinea* (NY).

### Notes

### Morphology

*Loculohypoxylon grandineum* is one of the rare pleosporalean species having aseptate ascospores. When emphasis is given to ascospore morphology, *Semidelitschia* (monotypified by *S. agasmatica* Cain & Luck-Allen) is the most comparable genus. The large ascomata and ascospores, the mucilaginous sheath surrounding the ascospores as well as the coprophilous habitat of *S. agasmatica* differ from *L. grandineum* greatly. Thus *Loculohypoxylon* was introduced as a new genus.

### Phylogenetic study

None.

### Concluding remarks

Aseptate ascospores are rare in *Pleosporales*, and the position of this fungus needs further verification. The familial status of *Loculohypoxylon* in *Teichosporaceae* is questionable, as it is simply based on the similarity of living habitat, ascomata and asci with *Immotthia* and *Teichospora* (Barr 2002).

*Lophionema* Sacc., Syll. fung. (Abellini) 2: 717 (1883). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat terrestrial, saprobic? *Ascomata* solitary, scattered or in small groups, immersed to erumpent, globose to subglobose, with a flattened base, wall black, papillate, ostiolate. *Peridium* comprising two types of cells which merge in the middle. *Hamathecium* of trabeculate pseudoparaphyses, septate, rarely anastomosing and branching. *Asci* 8-spored, bitunicate, fissitunicate unknown, clavate to cylindro-clavate, with a short and furcate pedicel and a small inconspicuous ocular chamber. *Ascospores* filliform, hyaline to pale yellow, multi-septate, slightly constricted at each septum.

**Anamorphs reported for genus:** none.

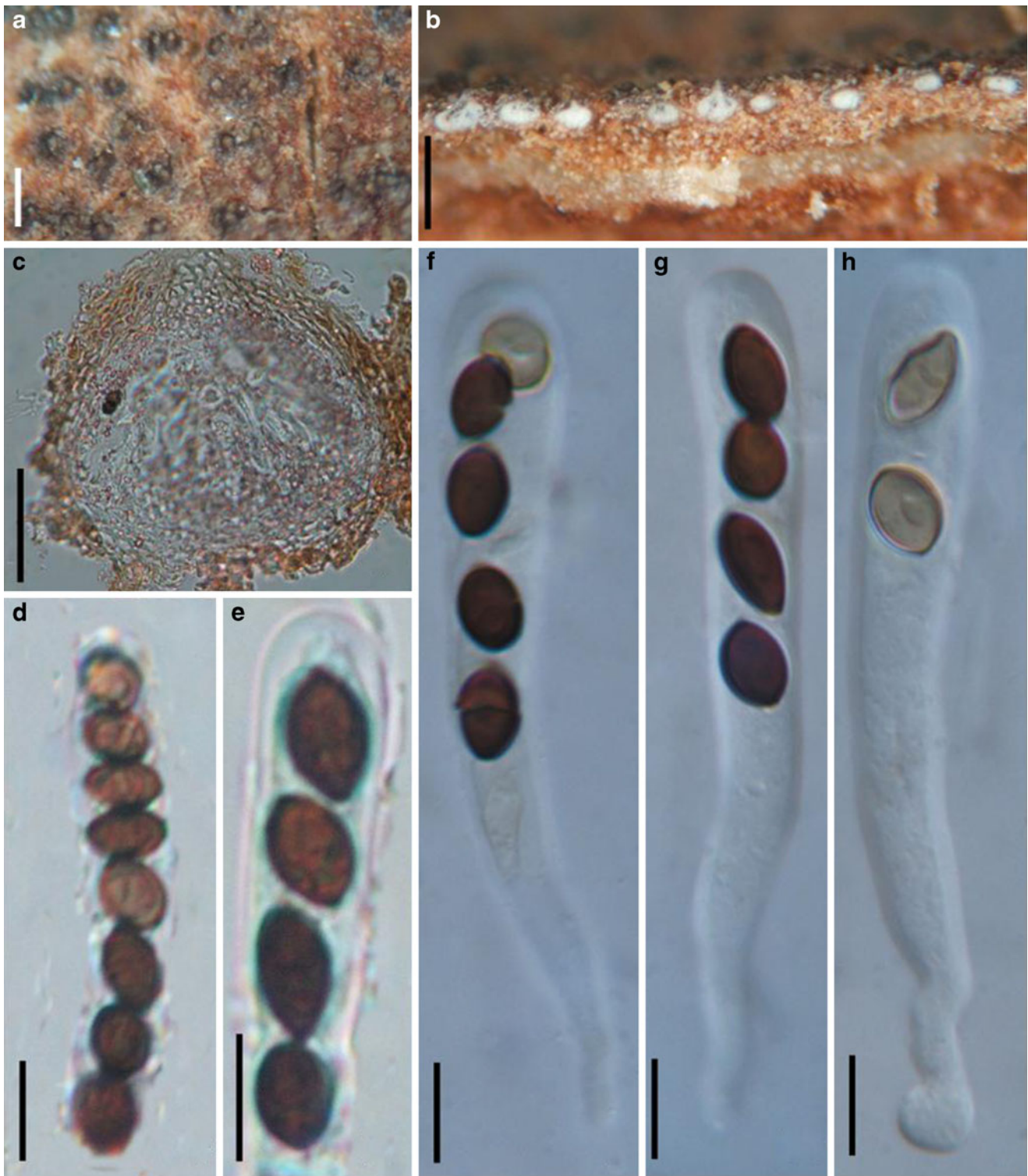
**Literature:** Barr 1992b; Chesters and Bell 1970; Ellis and Everhart 1892; Höhnel 1909; Solheim 1949.

### Type species

*Lophionema vermisporum* (Ellis) Sacc., Syll. fung. (Abellini) 2: 717 (1883). (Fig. 50)

≡ *Lophiostoma vermispora* Ellis, Bull. Torrey bot. Club 9: 19 (1882).

*Ascomata* 320–430  $\mu\text{m}$  high  $\times$  280–350  $\mu\text{m}$  diam., solitary, scattered or in small groups of 2–3, immersed to erumpent, globose to subglobose, black, papillate, ostiolate. *Papilla* 80–120  $\mu\text{m}$  high, up to 150  $\mu\text{m}$  broad, cylindrical to somewhat vertically flattened neck; mostly with a short



**Fig. 49** *Loculohypoxylon grandineum* (from N.A.F. 494). **a** Appearance of ascomata on the host surface. **b** Habitat section of ascomata. **c** Section of an ascoma. Note the pale brown thin-walled peridium cells.

**d, e** Uniseriate ascospores in asci. **f–f** Cylindro-clavate asci with ascospores. Note the ocular chamber in (**g**). Scale bars: **a**=100  $\mu\text{m}$ , **b**=200  $\mu\text{m}$ , **c**=50  $\mu\text{m}$ , **d–h**=10  $\mu\text{m}$

slot-like ostiole, periphysate (Fig. 50a). *Peridium* 30–45  $\mu\text{m}$  wide at the sides and slightly thicker at the apex,

2-layered, lateral walls and wall adjacent to neck comprising two types of cells which merge in the middle; outer

cells small heavily pigmented thick-walled cells of *textura angularis*, cells 4–7  $\mu\text{m}$  diam., cell wall 3.5–5  $\mu\text{m}$  thick, inner cells less pigmented, comprising thin-walled compressed cells; apical wall cells smaller and walls thicker, basal wall thinner (ca. 15  $\mu\text{m}$  wide), composed of lightly pigmented thin-walled compressed cells (Fig. 50b and c). *Hamathecium* of trabeculate pseudoparaphyses, 1–2  $\mu\text{m}$  broad, septate, anastomosing and branching rarely between and mostly above the asci. *Asci* 105–130(–150)  $\times$  10–15  $\mu\text{m}$  ( $\bar{x}$  = 123  $\times$  12  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate dehiscence not observed, clavate to cylindro-clavate, with a short, narrow, furcate pedicel which is 10–25  $\mu\text{m}$  long, and a small inconspicuous ocular chamber (to 1.5  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 50d and e). *Ascospores* (80-)90–115  $\times$  3–5  $\mu\text{m}$  ( $\bar{x}$  = 95  $\times$  3.5  $\mu\text{m}$ ,  $n$ =10), filliform, gradually tapering towards the base, hyaline to light yellow, (6-)7(–8)-septate, slightly constricted at each septum, smooth (Fig. 50f).

**Anamorph:** none reported.

**Material examined:** USA, New Jersey, Newfield, on dead stems of *Oenothera biennis*, Aug. 1881, Ellis (NY 643, **holotype**, NY 885, **isotype**).

## Notes

### Morphology

*Lophionema* is a relatively poorly studied genus, which was formally established by Saccardo (1883) as a monotypic genus represented by *L. vermisporum* based on its “globose ascomata, compressed ostiole, cylindrical to clavate ascus, and filamentous, septate, subhyaline to lightly pigmented ascospores”. *Lophionema vermisporum* was consequently listed as the generic type (Clements and Shear 1931). Berlese (1890) placed the genus in *Lophiostomataceae* but mentioned that the genus was similar to *Ophiobolus* according to the variable apex, and Shoemaker (1976) transferred *Lophionema vermisporum* to *Ophiobolus sensu lato*. Chesters and Bell (1970) however, had regarded *Lophionema* as related to *Lophiostoma* despite the distinct ascospore morphology. Barr (1992b) assigned *Lophionema* to *Entodesmium* based on the morphology of ascomata, papilla, peridium structure, pseudoparaphyses as well as the hyaline or slightly yellowish ascospores with a terminal appendage (not observed here). Species of *Entodesmium*, however, exclusively occur on legumes, but *Lophionema vermisporum* does not. We also note that the filliform ascospores, bitunicate asci, pseudoparaphyses and nature of the peridium may also be considered as typical of genera in the *Tubeufiaceae* (Barr 1980; Kodsueb et al. 2006b).

### Phylogenetic study

None.

### Concluding remarks

The immersed to erumpent ascomata, trabeculate pseudoparaphyses and laterally flattened papilla and periphysate ostioles indicate that this genus should be included in *Lophiostomataceae*. We do not accept the above proposals and, consider that *Lophionema* should be maintained as a separate genus with filliform ascospores in *Lophiostomataceae* until representative taxa can be sequenced and analyzed. Currently *Lophionema* comprises 10 species (<http://www.mycobank.org>, 08-01-2009). However, many of these are poorly studied and obscure.

***Lophiostoma*** Ces. & De Not., *Comm. Soc. crittog. Ital.* 1: 219 (1863). (*Lophiostomataceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* immersed to erumpent, usually with a distinct depressed papilla and a slot-like ostiole. *Hamathecium* of dense, long, septate pseudoparaphyses, embedded in mucilage, anastomosing and branching between and above the asci. *Peridium* unequal in thickness, thicker near the apex and thinner at base. *Asci* usually clavate. *Ascospores* 1-septate, multi-septate or even muriform, hyaline to deep brown, usually with terminal appendages.

**Anamorphs reported for genus:** *Pleuorhormopsis*-like (Hyde et al. 2011).

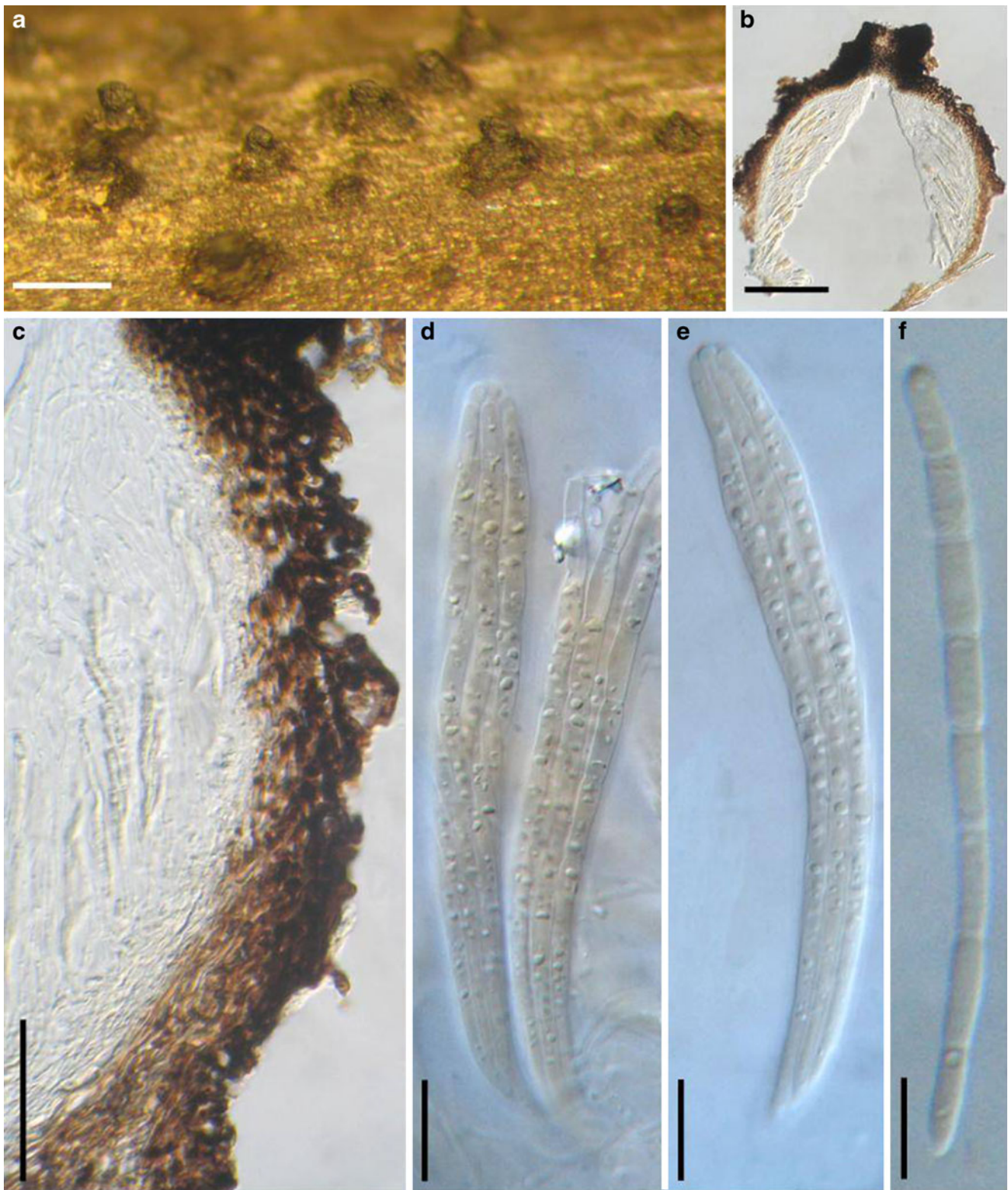
**Literature:** Barr 1990a; Chesters and Bell 1970; Holm and Holm 1988; Hyde and Aptroot 1998; Hyde et al. 2002; Tanaka and Harada 2003b; Yuan and Zhao 1994.

### Type species

***Lophiostoma macrostomum*** (Tode) Ces. & De Not., *Comm. Soc. crittog. Ital.* 1: 219 (1863). (Fig. 51)

$\equiv$  *Sphaeria macrostoma* Tode, *Fung. mecklenb. sel.* (Lüneburg) 2: 12 (1791).

*Ascomata* 400–600  $\mu\text{m}$  high  $\times$  420–560  $\mu\text{m}$  diam., densely scattered to gregarious, semi-immersed to erumpent, globose or subglobose, with a small to large flattened crest-like raised area above the ascomata which is variable in shape, up to 300  $\mu\text{m}$  high and 480  $\mu\text{m}$  wide, with a slit-like ostiole along the full length of the crest (Fig. 51a and b). *Peridium* 30–45  $\mu\text{m}$  thick at the sides, thicker at the apex and thinner at the base, composed of one cell type of small lightly pigmented thin-walled cells of *textura prismatica*, cells ca. 6–9  $\times$  3–4  $\mu\text{m}$  diam., apex composed of pseudoparenchymatous cells (Fig. 51b). *Hamathecium* of dense, filliform, up to 3  $\mu\text{m}$  near the base and less than 1.5  $\mu\text{m}$  broad in the



**Fig. 50** *Lophionema vermisporum* (from NY-643, **holotype**). **a** Appearance of ascomata on the host surface. Note the form of the neck. **b** Section of the peridium. **c** Peridium comprising two types of cells which merge in the middle; outer cells small heavily pigmented

thick-walled cells of *textura angularis*, inner cells less pigmented, and comprising thin-walled compressed cells. **d**, **e** Cylindro-clavate, 8-spored asci. **f** A 7-septate filliform ascospore. Scale bars: **a**=0.5 mm, **b**=100  $\mu$ m, **c**=50  $\mu$ m, **d**–**f**=10  $\mu$ m

upper place, septate pseudoparaphyses, embedded in mucilage, anastomosing and branching between and above the asci (Fig. 51f). Asci 110–145 × 10–15  $\mu\text{m}$  ( $\bar{x}$  = 127.5 × 13  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate (ectotunica no constriction), cylindro-clavate, with a furcate pedicel and a small ocular chamber (to 1.5  $\mu\text{m}$  wide × 2  $\mu\text{m}$  high) (J-) (Fig. 51c, d and e). Ascospores 27–38(–43) × 5–7.5  $\mu\text{m}$  ( $\bar{x}$  = 31.2 × 6.4  $\mu\text{m}$ ,  $n$  = 10), biseriata, fusoid, curved, hyaline, usually 1-septate, with 3–5 septa and faintly brown when old, with (2-)3(–4) distinct oil drops in each cell and short terminal appendage at ends (Fig. 51h, i and j), and ornamented with warts when spores are senescent (Fig. 51g).

**Anamorph:** none reported.

**Material examined:** SWEDEN, Smaland, Femsjö par., Femsjö, on *Prunus*, 2006, Elias Fries, det. Geir Mathiassen (UPS, **lectotype**, as *Sphaeria macrostoma* Fr.). FRANCE, Ariège, Rimont, Las Muros, on dead stems of *Vitis vinifera*, 2 Sept. 1996 (IFRD2005).

## Notes

### Morphology

*Lophiostoma* is morphologically a well studied genus (Barr 1990a; Chesters and Bell 1970; Holm and Holm 1988; Mugambi and Huhndorf 2009b; Yuan and Zhao 1994), and currently it comprises about 30 species (Tanaka and Harada 2003b). The genus was characterized as having immersed to erumpent ascomata with a cylindrical or crest-like papilla and full length, slit-like ostiole; a peridium of unequal thickness, which was broader near the base (*Lophiostoma*-type); mostly clavate, bitunicate asci and 1- to several septate, hyaline to pigmented ascospores with terminal appendages or surrounded by a mucilaginous sheath (Holm and Holm 1988). This definition was followed by Barr (1990a), Yuan and Zhao (1994) and Hyde et al. (2002).

The crest-like papilla has been regarded as a prominent morphological character of *Lophiostoma macrostomum* (Chesters and Bell 1970; Holm and Holm 1988). In the lectotype specimen, the raised area above the ascomata is up to 300  $\mu\text{m}$  high and 480  $\mu\text{m}$  long, and seen as a flattened or even Y-shaped crest (Fig. 51a). In *Lophiostoma curtum* (Fr.) De Not. and *Lophiotrema boreale* Math. the raised area above the ascomata varies considerably in height or is even lacking (Holm and Holm 1988). Thus the variable “crest-like raised area in *Lophiostomataceae*” was explained as an evolutionarily adaptation to the hard substrate within which the ascomata develop (Holm and Holm 1988). The ascospores of *L. macrostomum* usually turn reddish brown when mature, and minutely verrucose ornamentation was also found on the surface of the pigmented ascospores. Hyaline ascospores that became pigmented with age are common in *Lophiostoma*, such as

in *L. appendiculatum* Fuckel, *L. massarioides* (Sacc.) L. Holm & K. Holm, *L. semiliberum*, *L. subcorticale* Fuckel and *L. winteri* (Holm and Holm 1988; Tanaka and Harada 2003b). The phylogenetic significance of this character should be observed carefully in the future but at present its phylogenetic significance is unclear as this also occurs in some *Lophiotrema* species.

### Phylogenetic study

Phylogenetic affinity with some *Massarina* species has been reported by Liew et al. (2002), and several *Massarina* species were transferred into *Lophiostoma*. In a systematic study of *Lophiostoma*- and *Massarina*-related fungi conducted by Zhang et al. (2009b), *Lophiostoma* taxa clustered into two groups; one includes the type species *L. macrostomum* with crest-like ostioles, *L. rugulosum* Yin. Zhang, J. Fourn. & K.D. Hyde with a wide, umbilicate pore surrounded by 4–6 radial ridges, and *L. glabro-tunicatus* with small ostiolar pores; the other cluster comprises *Lophiostoma*-like taxa with slot-like ostioles lacking raised crests, which includes *L. arundinis* (Pers.) Ces. & De Not., *L. caulium*, *L. compressum* (Pers.) Ces. & De Not., *L. crenatum* (Pers.) Fuckel, *L. fuckelii* (Sacc.) Sacc., *L. macrostomoides*, *L. semiliberum* and *L. viridarium* Cooke, which seems to represent a natural group at the family level. This conclusion is tentative until verified sequences of *L. macrostomum* are included in analyses (see comments of Zhang et al. 2009a).

### Concluding remarks

We tend to accept a narrow concept of *Lophiostomataceae*, which only comprises species of *Lophiostoma sensu stricto* (Zhang et al. 2009a).

*Lophiotrema* Sacc., *Michelia* 1: 338 (1878). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* small- to medium-sized, with or without short papilla. *Hamathecium* of dense, long, septate pseudoparaphyses, anastomosing and branching between and above asci. *Asci* cylindrical to cylindro-clavate. *Ascospores* hyaline, 1–3-septate, usually with mucilaginous sheath.

**Anamorphs reported for genus:** none.

**Literature:** Barr 1990a; Chesters and Bell 1970; Holm and Holm 1988; Saccardo 1878a; Tanaka and Harada 2003c; Tang et al. 2003; Yuan and Zhao 1994.

### Type species

*Lophiotrema nucula* (Fr.) Sacc., *Michelia* 1: 338 (1878). (Fig. 52)



≡ *Sphaeria nucula* Fr., Syst. mycol. (Lundae) 2: 466 (1823).

*Ascomata* 200–240  $\mu\text{m}$  high  $\times$  200–280  $\mu\text{m}$  diam., scattered, erumpent to nearly superficial, with basal wall remaining immersed in host tissue, globose to subglobose, often laterally flattened, with a flattened base not easily removed from the substrate, black, roughened; with a cylindrical or slightly compressed papilla. *Papilla* to 120  $\mu\text{m}$  long and 150  $\mu\text{m}$  high, protruding, with a pore-like ostiole (Fig. 52a). *Peridium* 25–30  $\mu\text{m}$  wide, very thin at the base, composed of heavily pigmented pseudoparenchymatous cells near the apex, cells 2–2  $\times$  6  $\mu\text{m}$  diam., wall 1–3(–4)  $\mu\text{m}$  thick, lower sides composed of pigmented cells of *textura angularis*, 3–5  $\mu\text{m}$  diam., wall 0.8–1.5  $\mu\text{m}$  thick, ostiole wall composed of heavily pigmented and thick-walled small cells (Fig. 52b and c). *Hamathecium* of dense, long, septate pseudoparaphyses, 1–2  $\mu\text{m}$  broad, anastomosing and branching between and above asci, embedded in mucilage (Fig. 52i). *Asci* 90–115  $\times$  9–11.5  $\mu\text{m}$  ( $\bar{x}$  = 99.5  $\times$  11.5  $\mu\text{m}$ ;  $n$  = 10), 8-spored, bitunicate, fissionate, cylindrical, with a short, narrowed, furcate pedicel which is up to 10  $\mu\text{m}$  long, with a small ocular chamber (ca. 1.5  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (J-) (Fig. 52d, e, f and h). *Ascospores* 17–21(–25)  $\times$  (4–)5–6.5  $\mu\text{m}$  ( $\bar{x}$  = 19.5  $\times$  5.5  $\mu\text{m}$ ,  $n$  = 10), obliquely uniseriate and partially overlapping to biseriata, broadly fusoid to fusoid, with narrowly rounded ends, hyaline and lightly pigmented on very rare occasions when senescent, 1-septate, 3-septate when old, constricted at the median septum, the upper cell often broader than the lower one (Fig. 52g).

**Anamorph:** none reported.

**Material examined:** on decaying wood (UPS, **lectotype** as *Sphaeria nucula* Fr.).

## Notes

### Morphology

Holm and Holm (1988) provided a relatively strict definition for *Lophiotrema* after they examined several specimens including the type material which they lectotypified. *Lophiotrema* was mainly defined on the unique characters of small to medium ascomata, a “*Lophiotrema*-type” peridium and 1-septate ascospores. In *Lophiotrema*, Holm and Holm (1988) considered the ascomata to be small- to medium-sized, ca. pyriform but neck often reduced, even lacking and sometimes cylindrical. The peridium was of approximately equal thickness, 20–30  $\mu\text{m}$ , composed of an outer *textura angularis* of uniformly pigmented cells, up to 12  $\mu\text{m}$ , and an inner layer of very small hyaline cells, with somewhat thickened walls. Asci are cylindrical, spores hyaline, at first 1-septate, becoming 3-septate, with distinct guttules, often with a mucilaginous sheath. Much emphasis was given to the 1-septate ascospores by Holm and Holm (1988) when they described and distinguished the three *Lophiotrema* species: *L. boreale*, *L. nucula*, *L. vagabundum* (Sacc.) Sacc. and two

**Fig. 51** *Lophiostoma macrostomum* (a–h, j from UPS, **lectotype**; i from IFRD 2005). **a** Appearance of ascomata on the host surface. Note the raised crest-like areas and full length germ slits. **b** Section of the peridium. **c–e** Cylindro-clavate asci with ascospores arranged in a 2-3-seriate manner. **f** Hamathecium comprising branching and septate pseudoparaphyses. **g–j** Released or unreleased ascospores. Note the smooth young ascospores with terminal sheath, and the verrucose senescent ascospores. Scale bars: **a** = 0.5 mm, **b** = 200  $\mu\text{m}$ , **c–j** = 10  $\mu\text{m}$

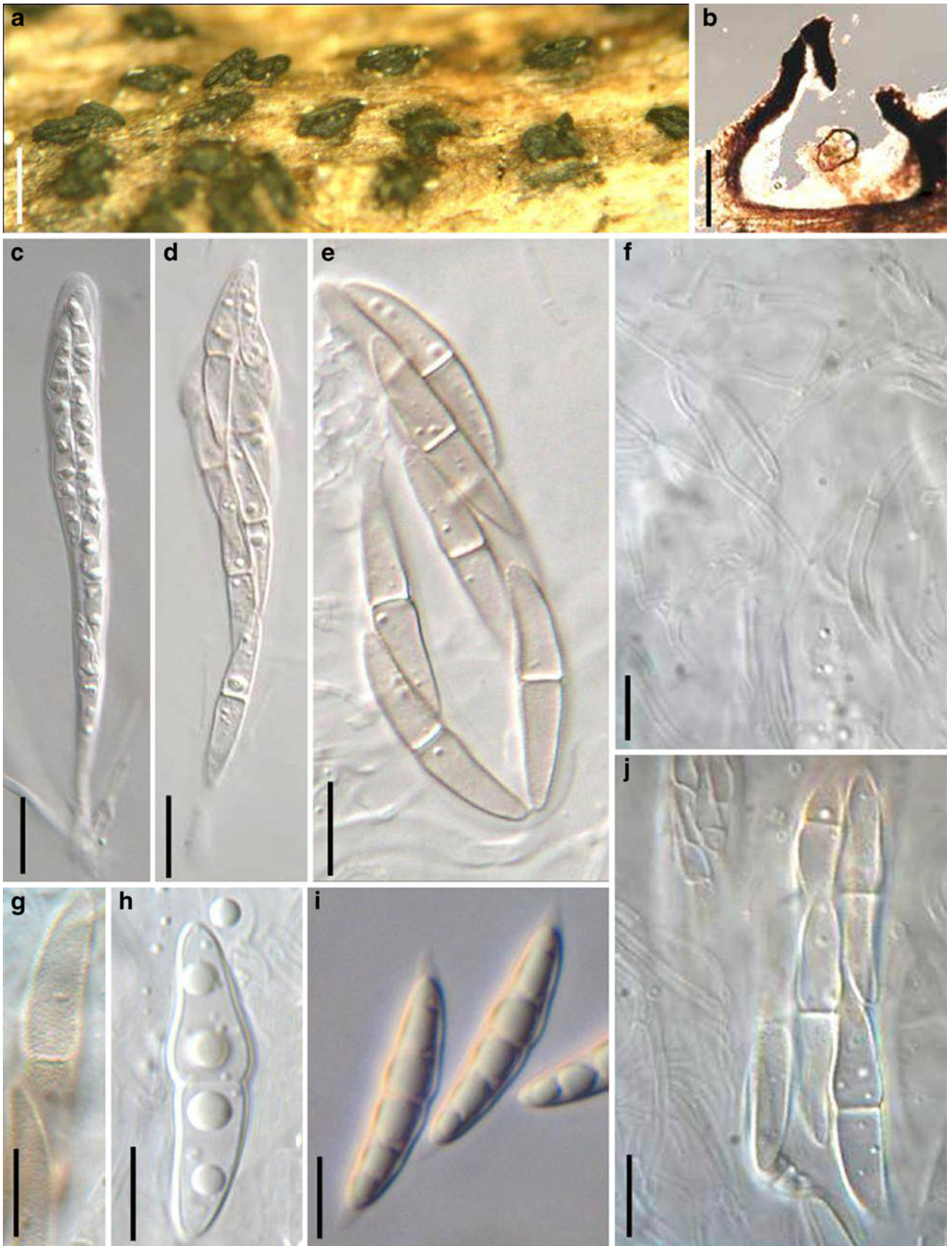
other unnamed species. This concept was widely accepted by later workers (Kirk et al. 2001; Yuan and Zhao 1994). Tanaka and Harada (2003c) considered the peridium and asci to distinguish *Lophiotrema* from *Lophiostoma*, while Tang et al. (2003) introduced a new *Lophiotrema* species with elongated slit-like ostiole stating that the main difference between *Lophiotrema* and *Lophiostoma* were size of ascomata, structure of peridium, shape of asci and sheath of ascospores. This peridium concept however, is not supported by the lectotype specimen we examined here, which has a flattened thin-walled base. Thus the “*Lophiotrema*-like peridium” sensu Holm and Holm (1988) should not serve as a diagnostic character of *Lophiotrema*, while the ostiole, asci and ascospores might have some phylogenetic significance (Zhang et al. 2009b). No anamorph is yet known for *Lophiotrema*. Although the ascospores was reported by Holm and Holm (1988) to be verrucose this could not be observed in the lectotype examined under light microscope (1000  $\times$ ) in the present study.

### Phylogenetic study

In the phylogenetic study of *Lophiostoma*, *Massarina* and related genera (Zhang et al. 2009b), *Lophiotrema nucula* formed a consistent and robust clade with three other *Lophiotrema* species: *L. lignicola* Yin. Zhang, J. Fourn. & K.D. Hyde, *L. brunneosporum* Yin. Zhang, J. Fourn. & K.D. Hyde and *L. vagabundum*, separate from other members of *Lophiostoma* and *Massarina sensu stricto*. This clade might represent *Lophiotrema sensu stricto*, however, the correctness of strains of *L. vagabundum* (CBS 628.86) and *L. nucula* (CBS 627.86) used in the phylogenetic study are not verified and warrant further study.

### Concluding remarks

Holm and Holm (1988) distinguished *Lophiostoma* from *Lophiotrema* based on the smaller ascomata, 1-septate versus multi-septate ascospores, and peridial wall structure. However, we doubt that these distinguishing characters (size of ascomata, number of septa of ascospores) can be confidently used to separate these genera and we could not establish any characters that could reliably distinguish between these two genera. The molecular data, however, does separate *Lophiostoma macrostomum* and *Lophiotrema nucula* into separate clades and provides some support that these are separate genera. Although the strain of *L. nucula*





**Fig. 52** *Lophiotrema nucula* (from UPS, lectotype). **a** Ascomata on the host surface. **b** Section of a partial ascoma. **c** Peridium structure near the apex. **d, h** Cylindrical asci in the pseudoparaphyses. **e, f**

Upper part of the asci, showing the small ocular chamber near the apex. **h** Mature ascospores. **i** Pseudoparaphyses. Scale bars: **a**= 0.5 mm, **b**=100  $\mu\text{m}$ , **c**, **d**=30  $\mu\text{m}$ , **e–i**=10  $\mu\text{m}$

(CBS 627.86) was isolated by K. & L. Holm, who had examined the type specimen of *L. nucula* (Holm and Holm 1988), the culture of *Lophiostoma macrostomum* used in the analysis are unverified (see comment by Zhang et al. 2009b). For the purpose of this monograph we tentatively maintain *Lophiotrema* as distinct from *Lophiostoma*.

**Macroventuria** Aa, Persoonia 6: 359 (1971).  
(*Didymellaceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* small, solitary, scattered, or in groups, initially immersed, becoming erumpent, to nearly superficial, globose to subglobose, roughened with cylindrical setae erect from apex. *Peridium* thin, membranous. *Hamathecium* of cellular pseudoparaphyses, seems to easily disappear when mature. *Asci* bitunicate, somewhat obclavate to fusoid. *Ascospores* fusoid with broadly to narrowly rounded ends, hyaline, 1-septate, constricted at the septum.

**Anamorphs reported for genus:** none.

**Literature:** van der Aa 1971; von Arx and Müller 1975; Barr 1987a.

### Type species

**Macroventuria wentii** Aa, Persoonia 6: 361 (1971). (Fig. 53)

*Ascomata* 135–180  $\mu\text{m}$  diam., rarely more than 200  $\mu\text{m}$  diam., solitary, scattered or in groups, initially immersed, becoming erumpent, to nearly superficial, with basal wall remaining immersed in host tissue, globose to subglobose, broadly or narrowly conical, setae erect from the apical region of the *ascomata*, cylindrical or tapering to the rounded or pointed tip, brown, up to 90  $\mu\text{m}$  long, 5–7.5  $\mu\text{m}$  thick (Fig. 53a). *Peridium*, 25–35  $\mu\text{m}$  thick, 2-layered, out layer composed of relatively thick-walled cells of *textura angularis*, cell wall up to 3  $\mu\text{m}$  thick; inner layer cells with a thinner wall and subhyaline; near apex cells smaller (Fig. 53a). *Hamathecium* of cellular pseudoparaphyses, 1–2  $\mu\text{m}$  thick, evanescent not sure. *Asci* 75–93  $\times$  24–30  $\mu\text{m}$ , 8-spored, without pedicel, bitunicate, somewhat obclavate to fusoid (Fig. 53b). *Ascospores* 22–32  $\times$  8–14  $\mu\text{m}$ , 1–3 seriate, fusoid with broadly to narrowly rounded ends, hyaline, 1-septate, constricted at the septum, smooth (Fig. 53b) (description adapted from van der Aa 1971).

**Anamorph:** none reported.

**Material referred:** USA, Nevada; Death Valley, plant litter, F.W. Went, 229, 1970 (CBS 526.71, **holotype**).

### Notes

### Morphology

*Macroventuria* was formally established by van der Aa (1971) represented by *M. anomochaeta* and *M. wentii* based

on its “near-hyaline, 1-septate ascospores, setose *ascomata*, and saprobic life style”. Almost all of the above characters (except the saprobic life style) point this group of fungi to *Venturiaceae*. Thus *Macroventuria* was assigned to this family as a relatively primitive genus (van der Aa 1971). Subsequently, von Arx and Müller (1975) assigned *Macroventuria* to *Pseudosphaeriaceae* (*Dothideales*), and this proposal was followed by Barr (1987a).

### Phylogenetic study

Phylogenetic analysis based on combined SSU rDNA and LSU rDNA sequences indicated that both of *Macroventuria anomochaeta* and *M. wentii* form a robust clade with *Leptosphaerulina argentinensis* (Speg.) J.H. Graham & Luttr., *L. australis*, *L. trifolii* (Rostr.) Petr. and *Platychora ulmi*, which appear to share phylogenetic affinities with the *Leptosphaeriaceae* and *Phaeosphaeriaceae*, but detached from other members of *Venturiaceae* and *Pleosporaceae* (Kodsueb et al. 2006a). In addition, culture characters also support the close relationship between *Macroventuria* and *Leptosphaerulina* (Barr 1987a). Analysis based on five genes, i.e. SSU, LSU, *RPB1*, *RPB2* and *TEF1*, indicated *Macroventuria anomochaeta* resides in the well supported clade of *Didymellaceae* (Zhang et al. 2009a).

### Concluding remarks

The morphological characters, such as small *ascomata* and hyaline, 1-septate ascospores all point at *Didymellaceae*, thus the familial status of *Macroventuria* is verified.

**Mamillisphaeria** K.D. Hyde, S.W. Wong & E.B.G. Jones, Nova Hedwigia 62: 514 (1996b). (?*Melanommataceae*)

### Generic description

Habitat freshwater, saprobic. *Ascomata* superficial, scattered or gregarious, conical, carbonaceous, papillate. *Hamathecium* of dense, filliform, trabeculate pseudoparaphyses. *Asci* broadly clavate to clavate, with small ocular chambers and short pedicels. *Ascospores* of two types, (1): 2–4-seriate, ellipsoid, hyaline, slightly constricted at the main septum; with apical appendages at each end and around the ascospore; (2) 1–2-seriate, ellipsoid to fusoid, brown, with mucilaginous sheath around the ascospore (Hyde et al. 1996b).

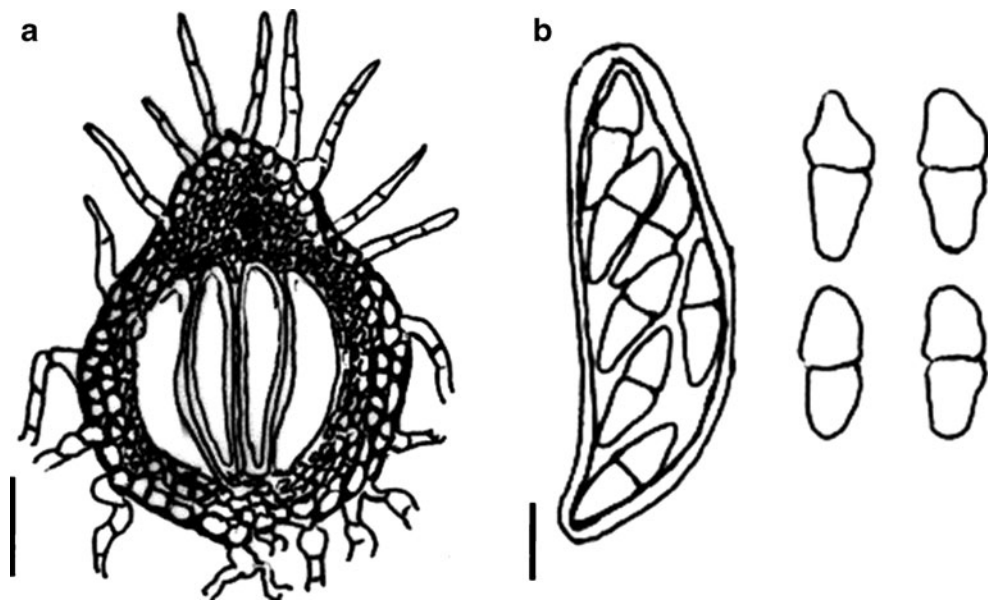
**Anamorphs reported for genus:** none.

**Literature:** Hyde et al. 1996a, b.

### Type species

**Mamillisphaeria dimorphospora** K.D. Hyde, S.W. Wong & E.B.G. Jones, Nova Hedwigia 62: 515 (1996b). (Fig. 54)

**Fig. 53** *Macroventuria wentii*. **a** Ascomata. Note the setae. **b** Ascus and ascospores. Scale bars: **a**=50  $\mu\text{m}$ , **b**=10  $\mu\text{m}$  (figures referred to van der Aa 1971)



Following description is adapted from Hyde et al. 1996a, b).

*Ascomata* 455–650  $\mu\text{m}$  high  $\times$  980–1430  $\mu\text{m}$  diam., scattered or in small groups, superficial, conical, carbonaceous, papillate, under pseudostroma which forms a thin layer on the host surface, up to 50  $\mu\text{m}$  thick between the ascomata and 125–250  $\mu\text{m}$  thick on the ascomata surface (Fig. 54a and b). *Peridium* 10–25  $\mu\text{m}$  thick, comprising several layers of compressed, densely packed, thin-walled, hyaline cells. A wedge-shaped area of vertically orientated hyaline palisade-like cells occurs at the periphery (Fig. 54b). *Hamathecium* of dense, trabeculate pseudoparaphyses, ca. 1  $\mu\text{m}$  broad, hyaline, branching and anastomosing, septate, embedded in mucilage (Fig. 54e). Two types of asci and ascospores exist in the same ascoma: TYPE 1: *asci* 185–320  $\times$  40–100  $\mu\text{m}$  ( $\bar{x}$  = 210  $\times$  78  $\mu\text{m}$ ,  $n$  = 50), 8-spored, cylindro-clavate, bitunicate, fissitunicate, short-pedicellate, with an ocular chamber (to 13  $\mu\text{m}$  wide  $\times$  5  $\mu\text{m}$  high) (Fig. 54c and d). Ascospores 66–84  $\times$  20–38  $\mu\text{m}$  ( $\bar{x}$  = 78  $\times$  25  $\mu\text{m}$ ,  $n$  = 50), 2–4-seriate, hyaline, ellipsoidal, constricted at the central septum, with pad-like mucilaginous appendage at each end and with some mucilage associated around the spore, and TYPE 2: *asci* 158–242  $\times$  8–15  $\mu\text{m}$  ( $\bar{x}$  = 182  $\times$  11  $\mu\text{m}$ ,  $n$  = 50), 8-spored, cylindrical, bitunicate, fissitunicate, pedicellate, with an ocular chamber and faint apical ring, ascospores 29–42  $\times$  6–9  $\mu\text{m}$  ( $\bar{x}$  = 35  $\times$  7  $\mu\text{m}$ ,  $n$  = 50), 1–2-seriate, brown, ellipsoidal-fusoid, surrounded by a thin mucilaginous sheath (Fig. 54f, g, h, i and j).

**Anamorph:** none reported.

**Material examined:** BRUNEI, on submerged wood, Aug. 1997, leg. K.D. Hyde (HKU(M) 7425).

## Notes

### Morphology

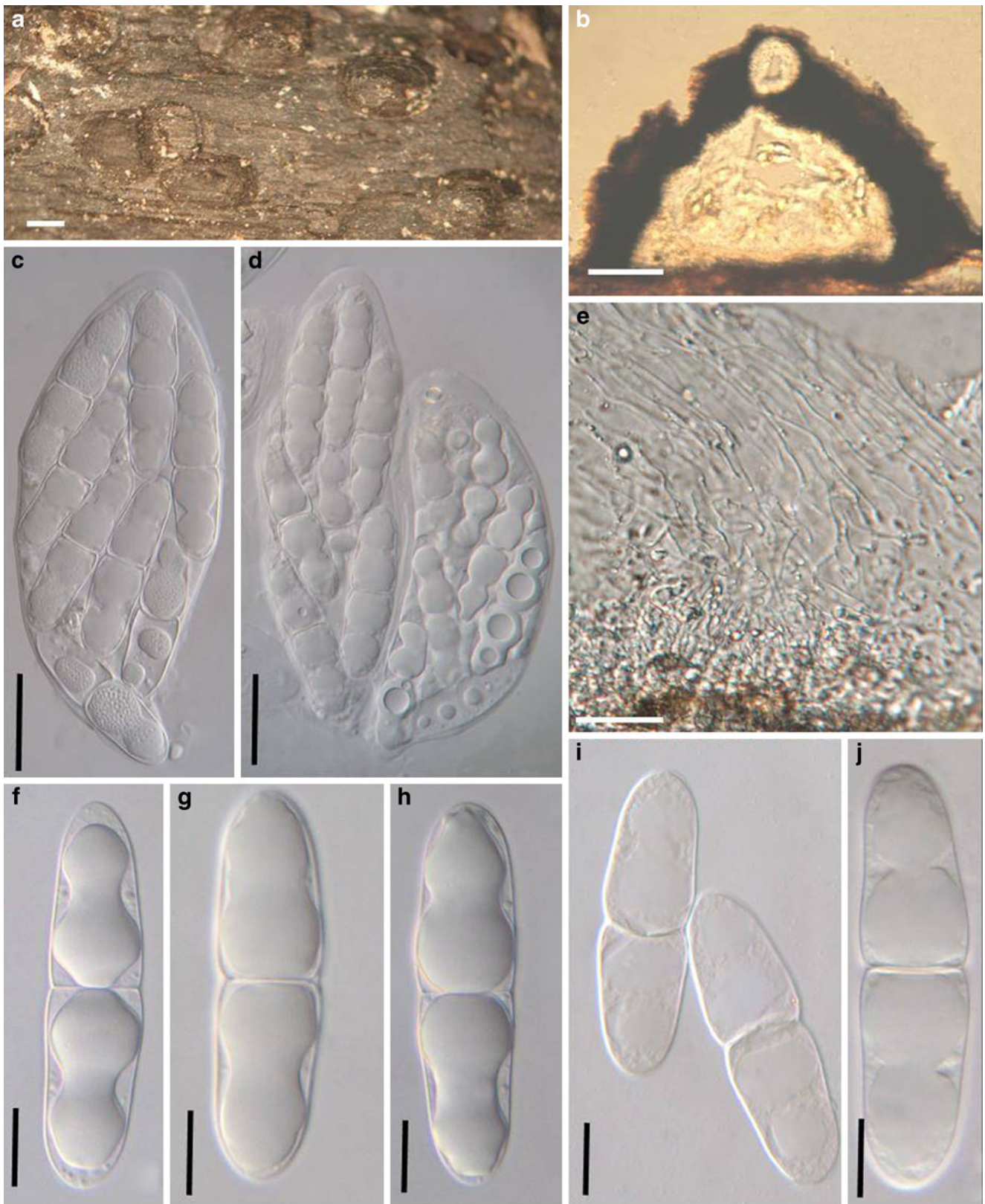
*Mamillisphaeria* was established as a monotypic genus according to its bitunicate, fissitunicate asci, trabeculate pseudoparaphyses and dimorphic ascospores, which is typified by the widely distributed freshwater fungus, *M. dimorphospora* (Hyde et al. 1996a, b). The most striking character of this fungus is its dimorphic ascospores, i.e. one type is large and hyaline, and the other is comparatively smaller and brown. Only a few ascomycetes have been reported having dimorphic ascospores, such as *Aquasphaeria dimorphospora* and *Nectria heterospora* Speg. (Hyde 1995b; Spegazzini 1889). Dimorphic ascospores appear to have evolutionary benefits, for example the large ascospores with mucilaginous sheaths may facilitate nutrient storage for germination and enhanced collision and attachment to substrates. The smaller brown ascospores may help resist desiccation and damage by UV light and contribute to aerial dispersal, which might explain the worldwide distribution of *M. dimorphospora* (Hyde et al. 1996a, b).

### Phylogenetic study

None.

### Concluding remarks

Although in the key by Barr (1990a), *M. dimorphospora* can be referred to *Massariaceae*, it is temporarily assigned to *Melanommataceae* here based on its trabeculate pseudoparaphyses embedded in mucilage (Hyde et al. 1996a, b).



**Fig. 54** *Mamillisphaeria dimorphospora* (from HKU(M) 7425, **paratype?**). **a** Ascomata scattered on the host surface. Note the small papilla. **b** Section of an ascoma. **c, d** Asci (TYPE 1). **e** Trabeculate

pseudoparaphyses in a gelatinous matrix. **f–j** Ascospores (TYPE 1). Scale bars: **a**=0.5 mm, **b–d**=100  $\mu\text{m}$ , **e**=10  $\mu\text{m}$ , **f–j**=20  $\mu\text{m}$

*Massarina* Sacc., Syll. fung. (Abellini) 2: 153 (1883).  
**emend.** (*Massarinaceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* immersed or superficial, scattered or clustered, globose, conical globose to lenticular, papillate or epapillate, ostiolate. *Hamathecium* of dense, cellular pseudoparaphyses. *Asci* clavate to cylindrical, with short pedicels. *Ascospores* ellipsoid to fusoid, hyaline, 1- to 3-septate, with or without mucilaginous sheath.

**Anamorphs reported for genus:** *Ceratophoma* (Sivanesan 1984).

**Literature:** Aptroot 1998; Barr 1990a; Bose 1961; Eriksson and Yue 1986; Hyde 1995a; Hyde and Aptroot 1998; Liew et al. 2002; Saccardo 1883; Sivanesan 1984; Tanaka and Harada 2003d; Zhang et al. 2009a, b.

### Type species

*Massarina eburnea* (Tul. & C. Tul.) Sacc., Syll. fung. (Abellini) 2: 153 (1883). (Fig. 55)

≡ *Massaria eburnea* Tul. & C. Tul., Sel. Fung. Carp. 2: 239 (1863).

*Ascomata* to 250  $\mu\text{m}$  high  $\times$  500–700  $\mu\text{m}$  diam., solitary or in small clusters, forming under raised dome-shaped areas, with blackened centres, with a central ostiole, immersed within the cortex of thin dead branches, ellipsoidal, rounded from above, clypeate, neck central, short and barely noticeable on host surface (Fig. 55a). *Clypeus* ca. 250  $\mu\text{m}$  diam., 60  $\mu\text{m}$  thick, brown, comprising compact brown-walled cells of *textura angularis* to *globulosa* beneath host epidermal cells (Fig. 55b). *Peridium* ca. 20  $\mu\text{m}$  thick comprising 3–5 layers of hyaline compressed cells, fusing at the outside with the host (Fig. 55e). *Hamathecium* filamentous, cellular pseudoparaphyses, ca. 2  $\mu\text{m}$  broad, septate, embedded in mucilage, without anastomosing (Fig. 55d). *Asci* 108–170  $\times$  18–22  $\mu\text{m}$  ( $\bar{x}$  = 144.5  $\times$  18.8  $\mu\text{m}$ ,  $n$  = 10), 8-spored, cylindro-clavate, pedunculate, bitunicate, fissitunicate, (1-)2-seriate, apically rounded, with an ocular chamber and faint ring (J-) (Fig. 55c and f). *Ascospores* 30–38  $\times$  8–12  $\mu\text{m}$  ( $\bar{x}$  = 32.4  $\times$  8.6  $\mu\text{m}$ ,  $n$  = 10), fusoid to ellipsoid, 4-celled, constricted at the septa, hyaline, with acute rounded ends and surrounded by (5–8  $\mu\text{m}$  diam.) mucilaginous sheath (Fig. 55g).

**Anamorph:** *Ceratophoma* sp. (Sivanesan 1984).

**Material examined:** FRANCE, on twig of *Fagus* sp., (Desmazières 1764. P, **holotype** of *Sphaeria pupula* var *minor*), (Mycotheca universalis no. 1951 **lectotype**). AUSTRALIA, Silesia, Karlsbrunn, on dead twigs of *Fagus sylvatica* L., Aug. and Sept. 1890, Niessl., De Thümen, sub. *Massarina eburnea*, ETH. Saxonia, Königsbrunn, on twigs of *Fagus*

*sylvatica*, Apr. 1882, W. Krieger, Rabenhorst & Winter, Fungi europaei no. 2767, ETH; FRANCE, on a dead twig of *Fagus sylvatica*, Deux Sèvres, Villiers en Bois, Forêt de Chizé, Rimbaud, 14 Apr. 2008, leg. det. Paul Leroy (IFRD 2006).

### Notes

#### Morphology

*Massarina* was introduced by Saccardo (1883) for species of pyrenocarpous ascomycetes that had previously been placed in *Massaria*, but typically had hyaline ascospores (Bose 1961). The family *Massarinaceae* was described by Munk (1956) to accommodate *Massarina*. This family was not commonly used and *Massarina* was later placed within the *Lophiostomataceae* in the *Pleosporales* (Barr 1990a; Bose 1961; Eriksson and Yue 1986). Of the 160 epithets listed in his monograph, Aptroot accepted only 43 species (Aptroot 1998). The concept of *Massarina* was widely accepted as having single or aggregated, immersed to erumpent, spherical to hemispherical, pseudothecoid ascomata; cellular pseudoparaphyses; bitunicate, cylindrical to clavate or obpyriform asci; and hyaline, 1–3(–7)-septate, fusoid to long ellipsoid ascospores that mostly have a mucilaginous sheath or appendages (Aptroot 1998; Hyde and Aptroot 1998; Tanaka and Harada 2003d).

In the holotype of *Sphaeria pupula* var. *minor* (P) and lectotype of *Massarina eburnea* (ETH), ascospores are reported as “not constricted at the septa” (Hyde 1995a). However, in one of our recent collections, ascospores that are constricted at their septa were observed (Fig. 55g), which was consistent with the description by Fallah and Shearer (2001). This might be because this character is not clear in the old (over 100 years) and dry herbarium specimens, or it may be variable between collections.

#### Phylogenetic study

Recent morphological, molecular and anamorphic results indicate, however, that *Massarina* is polyphyletic (Hyde 1995a; Kirk et al. 2001; Liew et al. 2002). Based on the rDNA dataset, *Massarina cisti* and the type of *Massarina* (*M. eburnea*) forms a robust clade representing *Massarina sensu stricto* (Zhang et al. 2009a, b).

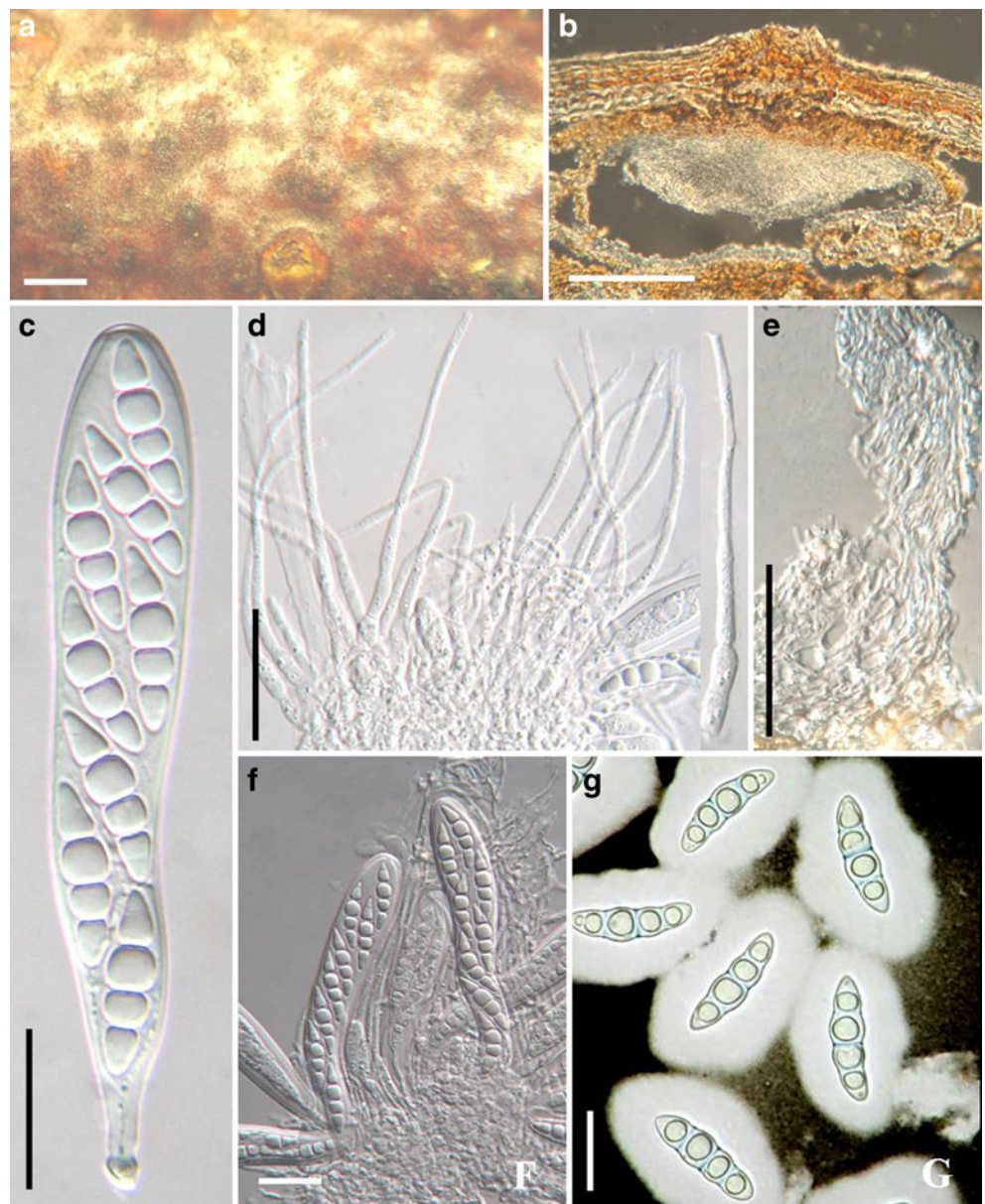
#### Concluding remarks

*Massarina sensu stricto* should be accepted, which seems to only include some terrestrial and saprobic species.

**Massariosphaeria** (E. Müll.) Crivelli, Diss. Eidgenöss. Techn. Hochschule Zürich 7318: 141 (1983). (?*Amniculicolaceae*)

≡ *Leptosphaeria* subgen. *Massariosphaeria* E. Müll., Sydowia 4: 206 (1950).

**Fig. 55** *Massarina eburnea* (from IFRD 2006). **a** Ascomata on the host surface. **b** Section of an ascoma. **c** Ascus with a short pedicel. **d** Cellular pseudoparaphyses. **e** Section of the peridium comprising a few layers of compressed cells. **f** Asci in pseudoparaphyses. **g** Three-septate ascospores. Scale bars: **a**=0.5 mm, **b**=100  $\mu$ m, **c–g**=20  $\mu$ m



### Generic description

Habitat terrestrial or freshwater, saprobic. *Ascomata* medium-sized, scattered, or in small groups, immersed, erumpent to superficial, subglobose, black; apex with a wide and usually somewhat compressed papilla. *Peridium* thick or thin, usually thicker near the apex, composed of 2–3 layers of thick walled scleroparenchymatous cells. *Hamathecium* of dense, trabeculate pseudoparaphyses. *Asci* 8-spored, bitunicate, cylindrical to cylindro-clavate, with a short, thick, furcate pedicel. *Ascospores* fusoid to narrowly ellipsoid, brown or dark brown, multi-septate.

**Anamorphs reported for genus:** none.

**Literature:** Barr 1989c; Huhndorf et al. 1990; Kohlmeyer et al. 1996; Müller 1950; Tanaka and Harada 2004; Tanaka et al. 2005.

### Type species

*Massariosphaeria phaeospora* (E. Müll.) Crivelli, Ueber die Heterogene Ascomycetengattung *Pleospora* Rabh.; Vorschlag für eine Aufteilung (Diss. Eid genössischen Tech Hochsch Zürich 7318): 141 (1983). (Fig. 56)

≡ *Leptosphaeria phaeospora* E. Müll., Sydowia 4: 208 (1950).

*Ascomata* 400–550  $\mu$ m high  $\times$  300–500  $\mu$ m diam., scattered, or in small groups, immersed, semi-immersed, subglobose, black, apex wide papilla, sometimes slightly compressed, 40–70(–100)  $\mu$ m broad (Fig. 56a). *Peridium*



10–20  $\mu\text{m}$  wide at sides, comprising one cell type of 2–3 layers of thick walled scleroparenchymatous cells, cell wall 2–5  $\mu\text{m}$  thick, peridium thicker near the apex (Fig. 56b). *Hamathecium* of dense, trabeculate pseudoparaphyses, 1–2  $\mu\text{m}$  broad, septate, branching and anastomosing. *Asci* 120–173  $\times$  18–25  $\mu\text{m}$  ( $\bar{x}$  = 133.2  $\times$  20.5  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate dehiscence not observed, broadly cylindrical to cylindro-clavate, with a short, thick, furcate pedicel, up to 15  $\mu\text{m}$  long. *Ascospores* 32.5–42  $\times$  10–13  $\mu\text{m}$  ( $\bar{x}$  = 36  $\times$  11.2  $\mu\text{m}$ ,  $n=10$ ), narrowly ellipsoid, usually slightly curved, dark brown, 7–9 septa, slightly constricted at the median septum (Fig. 56c and d).

**Anamorph:** none reported.

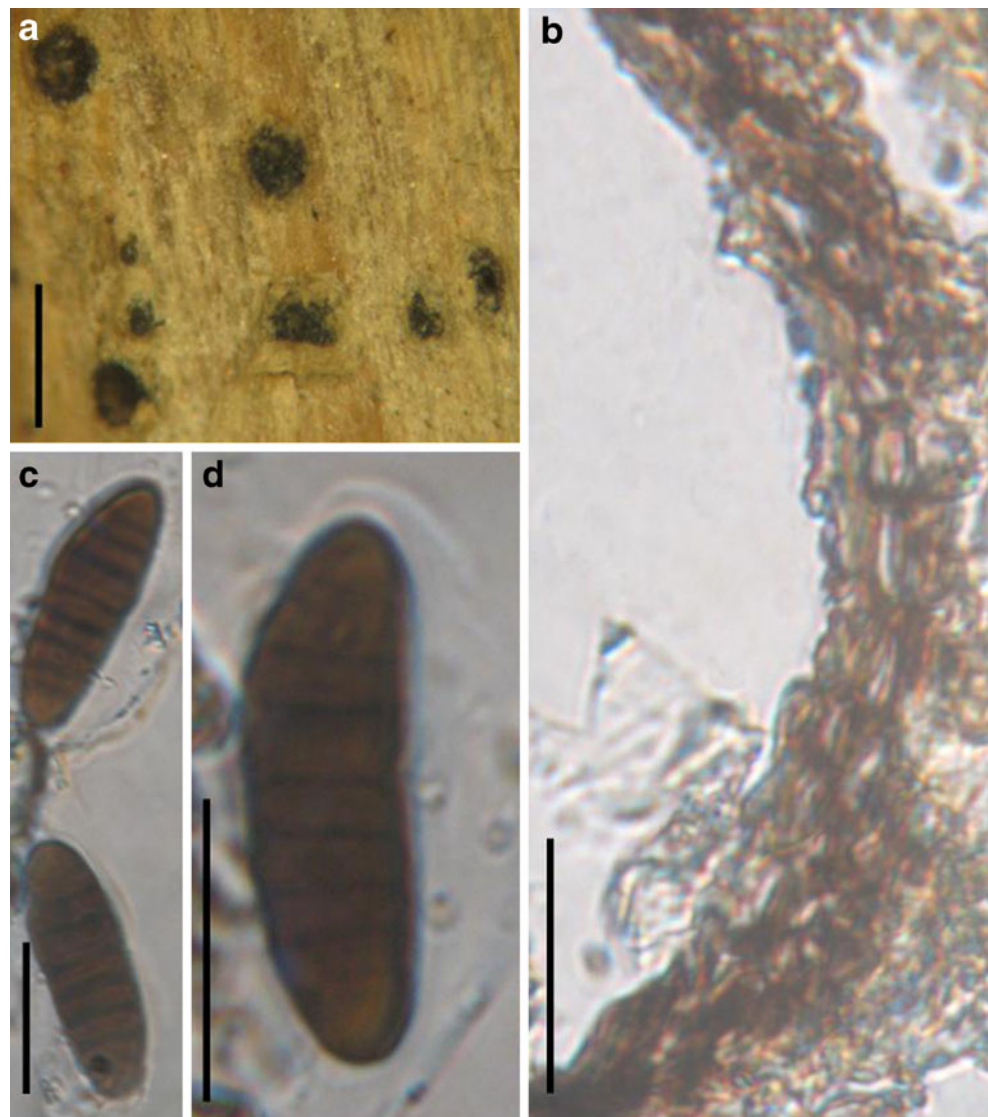
**Material examined:** SWITZERLAND, Kt. Wallis, Findelen, *Artemisia campestris* L., 10 Sept. 1895, H. Wegelin (ZT, holotype).

## Notes

## Morphology

*Massariosphaeria* was established by Müller (1950) as a section of *Leptosphaeria* based on its large, thick-walled ascospores with a mucilaginous sheath as well as its ascomata with a thick apex. *Massariosphaeria* was introduced as a separate genus by Crivelli (1983), characterized by its wide peridial apex comprising thick-walled cells, compressed to round papilla, and relatively large, thick-walled, reddish brown to brown, multi-septate to dictyosporous ascospores, usually surrounded by a sheath (Crivelli 1983; Huhndorf et al. 1990; Leuchtman 1984). In particular, Crivelli (1983) emphasized that species of *Massariosphaeria* often stain the woody substrate (or culture) purple, and this was accepted by Leuchtman (1984). Barr (1989c) had treated *Massarios-*

**Fig. 56** *Massariosphaeria phaeospora* (ZT, holotype). **a** Ascomata scattering on the host surface. Note the immersed to erumpent ascomata. **b** Section of a partial peridium. Note the peridium structure. **c, d** Released ascospores. Scale bars: **a**=1 mm, **b–d**=20  $\mu\text{m}$



*phaeria* as a synonym of *Chaetomastia*, but this viewpoint was rarely followed.

### Phylogenetic study

The polyphyletic nature of *Massariosphaeria* is detected by analyzing SSU and LSU rDNA sequences (Wang et al. 2007). The purple staining character has shown phylogenetic significance in *Amniculicolaceae*, a freshwater family from France (Zhang et al. 2009a). A single isolate of *M. phaeospora* was shown to be unrelated to *Amniculicolaceae* and clustered with a single isolate of *Thyridaria rubronotata* (Schoch et al. 2009; Zhang et al. 2009a).

### Concluding remarks

Based on phylogenetic analysis, staining the substrate purple may have more phylogenetic significance than morphological characters (Zhang et al. 2009a). Thus, the generic circumscription of *Massariosphaeria* should be re-evaluated by further phylogenetic study with more relevant taxa included.

***Mauritiana*** Poonyth, K.D. Hyde, Aptroot & Peerally, Fungal Divers. 4: 102 (2000). (?*Zopfiaceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium-sized, gregarious, ovoid, immersed, ostiolate, ostiole rounded. *Peridium* thin, thicker near the apex. *Hamathecium* of dense, cellular pseudoparaphyses, branching. *Asci* 8-spored, bitunicate, cylindrical to cylindro-clavate, with a short pedicel and a small ocular chamber. *Ascospores* 2-3-seriate, fusoid with rounded ends, dark brown with paler apical cells, multi-septate, distoseptate, slightly constricted at the primary septum.

**Anamorphs reported for genus:** none.

**Literature:** Hawksworth et al. 1995; Poonyth et al. 2000; Suetrong et al. 2009.

### Type species

***Mauritiana rhizophorae*** Poonyth, K.D. Hyde, Aptroot & Peerally, Fungal Divers. 4: 102 (2000). (Fig. 57)

*Ascomata* 390–410  $\mu\text{m}$  high  $\times$  310–325  $\mu\text{m}$  diam., gregarious, ovoid, immersed, ostiolate, ostiole rounded (Fig. 57a). *Peridium* 40–60  $\mu\text{m}$  thick laterally, thicker near the apex (Fig. 57a and b). *Hamathecium* of dense, long cellular pseudoparaphyses, 1.5–2  $\mu\text{m}$  broad, branching. *Asci* 130–180  $\times$  20–25  $\mu\text{m}$  ( $\bar{x}$  = 156  $\times$  21.8  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, cylindrical to cylindro-clavate, with a short pedicel, with a small ocular chamber (Fig. 57c, d and e). *Ascospores* 29–40  $\times$  9–13  $\mu\text{m}$  ( $\bar{x}$  = 35.4  $\times$  11  $\mu\text{m}$ ,  $n=10$ ), 2-3-seriate, fusoid with rounded ends, dark brown with paler apical cells, 9–13-distoseptate, slightly constricted at the primary septum, smooth (Fig. 57f, g, h and i).

**Anamorph:** none reported.

**Material examined:** MAURITIUS, Grand Gaube, Melville mangrove, on dead decorticated *Rhizophora mucronata* Lam. wood still attached to living tree, Jan. 1995, A.D. Poonyth (HKU(M)10219, **holotype**).

### Notes

### Morphology

*Mauritiana* was introduced to accommodate the mangrove fungus, *M. rhizophorae*, which is characterized by immersed ostiolate, periphysate ascomata, thin peridium, bitunicate, 8-spored, cylindrical to cylindro-clavate asci, fusoid, smooth, hyaline to pale brown, multi-septate and distoseptate ascospores (Poonyth et al. 2000). But after carefully studying the type of *M. rhizophorae*, no typical distoseptate ascospores observed. The pigmented curved septum of the ascospore gives a “thickened” appearance. Based on its immersed ascomata, presence of cellular pseudoparaphyses, thick-walled, fissitunicate asci and brown, phragmosporous ascospores constricted at the primary septum, *Mauritiana* was assigned to the *Pyrenulales sensu stricto* (*Melanommatales sensu lato*, *Dothideales sensu lato*) (Hawksworth et al. 1995; Poonyth et al. 2000).

### Phylogenetic study

Based on a multigene phylogenetic analysis, *Mauritiana rhizophorae* resided within a paraphyletic clade (Suetrong et al. 2009) sister to marine fungi *Halothia posidonia* and *Pontoporeia biturbinata*. In this study, the dendrogram shows it to be closely related to the *Sporormiaceae* and *Lophiostomataceae*, which may indicate an uncircumscribed familial clade (Plate 1). Thus, its familial placement remains undetermined.

### Concluding remarks

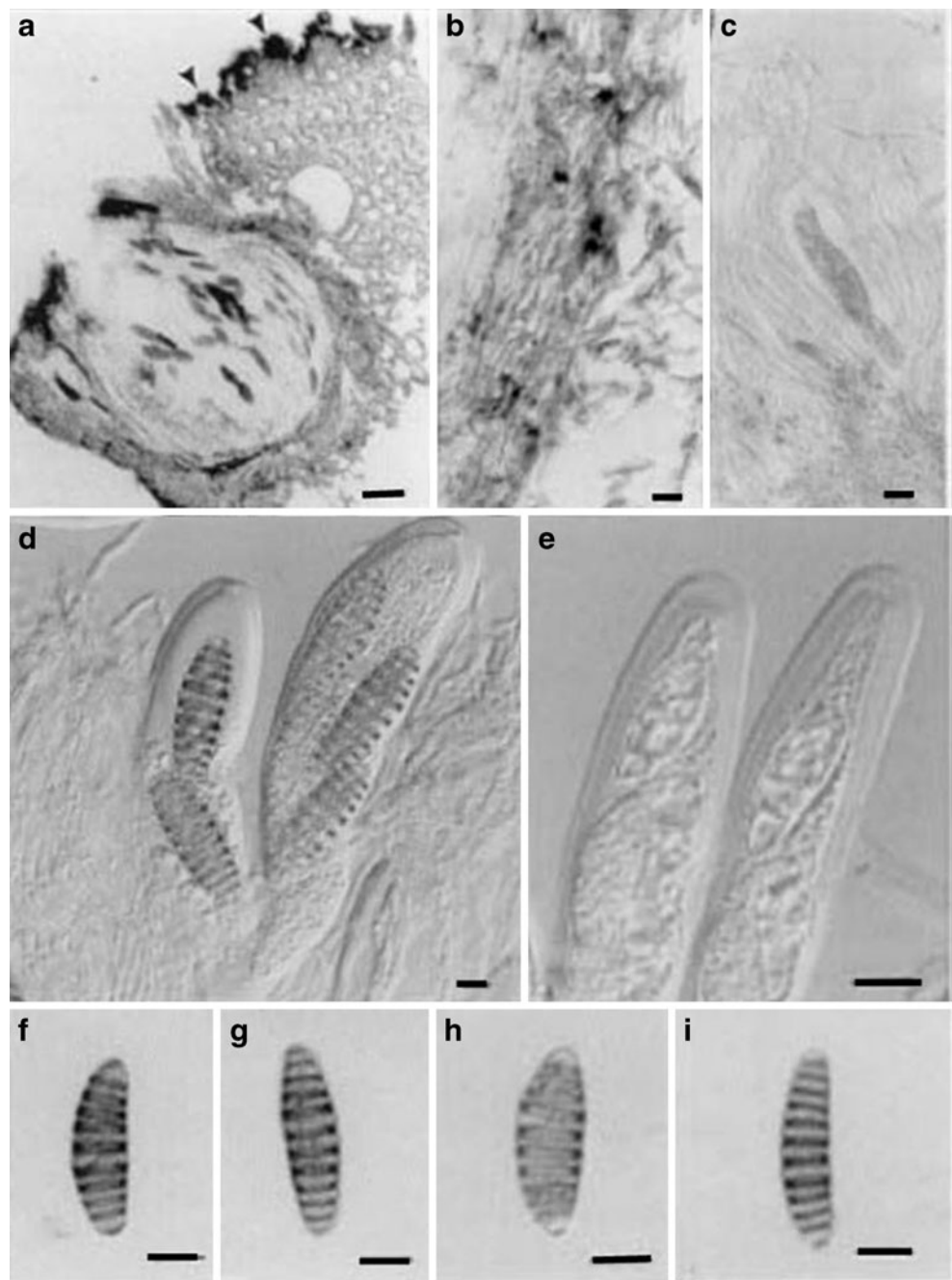
The “thickened” septa of ascospores of *Mauritiana rhizophorae* is quite unique in *Pleosporales*, which makes it easily distinguishable from other genera.

***Melanomma*** Nitschke ex Fuckel, Jb. Nassau. Ver. Naturk. 23–24: 159 (1870). (*Melanommataceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* immersed, erumpent to nearly superficial, medium- to large-sized, globose to subglobose, coriaceous, gregarious, short papillate. *Peridium* pseudoparenchymatous cells outside with pale compressed cells inside. *Asci* cylindrical to clavate with short pedicels. *Hamathecium* of dense, filamentous, branching, rarely anastomosing, septate pseudoparaphyses. *Ascospores* pale brown, reddish brown to olive-brown, ellipsoid to fusoid, 2 to multi-septate, constricted at the main septum.

**Fig. 57** *Mauritiana rhizophorae* (from HKU(M)10219, holotype). **a** Vertical section of an ascoma. Note the thin layer of fungal tissue (pseudostroma?) on the host surface. **b** Section of a partial peridium. **c** Pseudoparaphyses and immature ascus. **d** Fissitunicate asci. **e** Asci showing thickening of the apical wall. **f–i** Ascospores with transverse septa and paler polar cells. Scale bars: **a**=40  $\mu\text{m}$ , **b, d–i**=10  $\mu\text{m}$ , **c**=20  $\mu\text{m}$



**Anamorphs reported for genus:** *Aposphaeria*, *Nigrolentilocus*, *Phoma*-like and *Pseudospiropes* (Chesters 1938; Sivanesan 1984).

**Literature:** Barr 1990a; Chesters 1938; Fuckel 1870; Saccardo 1878; Zhang et al. 2008a.

#### Type species

*Melanomma pulvis-pyrius* (Pers.) Fuckel, Jb. nassau. Ver. Naturk. 23–24: 160 (1870). (Fig. 58)

≡ *Sphaeria pulvis-pyrius* Pers., Syn. meth. fung. (Göttingen) 1: 86 (1801).

*Ascomata* 215–471  $\mu\text{m}$  high  $\times$  260–440  $\mu\text{m}$  diam., gregarious, substrate surface covered with a thin layer of brown pseudostroma, superficial, globose, subglobose, broadly or narrowly conical, often laterally flattened, black, roughened and irregular, often bearing remnants of wood fibers; apex short papillate, often somewhat puckered or sulcate (Fig. 58a). *Peridium* 70–90  $\mu\text{m}$  wide, to 180  $\mu\text{m}$  wide at the base, coriaceous, comprising two types of cells, outer cells small heavily pigmented thick-walled cells of *textura angularis*, apical cells smaller and walls thicker, individual cell walls to 6  $\mu\text{m}$  thick, inner cells lightly pigmented to hyaline thin-walled cells of *textura angularis*,

5–8  $\mu\text{m}$  diam., individual cell wall to 1.5–2  $\mu\text{m}$  thick, in places with columns of *textura prismatica*, and larger, paler cells of *textura prismatica* towards the interior and at the base (Fig. 58b). *Hamathecium* of dense, filamentous, 1–2 (–2.5)  $\mu\text{m}$  broad, branching, rarely anastomosing, septate pseudoparaphyses. *Asci* 98–123  $\times$  6.5–7.5 (–9)  $\mu\text{m}$  ( $\bar{x}$  = 109  $\times$  7.5  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, cylindrical to fusoid, with a short, furcate pedicel, to 25  $\mu\text{m}$  long, with an ocular chamber (Fig. 58c, d, e, f and g). *Ascospores* 14–17.5 (–19)  $\times$  4.5–6.5  $\mu\text{m}$  ( $\bar{x}$  = 15.8  $\times$  5.2  $\mu\text{m}$ ,  $n=10$ ), obliquely uniseriate and partially overlapping, broadly fusoid to fusoid with broadly rounded ends, straight or slightly curved, smooth, olive-brown, 4-celled, slightly constricted at the septa, the second cell from the top slightly wider than the others, no sheath (Fig. 58h, i, j, k and l).

**Anamorph:** *Aposphaeria agminalis* Sacc. or *Phoma agminalis* Sacc. (Sivanesan 1984).

**Colonies** (of epitype) reaching 4 cm diam. after 20 days growth on PDA at 25°C, depressed to raised, cottony to woolly, with rhizoidal margin, grey, reverse darkened. *Phoma*-like anamorph has been reported by Chesters (1938) and Sivanesan (1984), but no anamorphic stage was observed in the cultures of IFRDCC 2044, CBS 109.77 and CBS 371.75 after culturing 3 months on PDA.

**Material examined:** on decaying wood (UPS, Scler. succ. n. 120, **holotype**, as *Sphaeria pulvis-pyrius* Pers.); FRANCE, Ariège, Rimont, Saurine, on bark of *Salix caprea*, 10 Apr. 2008, Jacques Fournier (IFRD 2001, **epitype**).

## Notes

### Morphology

*Melanomma*, the familial type of *Melanommataceae*, was formally established by Fuckel (1870, p 159) based on its small, carbonaceous ascomata, having: “sporen meist 2–3 mal septirt, selten ohne Scheidewand, braun oder wassrhell.” (Chesters 1938; Fuckel 1870). Saccardo (1878, p. 344) emended this genus as “Spores ovate or oblong, multi-septate, coloured.” Subsequently, Saccardo (1883, p. 98) extended the description of *Melanomma* as “Perithecia gregarious, seldom scattered, somewhat superficial, sphaerical, papillate or blunt, carbonaceous, smooth or somewhat hairy. *Asci* elongate, for the most part accompanied by paraphyses, 8-spored. Spores oblong or somewhat spindle-shaped, two to many septate, olive or dark brown. Species of *Sphaeria* belong here for the most part.” *Melanomma pulvis-pyrius* was erected as the lectotype species (Barr 1990a; Chesters 1938). Barr (1990a) gave a detailed circumscription for *Melanomma*, under which *Melanomma* contains about 20 species (Kirk et al. 2001).

*Melanomma pulvis-pyrius* is characterized by its gregarious, superficial ascomata with short papillate, cylindrical *asci* with a short pedicel and fusoid, olive-brown, 3-septate *ascospores* (Chesters 1938; Zhang et al. 2008a). One of the diagnostic

characters of *Melanommataceae* is the trabeculate pseudoparaphyses, although no typical trabeculate pseudoparaphyses could be found in the neotype (Scler. succ. n. 120, UPS) and epitype (IFRD 2001) of *M. pulvis-pyrius* (Zhang et al. 2008a).

### Phylogenetic study

Phylogenetic analysis based on five genes (LSU, SSU, *RPB1*, *RPB2* and *EF1*) indicates that *Melanomma pulvis-pyrius* forms a robust clade with *Byssosphaeria*, *Herpotrichia* and *Pleomassaria siparia* (*Pleomassariaceae*) and likely represents a separate family (or families comprising *Melanommataceae*) (Zhang et al. 2008a; Mugambi and Huhndorf 2009b). A more recent phylogenetic analysis included a group of coelomycete species with stellate conidia, isolated from *Fagales* trees clustered in *Melanommataceae* (Tanaka et al. 2010; Plate 1).

### Concluding remarks

The *Melanomma* concept based on *ascospore* morphology appears polyphyletic.

**Metameris** Theiss. & Syd., *Annl. mycol.* 13: 342 (1915). (*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, saprobic or parasitic. *Ascstromata* erumpent through the host surface in linear rows parallel to the host fibers. *Ascomata* small, globose to subglobose, black, coriaceous. *Peridium* composed of large lightly pigmented cells of *textura angularis*. *Hamathecium* of rare, broad pseudoparaphyses, septate, constricted at the septa. *Asci* bitunicate, fissitunicate, broadly cylindrical to slightly obclavate, with a short, thick, knob-like pedicel. *Ascospores* hyaline, 1- (rarely 2-) septate.

**Anamorphs reported for genus:** none.

**Literature:** von Arx and Müller 1975; Barr 1972; Clements and Shear 1931; Eriksson 2006; Lumbsch and Huhndorf 2007; Theissen and Sydow 1915.

### Type species

**Metameris japonica** (Syd.) Syd., *Annl. mycol.*, 13(3–4): 342 (1915). (Fig. 59)

≡ *Monographus japonicus* Syd. *Annl. mycol.* 10: 408 (1912).

*Ascstromata* erumpent through the host surface in linear rows parallel to the host fibers, 500–750  $\mu\text{m}$  long and 140–200  $\mu\text{m}$  wide, with three to ten *ascomata* arranged in a line (Fig. 59a). *Ascomata* 115–160  $\mu\text{m}$  diam., semi-immersed in substrate to erumpent, globose, subglobose, black, coriaceous (Fig. 59b). *Cells of ascstromata* heavily pigmented and thick-walled, cells of *peridium* composed of large lightly pigmented cells of *textura angularis*, cells 5–15  $\mu\text{m}$  diam.,



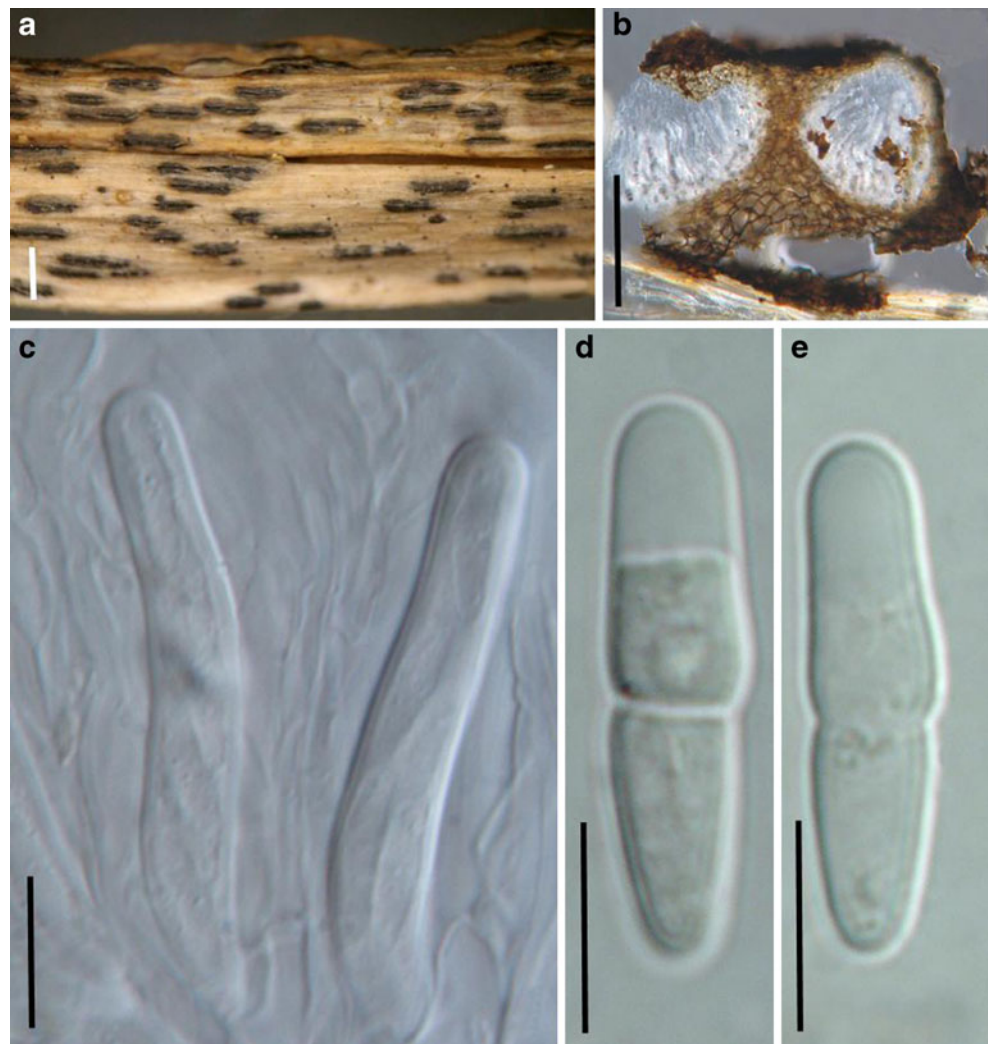
**Fig. 58** *Melanomma pulvis-pyrus* (a–b, d–e, h–j from UPS, holotype; c, g, k, l from epitype). **a** Ascomata gregarious on the host surface. **b** Vertical section of an ascoma. **c–f** Asci with pedicels. **g** Dehiscent ascus. **h–l** Ascospores. Scale bars: **a**=0.5 mm, **b**=200  $\mu\text{m}$ , **c–l**=10  $\mu\text{m}$

cell wall  $<1 \mu\text{m}$  thick, peridium thicker at the base, up to  $50 \mu\text{m}$  (Fig. 59b). *Hamathecium* of rare, pseudoparaphyses  $3\text{--}4 \mu\text{m}$  broad, septate, constricted at the septa, anastomosing or branching not observed. *Asci*  $(65\text{--})80\text{--}90 \times 12\text{--}15 \mu\text{m}$  ( $\bar{x} = 82.8 \times 13.3 \mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, broadly cylindrical to slightly obclavate, with a short, thick, knob-like pedicel, lacking an ocular chamber (Fig. 59c). *Ascospores*  $25\text{--}30 \times 5\text{--}6 \mu\text{m}$  ( $\bar{x} = 27.4 \times 5.6 \mu\text{m}$ ,  $n=10$ ), biseriolate, oblong, hyaline, 1-2-septate, the secondary septum exclusively occurring in the upper cells, slightly constricted at the primary septum which is slightly below the centre of the ascospore, the upper cells usually swollen near the main septum (Fig. 59d and e).

**Anamorph:** none reported.

**Material examined:** JAPAN, Province Mino. on *Osmunda regalis* L. var. *japonica* Milde., 10 May 1912, R. Hale (S, F7166, **type**, as *Monographos japonicus* Syd.).

**Fig. 59** *Metameris japonica* (from S, F7166, **type**). **a** Ascostroma arrangement on the host surface. **b** Section of two ascostroma from one ascostroma. **c** Immature asci within pseudoparaphyses. **d, e** Hyaline ascospores. Scale bars: **a**=0.5 mm, **b**=100  $\mu\text{m}$ , **c**–**e**=20  $\mu\text{m}$



## Notes

## Morphology

*Metameris* was formally established by Theissen and Sydow (1915) to accommodate *Monographos japonicus* Syd., which is characterized by the erumpent ascostromata arranged in linear ascostromata, the presence of pseudoparaphyses and hyaline 2-septate ascospores. Clements and Shear (1931) assigned it to *Dothideaceae* (subfamily *Dothideae*), and von Arx and Müller (1975) assigned it to *Pleosporaceae*. Currently, it is considered as a member of *Phaeosphaeriaceae* (*Pleosporales*) (Eriksson 2006; Lumbsch and Huhndorf 2007). *Scirrhodithis* and *Scirrhophragma* are considered synonyms of *Metameris* (von Arx and Müller 1975), and all three closely related to *Scirrhia* (Barr 1972; Müller and von Arx 1962).

## Phylogenetic study

None.

## Concluding remarks

Its small-sized ascomata, broadly cylindrical to slightly obclavate asci with a short, thick, knob-like pedicel, as well as its monocotyledonous host preference point *Metameris* to the *Phaeosphaeriaceae*. But DNA comparisons are needed for confirmation.

**Mixtura** O.E. Erikss. & J.Z. Yue, Mycotaxon 38: 203 (1990). (*Phaeosphaeriaceae*)

## Generic description

Habitat terrestrial, parasitic. *Ascomata* small-sized, scattered or clustered on the leaf spots, immersed, erumpent, minutely papillate, ostiolate. *Papilla* slightly raised. *Peridium* thin, comprising one cell type of lightly pigmented thin-walled cells of *textura angularis*. *Hamathecium* of dense, filliform, septate, cellular pseudoparaphyses, 4–6.3  $\mu\text{m}$  broad, embedded in mucilage. *Asci* bitunicate, ovoid, with a very short stumpy pedicel. *Ascospores* fusoid to narrowly fusoid with broadly to narrowly rounded ends, curved, dark brown, multi-septate, distoseptate, with a germ pore at the lower end.

**Anamorphs reported for genus:** none.

**Literature:** Eriksson and Yue 1990.

## Type species

**Mixtura saginata** (Syd.) O.E. Erikss. & J.Z. Yue, Mycotaxon 38: 203 (1990). (Fig. 60)

$\equiv$  *Leptosphaeria saginata* Syd., Anns mycol. 37: 376 (1939).

Producing elongated yellow spots with brownish margins, leaf spots up to 45 $\times$ 3–5 mm, opposite side visible as a brownish spots (Fig. 60a). *Ascomata* 170–200  $\mu\text{m}$  high $\times$ 210–280  $\mu\text{m}$  diam., scattered on the lower side of the leaf, immersed, erumpent, breaking through the epidermis, minutely papillate. *Papilla* central, slightly raised, ostiolate, ostiole surrounded by a white margin (Fig. 60b). *Peridium* 22–34  $\mu\text{m}$  wide, thicker at the apex, thinner at the base, comprising one cell type of lightly pigmented thin-walled cells of *textura angularis*, cells up to 6 $\times$ 8  $\mu\text{m}$  diam., cell wall 0.5–1.2  $\mu\text{m}$  thick, apex cells smaller and walls thicker (Fig. 60c). *Hamathecium* of dense, filliform, septate, cellular pseudoparaphyses, 4–6.3  $\mu\text{m}$  broad, embedded in mucilage. *Asci* 80–128 $\times$ 41–53(–69)  $\mu\text{m}$  ( $\bar{x}$  = 100.9  $\times$  52.8  $\mu\text{m}$ , n=10), 8-spored, bitunicate, fissionate dehiscence not observed, sac-like, with a very short stumpy pedicel and a small ocular chamber (Fig. 60d). *Ascospores* 86–94(–106) $\times$ 20.5–23.5  $\mu\text{m}$  ( $\bar{x}$  = 92.7  $\times$  21.7  $\mu\text{m}$ , n=10), fasciculate, fusoid to narrowly fusoid, slightly curved, dark brown, 7-septate, distoseptate,

with or without constriction at the primary septum, smooth-walled, with a germ pore at the lower end (Fig. 60e and f).

**Anamorph:** none reported.

**Material examined:** ECUADOR, Tungurahua, Hacienda San Antonio pr. Baños, Province, on the leaves of *Chusquea serrulatae* Pilger, 9 Jan. 1938, H. Sydow. (S reg. nr F8934 type, F8935 **isoelectotype**, as *Leptosphaeria saginata*).

## Notes

## Morphology

*Mixtura* was formally established by Eriksson and Yue (1990) as a monotypic genus represented by *M. saginata* based on its immersed and thin-walled ascomata, sparse, broad pseudoparaphyses, sac-like asci with a short pedicel and thick apex. *Mixtura* has a “mixture” of characters found in other pleosporalean genera. The peridium structure is comparable with *Phaeosphaeria*, the ascospores with *Trematosphaeria* and asci with *Wettsteinina* (Eriksson and Yue 1990). According to the structure of ascomata and hamathecium, *Mixtura* was provisionally assigned to *Phaeosphaeriaceae* (Eriksson and Yue 1990).

## Phylogenetic study

None.

## Concluding remarks

Morphologically, the sparse broad pseudoparaphyses and sac-like asci with a thick apical structure in *Mixtura* seem more comparable with the generic type of *Teratosphaeria* (*T. fibrillose* Syd. & P. Syd., *Teratosphaeriaceae*, *Capnodiales*, *Dothideomycetidae*) than that of *Phaeosphaeria* (*P. oryzae*). The heavily pigmented, multi-septate ascospores and the persistent pseudoparaphyses of *Mixtura* however, differ from those of *Teratosphaeria*. Thus, here we assign *Mixtura* under *Teratosphaeriaceae* as a distinct genus until phylogenetic work is carried out.

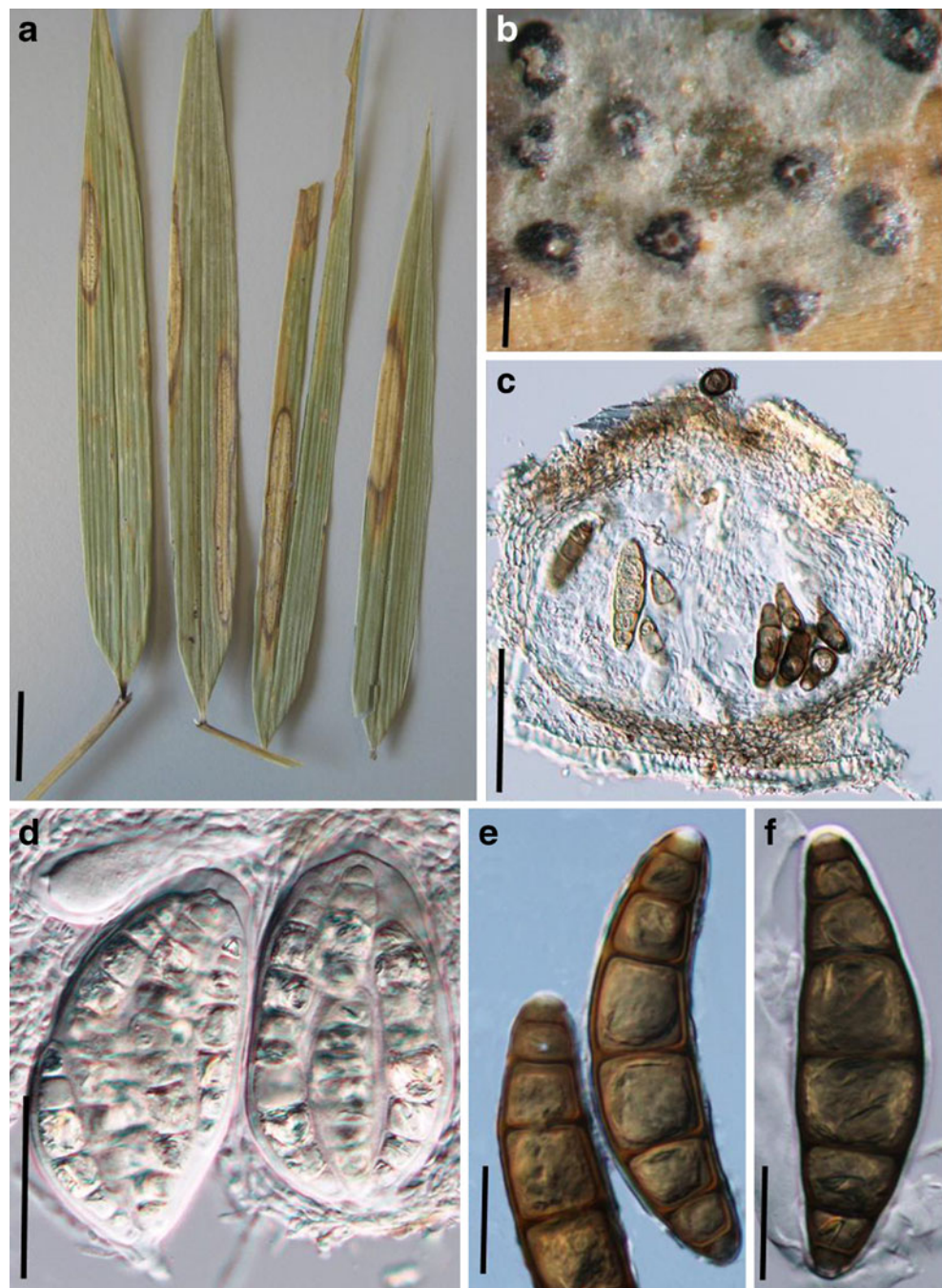
**Montagnula** Berl., Icon. fung. (Abellini) 2: 68 (1896). (*Montagnulaceae*)

## Generic description

Habitat terrestrial, saprobic. *Ascomata* small- to medium-sized, immersed to erumpent, gregarious or grouped, globose to subglobose, black. *Hamathecium* of dense, narrowly cellular, septate pseudoparaphyses. *Asci* bitunicate, fissionate, usually cylindro-clavate to clavate with a long pedicel. *Ascospores* oblong to narrowly oblong, straight or somewhat curved, reddish brown to dark yellowish brown, muriform or phragmosporous.

**Anamorphs reported for genus:** *Aschersonia* (Hyde et al. 2011).

**Fig. 60** *Mixtura saginata* (from S reg. nr F8934, **type**). **a**, **b** Leaf spots in leaves of *Chusquea serrulatae*. Note the erumpent ascomata surrounded by white material in **(b)**. **c** Section of an ascoma. Note the peridium structure which comprises cells of *textura angularis*. The arrangement of the asci and pseudoparaphyses can also be seen. **d** Immature asci in pseudoparaphyses. Note the stumpy pedicel and thickened apex with flattened ocular chamber. **e**, **f** Mature ascospores. Note the hyaline ends and distosepta. Scale bars: **a**=10 mm, **b**, **c**=100  $\mu$ m, **d**=50  $\mu$ m, **e**–**f**=20  $\mu$ m



**Literature:** Aptroot 1995; Barr 2001; Berlese 1896; Clements and Shear 1931; Crivelli 1983; Leuchtman 1984; Ramaley and Barr 1995; Schoch et al. 2006; Wehmeyer 1957, 1961; Zhang et al. 2009a.

#### Type species

*Montagnula infernalis* (Niessl) Berl., Icon. fung. (Abellini). 2: 68 (1896). (Fig. 61)

≡ *Leptosphaeria infernalis* Niessl, Inst. Coimbra 31: 13 (1883).

*Ascomata* 220–280  $\mu$ m high  $\times$  250–310  $\mu$ m diam., immersed to erumpent, gregarious or clustered, globose to subglobose, sometimes triangular in dried material, short ostiole always filled with hyaline closely adhering cells, black (Fig. 61a and b). *Peridium* 40–55  $\mu$ m thick at sides, up to 80  $\mu$ m thick near the apex, 3-layered, outer layer composed of heavily pigmented thick-walled small cells of *textura angularis*, cells 3–8  $\mu$ m diam., wall 1.5–3  $\mu$ m thick, apex thicker with smaller cells and thicker cell wall, thinner near the base; mid layer less pigmented, cells 4–13  $\mu$ m diam.; innermost layer of narrow compressed rows of cells, merging with



pseudoparaphyses (Fig. 61c). *Hamathecium* of dense, narrow cellular pseudoparaphyses, 2–4.5  $\mu\text{m}$  broad, septate (Fig. 61f). *Asci* 153–170(–200)  $\times$  17.5–21.5  $\mu\text{m}$  (including pedicel), bitunicate, fissitunicate, cylindro-clavate to clavate, pedicel 28–60(–85)  $\mu\text{m}$  long, 8-spored, biseriate, with an ocular chamber best seen in immature ascus (to 3  $\mu\text{m}$  wide  $\times$  3  $\mu\text{m}$  high) (Fig. 61d and e). *Ascospores* 24–29  $\times$  9–11  $\mu\text{m}$ , oblong to narrowly oblong, straight or somewhat curved, reddish brown to dark yellowish brown, verruculose, with five transverse septa and one vertical septum in each middle cells, constricted at the primary and secondary primary septa (Fig. 61g).

**Anamorph:** none reported.

**Material examined:** PORTUGAL, Coimbra Lusitania, on leaves of *Fourcroya longava* pr., Feb., 1881, leg. Moller. (M 1183, holotype).

## Notes

### Morphology

*Montagnula* was introduced to accommodate two *Pleospora* species, i.e. *P. infernalis* (Niessl) Wehm. and *P. gigantea* Mont. by Berlese (1896), based on the presence of hyphal stromatic tissues over the ascomata and asci with relatively long pedicels (Barr 2001). *Montagnula infernalis* was selected as the lectotype species (Clements and Shear 1931). Subsequently, Wehmeyer (1957, 1961) treated *Montagnula* as a subgenus of *Pleospora*. Crivelli (1983) accepted *Montagnula* as a separate genus, and divided it into two subgenera, i.e. *Montagnula* and *Rubiginospora*. *Montagnula* was characterized by having dark brown ascospores and exclusively occurring on *Agavaceae*, while *Rubiginospora* has reddish brown ascospores and occurs on *Poaceae*. This proposal was not accepted by many workers (Barr 2001). Subsequently, more species with various ascospores (such as phragmosporous species by Leuchtmann (1984) and didymosporous species by Aptroot (1995) were added in this genus), which has obviously become heterogenic. Barr (2001) assigned species of *Montagnula* into different genera, i.e. *Kalmusia* and *Didymosphaerella*, respectively and introduced *Montagnulaceae* to accommodate all of these genera.

### Phylogenetic study

*Montagnula opulenta* forms a robust phylogenetic clade with species of *Bimuria*, *Curreya*, *Didymocrea*, *Letendreaea*, *Paraphaeosphaeria*, *Phaeodothis* and *Karstenula*, which might represent a familial group (Schoch et al. 2006; Zhang et al. 2009a). A more convincing conclusion can only be obtained following sequence data from more verified fungi being added to the phylogenetic tree.

### Concluding remarks

One striking character of *Montagnula infernalis* is the very long ascus pedicel once it is released from the ascomata.

However, this character appears to have evolved more than once and can be found in *Kirschsteiniothelia elaterascus* Shearer which clusters with *Helicascus* (Shearer et al. 2009). The same ascus character is also found in *Xenolophium* and *Ostropella* in the *Platystomaceae* (Mugambi and Huhndorf 2009b). *Montagnula opulenta* is a didymosporous species, but phylogenetically closely related to those dictyosporous (*Karstenula rhodostoma*) and phragmosporous (*Paraphaeosphaeria michotii*) members of *Montagnulaceae* (Zhang et al. 2009a). This might indicate that compared to other morphological characters, ascospore type is not a valid character at family level classification.

**Moristroma** A.I. Romero & Samuels, *Sydowia* 43: 246 (1991). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium-sized, solitary, scattered, or in small groups, superficial, cushion-like, circular in outline, wall black, roughened, containing numerous locules. *Peridium* thin, 1-layered. *Hamathecium* of dense, long filliform pseudoparaphyses, 2–3  $\mu\text{m}$  broad, septate, branching. *Asci* polysporous, with a short, laterally displaced, sometimes papillate knob-shaped pedicel, apex very thick walled, bitunicate, fissitunicate, obclavate, ocular chamber not observed. *Polyspores* oblong to cylindrical, hyaline, non-septate. **Anamorphs reported for genus:** none.

**Literature:** Eriksson 2006; Romero and Samuels 1991.

### Type species

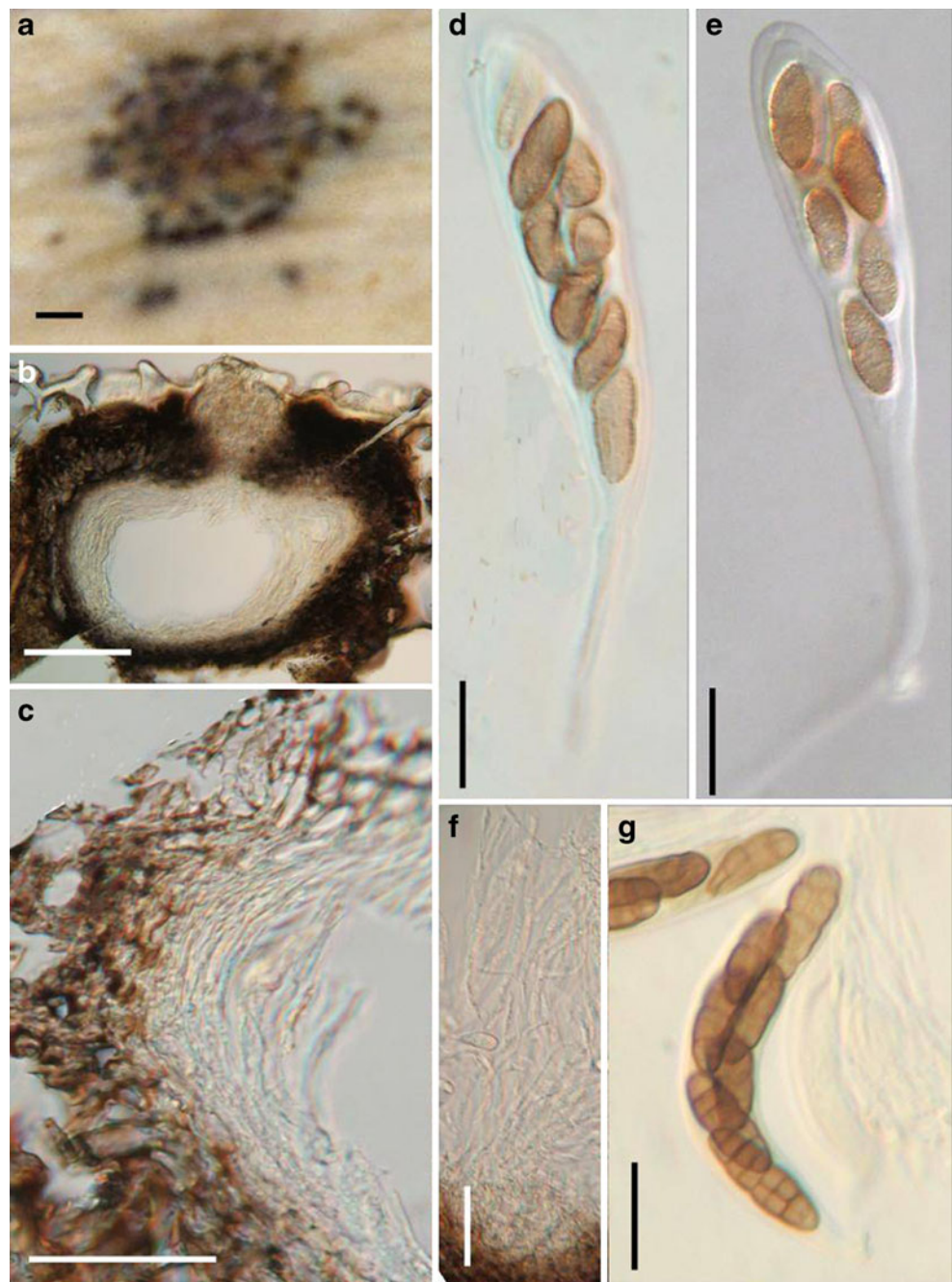
***Moristroma polysporum*** A.I. Romero & Samuels, *Sydowia* 43: 246 (1991). (Fig. 62)

*Ascomata* 100–210  $\mu\text{m}$  high  $\times$  340–600  $\mu\text{m}$  diam., solitary, scattered, or in small groups of 2–3, superficial, with basal wall remaining immersed in host tissue, cushion-like, circular in outline, wall black, roughened, containing numerous locules, each locule 120–240  $\mu\text{m}$  diam., ostiolate (Fig. 62a and b). *Peridium* 14–30  $\mu\text{m}$  thick, 1-layered, composed of small heavily pigmented thick-walled cells of *textura angularis*, cells 2–4  $\mu\text{m}$  diam., cell wall 1.5–3  $\mu\text{m}$  thick, peridium between the locules hyaline (Fig. 62b and c). *Hamathecium* of dense, long filliform pseudoparaphyses, 2–3  $\mu\text{m}$  broad, septate, branching. *Asci* 44–60  $\times$  12–14  $\mu\text{m}$  ( $\bar{x}$  = 54.3  $\times$  13  $\mu\text{m}$ ,  $n$  = 10), polysporous, with a short, papillate knob-shaped pedicel, apex very thick-walled, bitunicate, fissitunicate, obclavate, ocular chamber not observed (Fig. 62d and e). *Polyspores* 3–4(–5)  $\times$  0.6–1.2  $\mu\text{m}$ , oblong to cylindrical, hyaline, non-septate, smooth (Fig. 62f).

**Anamorph:** none reported.

**Material examined:** ARGENTINA, Buenos Aires, Ramallo, on *Eucalyptus viminalis* Labill., May 1982, Romero

**Fig. 61** *Montagnula infernalis* (from M 1183, **holotype**). **a** Appearance of ascomata immersed in host tissue. **b** Section of an immersed ascoma. Note the hyaline closely adhering cells in the ostiole region. **c** Section of the peridium comprising a few layers of cells. **d** An immature ascus with a long pedicel. **e, g** Mature muriform ascospores in asci. **f** Cellular pseudoparaphyses. Scale bars: **a**=0.5 mm, **b, c**=100  $\mu$ m, **d–g**=20  $\mu$ m



27/4-13 (BAFC 32036, **holotype**); Nov. 1982, on decorticated wood, Romero 35/4-13 (BAFC 32037, **paratype**).

#### Notes

#### Morphology

*Moristroma* was formally established by Romero and Samuels (1991) based on its “cushion-shaped ascomata containing lots of locules with numerous asci inside, asci obclavate, polysporous, with a knob-shaped pedicel”. The bitunicate asci and numerous cellular pseudoparaphyses

undoubtedly point it to *Pleosporales*, while the familial placement of *Moristroma* is uncertain, and it was temporarily assigned to *Dacampiaceae* by Romero and Samuels (1991), but no 3-layered peridium is found. Eriksson (2006) assigned it to *Teichosporaceae*.

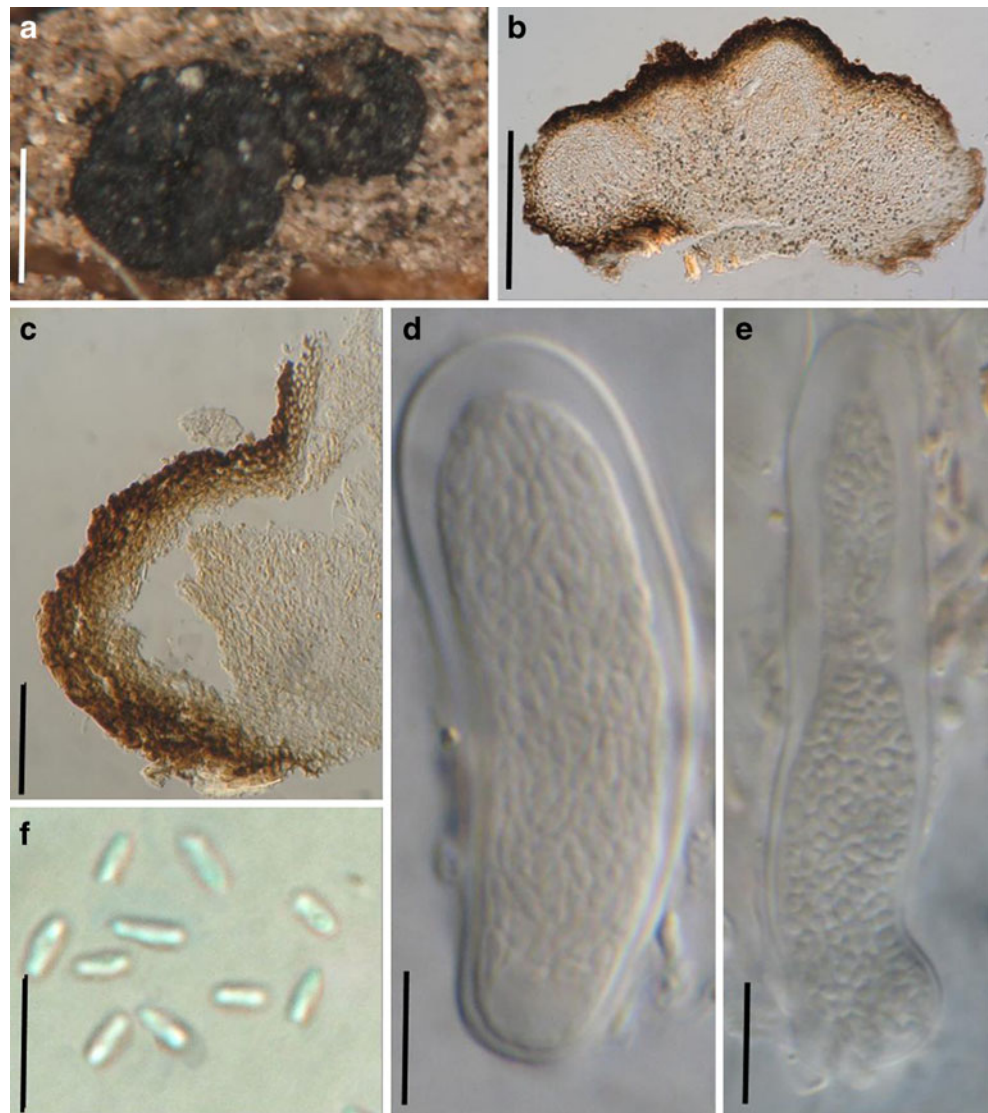
#### Phylogenetic study

None.

#### Concluding remarks

The familial status of *Moristroma* cannot be determined yet.

**Fig. 62** *Moristroma polysporum* (from BAFC 32036, **holotype**). **a** Two multiculate ascostroma on the host surface. **b** Section of an ascostroma. Note the multilocula. **c** Section of the peridium. Note the thick walled cells. **d, e** Broadly cylindrical to fusoid asci containing numerous part spores. **f** Released part spores. Scale bars: **a**=0.5 mm, **b**=200  $\mu$ m, **c**=50  $\mu$ m, **d–f**=10  $\mu$ m



*Morosphaeria* Suetrong, Sakay., E.B.G. Jones & C.L. Schoch, Stud. Mycol. 64: 161 (2009). (*Morosphaeriaceae*)

#### Generic description

Habitat marine, saprobic. *Ascomata* large, solitary or gregarious, immersed to erumpent, subglobose or depressed with a flattened base, ostiolate, papillate, brown to black, coriaceous. *Peridium* thick. *Hamathecium* of dense, long cellular pseudoparaphyses, septate. *Asci* 8-spored, bitunicate, cylindrical, with short pedicels. *Ascospores* uniseriate to partially overlapping, ellipsoidal, hyaline, 1–3-septate, constricted at the septa, central cells larger, apical cells if present small and elongated, surrounded with mucilaginous sheath.

**Anamorphs reported for genus:** none.

**Literature:** Hyde and Borse 1986; Hyde 1991a, b; Suetrong et al. 2009; Zhang et al. 2009a.

#### Type species

*Morosphaeria velataspora* (K.D. Hyde & Borse) Suetrong, Sakay., E.B.G. Jones & C.L. Schoch, Stud. Mycol. 64: 161 (2009). (Fig. 63)

≡ *Massarina velataspora* K.D. Hyde & Borse, Mycotaxon 27: 163 (1986).

*Ascomata* 0.7–1.2 mm diam., solitary or gregarious, immersed to erumpent, subglobose or depressed, with a flattened base not easily removed from the substrate, ostiolate, epapillate or papillate, brown to black, coriaceous (Fig. 63a). *Peridium* thick, the upper part of the peridium composed of brown thick-walled cells of *textura angularis*, cells are smaller and wall thicker near the apex, at the rim is composed of vertical, parallel, brown, elongate cells, wedge-shape in section (Fig. 63a). *Hamathecium* of dense, long cellular pseudoparaphyses, 1.1–1.7  $\mu$ m broad, septate. *Asci* 220–320×23–34  $\mu$ m ( $\bar{x}$  = 251 × 28.2  $\mu$ m,  $n$ =10), 8-

spored, bitunicate, cylindrical, with short pedicels (Fig. 63b). Ascospores  $45\text{--}56 \times 14\text{--}19 \mu\text{m}$  ( $\bar{x} = 49.5 \times 15.9 \mu\text{m}$ ,  $n=10$ ), uniseriate to partially overlapping, ellipsoidal, hyaline, 1-3-septate, constricted at the septa, central cells larger, apical cells if present small and elongated, surrounded with mucilaginous sheath,  $5\text{--}22 \mu\text{m}$  wide (Fig. 63c, d and e).

**Anamorph:** none reported.

**Material examined:** Jan. 1984, Herb. IMI 297770, slides 1–10 (holotype) and dried wood (isotype).

## Notes

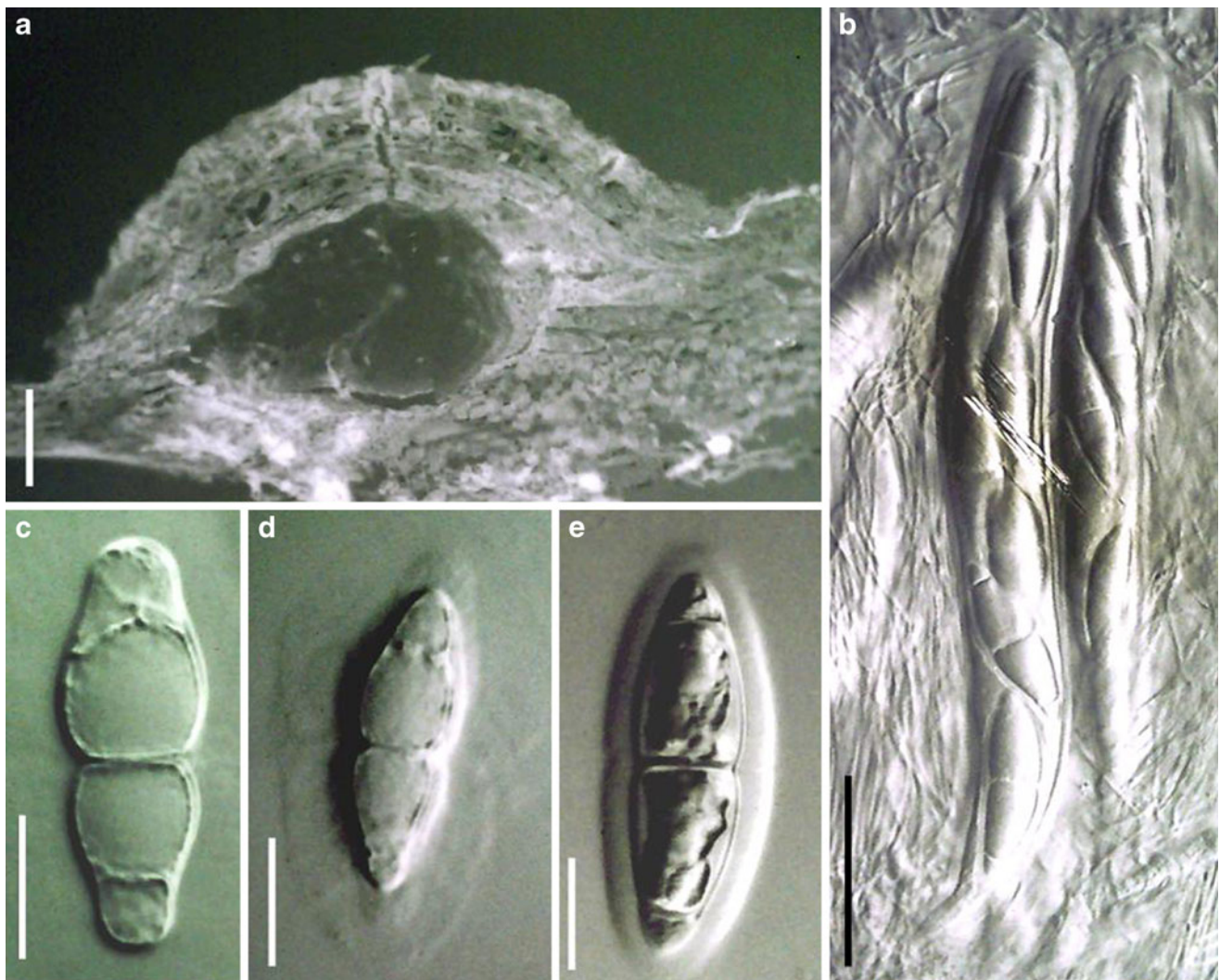
### Morphology

Two *Massarina sensu lato* species described from the marine environment, viz. *M. ramunculicola* (Sacc.) O.E. Erikss. & J.Z. Yue and *M. velataspora* K.D. Hyde & Borse, form a robust clade, and a new genus *Morosphaeria* was established for them (Suetrong et al. 2009). Together with

two *Helicascus* species, they belong to *Morosphaeriaceae* (another marine family) (Suetrong et al. 2009). Morphologically, *Morosphaeria* is characterized by solitary to gregarious, subglobose to lenticular, immersed to superficial ascomata which are ostiolate and papillate, numerous, filliform pseudoparaphyses, 8-spored, clavate to cylindrical, bitunicate, fissitunicate asci, and hyaline, 1-3-septate, fusoid to ellipsoidal ascospores which are surrounded with mucilaginous sheath.

### Phylogenetic study

Species of *Morosphaeria* form a sister group with *Helicascus* and both of these genera were assigned to a new family, i.e. *Morosphaeriaceae* (Suetrong et al. 2009). In this study, a strain of *Asteromassaria pulchra*, occurring on dead twigs of *Prunus spinosa*, is basal to other species of *Morosphaeriaceae*, and gets well support. Thus here we tentatively assign *Asteromassaria* in *Morosphaeriaceae*.



**Fig. 63** *Morosphaeria velataspora* (from IMI 297770, type). **a** Section of an ascoma. **b** Cylindrical asci embedded in pseudoparaphyses. **c–e** Hyaline, 1-3-septate, ascospores with mucilaginous sheath. Scale bars: **a**=100  $\mu\text{m}$ , **b**=50  $\mu\text{m}$ , **c–e**=20  $\mu\text{m}$

### Concluding remarks

The only morphological difference between *M. velataspora* and *M. ramunculicola* are their morphology of ascomata and size of ascospores (Hyde 1991b). But *M. velataspora* was reported staining the woody substrate (or agar in culture) purple (Hyde and Borse 1986; Hyde 1991b). Although this character could not be verified in the strain used by Suetrong et al. (2009), purple staining has been reported to have phylogenetic significance at familial rank in freshwater fungi (Zhang et al. 2009a).

***Murispora*** Yin. Zhang, C.L. Schoch, J. Fourn., Crous & K. D. Hyde, Stud. Mycol. 64: 95 (2009b). (*Amniculicolaceae*)

### Generic description

Habitat freshwater, saprobic. *Ascomata* medium-sized, scattered to gregarious, immersed, lenticular, apex slightly protruding, opening through a small rounded pore, substrate stained purple. *Peridium* thin, composed of a few layers cells of *textura angularis*, thicker at the apex with pseudoparenchymatous cells. *Hamathecium* of narrowly cellular pseudoparaphyses, embedded in mucilage. *Asci* 8-spored, bitunicate, fissitunicate, biseriata, cylindro-clavate with short pedicels. *Ascospores* curved-fusoid with narrowly rounded ends, golden yellow turning brown when senescent, multi-septate, constricted at the septa, with one, rarely two longitudinal septa in all cells except end cells, smooth or finely verruculose, surrounded by a wide mucilaginous sheath.

**Anamorphs reported for genus:** *Phoma* (Webster 1957).

**Literature:** Zhang et al. 2009a, b.

### Type species

***Murispora rubicunda*** (Niessl) Yin. Zhang, J. Fourn. & K. D. Hyde, Stud. Mycol. 64: 96 (2009a). (Fig. 64)

≡ *Pleospora rubicunda* Niessl, Notiz. Pyr.: 31 (1876).

*Ascomata* 170–200  $\mu\text{m}$  high  $\times$  380–410  $\mu\text{m}$  diam., scattered to gregarious, immersed, lenticular, apex laterally flattened, black, slightly protruding, opening through a small rounded pore, substrate stained purple (Fig. 64a). *Peridium* 15–18  $\mu\text{m}$  thick at sides, composed of 3–4 layers cells of *textura angularis*, up to 28–30  $\mu\text{m}$  thick at the apex with very thick-walled cells, pseudoparenchymatous, nearly absent at the base (Fig. 64b). *Hamathecium* of narrowly cellular pseudoparaphyses, 1–1.7  $\mu\text{m}$  broad, embedded in mucilage. *Asci* 124–142  $\times$  19–21  $\mu\text{m}$ , 8-spored, bitunicate, fissitunicate, biseriata, cylindro-clavate with a small ocular chamber, with short pedicels (Fig. 64c). *Ascospores* 30–38  $\times$  10–12  $\mu\text{m}$ , curved-fusoid with narrowly rounded ends, golden yellow turning brown when senescent, 7–9 trans-

versally septate, constricted at the septa, with one, rarely two longitudinal septa in all cells except end cells which are often slightly paler, all cells filled with a large refractive guttule, smooth to finely verruculose, surrounded by a wide mucilaginous sheath (Fig. 64d).

**Anamorph:** *Phoma* sp. (Webster 1957).

**Material examined:** FRANCE, Haute Garonne, Avignonet, Lac de Rosel, 16 Jan. 2007, on submerged dead herbaceous stem (*Dipsacus?*), leg. Michel Delpont, det. Jacques Fournier (IFRD 2017).

### Notes

### Morphology

*Murispora* was introduced based on *Pleospora rubicunda* which is characterized by immersed, erumpent or nearly superficial, globose to subglobose, elongated weakly papillate ascomata which stain the woody substrate purple, trabeculate pseudoparaphyses, 8-spored, bitunicate, fissitunicate, oblong to clavate asci, fusoid, pale or reddish brown, muriform ascospores (Zhang et al. 2009a). A phylogenetic study indicated that *Murispora* forms a robust clade with species of *Amniculicola*, and *Amniculicolaceae* was introduced to accommodate them (Zhang et al. 2009a).

### Phylogenetic study

*Murispora rubicunda* forms a robust clade with species of *Amniculicola* and *Neophaeosphaeria* (Zhang et al. 2009a).

### Concluding remarks

As has mentioned by Eriksson (1981, P. 135), the purple-staining species of *Pleospora*, treated by Webster (1957), should not belong to the *Pleosporaceae*. Both *Pleospora straminis* and *P. rubelloides* should be closely related to *Murispora*.

***Neomassariosphaeria*** Yin. Zhang, J. Fourn. & K.D. Hyde, Stud. Mycol. 64: 96 (2009a). (*Amniculicolaceae*)

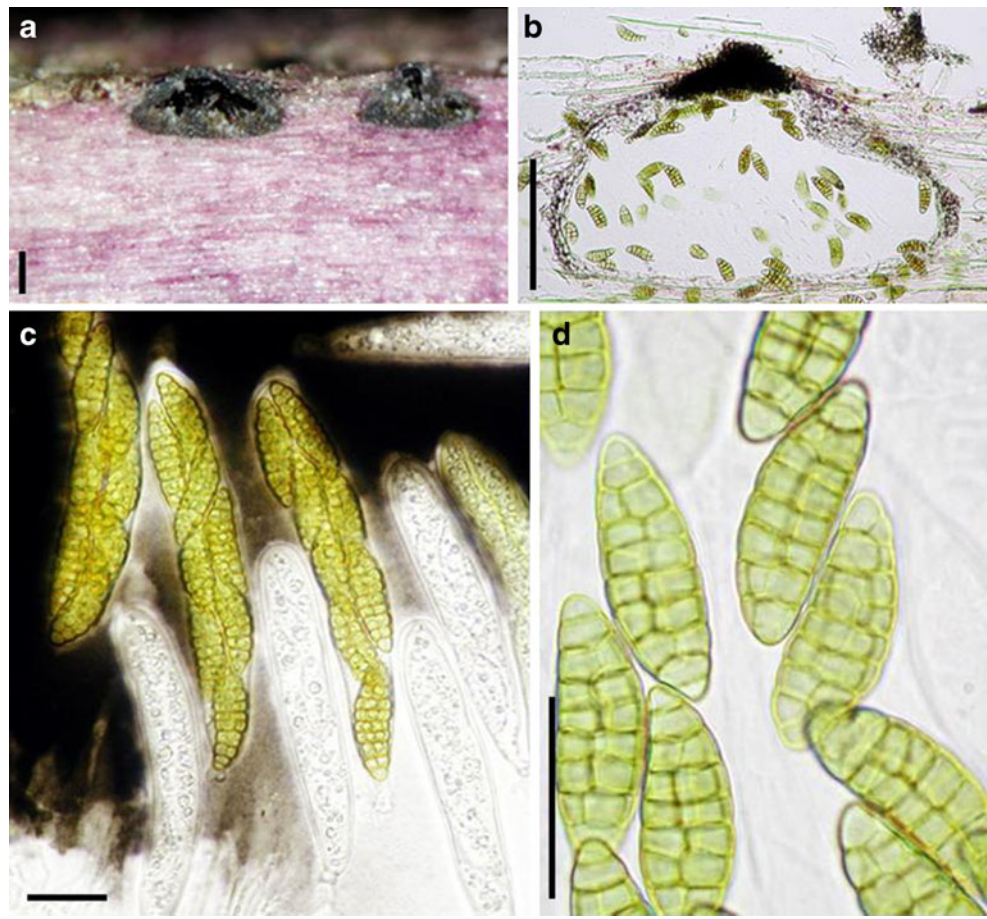
### Generic description

Habitat freshwater, saprobic. *Ascomata* medium-sized, scattered or in small groups, immersed, with a slightly protruding elongated papilla, ostiolate, lenticular, stain the substrate purple. *Peridium* thin. *Hamathecium* of dense, long cellular pseudoparaphyses, septate. *Asci* 8-spored, bitunicate, fissitunicate, cylindro-clavate, with short furcate pedicels. *Ascospores* 2–3-seriate, narrowly fusoid, somewhat curved, reddish brown, multi-septate, slightly constricted at the primary septum.

**Anamorphs reported for genus:** none.

**Literature:** Leuchtman 1984; Zhang et al. 2009a, b.

**Fig. 64** *Murispora rubicunda* (from IFRD 2017). **a** Habitat section of the immersed ascómata. **b** Section of an ascoma. Note the thin peridium and cells of *textura angularis*. **c** Mature and immature asci. **d** Muriform ascospores. Scale bars: **a**, **b**= 100  $\mu\text{m}$ , **c**, **d**=20  $\mu\text{m}$



### Type species

*Neomassariosphaeria typhicola* (P. Karst.) Yin, Zhang, J. Fourn. & K.D. Hyde, Stud. Mycol. 64: 96 (2009a). (Fig. 65)  
 ≡ *Leptosphaeria typhicola* P. Karst., Bidr. Känn. Finl. Nat. Folk 23: 100 (1873).

*Ascómata* 150–280  $\mu\text{m}$  high  $\times$  200–400  $\mu\text{m}$  diam., scattered or in small groups, immersed, lenticular, with a slightly protruding elongated papilla, ostiolate, stain the substrate purple (Fig. 65a). *Peridium* 15–30  $\mu\text{m}$  thick. *Hamathecium* of dense, long cellular pseudoparaphyses, 1.5–2.5  $\mu\text{m}$  thick, septate. *Asci* 110–160  $\times$  13–15  $\mu\text{m}$ , 8-spored, bitunicate, fissitunicate, cylindro-clavate, with short furcate pedicels (Fig. 65b, c and d). *Ascospores* 30–48  $\times$  7–11  $\mu\text{m}$ , 2–3-seriate, narrowly fusoid, somewhat curved, reddish brown, 7-septate, slightly constricted at the primary septum, verruculose (Fig. 65c and d).

**Anamorph:** none reported.

**Material examined:** DENMARK, Sjaeland, Frederikskilde, Suserup Skove, Tystrup Lake, 25 May 2007, on submerged culm of *Phragmites*, leg. & det. Jacques Fournier (IFRD 2018).

### Notes

#### Morphology

*Neomassariosphaeria* is most comparable with *Murispora*, and is distinguished from *Murispora* by its phragmosporous ascospores. Both genera were assigned to *Amniculicolaceae* (Zhang et al. 2009a).

#### Phylogenetic study

Both *Neomassariosphaeria grandispora* and *N. typhicola* clustered with species of *Murispora* and *Amniculicola* in *Amniculicolaceae* (Zhang et al. 2009a,c).

#### Concluding remarks

Similar with those purple-staining species of *Pleospora* assigned to *Murispora*, the purple-staining species of *Phaeosphaeria* mentioned by Crivelli (1983) and Leuchtman (1984) might be assigned to *Neomassariosphaeria*.

*Neophaeosphaeria* M.P.S. Câmara, M.E. Palm & A.W. Ramaley, Mycol. Res. 107: 519 (2003). (*Leptosphaeriaceae*)

**Fig. 65** *Neomassariosphaeria typhicola* (from IFRD 2018). **a** Immersed ascomata gregarious in the host substrate. **b–d** Cylindro-clavate asci embedded in pseudoparaphyses. Note the phragmosporous ascospores. Scale bars: **a**=200  $\mu\text{m}$ , **b–d**=20  $\mu\text{m}$



### Generic description

Habitat terrestrial, parasitic or saprobic. *Ascomata* small, forming in leaf spots, scattered or clustered, immersed, depressed globose, under clypeus, coriaceous. *Peridium* thin. *Hamathecium* of dense, cellular pseudoparaphyses, septate, embedded in mucilage. *Asci* 8-spored, bitunicate, fissituni-

cate dehiscence not observed, broadly cylindrical to oblong, with a short furcate pedicel. *Ascospores* obliquely uniseriate and partially overlapping, oblong, pale brown, 1-3-septate.

**Anamorphs reported for genus:** *Coniothyrium*-like (Câmara et al. 2003).

**Literature:** Câmara et al. 2001, 2003; Checa et al. 2002; Ellis and Everhart 1892.

## Type species

*Neophaeosphaeria filamentosa* (Ellis & Everh.) M.P.S. Câmara, M.E. Palm & A.W. Ramaley, Mycol. Res. 107: 519 (2003). (Fig. 66)

≡ *Leptosphaeria filamentosa* Ellis & Everh., J. Mycol. 4: 64 (1888).

*Ascomata* 115–157  $\mu\text{m}$  high  $\times$  115–186  $\mu\text{m}$  diam., forming in leaf spots, scattered or clustered in circular areas, immersed, depressed globose, with a small ostiolar pore slightly penetrating above the surface, under clypeus, coriaceous, papilla not conspicuous (Fig. 66a). *Peridium* 18–30  $\mu\text{m}$  thick, composed of large pigmented thin-walled cells of *textura angularis*, cells up to 10  $\mu\text{m}$  diam. (Fig. 66c). *Hamathecium* of dense, cellular pseudoparaphyses 1.5–2.5  $\mu\text{m}$  broad, septate, embedded in mucilage (Fig. 66b). *Asci* 70–105  $\times$  8–10  $\mu\text{m}$  ( $\bar{x}$  = 85.3  $\times$  9.7  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate dehiscence not observed, broadly cylindrical to oblong, with a short, broad, furcate pedicel, 6–13  $\mu\text{m}$  long, with a small ocular chamber, best seen in immature asci, up to 1.5  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high (Fig. 66d, e and f). *Ascospores* 12–15  $\times$  4–5  $\mu\text{m}$  ( $\bar{x}$  = 13.8  $\times$  5  $\mu\text{m}$ ,  $n$ =10), obliquely uniseriate and partially overlapping, oblong, yellowish brown, (1-2)-3-septate, constricted at the primary septum, the upper second cell often broader than others, verruculose, containing four refractive globules (Fig. 66g).

**Anamorph:** Ellis and Everhart (1892) noted that the “spermatogonial stage is a *Coniothyrium* (*C. concentricum*) with small (4  $\mu\text{m}$ ), globose, brown sporidia.”

**Material examined:** USA, New Jersey, Newfield, on dead parts in living leaves of *Yucca filamentosa* L., Jul. 1888, Ellis & Everhart (NY, **holotype**).

## Notes

### Morphology

*Neophaeosphaeria* was formally established by Câmara et al. (2003) by segregating *Paraphaeosphaeria* species with 3-4-septate ascospores and anamorphs of ovoid to ellipsoid, non-septate, brown, verrucose to punctuate conidia forming from percurrently proliferating conidiogenous cells. *Neophaeosphaeria filamentosa* was selected as the generic type. Currently, four species are included under *Neophaeosphaeria*, i.e. *N. barrii*, *N. conglomerate* (M.E. Barr) M.P.S. Câmara, M.E. Palm & A.W. Ramaley, *N. filamentosa* and *N. quadrisepata* (M. E. Barr) M.P.S. Câmara, M.E. Palm & A.W. Ramaley (Câmara et al. 2003). At present all species in *Neophaeosphaeria* occur on *Yucca* (*Agavaceae*).

### Phylogenetic study

The four *Neophaeosphaeria* species form a monophyletic clade based on both ITS and SSU rDNA

sequences (Câmara et al. 2001; Checa et al. 2002), and they fall in the group comprising members of *Phaeosphaeriaceae* and *Leptosphaeriaceae* (Câmara et al. 2003). *Neophaeosphaeria filamentosa*, the generic type of *Neophaeosphaeria*, nested in *Leptosphaeriaceae* with low to moderate bootstrap values (Schoch et al. 2009; Zhang et al. 2009a).

### Concluding remarks

The familial status of *Neophaeosphaeria* under *Leptosphaeriaceae* is confirmed, although this family remains poorly supported in phylogenetic studies.

*Nodulosphaeria* Rabenh., Klotzschii Herb. Viv. Mycol., Edn 2: no. 725 (in sched.) (1858). (*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, saprobic or hemibiotrophic. *Ascomata* small, immersed to erumpent, globose or subglobose, black, papillate, ostiolate. *Papilla* with numerous setae in the pore-like ostiole. *Peridium* thin, composed of thick- or thin-walled large cells. *Hamathecium* of cellular pseudoparaphyses, septate and branching. *Asci* 8-spored, bitunicate, fissitunicate, clavate to cylindro-clavate, with a very short, furcate pedicel and a small ocular chamber. *Ascospores* filamentous, hyaline or pale brown, multi-septate, one of the upper cells swollen.

**Anamorphs reported for genus:** none.

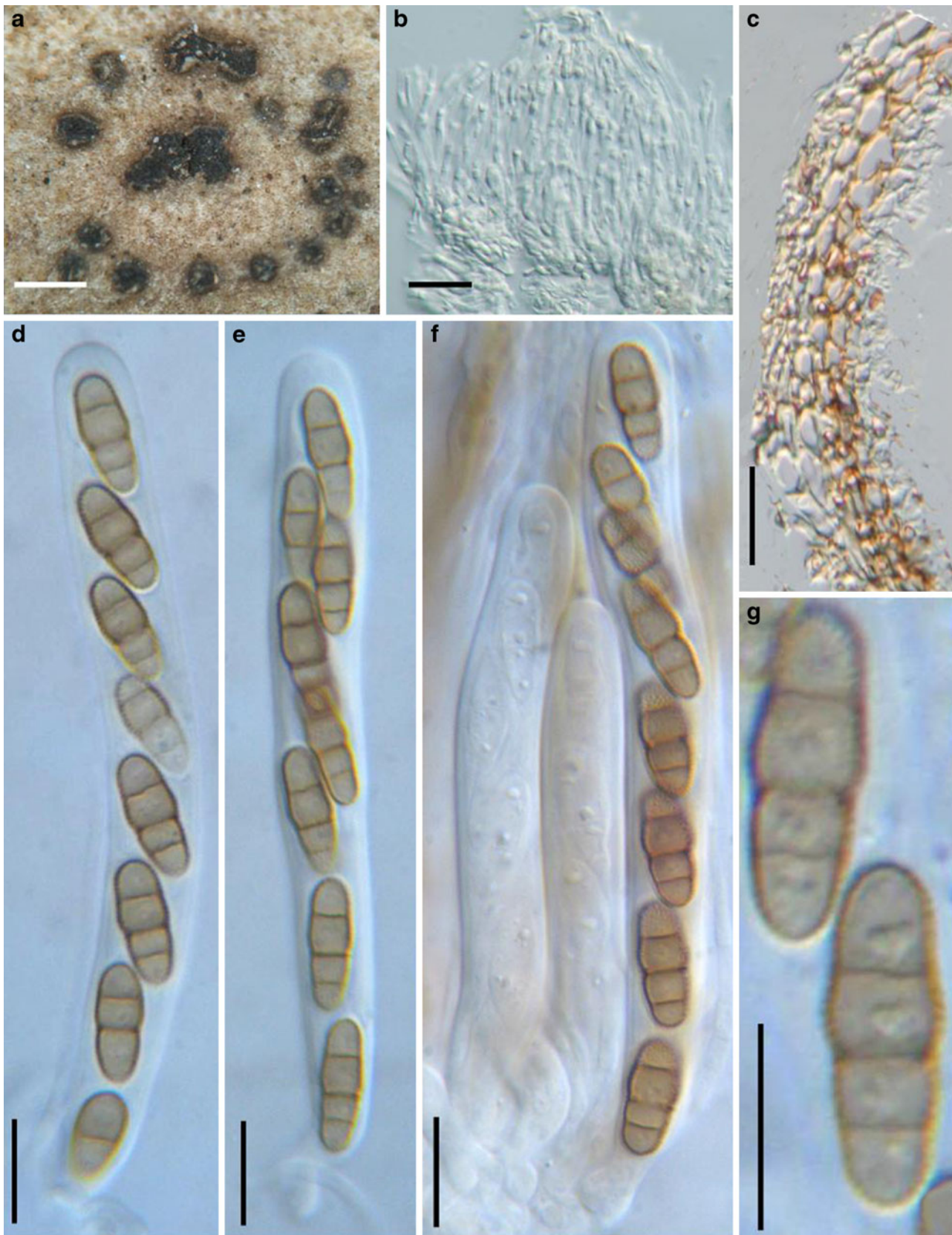
**Literature:** Barr 1992a; Holm 1957, 1961; Shoemaker 1984b; Shoemaker and Babcock 1987.

## Type species

*Nodulosphaeria hirta* Rabenh., Klotzschii Herb. Viv. Mycol., Edn 2: no. 725 (in sched.) (1858). (Fig. 67)

*Ascomata* 260–330  $\mu\text{m}$  high  $\times$  260–330  $\mu\text{m}$  diam., scattered, or in small groups, immersed to erumpent, globose or subglobose, black, papillate, ostiolate. *Papilla* 50–80  $\mu\text{m}$  high, numerous setae occur in the pore-like ostiole (Fig. 67a and b). *Peridium* 15–30  $\mu\text{m}$  wide at the sides, thinner at the base, coriaceous, comprising two types of cells, outer cells of 1–2 layers of heavily pigmented cells of *textura angularis*, cells 6–8  $\mu\text{m}$  diam., cell wall 1.5–3  $\mu\text{m}$  thick, inner of compressed cells, 5  $\times$  13–3  $\times$  8  $\mu\text{m}$  diam., wall 2–3  $\mu\text{m}$  thick (Fig. 67c). *Hamathecium* of long cellular pseudoparaphyses 2–3  $\mu\text{m}$  broad, septate and branching, mucilage not observed. *Asci* 100–123  $\times$  12.5–15 (–17.5)  $\mu\text{m}$  ( $\bar{x}$  = 110.8  $\times$  14.3  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, clavate to cylindro-clavate, with a very short, furcate pedicel, with a small ocular chamber (to 2  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 67d). *Ascospores* 48–63  $\times$  5–6.5  $\mu\text{m}$  ( $\bar{x}$  = 55.3  $\times$  5.6  $\mu\text{m}$ ,  $n$ =10), 4-seriate, filamentous, pale





**Fig. 66** *Neophaeosphaeria filamentosa* (from NY, holotype). **a** Ascomata as a circular cluster on the host surface. **b** Hamathecium of wide pseudoparaphyses. **c** Section of peridium comprising cells of *textura*

*angularis*. **d–f** Cylindrical asci with thickened apex. Note the short furcate pedicel. **g** Pale brown, 3-septate ascospores. Note the verruculose ornamentation. Scale bars: **a**=200  $\mu\text{m}$ , **b**, **c**=20  $\mu\text{m}$ , **d–g**=10  $\mu\text{m}$

brown, 8-septate, the 4th upper cell broader than the others, smooth-walled, without sheath (Fig. 67e and f).

**Anamorph:** none reported.

**Material examined:** GERMANY, Dresdae, in herbarum caulibus emortuis perrara, exeunte majo, 1858 (BR 101945–95, **holotype**, as *Nodulosphaeria hirta*).

## Notes

### Morphology

The name *Nodulosphaeria* was first used by Rabenhorst (1858) but was considered as a synonym of *Leptosphaeria* for many years (Clements and Shear 1931). The name was reinstated by Holm (1957) and was represented by *N. hirta*, which was concurrently treated as a synonym of *N. derasa* (Berk. & Broome) L. Holm. The most outstanding morphological characters of *Nodulosphaeria* were considered to be apex of ascomata often covered with setae, ascospore with three or more transverse septa with a suprmedian enlarged cell or elongated to a scoleospore, mostly with terminal appendages (Barr 1992a; Holm 1961; Shoemaker 1984b). The ascomata are usually immersed and the peridium comprises a few layers of brown, relatively thin-walled cells of *textura angularis* and *textura prismatica* similar to those of *Phaeosphaeria*. Thus, *Nodulosphaeria* is likely to be a member of *Phaeosphaeriaceae*. However, this needs to be confirmed by molecular analysis. The boundary between *Nodulosphaeria* and *Ophiobolus* is not clear-cut, and the circumscriptions of them usually depend on the viewpoint of different mycologists. For instance, Shoemaker (1976) has assigned some *Nodulosphaeria* species such as *N. erythrospora*, *N. fruticum*, *N. mathieui* and *N. megalosporus* to *Ophiobolus*. Subsequently, more species were added to *Nodulosphaeria* (Barr 1992a; Shoemaker 1984b; Shoemaker and Babcock 1987). Currently, more than 60 names are included in *Nodulosphaeria* (<http://www.mycobank.org/>, 06/2010).

### Phylogenetic study

None.

### Concluding remarks

All species included in *Nodulosphaeria* have an inflated ascospore cell as mentioned above. However, it is likely that this character would have evolved more than once as it is probably an adaption for ascospore ejection from the ascus (Shoemaker 1976). It occurs in *Ophiobolus* species and the ascomata of these species are quite dissimilar to *Nodulosphaeria* species and their exclusion from *Nodulosphaeria* seems warranted. When considering whether a species belongs in *Nodulosphaeria*, one must also consider the ascomata and peridium structure until DNA sequences are available.

**Ohleria** Fuckel, *Fungi rhenani* exsic.: no. 2173 (1868). (*Melanommataceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* small to medium size, solitary, scattered, or in small groups, erumpent to nearly superficial, papillate, ostiolate. *Peridium* thin, thicker at the apex, 1-layered. *Hamathecium* of dense, long trabeculate pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, with a short pedicel. *Ascospore* brown to reddish brown, broadly to narrowly fusoid, 3-septate, easily separating into two parts at the primary septum.

**Anamorphs reported for genus:** *Monodictys* (Samuels 1980).

**Literature:** Barr 1990b; Clements and Shear 1931; Patel et al. 1997; Samuels 1980.

### Type species

**Ohleria modesta** Fuckel, *Fungi rhenani* exsic. (1868) (Fig. 68)

*Ascomata* 214–357  $\mu\text{m}$  high  $\times$  285–400  $\mu\text{m}$  diam., solitary, scattered, or in small groups of 2–3, erumpent to nearly superficial, coriaceous, with basal wall remaining immersed in host tissue, broadly or narrowly conical, with a flattened base not easily removed from the substrate, black; apex with a conical protruding papilla and an often pore-like ostiole (Fig. 68a). *Peridium* 22–53  $\mu\text{m}$  thick laterally, thicker at the apex, 1-layered, composed of heavily pigmented thick-walled cells of *textura angularis*, cells to 7  $\mu\text{m}$  diam., cell wall 1.5–3  $\mu\text{m}$  thick, apex cells smaller and walls thicker, base cells walls thinner (Fig. 68b). *Hamathecium* of dense, long trabeculate pseudoparaphyses 1–2  $\mu\text{m}$  broad, septate, branching and anastomosing (Fig. 68c). *Asci* 90–130  $\times$  (5.5–)7–10  $\mu\text{m}$  ( $\bar{x}$  = 107.3  $\times$  8  $\mu\text{m}$ ,  $n$ =10), 8-spored, with a short pedicel up to 20  $\mu\text{m}$  long, bitunicate, fissitunicate, cylindrical, with a small ocular chamber (to 1.5  $\mu\text{m}$  wide  $\times$  1.5  $\mu\text{m}$  high) (Fig. 68c, d and e). *Ascospore* 15–22  $\times$  4–5  $\mu\text{m}$  ( $\bar{x}$  = 20  $\times$  4.4  $\mu\text{m}$ ,  $n$ =10), biseriate near the top and uniseriate at the base, broadly fusoid to fusoid with broadly to narrowly rounded ends, brown to reddish brown, 3-septum, deeply constricted at the median septum and breaking into two conical partspores, no constriction at the secondary septum, smooth (Fig. 68d and e).

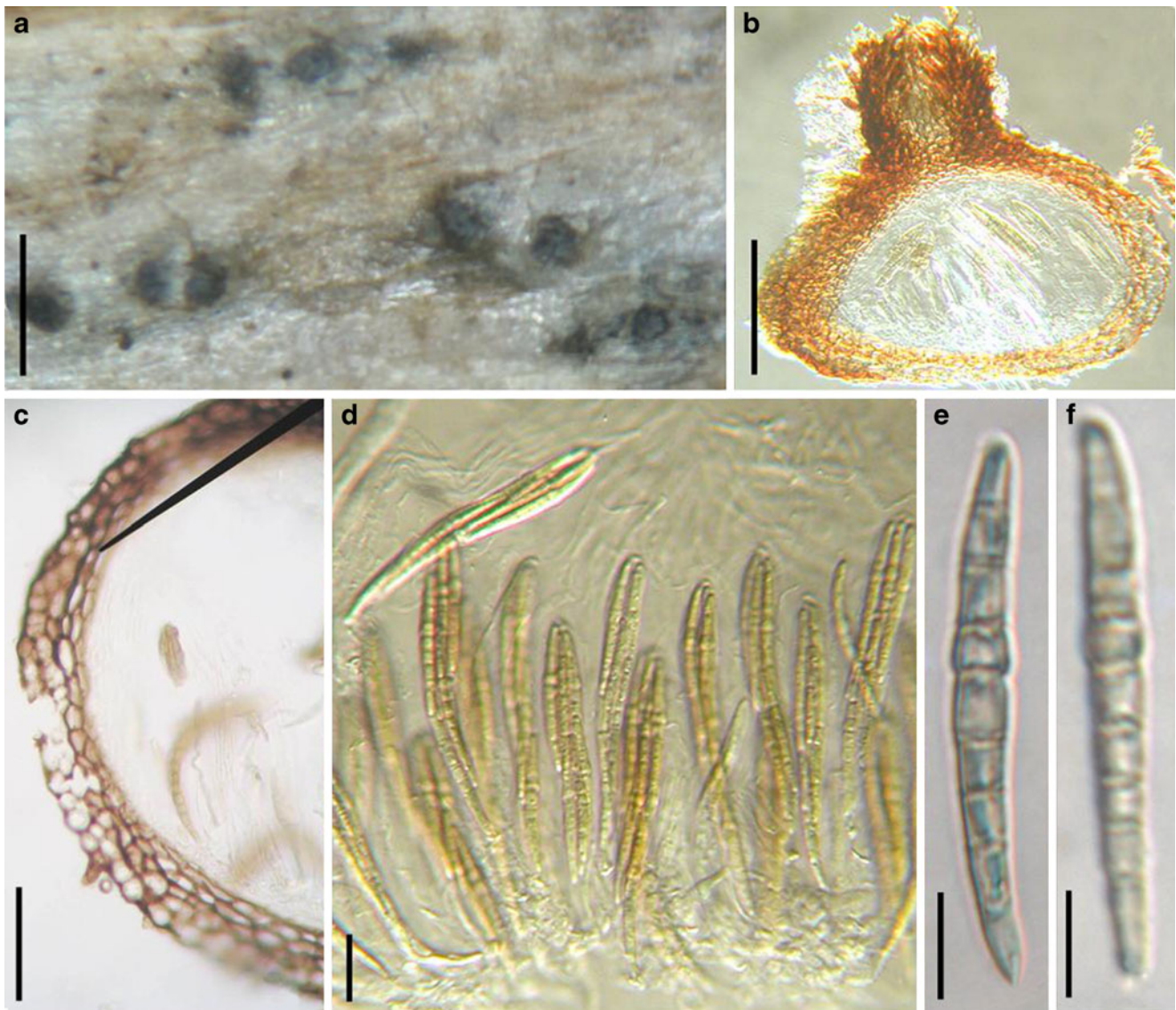
**Anamorph:** none reported.

**Material examined:** GERMANY, on decorticated, decaying roots of *Fagus sylvatica*, very rare, collected in autumn (G: F. rh. 2173, **isotype**).

## Notes

### Morphology

*Ohleria* is characterized by its subglobose to conic ascomata, produced on decorticated woody substrates, as



**Fig. 67** *Nodulosphaeria hirta* (from BR 101945–95, **holotype**). **a** Appearance of ascomata on the host surface. **b** Vertical section of an ascoma. Note the setae at the apex and in the ostiole. **c** Section of a partial peridium. Note the outer layer cells of *textura angularis* and

inner layer compressed cells. **d** Squash mount showing asci in pseudoparaphyses. **e, f** The light brown filiform ascospores. Scale bars: **a**=0.5 mm, **b**=100  $\mu\text{m}$ , **c**=50  $\mu\text{m}$ , **d**=20  $\mu\text{m}$ , **e, f**=10  $\mu\text{m}$

well as its brown and phragmosporous ascospores which break into two parts at the median septum (Samuels 1980). Some species of *Ohleria* are widespread. For instance, *O. brasiliensis* is reported from New Zealand, Brazil as well as United States (Samuels 1980). *Ohleria* has been considered closely related to *Sporormia* and *Preussia* based on the ascospore characters, and several species of *Ohleria*, such as *O. aemulans* Rehm, *O. haloxyli* Kravtzev, *O. silicata* Kravtzev and *O. kravtzevii* Schwarzman, have been transferred to these genera. Clements and Shear (1931) treated *Ohleria* as a synonym of *Ohleriella*, despite the fact that *Ohleriella* is a coprophilous fungus. When the ascomata and

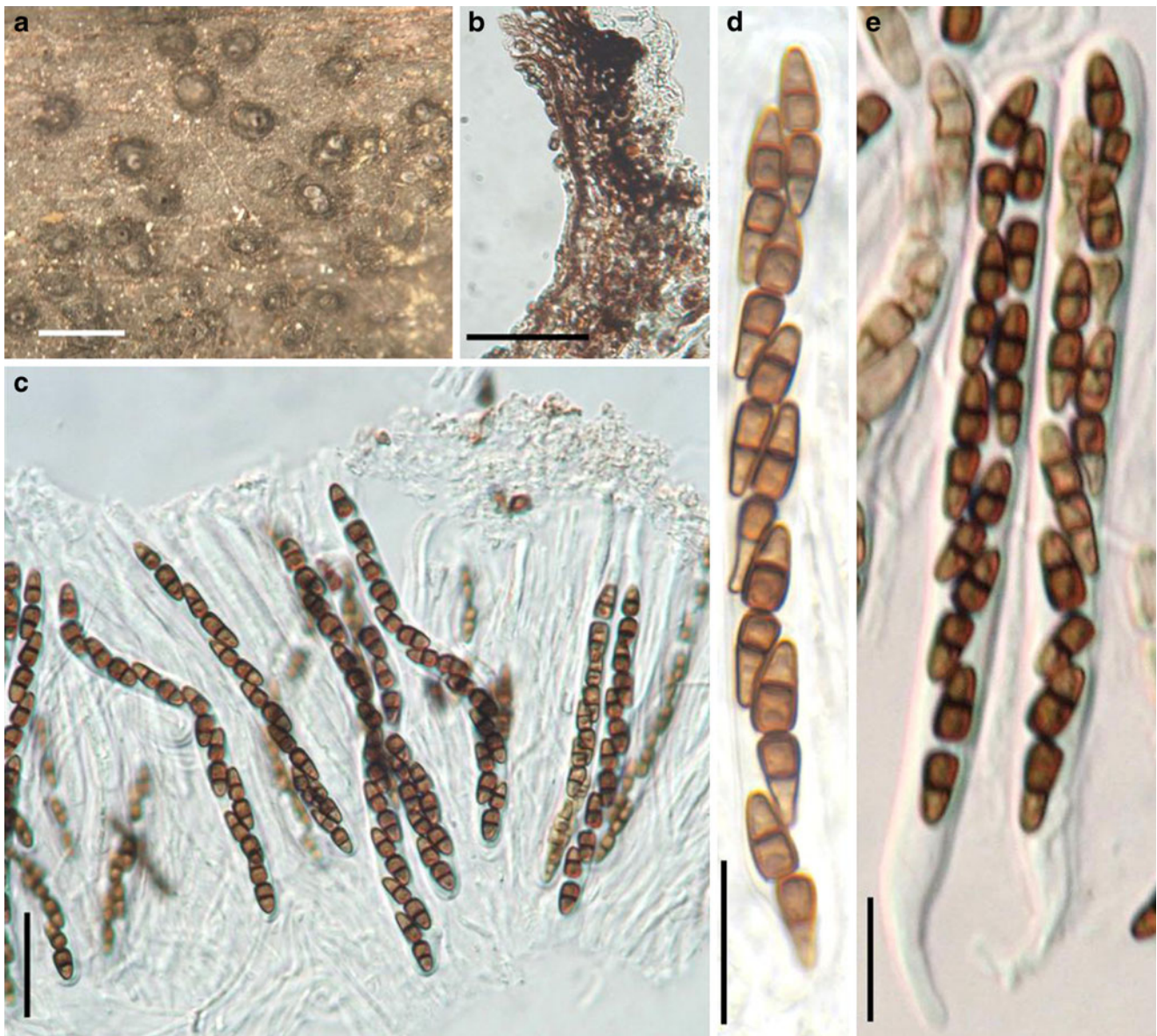
habitats are considered, *Ohleria* seems closely related to *Melanomma* and *Trematosphaeria* (Samuels 1980).

#### Phylogenetic study

None.

#### Concluding remarks

To some degree, habitats show phylogenetic significance (Zhang et al. 2009a). Thus, *Ohleria* seems less likely related to *Sporormia* and *Preussia*. But its relationship with *Melanomma* is uncertain, because of their differences in hamathecium and ascospores.



**Fig. 68** *Ohleria modesta* (from g: f. rh. 2173, isotype). **a** Ascomata scattering on host surface. **b** Section of a partial peridium. **c** Asci embedded in pseudoparaphyses. **d, e** Cylindrical asci with short pedicels. Scale bars: **a**=1 mm, **b, c**=50  $\mu\text{m}$ , **d, e**=20  $\mu\text{m}$

***Ohleriella*** Earle, Bull N Y Bot Gard 2: 349 (1902). (*Delitschiaceae*)

#### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium to large, immersed, erumpent to nearly superficial, scattered or in small groups, usually with a wide papilla, ostiolate, coriaceous. *Peridium* composed of small pigmented cells of *textura angularis*. *Asci* 8-spored or fewer, cylindro-clavate, with a furcate pedicel. *Hamathecium* of trabeculate pseudoparaphyses. *Ascospores* brown to dark brown, cylindrical to nearly clavate with broadly to narrowly round

ends, multi-septate, easily broken into partspores, smooth, with elongated germ slit in each cell.

**Anamorphs reported for genus:** none.

**Literature:** Ahmed and Cain 1972; von Arx and Müller 1975; Barr 1990a; Clements and Shear 1931.

#### Type species

***Ohleriella neomexicana*** Earle, Bull N Y Bot Gard 2: 349 (1902). (Fig. 69)

*Ascomata* 330–420  $\mu\text{m}$  high  $\times$  400–575  $\mu\text{m}$  diam., solitary, scattered, or in small groups, immersed to erumpent, to nearly superficial, with basal wall remaining

immersed in host tissue, coriaceous, globose or subglobose, usually a somewhat thick, short papilla, up to 100  $\mu\text{m}$  high, with a pore-like ostiole (Fig. 69a). *Peridium* 27–35  $\mu\text{m}$  thick laterally, up to 55  $\mu\text{m}$  thick at the apex, 1-layered, composed of small pigmented cells of *textura angularis*, cells up to 5  $\times$  8  $\mu\text{m}$  diam., cell wall 1.5–2  $\mu\text{m}$  thick, apex cells smaller and walls thicker (Fig. 69b). *Hamathecium* of dense, long trabeculate pseudoparaphyses, 1–1.5  $\mu\text{m}$  broad, anastomosing and branching between and above the asci. *Asci* 150–208  $\times$  17.5–25  $\mu\text{m}$  ( $\bar{x}$  = 182.5  $\times$  22  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a narrowed, furcate, thin pedicel, 15–55  $\mu\text{m}$  long, 2–3.5  $\mu\text{m}$  broad, with a large truncate ocular chamber best seen in immature asci (to 4  $\mu\text{m}$  wide  $\times$  3  $\mu\text{m}$  high) (Fig. 69e, f and g). *Ascospores* 55–72.5  $\times$  10–12  $\mu\text{m}$  ( $\bar{x}$  = 63  $\times$  10.4  $\mu\text{m}$ ,  $n$ =10), 3–4 seriate to uniseriate near the base, cylindrical to clavate, with broadly to narrowly rounded ends, brown, 6–7 transverse septa, easily separating into partspores, with germ slits, central partspores of the ascospores shorter than broad, rectangular in vertical section, round in transverse section, 7–8  $\times$  6–10  $\mu\text{m}$  diam., apical cells usually longer than broad, 11–17.5  $\times$  6–7  $\mu\text{m}$  diam. (Fig. 69c and d).

**Anamorph:** none reported.

**Material examined:** USA, Albuquerque, Bernalillo Co., New Mexico, dry gravelly hill, on wood, 29 Nov. 1901, T. S.A. Cockerell (NY, **holotype**).

## Notes

### Morphology

*Ohleriella* was formally established by Earle (1902) based on its “medium to large ascomata with a wide papilla, relatively wide peridium, cylindro-clavate asci, brown to deep brown multi-septate ascospore, with elongated germ slit on each cell”, and was monotypified by *O. neomexicana* (Barr 1990a). *Ohleriella* subsequently has been treated as a synonym of *Ohleria*, *Sporormiella* or *Preussia* (Ahmed and Cain 1972; von Arx and Müller 1975; Clements and Shear 1931). *Spororminula tenerifae*, the generic type of *Spororminula*, was assigned to *Ohleriella*, thus *Spororminula* was treated as a synonym of *Ohleriella* (Barr 1990a). Two new species were introduced by Barr (1990a) from North America. Currently, three species are included in this genus, i.e. *O. herculean* (Ellis & Everh.) M.E. Barr, *O. neomexicana* and *O. nudilignae* M.E. Barr & Malloch (<http://www.indexfungorum.org>; <http://www.mycobank.org>, 01/03/2009).

The generic type, *O. neomexicana*, is morphologically similar to the coprophilous genus *Sporormiella*, but is saprobic on grass stems.

### Phylogenetic study

None.

### Concluding remarks

Although we maintain *Ohleriella* as a separate genus here, its saprobic habitat on grasses and similarity to the coprophilous *Sporormiella* may indicate a close evolutionary relationship, with the grass saprobic possibly being an early relative of the coprophilous *Sporormiella*. Alternatively, the species/genera may simply occupy different ecological niches (i.e. dead grass vs dead grass in dung). Molecular studies are needed to resolve this issue.

***Ophiobolus*** Reiss, Hedwigia 1:27 (1854).  
(*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, saprobic or hemibiotrophic. *Ascomata* medium-sized, solitary, scattered, or in groups, globose or pyriform, coriaceous, black, papillate, ostiolate, periphysate. *Peridium* thin, thicker near the apex, thinner at the base. *Hamathecium* of long cellular pseudoparaphyses, septate, anastomosing or branching not observed. *Asci* 8-spored, bitunicate, fissitunicate dehiscence not observed, cylindrical, with a short, furcate pedicel. *Ascospores* filamentous, narrower toward the lower end, pale brown, multi-septate, separating into two partspores from the middle septum, from the breaking point, the second cell of each partspore enlarged.

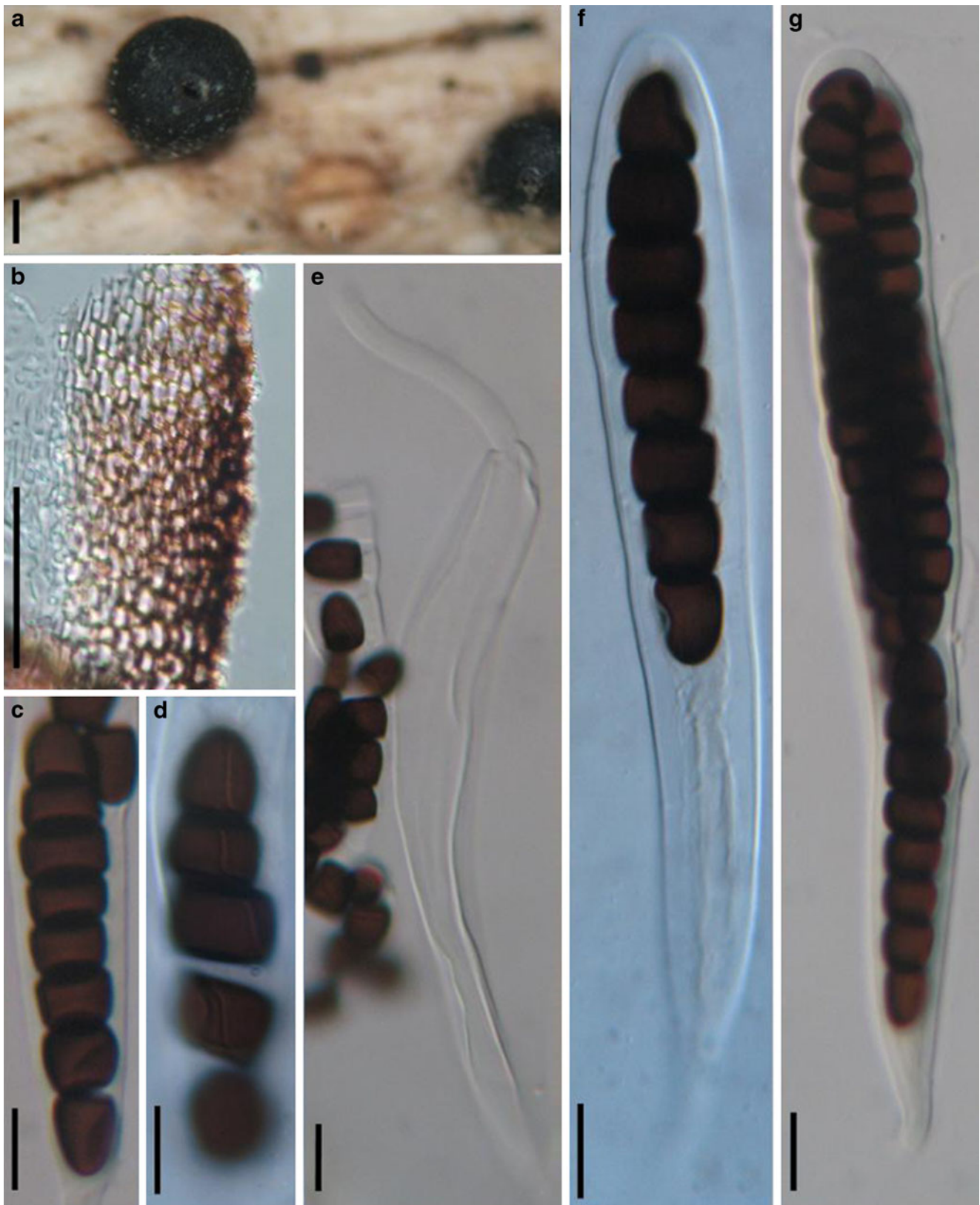
**Anamorphs reported for genus:** *Coniothyrium*-like, *Rhabdospora*, *Phoma*-like and *Scolecosporiella* (Hyde et al. 2011; Shoemaker 1976; Sivanesan 1984).

**Literature:** Holm 1948, 1957; Müller 1952; Reiss 1854; Shoemaker 1976; Sivanesan 1984.

### Type species

***Ophiobolus disseminans*** Reiss, Hedwigia 1:27 (1854) (Fig. 70).

*Ascomata* 220–380  $\mu\text{m}$  high  $\times$  290–430  $\mu\text{m}$  diam., solitary, scattered, or in groups often arranged in a row, immersed with a protruding papilla, globose, pyriform, coriaceous, black, periphysate. *Papilla* 40–90  $\mu\text{m}$  high, with a pore-like ostiole (Fig. 70a and b). *Peridium* 40–55  $\mu\text{m}$  wide at the sides, up to 70  $\mu\text{m}$  thick at the apex, thinner at the base, comprising two cell types, outer layer composed of small heavily pigmented thick-walled cells of *textura angularis*, cells 2–5  $\mu\text{m}$  diam., cell wall 2–3  $\mu\text{m}$  thick, apex cells smaller and walls thicker, inner layer composed of lightly pigmented or hyaline thin-walled cells of *textura angularis*, 5–7  $\mu\text{m}$  diam., wall 1.5–2  $\mu\text{m}$  thick, merging with pseudoparaphyses (Fig. 70c). *Hamathecium* of long cellular pseudoparaphyses, 2–3  $\mu\text{m}$  broad, septate, anastomosing or branching not observed (Fig. 70e). *Asci* 150–195  $\times$  8–12.5  $\mu\text{m}$  ( $\bar{x}$  = 169.5  $\times$  10.7  $\mu\text{m}$ ,



**Fig. 69** *Ohleriella neomexicana* (NY, holotype). **a** Ascospores scattering on the host surface. **b** Section of a partial peridium. Note the small cells of *textura angularis*. **c** Ascospore in ascus. **d** Ascospore breaking

into part spores. Note the sigmoid germ slit. **e** Dehiscent ascus. **f, g** Asci with short pedicels. Scale bars: **a**=100  $\mu\text{m}$ , **b**=50  $\mu\text{m}$ , **c**–**g**=10  $\mu\text{m}$

$n=10$ ), 8-spored, bitunicate, fissitunicate dehiscence not observed, cylindrical but narrowing towards the base, with a short, furcate pedicel which is 10–25  $\mu\text{m}$  long, ocular chamber not observed (Fig. 70d and e). *Ascospores* 110–160 $\times$ 2.5–4  $\mu\text{m}$  ( $\bar{x} = 135.3 \times 3\mu\text{m}$ ,  $n=10$ ), filamentous, narrower toward the lower end, pale brown, 22–30-septate, separating into two partspores from the middle septum, from the breaking point the second cell of each partspore enlarged.

**Anamorph:** none reported.

**Material examined:** GERMANY, near Kassel, on dead stem of *Cirsium arvense* (L.) Scop., Spring 1853 (BPI-629021, **type**).

## Notes

### Morphology

*Ophiobolus* was established by Reiss (1854) as a monotypic genus represented by *O. disseminans* based on its “Perithecia discreta, ostiolis prominentibus: sporae ascis inclusae, binatae, filliformes, multiseptatae”.

A broad generic concept was adopted for the genus by Holm (1948) and Müller (1952). Shoemaker (1976) surveyed Canadian species of *Ophiobolus* using the broad concept of Holm (1948) and Müller (1952). A narrower generic concept was used by Holm (1957), which only included species with ascospores separating into two halves. Holm (1957) assigned species with enlarged ascospore cells to *Nodulosphaeria*, and those with long spirally coiled ascospores to *Leptospora* (Shoemaker 1976). This left only three species accepted under *Ophiobolus* (Holm 1957), although this concept has rarely been followed with new species recently being described (Raja and Shearer 2008).

Walker (1980) provided a detailed description from the type material and dealt with many species of scolecospored fungi that had been placed in *Ophiobolus* by Saccardo (1883). Thus, currently several *Ophiobolus sensu lato* species are separated into *Acanthophiobolus*, *Entodesmium*, *Leptosphaeria* and *Leptospora*. *Ophiobolus sensu lato* contains about 300 species names (Sivanesan 1984; <http://www.mycobank.org/>, 04/02/2009).

### Phylogenetic study

*Ophiobolus fulgidus* (Cooke & Peck) Sacc. (as *Leptosphaeria fulgida* (Cooke & Peck) M. E. Barr in Dong et al. 1998) lacks support in the clade of *Leptosphaeriaceae* (Dong et al. 1998). We expect it may closely related to *Phaeosphaeriaceae*.

### Concluding remarks

We agree from morphological data that *Ophiobolus* should comprise species that have filamentous spores that break easily into two halves at the central septum, with the

second cell on either side being swollen (Walker 1980) and that the genus presently comprises three species (i.e. *O. anthrisci* (L. Holm) L. Holm, *O. ophioboloides* (Sacc.) L. Holm and *O. acuminatus*). All other *Ophiobolus* species need to be re-examined and should be placed in other genera such as *Nodulosphaeria* and *Leptospora*. The genus is in need of revision and molecular phylogenetic study.

***Ophiosphaerella*** Speg., Anal. Mus. nac. Hist. nat. B. Aires 19: 401–402 (1909). (*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, saprobic or hemibiotrophic. *Ascomata* small- to medium-sized, solitary or scattered, immersed, globose or subglobose, papillate, ostiolate. *Peridium* thin. *Hamathecium* of dense, filliform, septate pseudoparaphyses. *Asci* bitunicate, fissitunicate dehiscence not observed, cylindrical often narrower near the base, with a short furcate pedicel. *Ascospores* filamentous, pale brown, multi-septate.

**Anamorphs reported for genus:** *Scolecosporiella* (Farr et al. 1989).

**Literature:** von Arx and Müller 1975; Schoch et al. 2006, 2009; Spegazzini 1909; Walker 1980; Wetzel et al. 1999; Zhang et al. 2009a.

### Type species

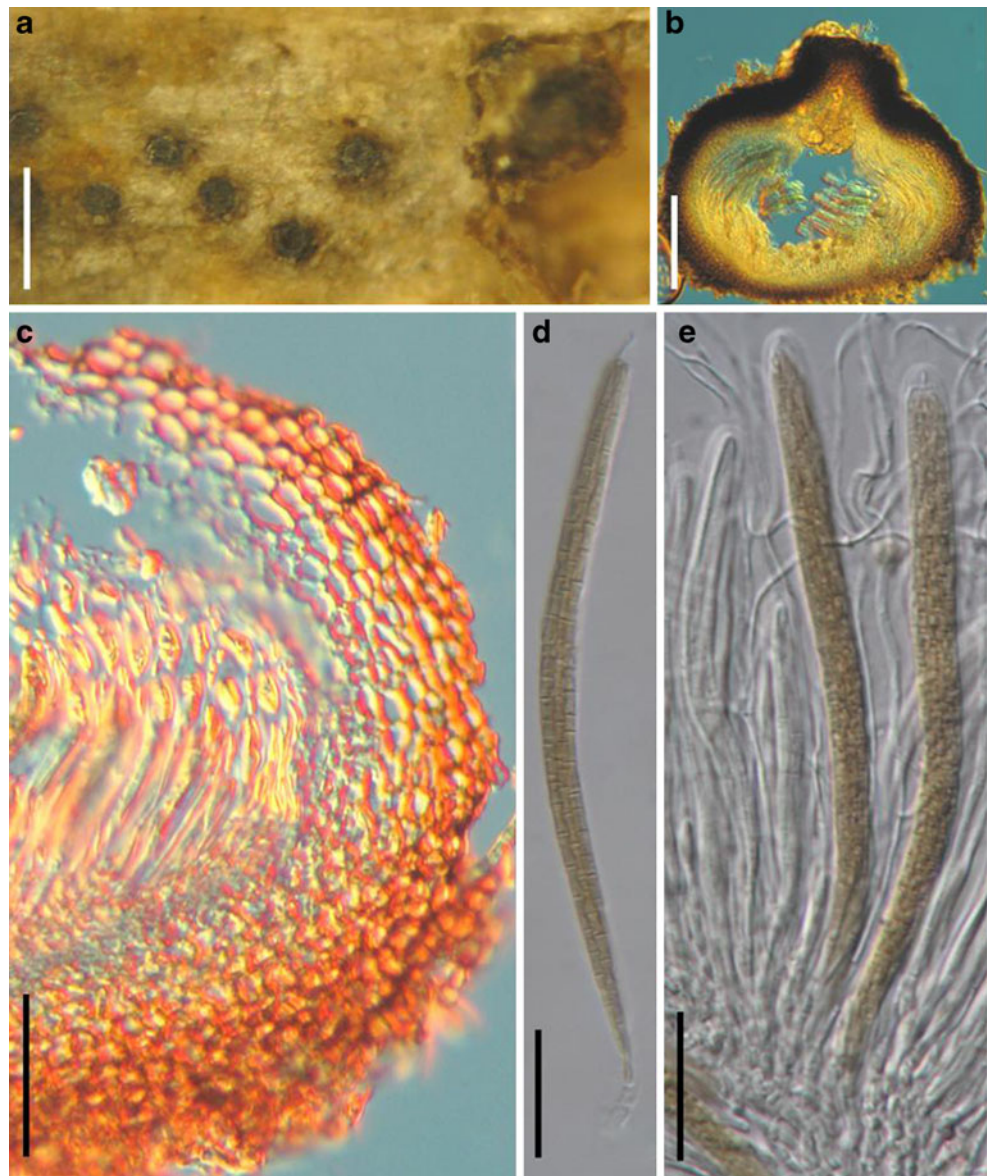
***Ophiosphaerella graminicola*** Speg., Anal. Mus. nac. Hist. nat. B. Aires 19: 401 (1909). (Fig. 71)

*Ascomata* 280–325  $\mu\text{m}$  high $\times$ 250–300  $\mu\text{m}$  diam., solitary or scattered, immersed with a short papilla protruding out of the substrate, globose or subglobose, often laterally flattened, dark brown to black, papillate, papilla ca. 100  $\mu\text{m}$  high, 140–180  $\mu\text{m}$  broad, disk-like in appearance from above, periphysate (Fig. 71a and b). *Peridium* 11–25  $\mu\text{m}$  wide, thicker near the apex, comprising two cell types of small cells, outer wall composed 6–10 layers of lightly brown flattened cells of *textura angularis*, inner layer composed of paler and thin-walled cells, both layers thicker near the apex (Fig. 71b). *Hamathecium* of dense, long pseudoparaphyses 0.8–1.5  $\mu\text{m}$  broad near the apex, septate, 2–3  $\mu\text{m}$  broad between the asci. *Asci* 105–135 $\times$ 5.5–10  $\mu\text{m}$  ( $\bar{x} = 118.5 \times 7\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, cylindrical and narrower near the base, with a short, furcate pedicel, up to 30  $\mu\text{m}$  long, small inconspicuous ocular chamber (to 1.5  $\mu\text{m}$  wide $\times$ 1  $\mu\text{m}$  high) (Fig. 71c, d, e and f). *Ascospores* 100–125 $\times$ 1.8–2.2  $\mu\text{m}$  ( $\bar{x} = 118 \times 2\mu\text{m}$ ,  $n=10$ ), filamentous, pale brown, 12–20 septa, smooth-walled.

**Anamorph:** none reported.

**Material examined:** ARGENTINA, Tucumán, on leaf sheath of *Leptochloa virgata* (L.) P. Beauv., 14 Apr. 1906, C. Spegazzini (LPS 858, **holotype**).

**Fig. 70** *Ophiobolus disseminans* (from BPI-629021, type). **a** Immersed ascomata scattered on the host surface. Note the erumpent papilla. **b** Section of an ascoma. Note the thick-walled outer layer and thin-walled inner layer (orange colour due to DIC). **c** Section of a partial peridium. Note the thick-walled outer layer and thin-walled inner layer (orange colour due to DIC). **d** Ascus with a short furcate pedicel. **e** Squash mount showing asci in pseudoparaphyses. Scale bars: **a**=0.5 mm, **b**=100  $\mu\text{m}$ , **c**=50  $\mu\text{m}$ , **d**, **e**=20  $\mu\text{m}$



## Notes

### Morphology

*Ophiosphaerella* was introduced by Spegazzini (1909) who described and illustrated a single new species, *O. graminicola*, and thus the genus was validly published (Walker 1980, p. 70). After checking the type specimen, Petrak and Sydow (1936) transferred the generic type to *Ophiobolus graminicolus* (Speg.) Petrak & Syd, and assigned *Ophiosphaerella* as a synonym of *Ophiobolus*. This was followed by von Arx and Müller (1975). *Ophiosphaerella* differs from *Phaeosphaeria* by its scolecospores without swollen cells or appendages, and from *Ophiobolus* by its ascospores without swollen cells or

separating into partspores, thus was kept as a separating genus (Eriksson 1967a; Walker 1980).

### Phylogenetic study

*Ophiosphaerella* forms a monophyletic group as a sister group of *Phaeosphaeria* located in *Phaeosphaeriaceae* (Schoch et al. 2006, 2009; Wetzell et al. 1999; Zhang et al. 2009a).

### Concluding remarks

Numerous *Ophiobolus* species are likely to belong in *Ophiosphaerella*. The two genera are distinguished as *Ophiobolus sensu* Shoemaker (1976) has swollen central cells or breaking into partspores or with long spirally coiled ascospores, and *Ophiosphaerella* (*sensu* Walker



1980) has scolecospores without swollen central cells or breaking into partspores. The recent introduction of *Ophiobolus shoemakeri* Raja & Shearer (Raja and Shearer 2008) is probably incorrect since the ascospores do not split up into partspores and there is no swelling above septum either. In particular, its freshwater habitat also distinguishes it from other species of *Ophiobolus*. Like *Ophiobolus*, *Ophiosphaerella* is in need of phylogenetic analysis but appears to be closely related to *Phaeosphaeriaceae* (Schoch et al. 2006).

***Ostropella*** (Sacc.) Höhn., Annl. mycol. 16: 144 (1918). (*Pleosporales*, genera incertae sedis)  
 ≡ *Ostropa* subgen. *Ostropella* Sacc., Syll. fung. (Abellini) 2: 805 (1883).

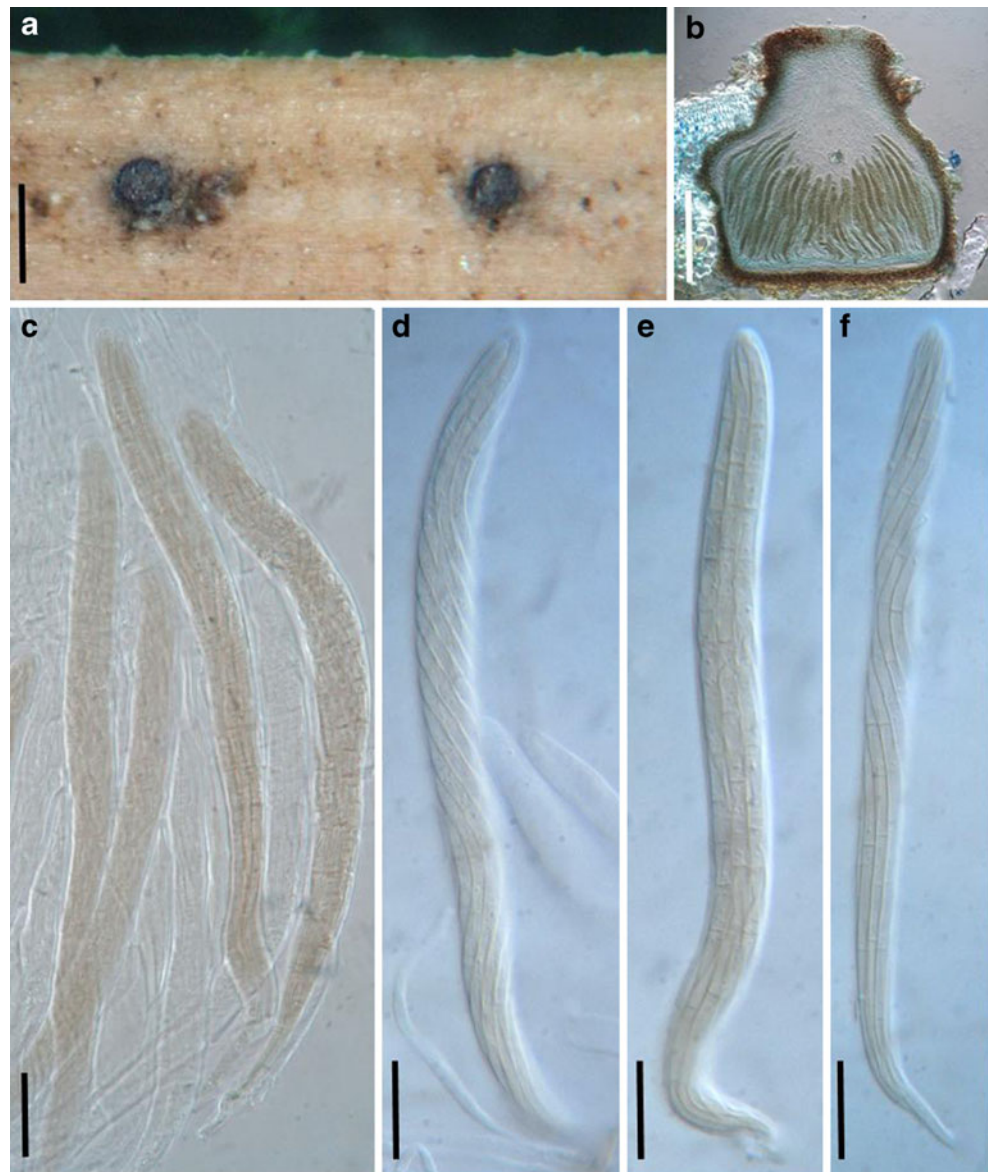
### Generic description

Habitat terrestrial, saprobic. *Ascomata* large, erumpent to superficial, solitary or gregarious, globose to subglobose, with broad and compressed papilla and slit-like ostiole. *Peridium* carbonaceous. *Hamathecium* of dense, long trabeculate pseudoparaphyses, anastomosing and branching, rarely septate, embedded in mucilage. *Asci* clavate with very long and thin and furcate pedicels. *Ascospores* pale brown, ellipsoid to fusoid, 1-septate, constricted.

**Anamorphs reported for genus:** none.

**Literature:** Barr 1990a; Chesters and Bell 1970; Holm and Yue 1987; Huhndorf 1993; Müller and von Arx 1962; Müller and Dennis 1965; Saccardo 1883.

**Fig. 71** *Ophiosphaerella graminicola* (from LPS 858, holotype). **a** Ascomata on the host surface. Note the protruding disk-like papilla. **b** Section of an ascoma. **c** Asci in pseudoparaphyses with short pedicels. **d–f** Cylindrical asci with short pedicels. Scale bars: **a**=0.5 mm, **b**=100  $\mu$ m, **c–f**=10  $\mu$ m



## Type species

*Ostropella albocincta* (Berk. & M.A. Curtis) Höhn., Annl. mycol. 16: 144 (1918). (Fig. 72)

≡ *Ostropa albocincta* Berk & M.A. Curtis, in Berkeley, J. Linn. Soc., Bot. 10: 372 (1868).

*Ascomata* 1000–1730  $\mu\text{m}$  high  $\times$  1050–1450  $\mu\text{m}$  diam., scattered to gregarious, erumpent to superficial, globose to subglobose, roughened, often covered with white crustose covering, with subiculum, with a broad compressed papilla and long and slit-like ostiole (Fig. 72a). *Peridium* 100–250  $\mu\text{m}$  thick, not of uniform thickness throughout entire wall area, composed of two cell types, one is of lightly pigmented thin-walled cells of *textura prismatica*, cells up to  $17 \times 3 \mu\text{m}$  diam., cell wall  $< 1 \mu\text{m}$  thick, intermingled with small heavily pigmented thick-walled cells of *textura globosa*, cells up to 5  $\mu\text{m}$  diam., cell wall 2–3  $\mu\text{m}$  thick (Fig. 72b). *Hamathecium* of dense, long trabeculate pseudoparaphyses, 1.2–1.8  $\mu\text{m}$  broad, anastomosing and branching, rarely septate, embedded in mucilage (Fig. 72c). *Asci* 90–150(–180)  $\times$  8–13(–17)  $\mu\text{m}$  ( $\bar{x} = 120.5 \times 11.5 \mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissionate dehiscence not observed, cylindro-clavate, with a long, narrowed, furcate pedicel which is up to 75  $\mu\text{m}$  long, and with a small ocular chamber best seen in immature asci (up to 2  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 72d and e). *Ascospores* 18–26  $\times$  5–6  $\mu\text{m}$  ( $\bar{x} = 22.4 \times 5.6 \mu\text{m}$ ,  $n=10$ ) biseriolate in upper part and uniseriolate in lower part, fusoid, pale brown, 1-septate, deeply constricted at the septum, smooth or rarely verrucose (Fig. 72f, g and h).

**Anamorph:** none reported.

**Material examined:** Wright s.n., Herb. G.E. Masee, (NY 921990, possible **isotype**); CUBA, as *Ostropa albocincta*, C. Wright 345, 1879 (K(M): 143941, **syntype**).

## Notes

### Morphology

*Ostropella* was established by Saccardo (1883) as a subgenus of *Ostropa* and was monotypic being represented by *O. albocincta*. The genus was formally established (as *Ostropella*) and redescribed by von Höhnel (1918b) and later the description was modified by several workers (Barr 1990a; Huhndorf 1993; Müller and von Arx 1962; Müller and Dennis 1965). *Ostropella* is characterized by having large ascomata, a conspicuous ridged compressed papilla with an elongated slit-like ostiole, and 1-septate lightly pigmented ascospores.

The affinity of *Ostropella* to *Schizostoma sensu* Sacc. was first recognized by von Höhnel (1918b) and this was accepted by Müller and von Arx (1962) and they transferred *Schizostoma pachythele* (Berk. & Broome) Sacc. and *Ostreionella fusispora* Seaver to *Ostropella*. Holm and Yue (1987), however, disagreed with this transfer because of the

differences in ascomatal vestiture and the rather thick wall comprising two cell types of *Ostropella albocincta* differ from those of *Schizostoma pachythele*. Chesters and Bell (1970) suggested that *S. pachythele*, *Xenolophium leve* and *X. verrucosum* Syd. are three varieties under *Lophiostoma pachythele* (Berk. & Broome) Chesters & A.E. Bell. The conspecific status of the three taxa was supported by Holm and Yue (1987). Although no combination was made, Holm and Yue (1987) assigned these taxa to *Xenolophium* instead of *Lophiostoma*. Barr (1990a) suggested that either *Ostropella* or *Xenolophium* could accommodate these closely related taxa, i.e. *O. fusispora* (Seaver) E. Müll., *S. pachythele*, *X. leve*, and *X. verrucosum*. Huhndorf (1993) formally transferred *S. applanata* Petch and *S. pachythele* to *Xenolophium*.

### Phylogenetic study

Phylogenetic analysis based on LSU sequences indicated that *Ostropella albocincta* clusters together with *Xenolophium applanatum* as well as species of *Platystomum*, but they receive poor support (Mugambi and Huhndorf 2009b). They all were temporarily assigned under *Platystomaceae* (Mugambi and Huhndorf 2009b).

### Concluding remarks

Although the placement of *Ostropella albocincta* under *Platystomaceae* lacks support, *Ostropella* should be excluded from *Melanommataceae* despite its trabeculate pseudoparaphyses.

***Paraliomyces*** Kohlm., Nova Hedwigia 1: 81 (1959). (*Pleosporales*, genera *incertae sedis*)

### Generic description

Habitat marine, saprobic. *Ascostromata* immersed, penetrating into the substrate with dark brown hyphae. *Ascomata* medium-sized, solitary, immersed or erumpent, subglobose to pyriform, subiculate or nonsubiculate, papillate or epapillate, ostiolate, periphysate, carbonaceous. *Peridium* thick. *Hamathecium* of long trabeculate pseudoparaphyses. *Asci* 8-spored, bitunicate, fissionate, cylindrical, with a short furcate pedicel, without apical apparatus, uniseriolate. *Ascospores* ellipsoid to broadly fusoid with broadly rounded ends, 1-septate, constricted at the septum, hyaline, smooth-walled, surrounded by a gelatinous sheath.

**Anamorphs reported for genus:** none.

**Literature:** Kohlmeyer 1959; Tam et al. 2003.

### Type species

***Paraliomyces lentifer*** Kohlm. [as ‘*lentiferus*’], Nova Hedwigia 1: 81 (1959). (Fig. 73)

*Ascostromata* black, immersed, penetrating into the substrate with dark brown hyphae. *Ascomata* up to 680  $\mu\text{m}$  high  $\times$  540  $\mu\text{m}$  diam., solitary, immersed or erumpent, subglobose to pyriform, subcylindrical or nonsubcylindrical, papillate or epapillate, ostiolate, periphysate, carbonaceous (Fig. 73a). *Peridium* thick. *Hamathecium* of long trabeculate pseudoparaphyses, 1–1.5  $\mu\text{m}$  broad. *Asci* 90–130  $\times$  12–17  $\mu\text{m}$  ( $\bar{x}$  = 116  $\times$  15  $\mu\text{m}$ ,  $n$  = 10), bitunicate, fissitunicate, cylindrical, 8-spored, uniseriate, with a short furcate pedicel, without apical apparatus (Fig. 73b, c and d). *Ascospores* 17.5–25  $\times$  10–12.5  $\mu\text{m}$  ( $\bar{x}$  = 21  $\times$  11  $\mu\text{m}$ ,  $n$  = 10), ellipsoid to broadly fusoid with broadly rounded ends, 1-septate, constricted at the septum, hyaline, smooth-walled, surrounded by a gelatinous sheath that contracts to form a lateral, lentiform, viscous appendage over the septum, 7.5–12.5  $\mu\text{m}$  diam., 1–3  $\mu\text{m}$  thick (Fig. 73e, f, g and h).

**Anamorph:** none reported.

**Material examined:** USA, Florida, Charlotte Harbor in Punta Garda, 10 Jan. 1964, leg., det. J. J. Kohlmeyer (Herb. J. Kohlmeyer No. 1720).

## Notes

### Morphology

*Paraliomyces* was introduced to accommodate the marine fungus *P. lentifer*, which is characterized by immersed ascomata produced within the ascostroma, trabeculate pseudoparaphyses, cylindrical, 8-spored asci, ellipsoidal, hyaline, 1-septate ascospores surrounded by a gelatinous sheath, which forms a lentiform, viscous appendage over the septum (Kohlmeyer 1959).

### Phylogenetic study

Based on analysis of SSU sequences, *Paraliomyces lentifer* nested within *Pleosporales*, but its familial status was left undetermined (Tam et al. 2003).

### Concluding remarks

None.

***Phaeosphaeria*** I. Miyake, Bot. Mag., Tokyo 23: 93 (1909). (*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, saprobic or hemibiotrophic. *Ascomata* small, solitary, scattered, or in small groups, immersed, globose, subglobose, wall black. *Apex* with a pore-like ostiole. *Peridium* thin. *Hamathecium* of dense, filliform, septate pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, broadly cylindrical to narrowly fusoid, with a short pedicel. *Ascospores* fusoid to narrowly fusoid, pale brown to brown, 3-septate.

**Fig. 72** *Ostropella albocincta* (K(M): 143941, syntype). **a** Ascomata gregarious on host surface. **b** Section of the partial peridium. Note the peridium comprising two cell types and the whitening tissue (arrowed). **c** Pseudoparaphyses. **d, e** Asci with long pedicel. **f–h** Ascospores, which are strongly constricted at the central septum. Scale bars: **a** = 1 mm, **b** = 100  $\mu\text{m}$ , **d, e, h** = 20  $\mu\text{m}$ , **c, g, f** = 10  $\mu\text{m}$

**Anamorphs reported for genus:** *Amarenographium*, *Hendersonia*-like, *Phaeoseptoria*, *Scolecosporella* and *Stagonospora* (Hyde et al. 2011; Leuchtmann 1984; Shoemaker and Babcock 1989b).

**Literature:** von Arx and Müller 1975; Câmara et al. 2002; Eriksson 1967a, 1981; Holm 1957; Khashnobish and Shearer 1996; Leuchtmann 1984; Miyake 1909; Shoemaker and Babcock 1989b.

### Type species

***Phaeosphaeria oryzae*** I. Miyake, Bot. Mag., Tokyo 23: 136 (1909). (Fig. 74)

*Ascomata* 120–140  $\mu\text{m}$  high  $\times$  100–140  $\mu\text{m}$  diam., solitary, scattered, or in small groups, immersed, globose, subglobose, wall black, forming black spots on the leaves of hosts (Fig. 74a). *Apex* with a pore-like ostiole. *Peridium* 4–8  $\mu\text{m}$  wide at the sides, composed of heavily pigmented thin-walled cells of *textura angularis*, cells 2–2.5  $\times$  3–5  $\mu\text{m}$  diam., cell wall less than 1  $\mu\text{m}$  thick (Fig. 74b). *Hamathecium* of dense, long cellular pseudoparaphyses 2–2.5  $\mu\text{m}$  broad, embedded in mucilage, rarely branched, septate. *Asci* 53–80(–90)  $\times$  7–10  $\mu\text{m}$  ( $\bar{x}$  = 65.3  $\times$  8.3  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate, broadly cylindrical to narrowly fusoid, with a short pedicel which is ca. 8  $\mu\text{m}$  long, with a small ocular chamber and an inconspicuous apical apparatus (to 2  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 74c, d and e). *Ascospores* 17–22(–28)  $\times$  4–5  $\mu\text{m}$  ( $\bar{x}$  = 20.5  $\times$  4.6  $\mu\text{m}$ ,  $n$  = 10), obliquely uniseriate, partially overlapping or biseriate, narrowly fusoid with rounded ends, pale brown, 3-septate, slightly constricted at primary septum, granulate (Fig. 74f and g).

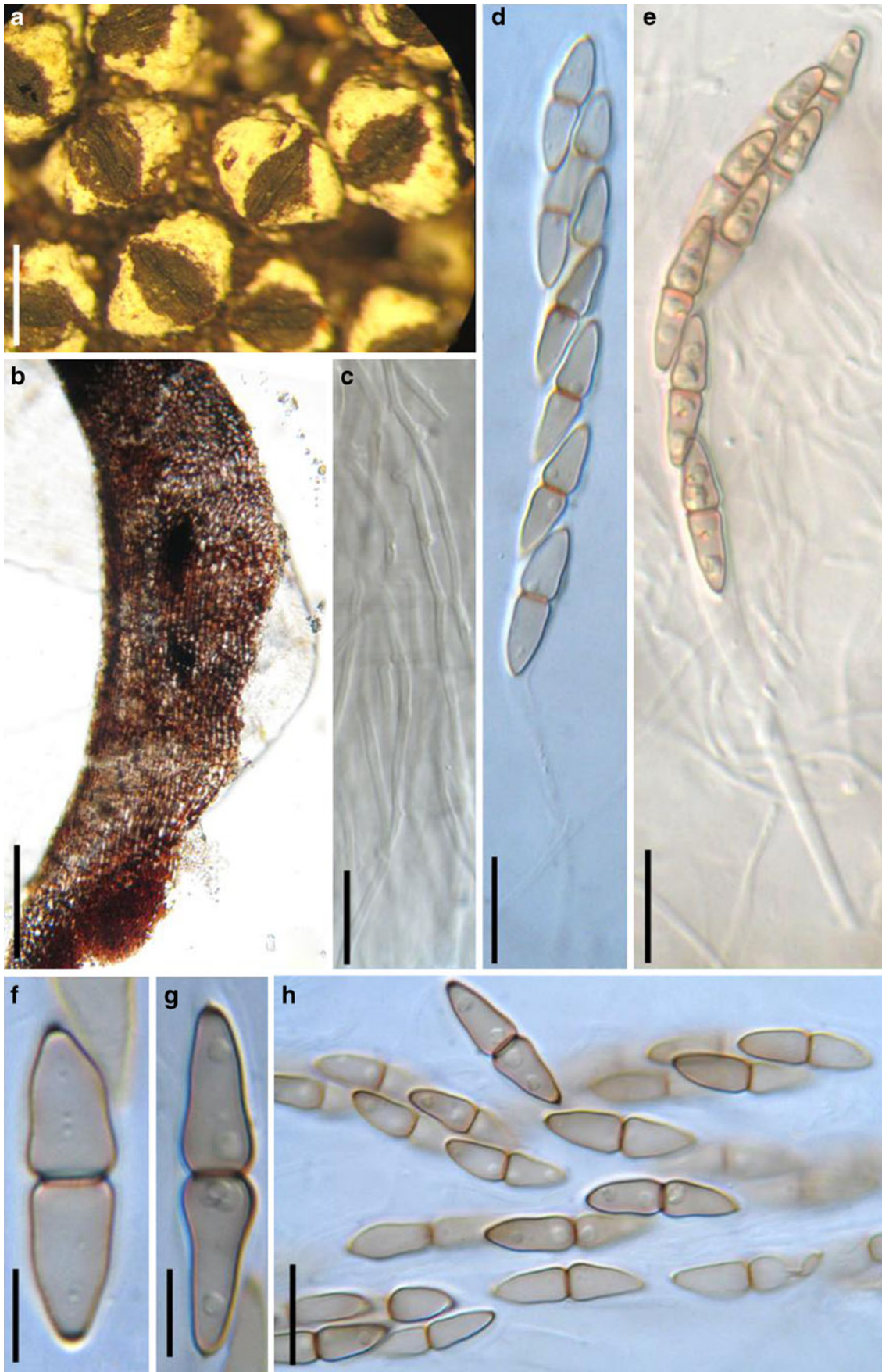
**Anamorph:** none reported.

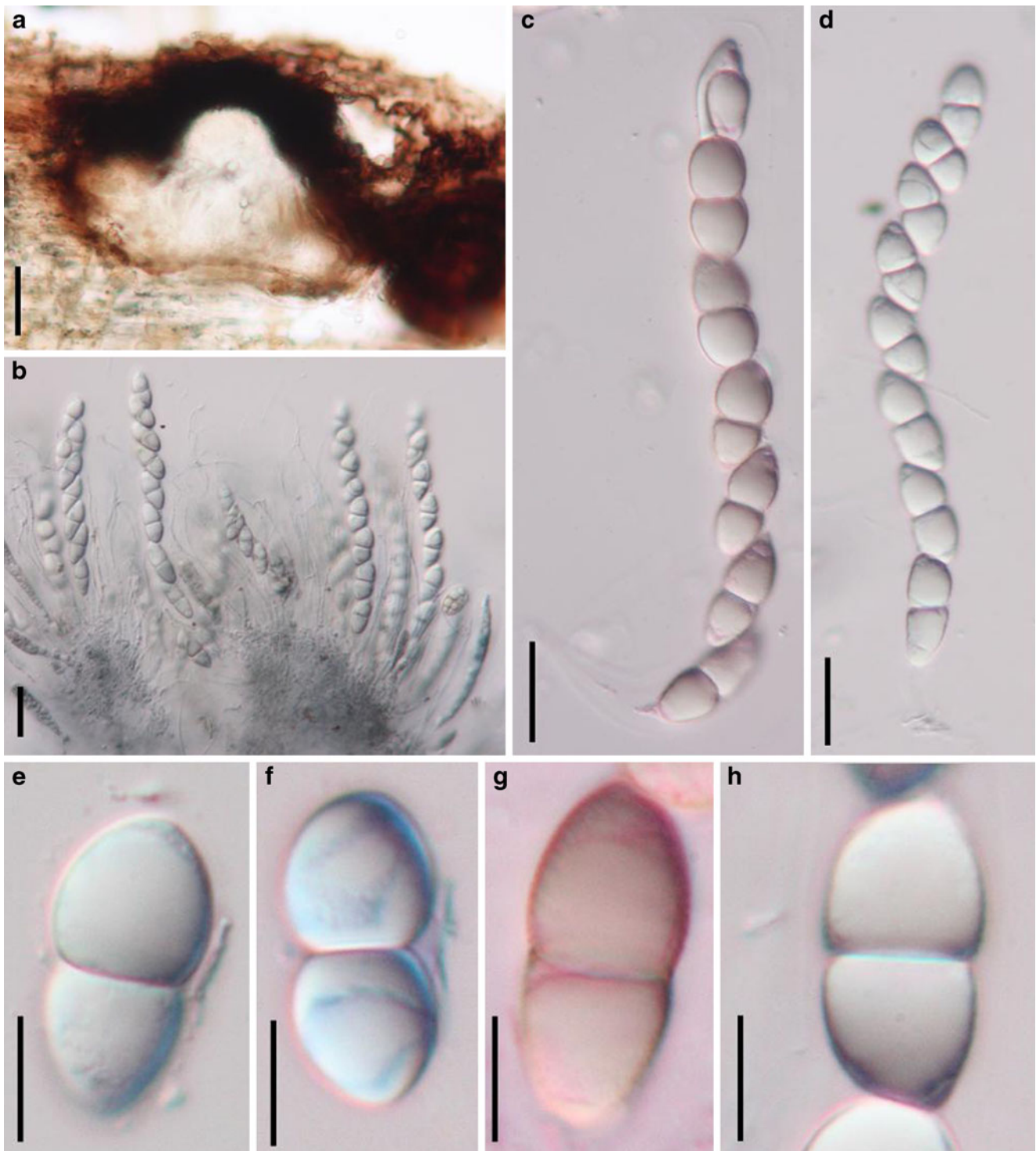
**Material examined:** JAPAN, Suruya, Shizuoka, on the leaves of *Oryza sativa*, Sept. 1907 (S nr F9572, F9573, lectotype).

## Notes

### Morphology

*Phaeosphaeria* was introduced by Miyake (1909), but was regarded as a synonym of *Leptosphaeria* for a long time. Holm (1957), however, reinstated *Phaeosphaeria*, assigning some *Leptosphaeria sensu lato* species with relatively small ascomata and which occurred on monocotyledons to *Phaeosphaeria*. Although this division based





**Fig. 73** *Paraliomyces lentifer* (from Herb. J. Kohlmeyer No. 1720). **a** Section of an immersed ascoma. **b** Eight-spored cylindrical asci embedded in pseudoparaphyses. **c**, **d** Cylindrical asci with short

pedicels. **e–h** One-septate hyaline ascospores. Scale bars: **a**=100  $\mu\text{m}$ , **b–d**=20  $\mu\text{m}$ , **e–h**=10  $\mu\text{m}$

on host range is considered unnatural by some workers (Dennis 1978; Sivanesan 1984), it has been widely accepted (von Arx and Müller 1975; Eriksson 1967a; Hedjaroude 1969; Shoemaker and Babcock 1989b). Eriksson (1981) further revised the generic concept of

*Phaeosphaeria* by including dictyosporous taxa as well as some perisporium taxa. *Phaeosphaeria* was further divided into six subgenera, i.e. *Ovispora*, *Fusispora*, *Phaeosphaeria*, *Spathispora*, *Vagispora* and *Sicispora*, based on differences in ascospore shape and the number of septa

(Shoemaker and Babcock 1989b). *Phaeosphaeria* species are usually associated or parasitic on annual monocots, such as *Cyperaceae*, *Juncaceae* or *Poaceae* but have also been recorded as saprobes and on dicotyledons (e.g. *P. viridella* and *P. vagans*).

### Phylogenetic study

The separation of *Phaeosphaeria* from *Leptosphaeria* *sensu stricto* was supported by phylogenetic studies based on ITS sequences. The peridium structure, pseudoparenchymatous cells in *Phaeosphaeria* versus scleroplectenchymatous cells in *Leptosphaeria* had phylogenetic significance in the distinction between these two genera, while the subgenus division was not supported by the phylogenetic results (Câmara et al. 2002; Morales et al. 1995). The familial status of both *Phaeosphaeriaceae* and *Leptosphaeriaceae* was verified by multigene phylogenetic analysis (Schoch et al. 2009; Zhang et al. 2009a).

### Concluding remarks

*Phaeosphaeria* was originally thought to be a synonym of *Leptosphaeria* (Müller 1950; Munk 1957), however, molecular analysis has shown these two genera differ with *Phaeosphaeria* having pseudoparenchymatous peridium, *Stagonospora*-like anamorph and mostly monocotyledonous hosts and *Leptosphaeria* having scleroplectenchymatous peridium, *Phoma*-like anamorph and mostly dicotyledonous hosts (Câmara et al. 2002; Schoch et al. 2009; Shoemaker and Babcock 1989b; Zhang et al. 2009a). It is now recognized that *Phaeosphaeria* is the type genus of *Phaeosphaeriaceae* and related genera include *Entodesmium* and *Setomelanomma* and probably *Ophiosphaerella* (Schoch et al. 2009; Zhang et al. 2009a). *Paraphaeosphaeria* was introduced as an off-shoot of *Phaeosphaeria* and differs in ascospore shape and septation as well as anamorphic stages (Eriksson 1967a, b). Similarly, *Nodulosphaeria* was recently reinstated and differs from *Phaeosphaeria* because of setae over the apex as well as its ascospores with swelling suprmedian cells and terminal appendages (Holm 1957, 1961). While the newly reinstated *Phaeosphaeria* was confined to monocotyledons and particularly grasses, there are now many species that have been described from dicotyledons (Farr et al. 1989). Whether these taxa form a monophyletic group needs to be investigated with fresh collections and molecular data.

***Phaeosphaeriopsis*** M.P.S. Câmara, M.E. Palm & A.W. Ramaley, Mycol. Res. 107: 519 (2003). (*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, saprobic or hemibiotrophic? *Ascomata* small, scattered or in small groups, immersed,

globose, subglobose. *Peridium* thin, comprising one cell type of *textura angularis*. *Hamathecium* of dense, wide cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, cylindrical to broadly fusoid, with a short pedicel and a small ocular chamber. *Ascospores* obliquely uniseriate and partially overlapping to biseriate even triseriate, cylindrical, pale brown, multi-septate, primary septum submedian, with or without constriction, verrucose or baculate.

**Anamorphs reported for genus:** *Coniothyrium*-like, *Phaeostagonospora* (Câmara et al. 2003).

**Literature:** Câmara et al. 2003.

### Type species

***Phaeosphaeriopsis glaucopunctata*** (Grev.) M.P.S. Câmara, M.E. Palm & A.W. Ramaley, Mycol. Res. 107: 519 (2003). (Fig. 75)

≡ *Cryptosphaeria glaucopunctata* Grev. Fl. Edin.: 362 (1824).

*Ascomata* 120–150  $\mu\text{m}$  high  $\times$  140–200  $\mu\text{m}$  diam., scattered, or in small groups, immersed, globose, subglobose (Fig. 75a). *Peridium* 10–25  $\mu\text{m}$  wide, comprising one type of cells, composed of thick-walled cells of *textura angularis*, cells 4–9  $\mu\text{m}$  diam., cell wall 2–3  $\mu\text{m}$  thick, almost equal in thickness. *Hamathecium* of dense, wide cellular pseudoparaphyses, 3–5  $\mu\text{m}$  broad. *Asci* (50-)60–110  $\times$  10–15  $\mu\text{m}$  ( $\bar{x}$  = 82.3  $\times$  12  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate dehiscence not observe, cylindrical to broadly fusoid, with a short pedicel, with a small ocular chamber (to 0.8  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 75b). *Ascospores* 18–28  $\times$  5–7.5  $\mu\text{m}$  ( $\bar{x}$  = 23.5  $\times$  6.2  $\mu\text{m}$ ,  $n$  = 10), obliquely uniseriate and partially overlapping to biseriate even triseriate, cylindrical, pale brown, 4(–)5-septate, without constriction or slightly constricted at the basal septum, the forth cell from the apex usually slightly inflated, the basal cell often longer, baculate (Fig. 75c, d, e and f).

**Anamorph:** none reported.

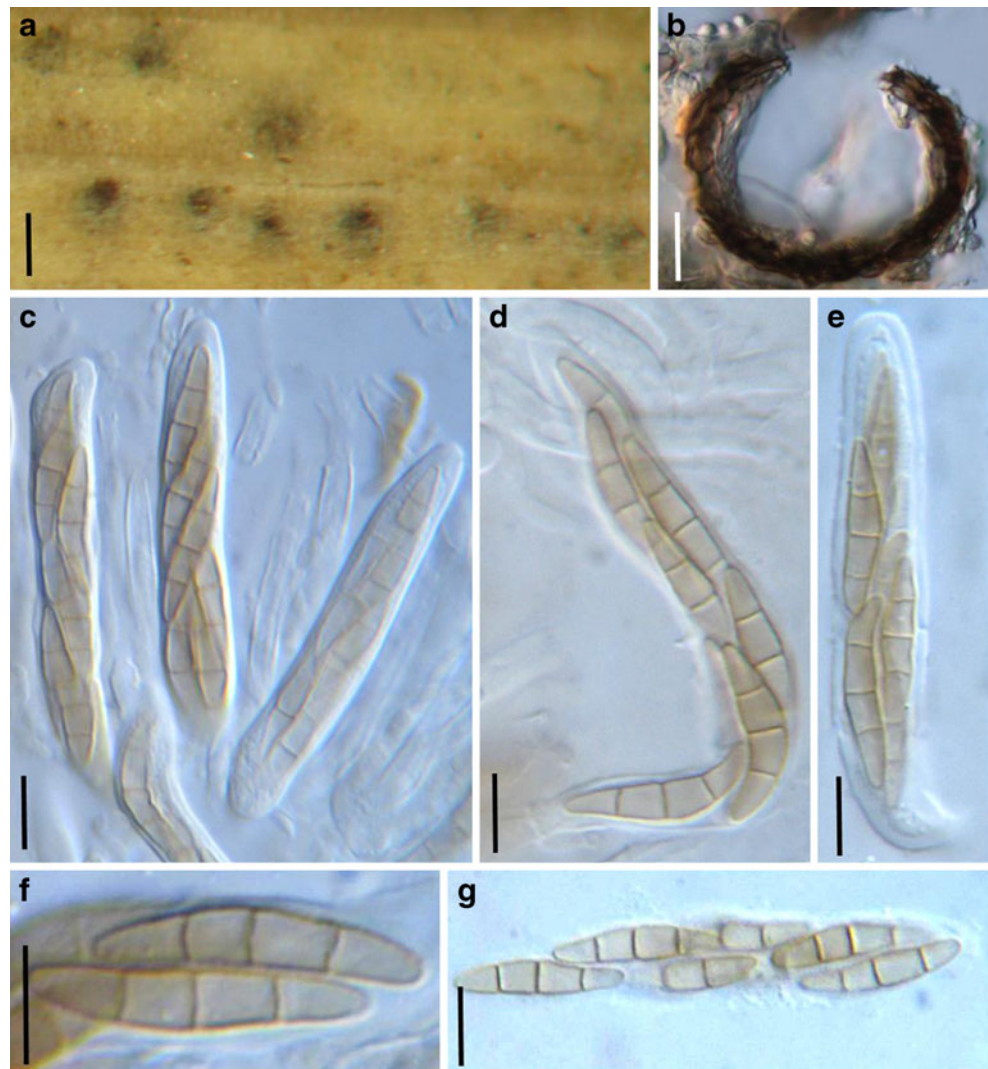
**Material examined:** UK, Epping, Sept. 1863 (E, M.C. Cooke 166, barcode: E00074286).

### Notes

### Morphology

*Phaeosphaeriopsis* was introduced to accommodate some species of *Paraphaeosphaeria* based on both morphological characters and results of SSU rDNA sequence analyses (Câmara et al. 2003). Most of the *Phaeosphaeriopsis* species occur on the *Agavaceae*, although *P. glaucopunctata* occurs on *Liliaceae* (*Ruscus*). *Phaeosphaeriopsis* is characterized by having uni- or multioculate stromata and 4- or 5-septate ascospores. Although the

**Fig. 74** *Phaeosphaeria oryzae* (from S nr F9572, F9573, **lectotype**). **a** Appearance of ascomata on the host surface. **b** Section of an ascoma. **c** Squash mount showing asci in pseudo-paraphyses. Note that asci with short pedicels. **d, e** Asci with short pedicels. **F, G**. Light brown 3-septate ascospores. Scale bars: **a**=100  $\mu\text{m}$ , **b–g**=10  $\mu\text{m}$



morphological characters of *Phaeosphaeriopsis* species is more diverse than those of *Paraphaeosphaeria sensu stricto* or *Neophaeosphaeria*, the ITS sequences are more similar to each other than those of the other two genera (Câmara et al. 2003). Currently, *Phaeosphaeriopsis* comprises seven species, namely *P. agavensis* (A.W. Ramaley, M.E. Palm & M.E. Barr) M.P.S. Câmara, M.E. Palm & A.W. Ramaley, *P. amblyospora* A.W. Ramaley, *P. glaucopunctata*, *P. musae* Arzanlou & Crous, *P. nolinae* (A.W. Ramaley) M.P.S. Câmara, M.E. Palm & A.W. Ramaley, *P. obtusispora* (Speg.) M.P.S. Câmara, M.E. Palm & A.W. Ramaley and *P. phacidiomorpha* (Ces.) D.F. Farr & M.E. Palm (<http://www.mycobank.org/>, 06/2010).

#### Phylogenetic study

The generic type of *Phaeosphaeriopsis*, *P. glaucopunctata*, located in *Phaeosphaeriaceae* based on SSU rDNA sequences (Câmara et al. 2003). *Phaeosphaeriopsis musae*

is also shown to belong to *Phaeosphaeriaceae* in recent phylogenetic studies (Schoch et al. 2009; Plate 1).

#### Concluding remarks

None.

*Platysporoides* (Wehm.) Shoemaker & C.E. Babco., Can. J. Bot. 70: 1648 (1992). (*Pleosporaceae*)

≡ *Pleospora* subgenus *Platysporoides* Wehmeyer, A World Monograph of the genus *Pleospora* and its Segregates, p. 236. 1961.

#### Generic description

Habitat terrestrial, saprobic? *Ascomata* small, scattered, immersed, semi-immersed to nearly superficial, globose, subglobose, black, smooth; apex with a protruding papilla and pore-like ostiole, without periphyses. *Perid-*

*ium* thin, composed of a few layers of *textura angularis*. *Hamathecium* of numerous, cellular pseudoparaphyses, anastomosing, septate. *Asci* bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a short, furcate pedicel. *Ascospores* broadly ellipsoid, reddish brown, muriform.

**Anamorphs reported for genus:** none.

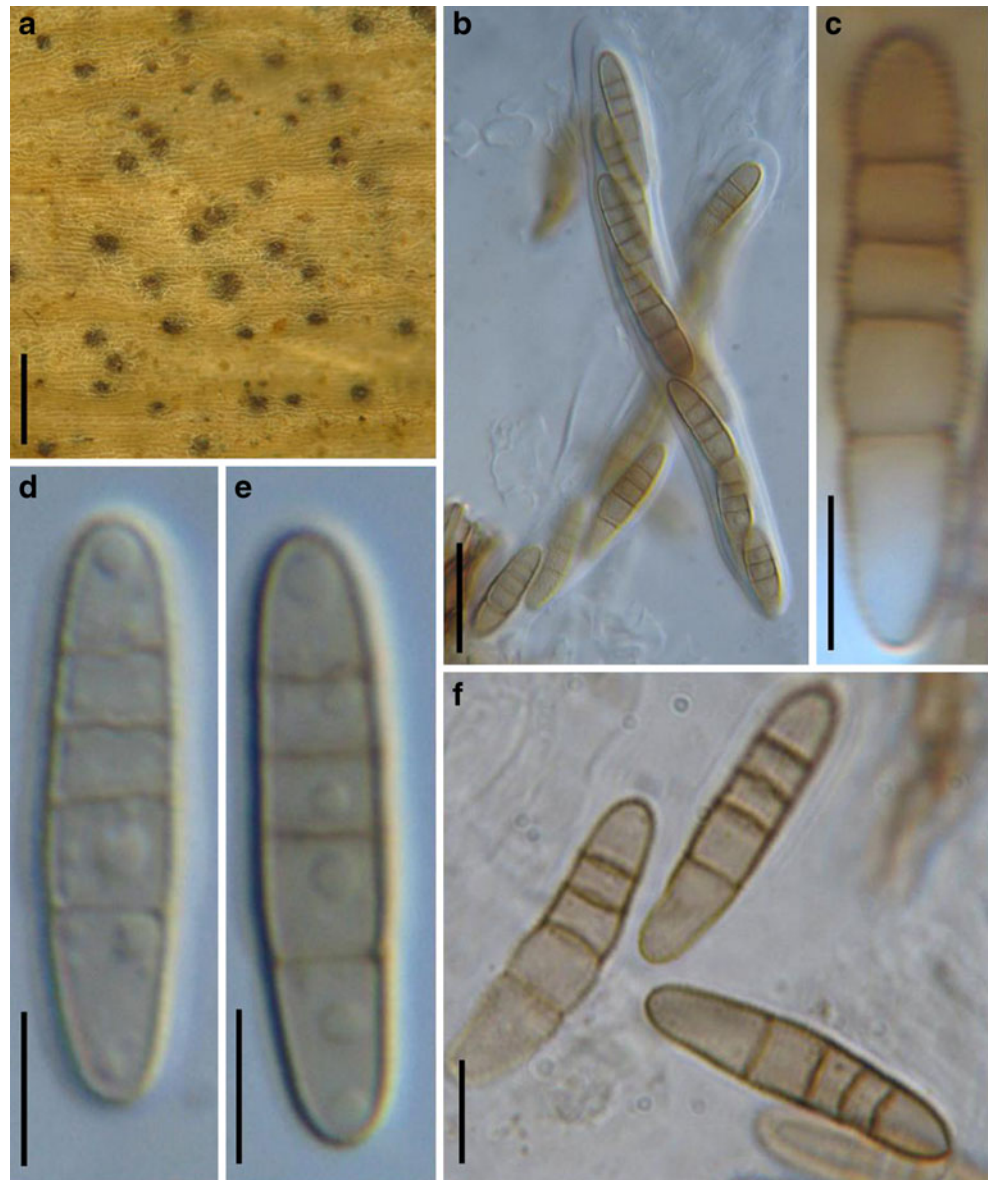
**Literature:** Shoemaker and Babcock 1992; Wehmeyer 1961.

#### Type species

*Platysporoides chartarum* (Fuckel) Shoemaker & C.E. Babc., Can. J. Bot. 70: 1650 (1992) (Fig. 76)

≡ *Pleospora chartarum* Fuckel, Jb. nassau. Ver. Naturk. 23–24: 133–134 (1870).

**Fig. 75** *Phaeosphaeriopsis glauco-punctata* (from M.C. Cooke 166). **a** Ascomata immersed in the substrate. **b** Eight-spored cylindrical asci. **c–f**. Pale brown baculate ascospores which are released from asci. Scale bars: **a**=200  $\mu\text{m}$ , **b**=20  $\mu\text{m}$ , **c, d–f**=10  $\mu\text{m}$



*Ascomata* 150–230  $\mu\text{m}$  high  $\times$  180–260  $\mu\text{m}$  diam., scattered, immersed, semi-immersed to rarely superficial, globose, subglobose, black, smooth; apex with a protruding papilla, 50–85  $\mu\text{m}$  long, 60–85  $\mu\text{m}$  broad, ostiolate (Fig. 76a and b). *Peridium* 8–22  $\mu\text{m}$  wide, composed of 2–4 layers of brown cells of *textura angularis*, cells 5–9  $\mu\text{m}$  diam., cell wall 1–2.5  $\mu\text{m}$  thick, without periphyses. *Hamathecium* of dense, long cellular pseudoparaphyses, 2–3  $\mu\text{m}$  broad, anastomosing, septate (Fig. 76c). *Asci* 110–140  $\times$  12.5–16.5  $\mu\text{m}$  ( $\bar{x}$  = 121.5  $\times$  14.7  $\mu\text{m}$ ,  $n=10$ ), (6-)8-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a short, furcate pedicel, 8–17  $\mu\text{m}$  long, ocular chamber not observed (Fig. 76c, d and e). *Ascospores* 20–26  $\times$  8–11  $\mu\text{m}$  ( $\bar{x}$  = 23.7  $\times$  9  $\mu\text{m}$ ,  $n=10$ ), obliquely uniseriate and partially overlapping, flattened, broadly ellipsoid in front view, reddish brown, 3



transverse septa, 1 longitudinal septum in each central cell, 1 oblique septum in each end cell, constricted at all septa, granulate, with a sheath 2–3  $\mu\text{m}$  wide (as reported in Shoemaker and Babcock 1992) (Fig. 76f, g and h).

**Anamorph:** none reported.

**Material examined:** GERMANY, Budenheim, Leopold Fuckel, Nassau's Flora, on old paper (G NASSAU: 210558 (a), as *Sphaeria chartarum* Wallr., **type**).

## Notes

### Morphology

*Platysporoides* was introduced as a subgenus of *Pleospora* by Wehmeyer (1961) and was typified by *Pleospora chartarum*. Shoemaker and Babcock (1992) raised *Platysporoides* to generic rank and placed it in the *Pleosporaceae* based on its “aplanodictyospore” and “terete pored beak of the ascomata”. Currently, eleven species are included in this genus (Shoemaker and Babcock 1992). Another comparable pleosporalean family is *Diademaceae*, which is distinguished from *Platysporoides* by its ascoma opening as “an intraepidermal discoid lid” (Shoemaker and Babcock 1992).

### Phylogenetic study

None.

### Concluding remarks

*Aigialus grandis* is another pleosporalean fungus with flattened and muriform ascospores as well as papilla and ostioles, which belongs to *Aigialaceae*, a phylogenetically well supported marine family (Suetrong et al. 2009). Thus, it is highly likely that flattened and muriform ascospores are of little phylogenetic significance.

*Pleomassaria* Speg., Anal. Soc. cient. argent. 9: 192 (1880). (*Pleomassariaceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium to large, solitary, scattered, or in small groups, immersed, erumpent by a minute slit or a small conical swelling in the bark, flattened, papillate, ostiolate. *Hamathecium* of dense, cellular pseudoparaphyses, embedded in mucilage. *Asci* bitunicate, fissionate, broadly cylindrical to broadly cylindro-clavate, with a short, thick pedicel. *Ascospores* muriform, brown, constricted at the septa.

**Anamorphs reported for genus:** *Prosthemium* and *Shearia* (Barr 1982b; Sivanesan 1984).

**Literature:** Barr 1982b, 1990b, 1993a; Clements and Shear 1931; Eriksson 2006; Lumbsch and Huhndorf 2007;

Shoemaker and LeClair 1975; Sivanesan 1984; Tanaka et al. 2005.

### Type species

*Pleomassaria siparia* (Berk. & Broome) Sacc., Syll. fung. 2: 239 (1883) (Fig. 77)

$\equiv$  *Sphaeria siparia* Berk. & Broome, Ann. Mag. nat. Hist., Ser. 2 9: 321 (1852).

*Ascomata* 150–410  $\mu\text{m}$  high  $\times$  440–740  $\mu\text{m}$  diam., solitary, scattered, or in small groups, immersed, erumpent by a minute slit or a small conical swelling in the bark, depressed globose, papillate, ostiolate (Fig. 77a). *Peridium* 45–60  $\mu\text{m}$  wide, thicker at the apex, thinner at the base, 1-layered, composed of small pigmented thick-walled compressed cells, cells ca. 15  $\times$  3  $\mu\text{m}$  diam., cell wall 2–3.5  $\mu\text{m}$  thick, apex cells larger, base composed of small pigmented thick-walled cells of *textura angularis*, ca. 5  $\mu\text{m}$  diam. (Fig. 77b). *Hamathecium* of dense, cellular pseudoparaphyses, 1–2  $\mu\text{m}$  broad, embedded in mucilage, anastomosing or branching not observed. *Asci* 180–250  $\times$  28–42  $\mu\text{m}$  ( $\bar{x}$  = 206.3  $\times$  36.8  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissionate, broadly cylindrical to broadly cylindro-clavate, with a short, thick pedicel, 15–45  $\mu\text{m}$  long, with inconspicuous ocular chamber (Fig. 77c and d). *Ascospores* 45–58  $\times$  12.5–17.5  $\mu\text{m}$  ( $\bar{x}$  = 50.5  $\times$  14.8  $\mu\text{m}$ ,  $n$  = 10), biserial, narrowly oblong with broadly to narrowly rounded ends, brown, muriform with 5–8 transverse septa and 1–2 vertical septa in some cells, smooth to verrucose, constricted at the septa, surrounded by a mucilaginous sheath (Fig. 77e, f and g).

**Anamorph:** *Prosthemium betulinum* Kunze (Sivanesan 1984).

*Conidia* to 120  $\mu\text{m}$  diam., with 3–5 arms, each arm 3–5-septate, 40–55  $\times$  13–16  $\mu\text{m}$ , connected to a central cell (Fig. 77h, i and j).

**Material examined:** UK, Wiltshire, Spye Park, on branch of *Betulina* with *Hendersonia polycystis* Berk., et Br. leg. C.E. Broome, 1850? (BR, **type**).

## Notes

### Morphology

*Pleomassaria* as characterized by Barr (1982b) has medium- to large-sized, immersed ascomata, cellular pseudoparaphyses, clavate to oblong asci and large, muriform ascospores (Barr 1982b; Sivanesan 1984). The muriform and somewhat asymmetrical ascospores with a submedian primary septum distinguish *Pleomassaria* from *Asteromassaria* in the family *Pleomassariaceae*, while in *Splanchnonema* ascospores have distinct bipolar asymmetry. Barr (1982b) included five North American species in the genus, while Kirk et al. (2008) listed four species.

**Fig. 76** *Platysporoides chartarum* (from G NASSAU: 210558, **type**). **a, b** Ascomata scattered among fibers. Note the central ostioles. **c** Asci in numerous cellular pseudoparaphyses. **d, e** Cylindro-clavate asci with short pedicels. **f–h**. Muriiform ascospores. Scale bars: **a, b**=200  $\mu\text{m}$ , **c–e**=20  $\mu\text{m}$ , **f–h**=10  $\mu\text{m}$



Barr (1993a) treated *Pleomassaria* as a synonym of *Splanchnonema* based on a morphological cladistic analysis, but this proposal was not followed by later workers (Eriksson 2006; Lumbsch and Huhndorf 2007; Tanaka et al. 2005).

#### Phylogenetic study

*Pleomassaria siparia* forms a robust phylogenetic clade with *Melanomma pulvis-pyrius* (generic type) (Schoch et al. 2009; Zhang et al. 2009a), which might represent a phylogenetic family (or suborder?).

### Concluding remarks

The genera *Asteromassaria*, *Pleomassaria* and *Splanchnonema* of *Pleomassariaceae* are considered to be closely related and difficult to separate (Barr 1982b; Crivelli 1983). They all have ascomata which are immersed in bark and are visible as slightly raised pustules with small ostioles, but may eventually become erumpent (e.g. *Asteromassaria macrospora*). Pseudoparaphyses are cellular, asci are bitunicate, while ascospores vary from 1-septate and pale brown (e.g. *Asteromassaria macrospora*) to muriform (e.g. *Pleomassaria siparia*) and may be symmetrical (e.g. *Asteromassaria macrospora*) or highly asymmetrical (e.g. *Splanchnonema pustulatum*). The peridium ranges from thick-walled *textura angularis* (e.g. *Asteromassaria macrospora*) to thin-walled compressed cells (e.g. *Splanchnonema pustulatum*) and medium *textura prismatica* (e.g. *Pleomassaria siparia*). Anamorphs also vary distinctly, *Prosthemium* in *Pleomassaria siparia*, *Scolicosporium* in *Asteromassaria macrospora* but no anamorphic stage reported for *Splanchnonema pustulatum*. Furthermore, *Asteromassaria pulchra* clusters in *Morosphaeriaceae* in this study, thus here we tentatively assign *Asteromassaria* in *Morosphaeriaceae* (Plate 1). There seems to be considerable confusion in this family, especially when *Pleomassaria siparia* forms a robust phylogenetic clade with *Melanomma pulvis-pyrius* (*Melanommataceae*). Thus in this study, *Pleomassariaceae* is restated as a separate family from *Melanommataceae*. Therefore, fresh collections of the types of these genera are needed for molecular analysis and to establish which characters are important for classification.

***Pleophragmia*** Fuckel, Jb. nassau. Ver. Naturk. 23–24: 243 (1870). (*Sporormiaceae*)

### Generic description

Habitat terrestrial, saprobic (coprophilous). *Ascomata* small- to medium-sized, gregarious, immersed to erumpent, globose to subglobose, black, coriaceous; apex with a short papilla, or sometimes forming an ostiolar pore. *Peridium* thin, composed of several layers of thin-walled cells of *textura angularis*. *Hamathecium* of dense, delicate pseudoparaphyses. *Asci* 8-spored, bitunicate, fissionate, clavate to cylindro-clavate, with a relatively long pedicel and an ocular chamber. *Ascospores* muriform, narrow oblong to cylindrical with rounded ends, dark brown, constricted at each septum.

**Anamorphs reported for genus:** none.

**Literature:** von Arx and Müller 1975; Cain 1934.

### Type species

***Pleophragmia leporum*** Fuckel, Jb. nassau. Ver. Naturk. 23–24 (1870) [1869–70]. (Fig. 78)

*Ascomata* 330–480  $\mu\text{m}$  high  $\times$  320–430  $\mu\text{m}$  diam., gregarious, immersed to slightly erumpent, globose to subglobose, black; apex with a short papilla, sometimes forming an ostiolar pore (Fig. 78a). *Peridium* 25–35  $\mu\text{m}$  thick at the sides, composed of one cell type of lightly pigmented thin-walled cells of *textura angularis*, cells 6–10  $\mu\text{m}$  diam., cell wall 1.5–2  $\mu\text{m}$  thick (Fig. 78b). *Hamathecium* of numerous, long pseudoparaphyses, 1–2  $\mu\text{m}$  broad, anastomosing not observed. *Asci* 160–250  $\times$  22.5–27.5  $\mu\text{m}$  ( $\bar{x}$  = 203.6  $\times$  25  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissionate, clavate to cylindro-clavate, with a 20–50  $\mu\text{m}$  long pedicel and an ocular chamber (to 5  $\mu\text{m}$  wide  $\times$  2  $\mu\text{m}$  high) (Fig. 78e and f). *Ascospores* 42–50  $\times$  8–10  $\mu\text{m}$  ( $\bar{x}$  = 46  $\times$  10  $\mu\text{m}$ ,  $n$  = 10), biseriate to uniseriate and partially overlapping, narrowly oblong to cylindrical with rounded ends, dark brown, often slightly curved, with 9 transverse septa with two crossing longitudinal septa in the centre, constricted at each septum, smooth-walled (Fig. 78c, d, g and h).

**Anamorph:** none reported.

**Material examined:** GERMANY, between Königstein and Glashütten, on the same dung with *Delitschia minuta*. s.d. (G, Fungi rhenani n2272, type).

### Notes

### Morphology

*Pleophragmia* was formally established by Fuckel (1870) and monotypified by *Pleophragmia leporum*. The most comparable genus to *Pleophragmia* is *Sporormia*, as ascospores of both have no germ slits and the inner layer of wall is considerably thinner than the outer layer (Barr 1990a, b). But the muriform ascospores of *Pleophragmia* can be readily distinguished from the phragmosporous ascospores of *Sporormia*. Currently, only four species are accommodated under this genus (<http://www.mycobank.org>, 28-02-2009).

### Phylogenetic study

None.

### Concluding remarks

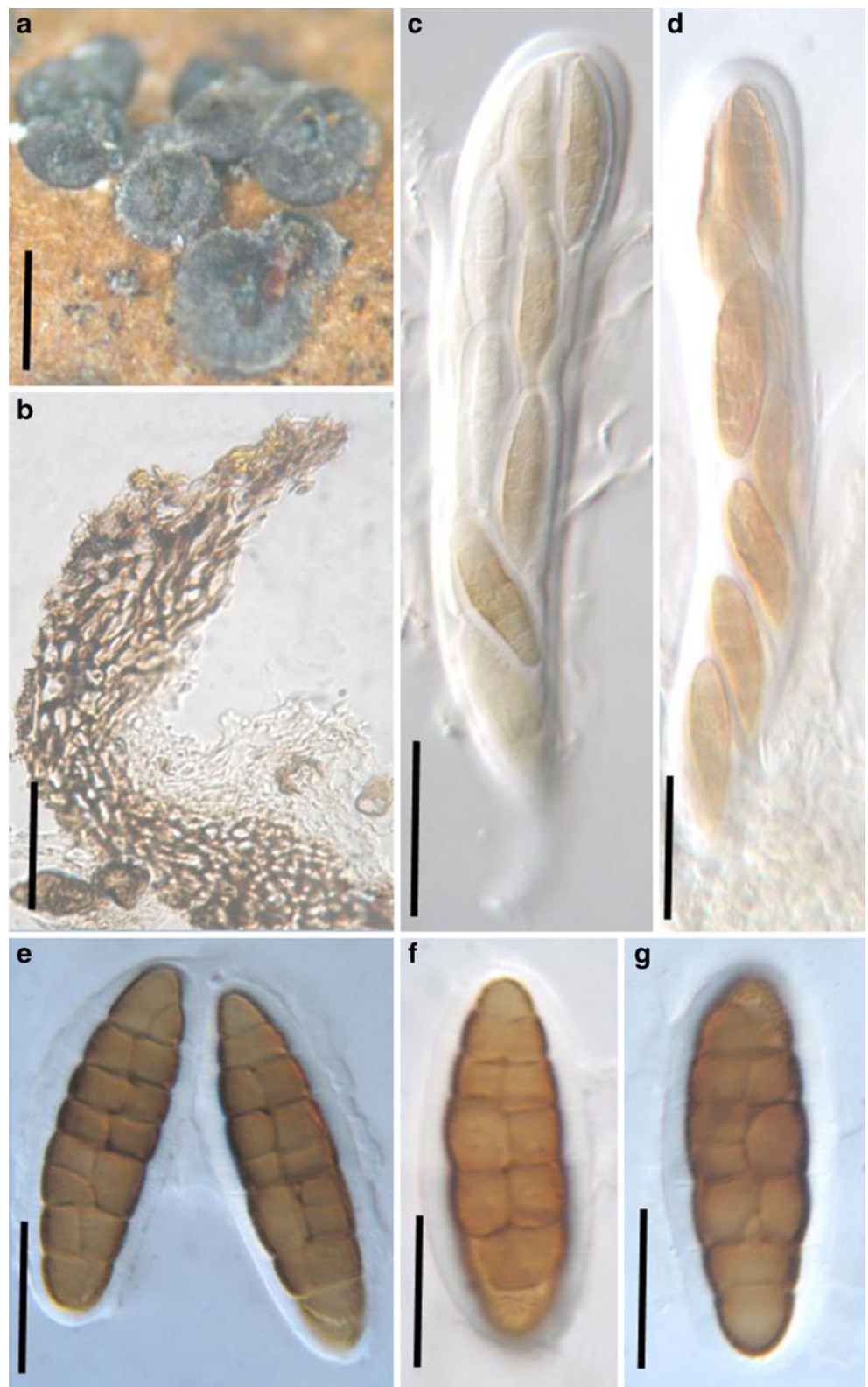
The presence of both transverse and crossing longitudinal septa is the most striking character of *Pleophragmia*, although the phylogenetic significance of this character is unclear.

***Pleoseptum*** A.W. Ramaley & M.E. Barr, Mycotaxon 54: 76 (1995). (*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, saprobic? *Ascomata* medium-sized, scattered, or in small groups, immersed, globose to conoid,

**Fig. 77** 1 *Pleomassaria siparia* (from BR, type). **a** Ascomata on the host surface (after removing the cortices). **b** Section of a partial peridium. **c, d** Asci with short pedicels. **e–g** Ascospores with thin sheath. Scale bars: **a**=0.5 mm, **b–d**=50  $\mu$ m, **e–g**=20  $\mu$ m. 2 *Prosthemium betulinum* (from BR, type). **h–j** Conidia with arms. Scale bars: **h–j**=20  $\mu$ m



black, papillate, ostiolate. *Peridium* 1-layered. *Hamathecium* of dense, long cellular pseudoparaphyses, septate, branching. *Asci* 8-spored, bitunicate, fissionitic, cylindrical to cylindro-clavate, with furcate pedicel. *Ascospores*

obliquely uniseriate and partially overlapping, muriform, ellipsoid, ovoid to fusoid, yellowish to dark brown.

**Anamorphs reported for genus:** *Camarosporium* (Ramaley and Barr 1995).

Fig. 77 (continued)



**Literature:** Ramaley and Barr 1995.

### Type species

*Pleoseptum yuccaesedum* A.W. Ramaley & M.E. Barr, Mycotaxon 54: 76 (1995). (Fig. 79)

*Ascomata* 300–500  $\mu\text{m}$  diam., scattered, or in small groups of 2–3, immersed with a flattened top, globose to conoid, black, papillate, ostiolate (Fig. 79a). *Papilla* small, slightly protruding from the host surface. *Peridium* 30–50  $\mu\text{m}$  thick at sides, up to 100  $\mu\text{m}$  thick at the apex, 1-layered, composed of 5–8 layers of heavily pigmented purplish-brown cells of *textura angularis*, cells 5–12  $\mu\text{m}$  diam., cell wall 1–2  $\mu\text{m}$  thick, apex cells smaller and walls thicker (Fig. 79c). *Hamathecium* of dense, long cellular pseudoparaphyses 1–2  $\mu\text{m}$  broad, septate, branching (Fig. 79b). *Asci* 125–170(–195)  $\times$  15–22  $\mu\text{m}$  ( $\bar{x}$  = 153.8  $\times$  19.3  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a short, narrowed, furcate pedicel which is 10–20  $\mu\text{m}$  long, with an ocular chamber best seen in immature asci (to 5  $\mu\text{m}$  broad  $\times$  3  $\mu\text{m}$  high) (Fig. 79d and e). *Ascospores* 22–30  $\times$  11–14  $\mu\text{m}$  ( $\bar{x}$  = 27.1  $\times$  12.6  $\mu\text{m}$ ,  $n=10$ ) obliquely uniseriate and partially overlapping, ellipsoid, ovoid to fusoid, yellowish to yellowish brown, becoming reddish brown to dark brown, muriform, with 3–(4) transverse septa, constricted at the primary septum, part above central septum wider, vertical septa exist in each cell, ornamentation of foveolae in linear rows (Fig. 79f and g).

**Anamorph:** *Camarosporium yuccaesedum* Fairm. (Ramaley and Barr 1995).

*Conidiomata* 200–450  $\mu\text{m}$  diam., pycnidial, immersed, scattered, subglobose to conoid, ostiolate. *Macroconidiogenous cells* determinate or indeterminate, enteroblastic, hyaline, smooth. *Macroconidia* holoblastic, 20–36  $\times$  10–15  $\mu\text{m}$  diam., ellipsoid to narrowly ovoid, muriform, yellowish brown, 3–7 transverse septa, constricted at the septa. *Microconidiogenous cells* produced near or in the ostiole, hyaline, smooth. *Microconidia* 5–10  $\times$  5–7  $\mu\text{m}$  diam., globose to ovoid, aseptate, hyaline, smooth.

**Material examined:** USA, Colorado, Montezuma County, hillside near entrance to Mesa Verde National Park, on dead leaves of *Yucca baccata*, 11 Oct. 1992, Ramaley Annette (9237A) (BPI 802381, **holotype**).

### Notes

#### Morphology

*Pleoseptum* is a monotypic genus established by Ramaley and Barr (1995) and represented by *P. yuccaesedum* based on its “immersed ascomata, thick peridium, muriform ascospores, anamorphic stage and the lineate ornamentation of the ascospores and conidia”. The shape of ascomata of *Pleoseptum* is comparable with that of *Chaetoplea*, but the peridium structure easily distinguishes them. Some species of *Curreya*, *Leptosphaeria* and *Heptameria* are comparable with *Pleoseptum*, but their anamorphic stages differ.

*Pleoseptum yuccaesedum* and its *Camarosporium yuccaesedum* anamorph both formed in the leaves of *Yucca baccata* and the ascomata and conidiomata were indistinguishable. *Camarosporium* is the anamorph of diverse teleomorph genera included in *Botryosphaeriales* and *Cucurbitariaceae* (Kirk et al. 2008). The genus is in need of revision (Sutton 1980) and is no doubt polyphyletic.

#### Phylogenetic study

None.

#### Concluding remarks

The placement of *Pleoseptum* under *Phaeosphaeriaceae* is still tentative.

*Pleospora* Rabenh. ex Ces. & De Not., Comm. Soc. crittog. Ital. 1: 217 (1863). (*Pleosporaceae*)

#### Generic description

Habitat terrestrial, saprobic or parasitic. *Ascomata* small- to medium-sized, immersed, erumpent to superficial,



**Fig. 78** *Pleophragmia leporum* (from G. Fungi rhenani n2272, type). **a** Appearance of ascomata on the substrate surface. Note the ostiolar pore. **b** Section of a partial peridium. **c, h** Apical part of an ascus. Note the apical apparatus in (c). **d** Released ascospores. **e, f**

Clavate Asci with pedicels. **g** Part of a broken ascospore. Note the crossing septa. Scale bars: **a**=0.5 mm, **B**=50  $\mu\text{m}$ , **c–f**=20  $\mu\text{m}$ , **g, h**=10  $\mu\text{m}$



**Fig. 79** *Pleoseptum yuccaesedum* (from BPI 802381, holotype). **a** Appearance of ascomata scattered on the host surface. Only the upper region is visible. **b** Squash mount of asci in pseudoparaphyses. **c** Section of an ascoma. Note the peridium comprising cells of

*textura angularis*. **d, e** Asci with short furcate pedicels. **f, g** Muriform dark-brown ascospores. Scale bars: **a**=0.5 mm, **b**=40  $\mu$ m, **c**=100  $\mu$ m, **d, e**=20  $\mu$ m, **f, g**=10  $\mu$ m

papillate, ostiolate. *Peridium* thin. *Hamathecium* of dense, cellular pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical to clavate, with furcate pedicel and small inconspicuous ocular chamber. *Ascospores* muriform, brown or pale brown, with or without sheath.

**Anamorphs reported for genus:** *Stemphyllium* (Simmons 1985).

**Literature:** Barr 1981; Frisullo and Braun 1996; Kodsueb et al. 2006a; Luttrell 1951; Wehmeyer 1946, 1961, 1975; Zhang et al. 2009a.

### Type species

***Pleospora herbarum*** (Pers.) Rabenh., Klotzschii Herb. Viv. Mycol. 2: no. 547 (1854). (Fig. 80)

≡ *Sphaeria herbarum* Pers., Syn. meth. fung. (Göttingen) 1: 78 (1801).

*Ascomata* 130–220  $\mu\text{m}$  high  $\times$  250–420  $\mu\text{m}$  diam., scattered, or in small groups of 2–3, immersed, semi-immersed to erumpent, broadly to narrowly oblong and flattened, with flattened base not easily removed from the substrate, wall black, papillate, ostiolate (Fig. 80a and b). *Peridium* 30–50  $\mu\text{m}$  thick on sides, thinner at the base, coriaceous, 2-layered, outer layer composed of one or two layers of heavily pigmented thick-walled cells of *textura angularis*, cells 5–10  $\mu\text{m}$  diam., cell wall 2–4  $\mu\text{m}$  thick, apex cells smaller and walls thicker, inner layer composed of hyaline thin-walled cells of *textura angularis*, 8–12  $\mu\text{m}$  diam., wall hyaline, 0.5–1.5  $\mu\text{m}$  thick (Fig. 80c). *Hamathecium* of dense, cellular pseudoparaphyses, 2–3  $\mu\text{m}$  broad, filling the gaps between the asci. *Asci* 100–210  $\times$  27.5–30  $\mu\text{m}$  ( $\bar{x}$  = 142.2  $\times$  28.3  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate, broadly cylindrical to clavate, with a short, thick, furcate pedicel, 8–12(–20)  $\mu\text{m}$  long, with small inconspicuous ocular chamber (ca. 3  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 80d and e). *Ascospores* 28–38  $\times$  12.5–15  $\mu\text{m}$  ( $\bar{x}$  = 33  $\times$  14.5  $\mu\text{m}$ ,  $n$  = 10), ellipsoidal, straight or sometimes curved, with broadly rounded ends and upper hemispore slightly shorter and broader; spores usually divided by 3 A-transsepta, all 4 segments by longisepta and then by one stratum of B-transsepta (mature spores as a rule with 7 transsepta, 3A+4B), yellowish brown, smooth; each hemispore with thick gelatinous sheath, the lower one with umbilicus (sheaths fused in mature spores) (Fig. 80f, g, h, i, j and k).

**Anamorph:** *Stemphyllium herbarum* E. Simmons (Simmons 1985).

**Material examined:** GERMANY, on stalks of *Melilotus* at the bank of the Elbe in Königstein, 1882 (E, Krieger 683); as *Sphaeria herbarum* Persoon Syn. fung. p. 78 (E, 81); as *Sphaeria herbarum* Fries, Scleromyceti Sueciae 38 (E, lectotype).

### Notes

### Morphology

*Pleospora* was originally assigned within *Sphaeriales*. Subsequently, it was assigned within *Pseudosphaeriales* and *Pleosporales* (Wehmeyer 1961). *Pleospora* is a large group, which is widely distributed and associated with a wide range of species of monocotyledons as well as dicotyledons (Wehmeyer 1975). All species of *Pleospora* have muriform ascospores (Wehmeyer 1961, 1975). *Pleospora* has downward growing pseudoparaphyses within the ascomata of “*Pleospora*-type” development (Luttrell Univ. Mo. Stud. 1951), which subsequently served as a diagnostic character. However, only a limited number of species had detailed studies on this character (Wehmeyer 1961). The heterogeneous nature of *Pleospora* has been noted, and several subgenera have been erected, such as *Scleroplea* to include all “sclerotoid” species of *Pleospora*, *Teichosporoides* to accommodate species of *Pleospora* with immersed ascomata, *Pleosphaeria* for those having superficial and setose ascomata (Wehmeyer 1961). Similarly, *Cucurbitaria*, *Fenestella* and *Montagnula* are also separated as a section from *Pleospora*. Most of these subgenera are currently at genus rank.

### Phylogenetic study

The polyphyletic nature of *Pleospora* is clear (Kodsueb et al. 2006a), and those that stain the woody substrate purple should be assigned to *Amniculicolaceae* (Zhang et al. 2009a).

### Concluding remarks

As some *Pleospora* species have a wide range of host spectrum, especially on both monocotyledons and dicotyledons, it is highly possible they are cryptic species.

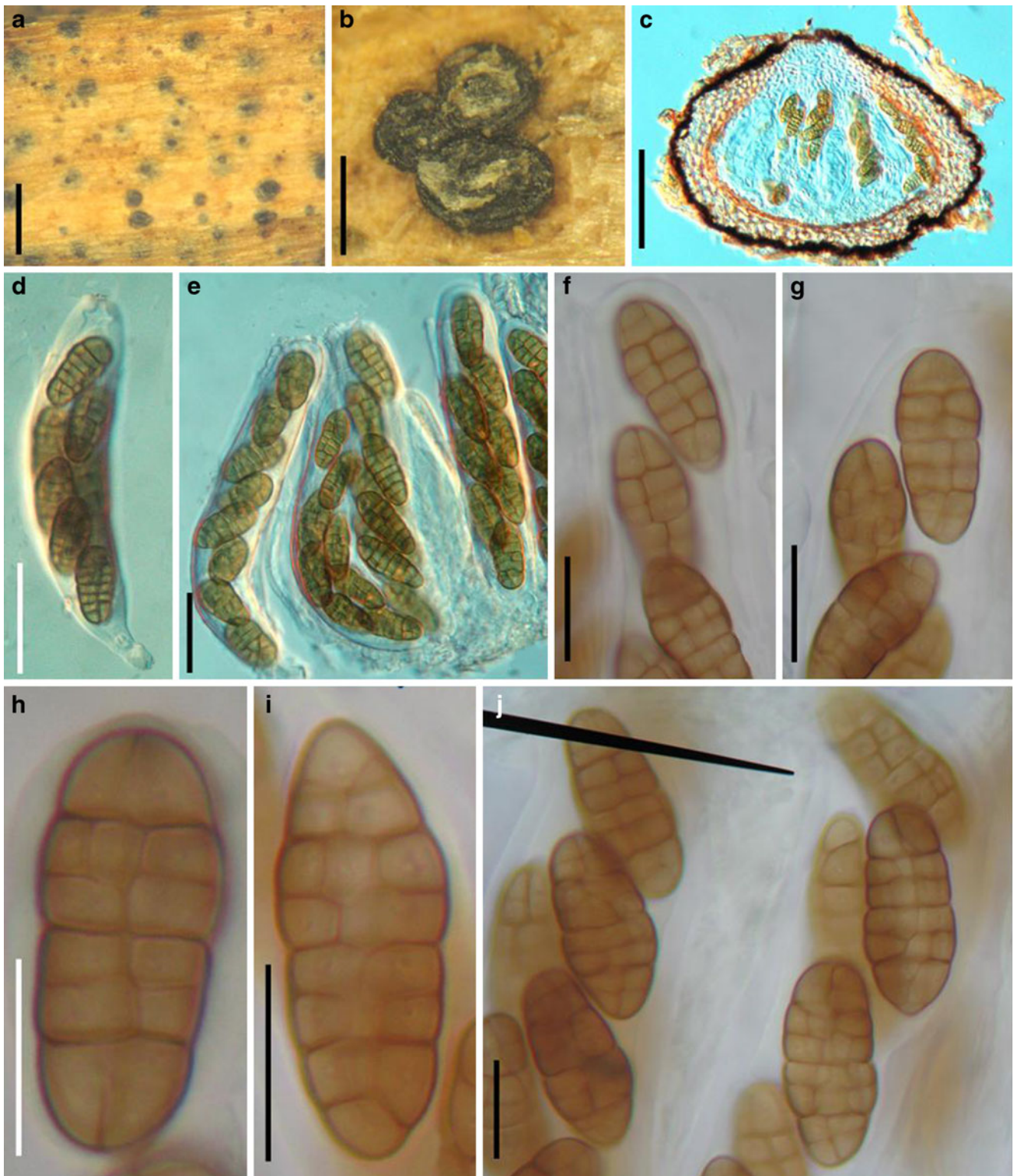
***Preussia*** Fuckel, Hedwigia 6: 175 (1867) [1869–70]. (*Sporormiaceae*)

### Generic description

Habitat terrestrial, saprobic (on decaying fibers or coprophilous). *Ascomata* small- to medium-sized, cleistothecial or perithecial, solitary or scattered on substrate surface, globose, membranous, black. *Peridium* thin, composed of thick-walled, poly-angular cells from the surface view. *Pseudoparaphyses* not observed. *Asci* (4-) 8-spored, bitunicate, clavate to broadly clavate, with a long and thin and furcate pedicel. *Ascospores* 3–6 seriate to uniseriate near the base, cylindrical with rounded ends, brown, septate, easily breaking into partspores, with germ slits in each cell. **Anamorphs reported for genus:** *Phoma* (von Arx 1973; Cain 1961; Malloch and Cain 1972).

**Literature:** Ahmed and Cain 1972; Arenal et al. 2005; von Arx 1973; von Arx and van der Aa 1987; Auerswald 1866;





**Fig. 80** *Pleospora herbarium* (from E. Krieger 683). **a** Immersed ascomata scattering on host surface. **b** Ascomata in small groups. Note: the surface layer of the host is removed. **c** Section of an ascoma. Note

the peridium cells of *textura angularis*. **d, e**. Asci with short pedicels **f–j** Ascospores. Scale bars: **a, b**=0.5 mm, **c**=100  $\mu\text{m}$ , **d, e**=30  $\mu\text{m}$ , **f–j**=20  $\mu\text{m}$

Barr 1987b, 1990a; Boylan 1970; Cain 1961; Eriksson 1992; Fuckel 1866; Guarro et al. 1981, 1997a, b; Khan and Cain

1979a, b; Kruys and Wedin 2009; Lodha 1971; Lorenzo 1994; Luck-Allen and Cain 1975; Maciejowska and

Williams 1963; Malloch and Cain 1972; Munk 1957; Narendra and Rao 1976; Rai and Tewari 1963; Sultana and Malik 1980.

### Type species

*Preussia funiculata* (Preuss) Fuckel, Jb. Nassau. Ver. Naturk. 23–24: 91 (1870) [1869–70]. (Fig. 81)

≡ *Perisporium funiculatum* Preuss, Fung. Hoyerw.: no. 145 (1851).

*Ascomata* 240–500  $\mu\text{m}$  diam., cleistothecial, solitary, scattered on substrate, superficial, globose, membranous, black (Fig. 81a). *Peridium* thin, composed of thick-walled, poly-angular cells in front view (Fig. 81b). *Pseudoparaphyses* not observed. *Asci* 42–65  $\times$  20–25  $\mu\text{m}$  ( $\bar{x}$  = 55.8  $\times$  21.8  $\mu\text{m}$ ,  $n$  = 10), (4–)8-spored, bitunicate, broadly clavate, with a long and thin and furcate pedicel, up to 115  $\mu\text{m}$  long, ocular chamber not observed (Fig. 81c and d). *Ascospores* 30–40  $\times$  6.3–7.5  $\mu\text{m}$  ( $\bar{x}$  = 35.6  $\times$  6.9  $\mu\text{m}$ ,  $n$  = 10), 3–6 seriate to uniseriate near the base, cylindrical with rounded ends, brown, with 3 transverse septa, easily breaking into partspores, central cells round in transverse section but rectangular in vertical section, with a germ slit in each cell, 6.5–8.5  $\times$  4–7.5  $\mu\text{m}$  broad, apical cells 8.8–10  $\times$  5–7  $\mu\text{m}$  broad, sheath not observed.

**Anamorph:** none reported.

**Material examined:** USA, Ontario, York Co., Nashville, on old jute sack on ground, 1 Jul. 1960, leg. & det. R.F. Cain (in part *Preussia typharum*) (TRTC 46985).

### Notes

#### Morphology

*Preussia* was introduced by Fuckel (1866) to accommodate species having cleistothecioid ascomata, bitunicate asci, multi-septate ascospores with a germ slit in each cell and with a gelatinous sheath, and occurring in soil or plant debris. *Preussia*, *Sporormia* and *Sporormiella* are regarded as closely related genera, which share numerous morphological characters. *Sporormia* can be distinguished from *Preussia* by its perithecioid ascomata and cylindrical asci. The only distinguishing morphological character for *Preussia* from *Sporormiella* are the cleistothecioid ascomata in *Preussia* (Barr 2000; Cain 1961), but this has been shown to have little phylogenetic significance (von Arx 1973; Zhang et al. 2009a). Substrate preference has been used to distinguish species of *Sporormiella* and *Preussia*, with *Sporormiella* being restricted to a coprophilous habitat, while *Preussia* grows in plant debris, wood or soil (von Arx and van der Aa 1987). This proposal was rejected, as *P. intermedia* (Clum) Cain can be isolated from either soil or dung (Guarro et al. 1997b). In a review of *Preussia*, Cain

(1961) accepted 12 species, and some of them are coprophilous. Subsequently, numerous additional new species have been published (Arenal et al. 2005; Barr 1987b, 1990a; Boylan 1970; Eriksson 1992; Guarro et al. 1981, 1997a, b; Khan and Cain 1979a; Lodha 1971; Lorenzo 1994; Luck-Allen and Cain 1975; Maciejowska and Williams 1963; Malloch and Cain 1972; Narendra and Rao 1976; Rai and Tewari 1963; Sultana and Malik 1980). Currently, 84 species are listed under *Preussia* (<http://www.mycobank.org/mycotaxo.aspx>, 10/2010) and Kirk et al. (2008) estimates there are 51 species.

#### Phylogenetic study

In phylogenetic analysis based on ITS, nLSU, mtSSU and  $\beta$ -tubulin gene fragments, *Preussia*, *Sporormiella* and *Spororminula* clustered together. Thus, *Sporormiella* together with *Spororminula* are treated as synonyms of *Preussia* (Kruys and Wedin 2009).

#### Concluding remarks

*Preussia sensu lato* (including *Sporormiella* and *Spororminula*) based on both morphology and molecular data should be accepted pending further research.

*Quintaria* Kohlm. & Volkm.-Kohlm., Bot. Mar. 34: 34 (1991). (*Pleosporales*, genera *incertae sedis*)

Habitat marine, saprobic. *Ascomata* medium-sized, scattered or loosely gregarious, immersed, mostly subglobose, rarely globose, with a protruding papilla, ostiolate. *Peridium* thin, 2-layered, coriaceous, thicker near the apex. *Hamathecium* of dense, filamentous, trabeculate pseudo-paraphyses, branching and anastomosing between and above asci. *Asci* 8-spored, bitunicate, fissitunicate, cylindro-clavate, with a short furcate pedicel. *Ascospores* biseriate, broadly fusoid to fusoid, hyaline, mostly 5-septate, rarely up to 7-septate.

**Anamorphs reported for genus:** none.

**Literature:** Hyde and Goh 1999; Kohlmeyer and Volkmann-Kohlmeyer 1991; Suetrong et al. 2009; Zhang et al. 2008b.

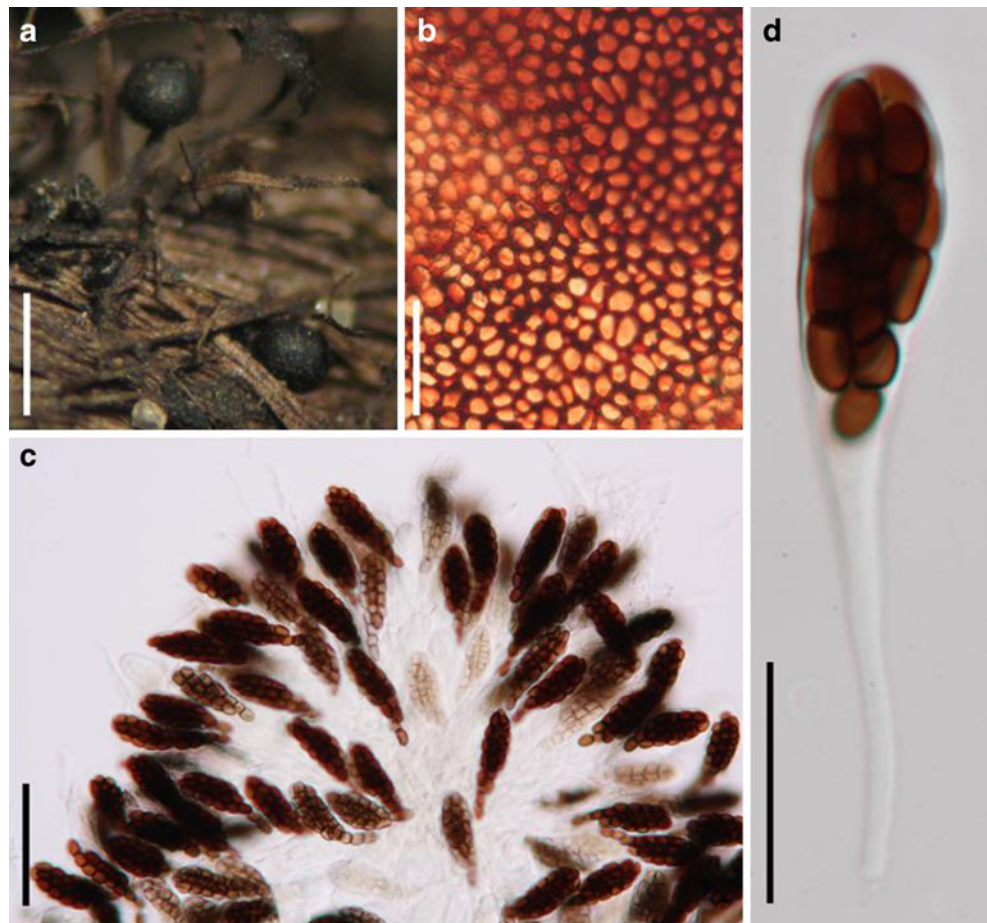
#### Type species

*Quintaria lignatilis* (Kohlm.) Kohlm. & Volkm.-Kohlm., Bot. Mar. 34: 35 (1991). (Fig. 82)

≡ *Trematosphaeria lignatilis* Kohlm., Marine Ecology, [Pubblicazioni della Stazione Zoologica Napoli I] 5(4): 365 (1984).

*Ascomata* 240–500  $\mu\text{m}$  diam., scattered or loosely gregarious, immersed, globose to subglobose, coriaceous, ostiolate, ostiole is encrusted with thick-walled black cells, papilla up to 400  $\mu\text{m}$  long (Fig. 82a). *Peridium* thin, 20–30  $\mu\text{m}$  wide, thinner at the base, thicker near the apex, up to

**Fig. 81** *Preussia funiculata* (from TRTC 46985). **a** Superficial cleistothecoid ascomata. **b** Part of peridium from front view. **c** Squash mounts showing a large number of asci. **d** A clavate ascus with a long and thin pedicel. Scale bars: **a**=0.5 mm, **b**=20  $\mu\text{m}$ , **c**, **d**=50  $\mu\text{m}$



300  $\mu\text{m}$ , 2-layered, outer layer composed of hyphoid cells, inner layer composed of compressed cells of *textura angularis* (Fig. 82b). *Hamathecium* of dense, filamentous, trabeculate pseudoparaphyses, 0.8–1.5  $\mu\text{m}$  broad, branching and anastomosing between and above asci (Fig. 82e). *Asci* 175–250  $\times$  25–35  $\mu\text{m}$  ( $\bar{x}$  = 220  $\times$  28  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, cylindro-clavate, with a short, furcate pedicel, to 20  $\mu\text{m}$  long (Fig. 82c and e). *Ascospores* 55–73  $\times$  12.5–15  $\mu\text{m}$  ( $\bar{x}$  = 63.3  $\times$  13.1  $\mu\text{m}$ ,  $n$ =10), biseriata, broadly fusoid to fusoid, usually slightly curved, smooth, hyaline, mostly 5-septate, rarely up to 7-septate, smooth-walled, lacking a sheath.

**Anamorph:** none reported.

**Material examined:** BELIZE, Twin Cays, on attached dead tip of prop root of *Rhizophora mangle*, with shipworms, 3 Apr. 1983, leg. & det. J.K. Kohlmeyer (J. Kohlmeyer No. 4365a, **holotype**).

## Notes

## Morphology

*Quintaria* was introduced to accommodate the marine fungus, *Trematosphaeria lignatilis*, based on its immersed ascomata with rounded bases, black incrustations surround-

ing the sides of the ostiolar canal as well as its hyaline ascospores (Kohlmeyer and Volkmann-Kohlmeyer 1991). Subsequently, three more species were introduced to this genus, viz. *Q. aquatica* K.D. Hyde & Goh, *Q. microsporium* Yin. Zhang, K.D. Hyde & J. Fourn. and *Q. submersa* K.D. Hyde & Goh, which are all from freshwater (Hyde and Goh 1999; Zhang et al. 2008b).

## Phylogenetic study

Multigene phylogenetic study indicated that *Quintaria lignatilis* forms a separate sister clade to other families of *Pleosporales*, which may represent a new familial lineage (Suetrong et al. 2009). This was supported by phylogenetic studies which place the freshwater *Q. submersa* separate from *Q. lignatilis* (Schoch et al. 2009; Suetrong et al. 2009; Plate 1).

## Concluding remarks

The freshwater members of *Quintaria* should likely be excluded from this genus, and only the generic type, *Q. lignatilis* retained, but this needs confirmation.

*Roussoëlla* Sacc., in Saccardo & Paoletti, Atti Inst. Veneto Sci. lett., ed Arti, Sér. 3 6: 410 (1888). (*Arthopyreniaceae* (or *Massariaceae*))

## Generic description

Habitat terrestrial, saprobic. *Ascomata* medium-sized, clustered, immersed in host tissue, forming under darkened, slightly raised, somewhat liner or dome-shaped stroma on the host, with a flush intra-epidermal papilla; immersed under clypeus, papillate, ostiolate. *Peridium* thin, comprising several layers of compressed cells. *Hamathecium* of dense, long trabeculate pseudoparaphyses, embedded in mucilage, hyaline, anastomosing and septate. *Asci* 8-spored, bitunicate, cylindrical, with furcate pedicel, and a conspicuous ocular chamber. *Ascospores* uniseriate to partially overlapping, fusoid or ellipsoidal, brown, 1-septate, constricted at the septum.

**Anamorphs reported for genus:** *Cytoplea* (Hyde et al. 1996a).

**Literature:** Hyde et al. 1996a; Hyde 1997; Ju et al. 1996; Tanaka et al. 2009.

## Type species

***Roussoëlla nitidula*** Sacc. & Paol., Atti Ist. Veneto Sci., Ser. 6, 6:410. (1888). (Fig. 83)

*Ascomata* 160–200  $\mu\text{m}$  high  $\times$  400–500  $\mu\text{m}$  diam., clustered, immersed in host tissue, forming under darkened, slightly raised, somewhat liner or dome-shaped stroma on the host, with a flush intra-epidermal papilla; in vertical section subglobose with a flattened base, immersed under clypeus, subglobose with a flattened base, papillate, ostiolate (Fig. 83a). *Peridium* up to 20  $\mu\text{m}$  thick, comprising several layers of compressed cells. *Hamathecium* of dense, long trabeculate pseudoparaphyses, 1–1.5  $\mu\text{m}$  broad, embedded in mucilage, anastomosing and septate. *Asci* 123–220  $\times$  7–11  $\mu\text{m}$ , 8-spored, bitunicate, cylindrical, with furcate pedicels, and a conspicuous ocular chamber (Fig. 83b, c and d). *Ascospores* 17.5–22  $\times$  5.5–8  $\mu\text{m}$ , uniseriate to partially overlapping, fusoid or ellipsoidal, brown, 1-septate, constricted at the septum, ornamented with longitudinal wall striations and surrounded by a wide mucilaginous sheath (Fig. 83e, f, g and h).

**Anamorph:** *Cytoplea hysteroioides* K.D. Hyde (Hyde et al. 1996a).

**Material examined:** MALAYSIA, Malacca, on culms of *Bambusa* Bar & Grill, 1885, B. Scortechini 15 (PAD), *Roussoëlla nitidula* Sacc. Paol. 2484, **holotype**, on a loose label *Roussoëlla nitidula* S. & P. Est *Phyllachora phaeodidym.*/15 prob. original material from Malacca Peninsula).

## Notes

### Morphology

*Roussoëlla* was introduced by Saccardo for the single species *R. nitidula* Sacc. & Paol. (Saccardo and Paoletti 1888). It was redescribed by Hyde et al. (1996a) and the anamorph of *Roussoëlla hysteroioides* (Ces.) Höhn., *Cyto-*

*plea hysteroioides* K.D. Hyde was determined and described. *Roussoëlla* was then reviewed by Hyde (1997) and a modified key for *Roussoëlla* species was provided based on the one proposed by Ju et al. (1996). *Roussoëlla* is characterized as having immersed ascomata containing long cylindrical asci and brown 1-septate ornamented ascospores. In this study, we have checked the type species and it matches Hyde et al. (1996a). The asci are bitunicate, but we could not observe the fissitunicate dehiscence.

## Phylogenetic study

Species of *Roussoëlla*, *Roussoellopsis* as well as *Arthopyrenia salicis* form a robust phylogenetic clade, which form a sister group with pleosporalean families, but the generic type of *Roussoëlla* (*R. nitidula*) was not included in the phylogenetic study (Tanaka et al. 2009).

## Concluding remarks

The bambusicolous habitat of *Roussoëlla* is a striking character at generic rank classification but its relationship to the lichenized *Arthopyrenia* is unexpected and will require more analysis.

***Saccharicola*** D. Hawksw. & O.E. Erikss., in Eriksson & Hawksworth, Mycologia 95: 431 (2003). (*Massarinaceae*)

## Generic description

Habitat terrestrial, parasitic. *Ascomata* medium-sized, solitary, scattered, immersed, globose to subglobose, carbonaceous, papillate, ostiolate. *Peridium* relatively thin, composed of one cell type of pale brown to hyaline pseudoparenchymatous cells. *Hamathecium* of trabeculate pseudoparaphyses. *Asci* bitunicate, 8-spored, cylindro-clavate to clavate. *Ascospores* biserial and sometimes laterally uniseriate, fusoid with narrowly rounded ends, septate, constricted at the septa, the upper second cell becoming pigmented when mature, smooth or verruculose.

**Anamorphs reported for genus:** *Stagonospora* (Eriksson and Hawksworth 2003; Kaiser et al. 1979; Leuchtman 1984).

**Literature:** Eriksson and Hawksworth 2003.

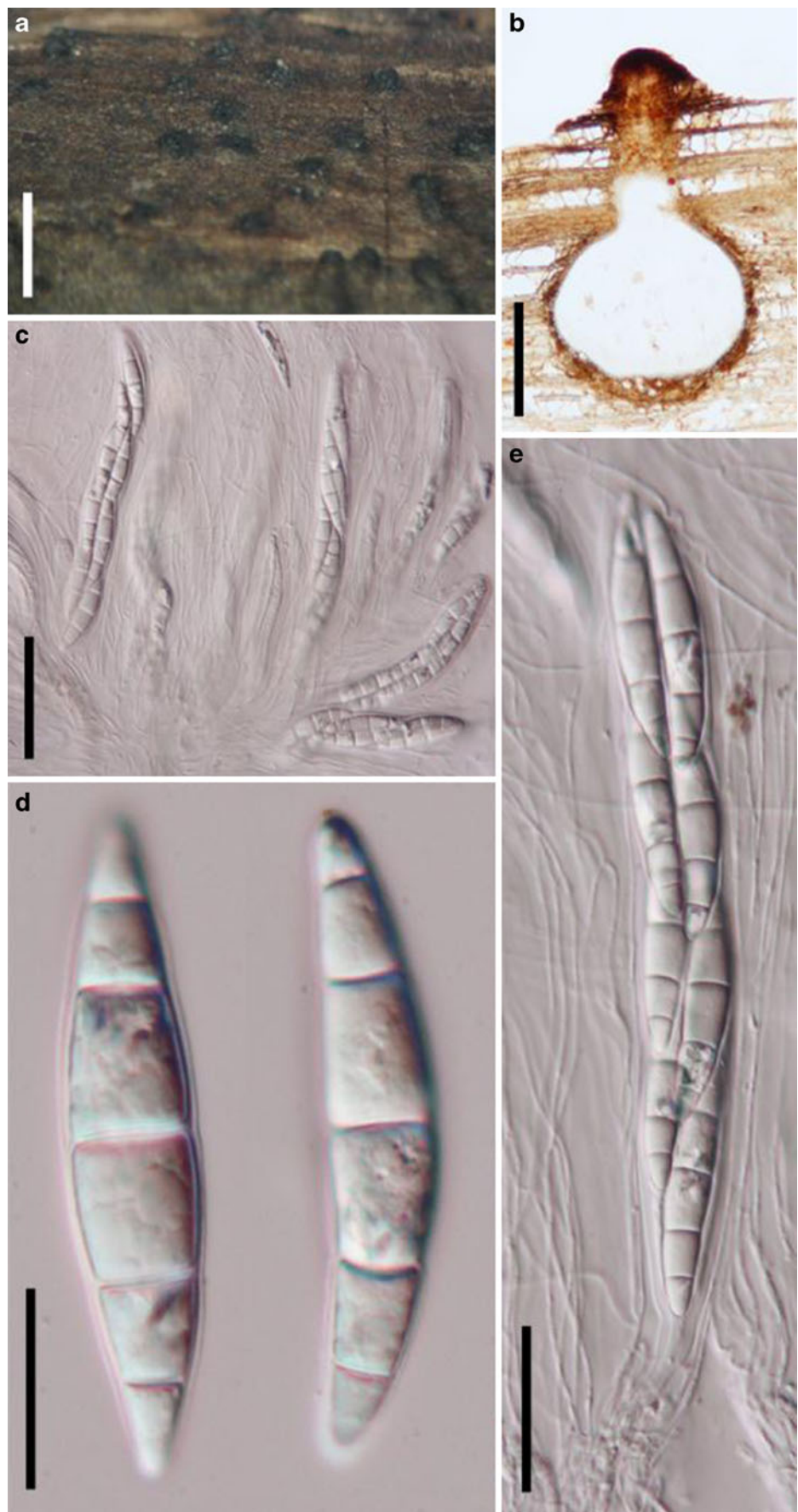
## Type species

***Saccharicola bicolor*** (D. Hawksw., W.J. Kaiser & Ndimande) D. Hawksw. & O.E. Erikss., Mycologia 95: 431 (2003). (Fig. 84)

$\equiv$  *Leptosphaeria bicolor* D. Hawksw., W.J. Kaiser & Ndimande, Mycologia 71: 483 (1979).

*Ascomata* 125–175  $\mu\text{m}$  high  $\times$  175–220  $\mu\text{m}$  diam., solitary, scattered, immersed, globose to subglobose, wall black, carbonaceous, with a protruding papilla, with a central ostiole (Fig. 84a). *Peridium* 15–20  $\mu\text{m}$  thick

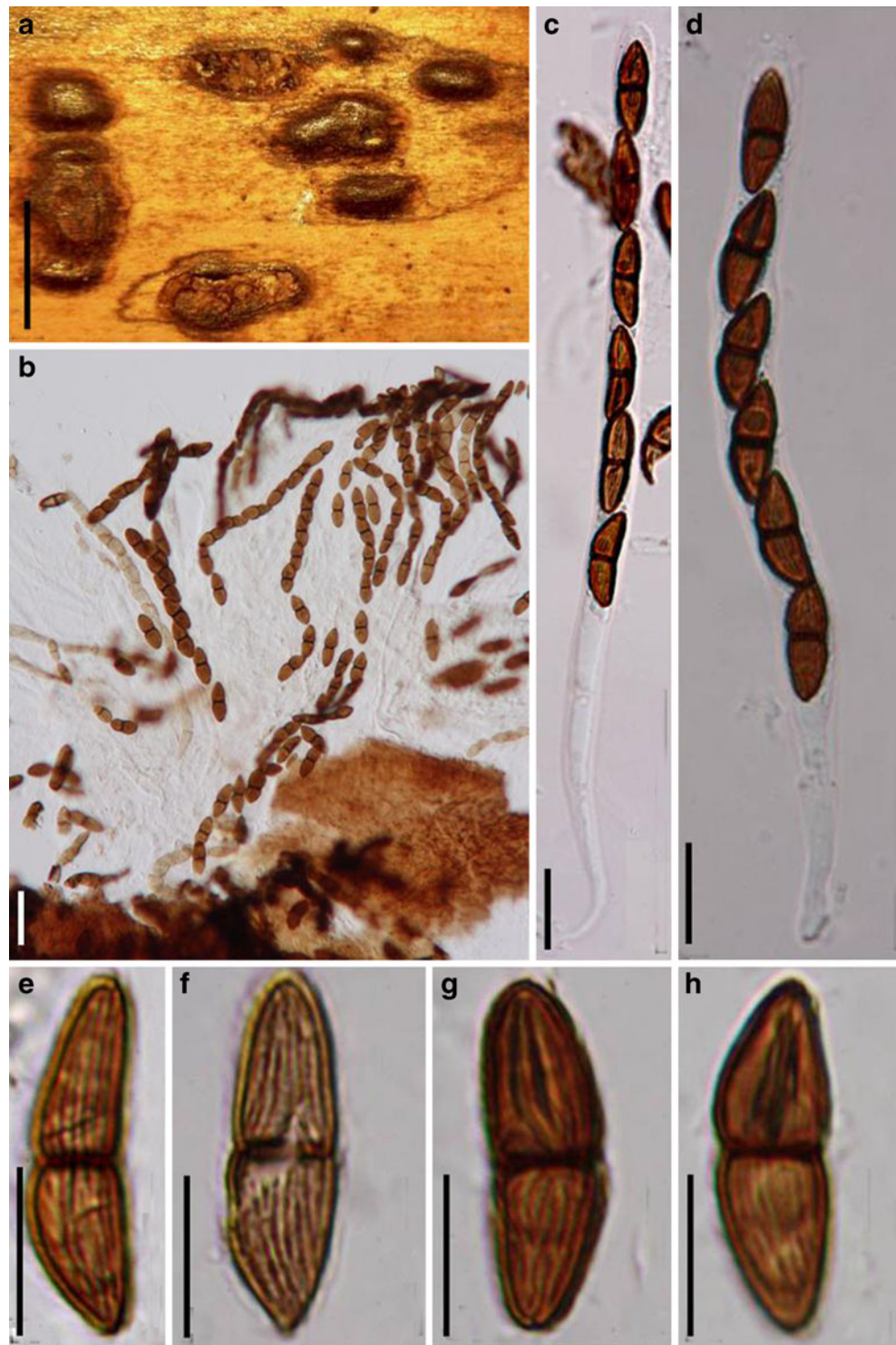
**Fig. 82** *Quintaria lignitalis* (from J. Kohlmeyer No. 4365a, **holotype**). **a** Ascomata immersed in substrate. **b** Section of an ascoma. Note the thin peridium and elongated papilla. **c, e** Asci embedded in pseudoparaphyses. **d** Five septate fusoid hyaline ascospores. Scale bars: **a**=0.5 mm, **b**=200  $\mu$ m, **c, e**=50  $\mu$ m, **d**=20  $\mu$ m



composed of one cell type of pale brown to hyaline pseudoparenchymatous cells, becoming thicker near the apex (Fig. 84a). *Hamathecium* of 1–2  $\mu\text{m}$  broad, filiform, hyaline, septate pseudoparaphyses, branching and anastomosing in mucilage. *Asci* (90–)125–150 $\times$ (20–)25–30  $\mu\text{m}$ , 8-spored, with a short pedicel, bitunicate, cylindro-clavate to clavate, with a small ocular chamber at the apex (Fig. 84c). *Ascospores* 29–

42 $\times$ 8–11  $\mu\text{m}$ , biseriata and sometimes laterally uniseriate, fusoid with narrowly rounded ends, (2–)3-septate, deeply constricted at the septa, the upper second cell subhyaline to pale brown when young and becoming dark brown to almost black at maturity, smooth or verruculose (Fig. 84d). (data from the original description by Kaiser et al. (1979) because of the bad condition of the type material).

**Fig. 83** *Roussoëlla nitidula* (from PAD Paol. 2484, **holotype**). **a** Appearance of the stroma on host surface. **b** Asci and pseudoparaphyses. **c, d** Long cylindrical furcate asci. **e–h**. Ascospores. Note the striate ornamentation. Scale bars: **a**=0.5 mm, **b–d**=20  $\mu\text{m}$ , **e–h**=10  $\mu\text{m}$



**Anamorph:** *Pycnidia* typical of *Stagonospora* (*Sphaeropsidales*), “scattered, arising singly both on the host and in pure culture, in culture generally surrounded by an envelope of mycelial hyphae, numerous, immersed on the host, but nearly superficial in culture, subglobose to slightly applanate, black, 150–250  $\mu\text{m}$  diam., with a central slightly papillate ostiole, lacking a distinct neck; walls mainly 15–20  $\mu\text{m}$  thick, composed of three to six layers of pseudoparenchymatous cells, the outermost layers dark brown and inner pale brown to hyaline cells somewhat compressed radially, very variable in size, cells of the outer layers mainly 7–12  $\mu\text{m}$  long  $\times$  4–6  $\mu\text{m}$  wide in vertically section and 10–12  $\mu\text{m}$  diam. in surface view, wall not or only slightly thickened near the ostiole. *Conidiogenous cells* lining the inner surface of the pycnidial cavity, holoblastic, minute and difficult to distinguish from the pseudoparenchymatous cells with which they are mixed, mammiform with a flattened apex, hyaline, smooth walled, about 4–6  $\mu\text{m}$  tall and 4–6  $\mu\text{m}$  wide. *Conidia* copiously produced, ellipsoid, with somewhat truncated ends, hyaline, smooth walled, (2-)3 septate, not or slightly constricted at the septa, often guttulate, rather thin walled, (21-)24–28(–34)  $\mu\text{m} \times$  7–8.5(–11.5)  $\mu\text{m}$ ” (from Kaiser et al. 1979).

**Material examined:** KENYA, near Nairobi, on leaves of *Saccharum officinarum* L.; 24 Aug. 1977; leg. W.J. Kaiser (IMI 215888, **holotype**).

## Notes

## Morphology

*Saccharicola* was separated from *Leptosphaeria* as a new genus based on its *Stagonospora* anamorph and its biotrophic habitat in leaves of sugar cane, and two species were included, i.e. *Saccharicola bicolor* and *S. taiwanensis* (J.M. Yen & C.C. Chi) O.E. Erikss. & D. Hawksw. (Eriksson and Hawksworth 2003). *Saccharicola* is characterized by its parasitic habitat on monocots, small ascomata, bitunicate asci, presence of pseudoparaphyses as well as its 3-septate ascospores (Eriksson and Hawksworth 2003).

## Phylogenetic study

Based on the limited phylogenetic analysis of SSU sequences, *Saccharicola* is considered to be closely related to *Massarina eburnea*, the generic type of *Massarina* (Eriksson and Hawksworth 2003). Thus, *Saccharicola* was assigned to *Massarinaceae*, which includes *Keissleriella*, *Massarina* and *Saccharicola* (Eriksson and Hawksworth 2003).

## Concluding remarks

Based on the parasitic habitat on monocots and its small ascomata and *Stagonospora* (or *Cercospora*? for *S. taiwanensis*, see Eriksson and Hawksworth 2003; Shoemaker and Babcock 1989b) anamorph, *Saccharicola* seems more

similar to *Pleosporineae*. Further molecular study is needed for confirmation.

***Salsuginea*** K.D. Hyde, Bot. Mar. 34: 315 (1991). (*Pleosporales*, *genera incertae sedis*)

## Generic description

Habitat marine, saprobic. *Ascomata* large, solitary, fusoid, conical or subglobose, with or without a flattened base, immersed under a darkened clypeus, papillate, ostiolate. *Peridium* thin, composed of round cells (in cross section) at sides, fusing at the top with the clypeus, thin at the base. *Hamathecium* of dense, long trabeculate pseudoparaphyses, anastomosing, embedded in mucilage. *Asci* 8-spored, bitunicate, fissitunicate, clavate to cylindro-clavate, pedunculate, with a large ocular chamber and conspicuous apical ring. *Ascospores* uniseriate, obovoid, brown to black, with hyaline apical germ pores, 1-septate, constricted at the septum, dark brown with paler apical cells, lacking sheath, smooth.

**Anamorphs reported for genus:** none.

**Literature:** Hyde 1991a; Suetrong et al. 2009.

## Type species

***Salsuginea ramicola*** K.D. Hyde, Bot. Mar. 34: 316 (1991). (Fig. 85)

*Ascomata* 1040–2600  $\mu\text{m}$  high  $\times$  455–1430  $\mu\text{m}$  diam., solitary, fusoid, conical or subglobose, with or without a flattened base, immersed under a darkened clypeus, papillate, ostiolate, ostiole rounded (Fig. 85a). *Peridium* up to 39  $\mu\text{m}$  thick, composed of round cells (in cross section) at sides, fusing at the top with the clypeus, thin at the base (Fig. 85b). *Hamathecium* of dense, long trabeculate pseudoparaphyses, 1–2  $\mu\text{m}$  broad, anastomosing, embedded in mucilage. *Asci* 440–512  $\times$  29–34  $\mu\text{m}$ , 8-spored, bitunicate, fissitunicate, clavate to cylindro-clavate, pedunculate, with a large ocular chamber and conspicuous apical ring (Fig. 85c and e). *Ascospores* 59–72  $\times$  24–30  $\mu\text{m}$ , uniseriate, obovoid, brown to black, with hyaline apical germ pores, 1-septate, constricted at the septum, dark brown with paler apical cells, lacking sheath, smooth (Fig. 85d and f).

**Anamorph:** none reported.

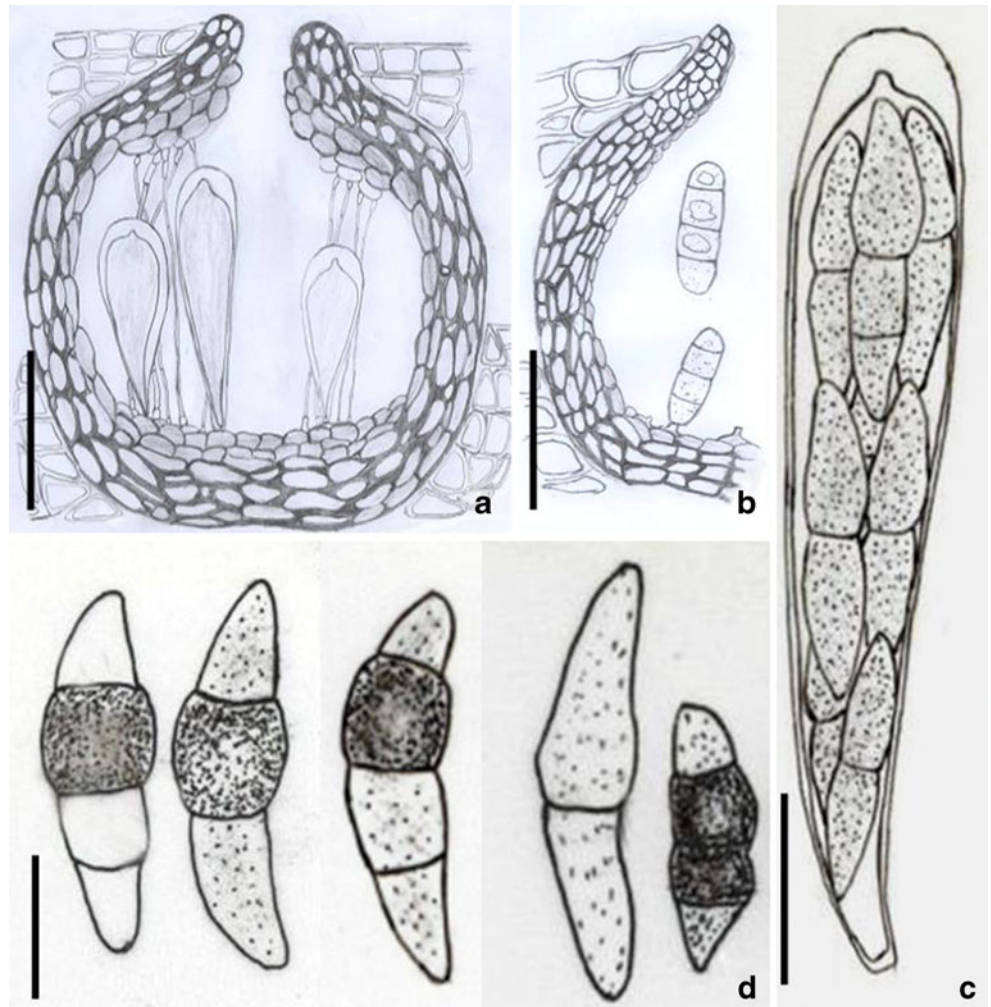
**Material examined:** THAILAND, Ranong mangrove, *Aegiceras corniculatum* (L.) Blanco., Oct. 1988, leg. & det. K.D. Hyde (BRIP 17102, **holotype**).

## Notes

## Morphology

*Salsuginea* was introduced to accommodate the mangrove fungus, *S. ramicola*, which is characterized by large, immersed, ostiolate and papillate ascomata under a clypeus,

**Fig. 84** *Saccharicola bicolor* (from IMI 215888, **holotype**). **a** Section of an ascomata immersed in the host tissue. **b** Section of a partial pycnidia. Note the phragmosporous conidia. **c** Clavate ascus with ocular chamber and short pedicel. **d** Ascospores. Note the pigmented central cell(s). Scale bars: **a**, **b**=50  $\mu\text{m}$ , **c**=20  $\mu\text{m}$ , **d**=10  $\mu\text{m}$



dense, trabeculate pseudoparaphyses embedded in gel matrix, fissitunicate, 8-spored, cylindrical asci with short pedicel and conspicuous apical apparatus, 1-septate, dark brown ascospores with paler apical cells (Hyde 1991a). *Salsuginea* is considered closely related to *Helicascus* and *Caryospora*, and they are all proposed to *Melanommataceae* (Hyde 1991a).

#### Phylogenetic study

Based on a multigene phylogenetic analysis, *Salsuginea ramicola* nested in a paraphyletic clade within *Pleosporales*; its familial status is undetermined (Suetrong et al. 2009).

#### Concluding remarks

It has been shown that trabeculate pseudoparaphyses has no phylogenetic significance at familial rank, so a well resolved phylogeny based on DNA comparisons will be necessary to categorize this genus.

*Semidelitschia* Cain & Luck-Allen, Mycologia 61: 581 (1969). (*Delitschiaceae*)

#### Generic description

Habitat terrestrial, saprobic (coprophilous). *Ascomata* immersed to slightly erumpent, scattered, coriaceous, papillate, ostiolate. *Hamathecium* of non-typical trabeculate pseudoparaphyses, thin, septate, rarely branching. *Asci* cylindrical, pedicellate, each with a conspicuous large apical ring. *Ascospores* non-septate, dark brown to nearly black, each with an elongated germ slit.

**Anamorphs reported for genus:** none.

**Literature:** Barr 2000; Cain and Luck-Allen 1969.

#### Type species

*Semidelitschia agasmatica* Cain & Luck-Allen, Mycologia 61: 581 (1969). (Fig. 86)

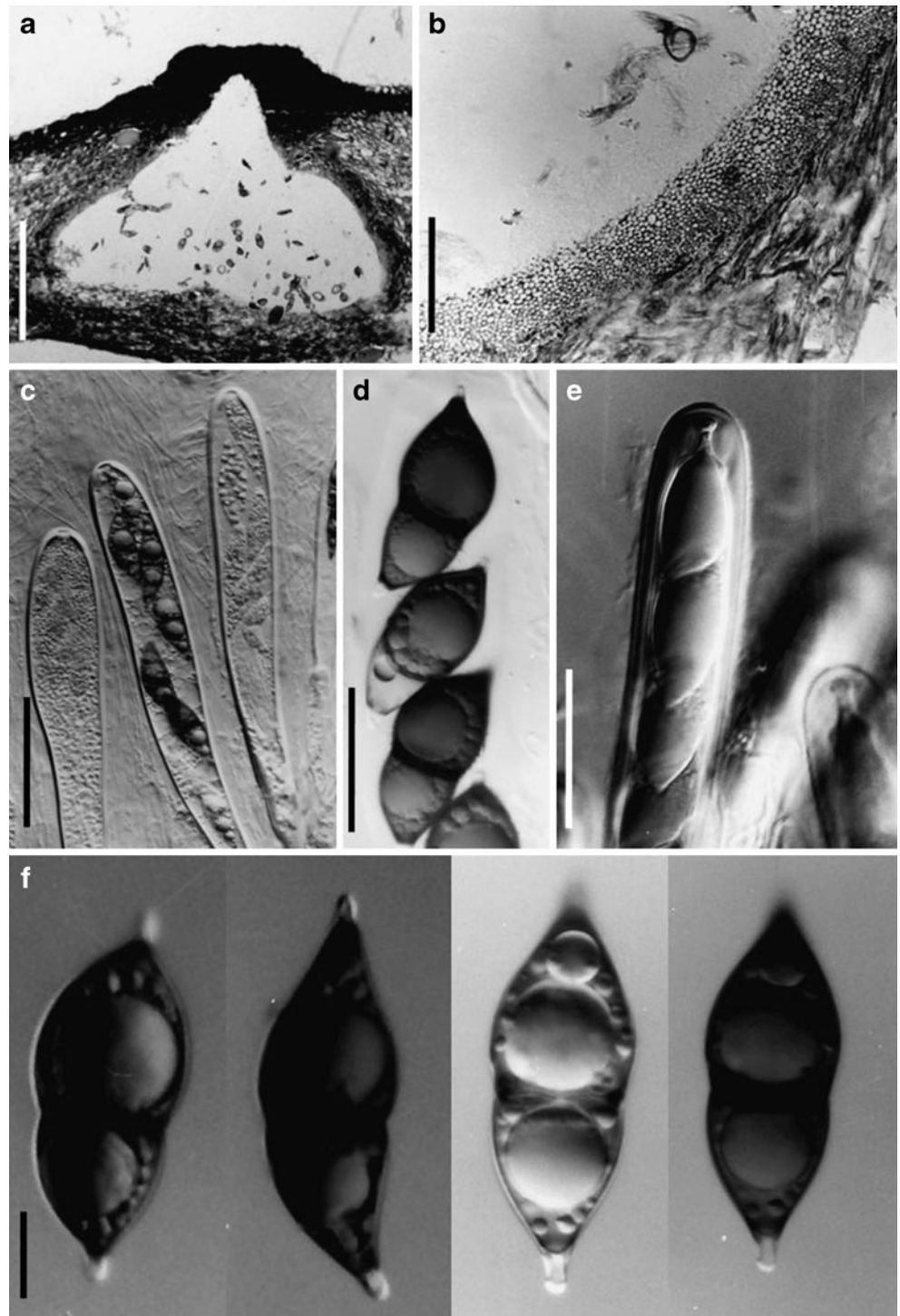
*Ascomata* 550–900  $\mu\text{m}$  diam., solitary, immersed to erumpent, globose to subglobose, black, semicoriaceous, smooth-walled, with a protruding papilla and a conspicuous ostiole (Fig. 86a). *Peridium* thin, comprising multi-angular



cells from front view. *Hamathecium* of non-typical trabeculate pseudoparaphyses, 1–2  $\mu\text{m}$  broad, septate, rarely branching, anastomosing not observed. *Asci* 410–505 $\times$ (38–) 43–50  $\mu\text{m}$  ( $\bar{x}$  = 470.6  $\times$  46.4 $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissionate dehiscence not observed, cylindrical, with a thick pedicel which is up to 90  $\mu\text{m}$  long, and with a large

and conspicuous dome-shaped ocular chamber surrounded by apical ring (to 18  $\mu\text{m}$  wide $\times$ 4  $\mu\text{m}$  high) (Fig. 86b and e). *Ascospores* 53–65 $\times$ 30–38  $\mu\text{m}$  ( $\bar{x}$  = 61.3  $\times$  34.1 $\mu\text{m}$ ,  $n=10$ ), uniseriate to obliquely uniseriate and partially overlapping, broad fusoid to subglobose, hyaline when young, then becoming yellowish brown, reddish brown

**Fig. 85** *Salsuginea ramicola* (from BRIP 17102, **holotype**). **a** Habitat section of an ascoma. **b** Section of the partial peridium. **c** Clavate mature and immature asci. **d** Ascospores within ascus. **e** Apical part of immature asci. **f** Ascospores with an apical chamber at each end. Scale bars: **a**=0.5 mm, **b–e**=50  $\mu\text{m}$ , **f**=10  $\mu\text{m}$



and nearly black and opaque when mature, non-septate, smooth-walled, with a full length germ slit, surrounded by a broad gelatinous sheath (Fig. 86c and d).

**Anamorph:** none reported.

**Material examined:** CANADA, Alberta, North of Beaver Mines, on sheep dung, 28 Jul. 1962, E.R. Luck-Allen, (TRTC 41607, **paratype**); USA, Montana: Gallatin County, 60 min S of Bozeman, on sheep dung, 2 Sept. 1957, Cain (TRTC 42032, **paratype**); Stillwater County Columbus, on cow dung, 3 Sept. 1957, Cain (TRTC 42031, **paratype**); South Dakota, Meade Co.: South of Wall, on cow dung, 3 Sept. 1962, Cain (TRTC 40697, **holotype**).

## Notes

### Morphology

*Semidelitschia* was formally established by Cain and Luck-Allen (1969) and was assigned to *Sporormiaceae*. Although it is similar to *Delitschia*, it differs as the ascospores are 1-celled, as opposed to 2-celled. Subsequently, *Semidelitschia* was transferred to *Delitschiaceae* together with *Delitschia* (Barr 2000). Currently, three species are listed under this genus, i.e. *S. agasmatica* Cain & Luck-Allen, *S. nanostellata* A.E. Bell & Mahoney and *S. tetraspora* J.H. Mirza & S.M. Khan (Index Fungorum) although the number of species in the genus are given as only two in Kirk et al. (2008).

### Phylogenetic study

None.

### Concluding remarks

This is a clearly defined genus that differs from *Delitschia* in having 1-celled ascospores. Cultures of *S. agasmatica* are needed for sequencing and for establishing the placement and uniqueness of the genus.

***Setomelanomma*** M. Morelet, Bull. Soc. Sci. nat. Arch. Toulon et du Var 227:15 (1980). (*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, hemibiotrophic or biotrophic. *Ascomata* small, solitary, scattered, immersed, erumpent to superficial, globose to subglobose, black; with or without a small papilla, apex covered with setae and a periphysate ostiole. *Peridium* thin, 1-layered, composed of several layers of cells of *textura angularis*. *Hamathecium* of dense, 1–2  $\mu\text{m}$  broad pseudoparaphyses, septate, anastomosing. *Asci* 8-spored, bitunicate, broadly cylindrical. *Ascospores* fusoid to broadly clavate, pale brown to brown, 3-septate.

**Anamorphs reported for genus:** none.

**Literature:** Leonard and Suggs 1974; Morelet 1980; Rossman et al. 2002; Schoch et al. 2009; Zhang et al. 2009a.

### Type species

***Setomelanomma holmii*** M. Morelet, Bulletin de la Société des Sciences naturelles et d'Archéologie de Toulon et du Var 36 (no. 227): 15 (1980). (Fig. 87)

(Some information in the following description is from Rossman et al. (2002))

*Ascomata* 80–250  $\mu\text{m}$  diam., solitary, scattered, immersed, erumpent to superficial, globose to subglobose, black, with setae; with or without a small papilla, apex covered with setae and a periphysate ostiole. *Peridium* 15–25  $\mu\text{m}$  thick, 1-layered, composed of several layers of cells of *textura angularis*, cell wall thinner and more lightly pigmented towards centrum, cell wall thicker near the apex. *Hamathecium* of dense, 1–2  $\mu\text{m}$  broad pseudoparaphyses, thicker near the base, septate, anastomosing (Fig. 87a and d). *Asci* 70–100 $\times$ 11–14  $\mu\text{m}$ , 8-spored, bitunicate, broadly cylindrical with a short, thick, furcate pedicel, with a small ocular chamber (Fig. 87a, b and c). *Ascospores* 16–21 $\times$ 5–6.5  $\mu\text{m}$ , obliquely uniseriate and partially overlapping to biseriate, fusoid to broadly clavate with broadly to narrowly rounded ends, pale brown to brown, 3-septate, slightly constricted at the median septum, smooth (Fig. 87e).

**Anamorph:** none reported.

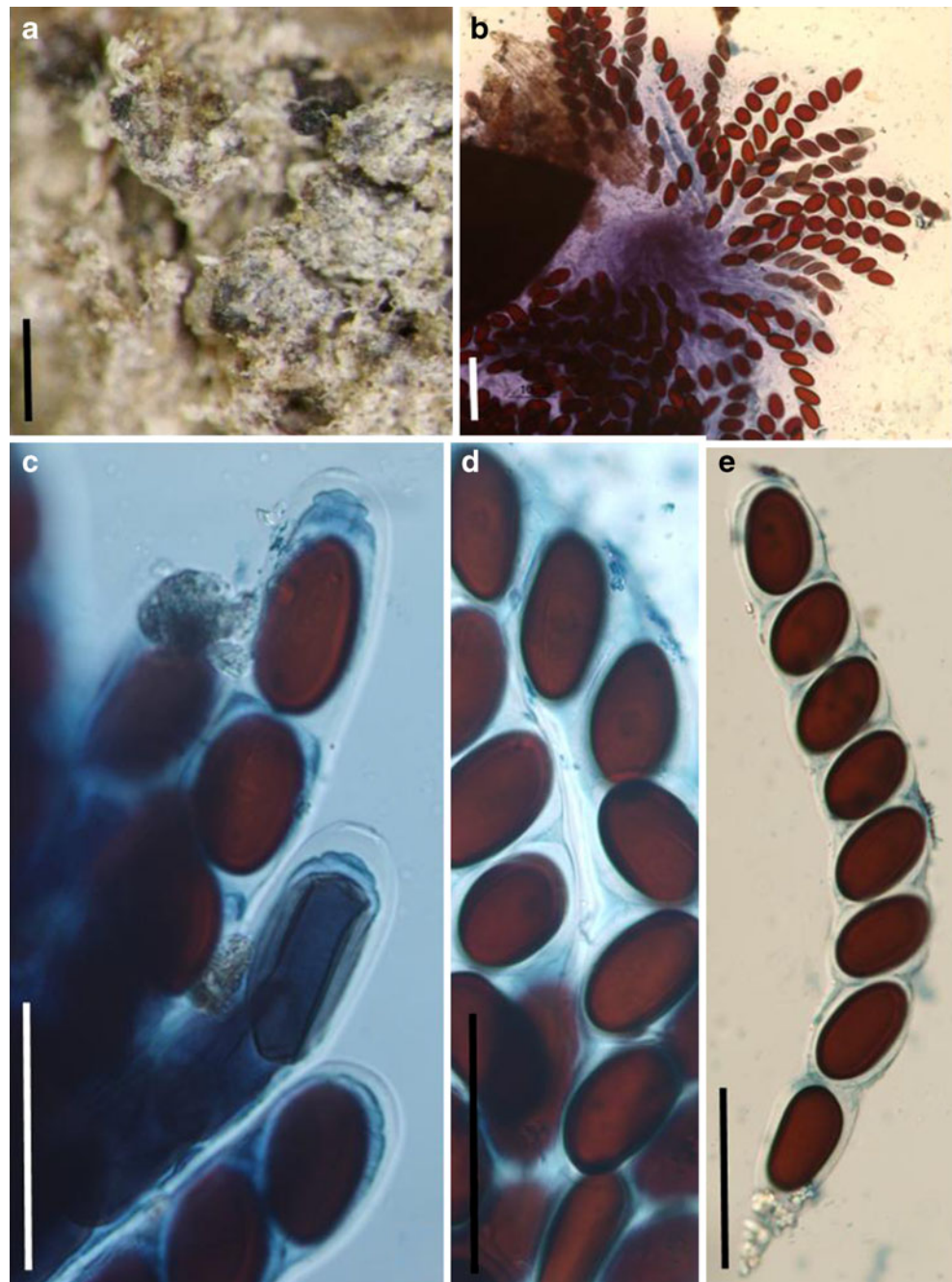
**Material examined:** FRANCE, Leuglay, on dying twigs of *Picea pungens*. 8 May 1987, leg. M. Morelet (UPS F-117969 (slide), **isotype**).

## Notes

### Morphology

*Setomelanomma* was formally established by Morelet (1980) as a monotypic genus represented by *S. holmii*, which was collected in France. The description, however, is not detailed and lacks illustrations. Rossman et al. (2002) collected this species in North America and detailed studies were conducted including both morphology and phylogeny. The bitunicate, broadly cylindrical asci, cellular pseudoparaphyses as well as the pale brown, septate ascospores with a median primary septum point *Setomelanomma* to *Phaeosphaeriaceae* as defined by Barr (1992a) and Eriksson et al. (2002) (Rossman et al. 2002). However, its setose ascomata, brown and 3-septate ascospores together with its residence in conifers distinguish it from all other genera under *Phaeosphaeriaceae* (Rossman et al. 2002). *Setomelanomma* is mostly comparable with *Kalmusia* and *Phaeosphaeria*. *Setomelanomma* can be distinguished from *Kalmusia* by its erumpent to superficial ascomata with almost no papilla, and *Phaeosphaeria* differs from *Setomelanomma* by its host spectrum and reported anamorphic stages (Rossman et al. 2002). Currently, five species are included in *Setomelanomma*, namely *S. holmii*, *S. monoceras*, *S. prolata* K.J. Leonard & Suggs, *S. rostrata* (K.J. Leonard) K.

**Fig. 86** *Semidelitschia agas-matica* (from TRTC 40697, **holotype**). **a** Immersed ascomata scattered on the surface of the substrate. **b** Squash of ascoma. Note the numerous released asci. **c** Apical ring of cylindrical asci. **d** One-celled ascospores. Note the germ slits (see *arrow*). **e** Cylindrical ascus. Note the tapering pedicel. Scale bars: **a**=0.5 mm, **b–e**=100  $\mu$ m



J. Leonard & Suggs and *S. turcica* (Luttr.) K.J. Leonard & Suggs (<http://www.mycobank.org/>, 06/2010).

#### Phylogenetic study

*Setomelanomma* forms a well supported phylogenetic clade with other members of *Phaeosphaeriaceae* (Schoch et al. 2009; Zhang et al. 2009a).

#### Concluding remarks

None.

*Shiraia* Henn., Bot. Jb. 28: 274 (1900). (*Pleosporales*, genera *incertae sedis*)

#### Generic description

Habitat terrestrial, parasitic. *Ascostroma* warty-like or tuber-like. *Ascomata* medium to large, subglobose, gregarious on the surface layer of ascostroma, immersed, ostiolate, with a small black opening seen on the surface of the ascostroma, ostiole rounded. *Hamathecium* of

dense, long trabeculate pseudoparaphyses, anastomosing and branching between the asci. *Asci* bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a short furcate pedicel, with a big and truncate ocular chamber. *Ascospores* obliquely uniseriate and partially overlapping, narrowly fusoid to fusoid or broadly fusoid with tapering or narrowly rounded ends, hyaline to pale brown or brown, muriform.

**Anamorphs reported for genus:** coelomycetous with muriform conidia (see Liu 2009).

**Literature:** Cheng et al. 2004; Hino 1961; Kishi et al. 1991; Liu 2009; Morakotkarn et al. 2008.

### Type species

*Shiraia bambusicola* Henn., Bot. Jb. 28: 274 (1900). (Fig. 88)

*Ascstroma* 1–1.5 cm high × 1–2.5 cm diam., subglobose, oblong to irregular, slightly pink with cracking surface. *Ascomata* 350–800  $\mu\text{m}$  high × 300–700  $\mu\text{m}$  diam., subglobose, gregarious on the surface layer of ascostroma, immersed, ostiolate, with a small black opening seen on the surface of the ascostroma, ostiole rounded, the inner tissue of ascostroma carnation red (Fig. 88a and b). *Hamathecium* of dense, long trabeculate pseudoparaphyses, 0.8–1.5  $\mu\text{m}$  broad, anastomosing and branching between the asci. *Asci* 300–425 × 20–35  $\mu\text{m}$  ( $\bar{x}$  = 360.5 × 28  $\mu\text{m}$ ,  $n$  = 10), 6-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a short furcate pedicel, up to 50  $\mu\text{m}$  long, with a big and truncate ocular chamber (Fig. 88c and d). *Ascospores* 62.5–80 × 17.5–22.5  $\mu\text{m}$  ( $\bar{x}$  = 72.3 × 19.3  $\mu\text{m}$ ,  $n$  = 10), obliquely uniseriate and partially overlapping, narrowly fusoid to fusoid with tapering or narrowly rounded ends, hyaline turning pale brown when mature, muriform, with 9–13 transversal septa, 1–3 longitudinal septa in central cells, slightly constricted at the septa, usually with a gelatinous cap at each end (Fig. 88e, f and g).

**Anamorph:** coelomycetous with muriform conidia (see Liu 2009).

**Material examined:** CHINA, Zhejiang, Hangzhou, Panan, on bamboo, 15 Jun. 2009, leg. Liu Yongxiang (IFRD 2040).

### Notes

#### Morphology

*Shiraia* is reported as a parasite on branches of several genera of bamboo distributed mainly in southern regions of China and Japan (Hino 1961; Kishi et al. 1991; Liu 2009). *Shiraia* is characterized by its bambusicolous habitat, large ascostroma and muriform ascospores. Asci comprise 6 ascospores in this study and some previous studies (Hino

1961; Liu 2009). *Shiraia bambusicola* is well studied because of its medical effect in anticancer treatment (Kishi et al. 1991).

#### Phylogenetic study

Based on the SSU and ITS rDNA sequences analysis, its pleosporalean status was verified, and *Shiraia* was suggested to be closely related to *Leptosphaeriaceae* and/or *Phaeosphaeriaceae* (*Pleosporineae*) (Cheng et al. 2004). Based on the molecular phylogenetic analysis, another *Shiraia*-like fungus was reported which produced distinctive prawn-shaped conidioma-like structures (Morakotkarn et al. 2008), and differed from conidiomata in the anamorph of *S. bambusicola* described by Liu (2009).

**Concluding remarks** A relatively broad species concept of *Shiraia bambusicola* is currently used, which could comprise several species.

*Sinodidymella* J.Z. Yue & O.E. Erikss., Mycotaxon 24: 295 (1985). (*Teichosporaceae*)

#### Generic description

Habitat terrestrial, saprobic? *Ascomata* medium to large, scattered, or in small groups, immersed, erumpent, to superficial, globose, subglobose, coriaceous, apex flattened, with radial ridges arranged around the central region. *Peridium* thick, 2-layered. *Hamathecium* of dense, broadly trabeculate pseudoparaphyses, anastomosing and branching between the asci. *Asci* 8-spored, with a short, furcate pedicel, bitunicate, cylindrical. *Ascospores* broadly ellipsoid, hyaline, becoming pale brown when mature, 1-septate, constricted at the median septum.

**Anamorphs reported for genus:** none.

**Literature:** Yue and Eriksson 1985.

#### Type species

*Sinodidymella verrucosa* (Petr.) J.Z. Yue & O.E. Erikss., Mycotaxon 24: 295 (1985). (Fig. 89)

≡ *Amphididymella verrucosa* Petr., Meddn Göteborg. Bot. 17: 129 (1947).

*Ascomata* 620–930  $\mu\text{m}$  high × 800–1250  $\mu\text{m}$  diam., scattered, or in small groups, immersed, becoming erumpent, to nearly superficial, globose, subglobose, coriaceous, apex flattened, with 3–6 radial ridges arranged around the central region, with a flattened base not easily removed from the substrate, wall black, roughened (Fig. 89a and b). *Peridium* 100–150  $\mu\text{m}$  thick, thinner at the base, 2-layered, outer layer thin, up to 40  $\mu\text{m}$  thick, composed of small heavily pigmented thick-walled cells of *textura globulosa*, cells up to 5  $\mu\text{m}$  diam., cell wall 3–6  $\mu\text{m}$  thick, inner layer thick, composed of

hyaline small cells of *textura epidermoidea*, 2–4  $\mu\text{m}$  diam., cell wall 1–3  $\mu\text{m}$  thick, interspersed with interwoven mycelium in places (Fig. 89b and c). *Hamathecium* of dense, broadly trabeculate pseudoparaphyses 1–2  $\mu\text{m}$  broad, anastomosing between and above the asci (Fig. 89d). *Asci* 140–190 (–205)  $\times$  12.5–15 (–17.5)  $\mu\text{m}$  ( $\bar{x}$  = 164  $\times$  14.3  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, cylindrical, with a short, furcate pedicel, 20–45  $\mu\text{m}$  long, and an inconspicuous ocular chamber (to 2  $\mu\text{m}$  wide  $\times$  1  $\mu\text{m}$  high) (Fig. 89d and e). *Ascospores* 20–25  $\times$  10–12  $\mu\text{m}$  ( $\bar{x}$  = 22.1  $\times$  10.3  $\mu\text{m}$ ,  $n$ =10), obliquely uniseriate and partially overlapping, broadly ellipsoid with rounded ends, hyaline, becoming pale brown when mature, 1-septate, constricted at the median septum, smooth (Fig. 89f).

**Anamorph:** none reported.

**Material examined:** CHINA, Kansu Prov., between Scharakuto and Kweite, on rotten stems of *Salsola gemmascens* Pall., 25 Jul. 1935, G. Fenzel 2400 (W 16366, **type**).

## Notes

### Morphology

*Sinodidymella* was formally established by Yue and Eriksson (1985) as they noticed that *Amphididymella verrucosa* Petr. was not congeneric with the generic type, *A. adeana* Petr., which is a pyrenolichen. Thus a new monotypic genus, *Sinodidymella* was introduced to accommodate it. The most outstanding morphological character of *Sinodidymella* is its radial ridges, which are somewhat comparable with that of *Lophiostoma rugulosum* Yin. Zhang, J. Fourm. & K.D. Hyde, although their pseudoparaphyses are dissimilar. *Lophiostoma rugulosum* has “tightly aggregated cellular pseudoparaphyses” and “apically ending into bunches of clavate cells” (Zhang et al. 2009b).

### Phylogenetic study

None.

### Concluding remarks

The radial ridges have little phylogenetic significance in genus level classification (Zhang et al. 2009b), but the broadly trabeculate pseudoparaphyses of *Sinodidymella* may fit *Melanommataceae*.

***Splanchnonema*** Corda, in Sturm, Deutschl. Fl., 3 Abt. (Pilze Deutschl.) 2(9), Tome 3: 115 (1829). (?*Pleomassariceae*)

### Generic description

Habitat terrestrial, saprobic. *Ascomata* medium to large, solitary or scattered, immersed in cortex with a pseudostromal covering, with a small ostiole appearing on the host surface, flattened subglobose. *Peridium* thin. *Hamathecium*

**Fig. 87** *Setomelanomma holmii* (from UPS F-117969 (slide), **isotype**). **a, b** Asci with short pedicels in pseudoparaphyses. **c** Partial view of ascus. **d** Branching and septate pseudoparaphyses. **a** Three-septate lightly pigmented ascospores in ascus. Scale bars: **a–e**=10  $\mu\text{m}$

of dense, cellular pseudoparaphyses, embedded in mucilage, anastomosing and branching. *Asci* bitunicate, fissitunicate, clavate to broadly cylindrical, with a short, narrowed, furcate pedicel. *Ascospores* clavate with a rounded apex and acute base, reddish brown, constricted at the septa.

**Anamorphs reported for genus:** *Myxocyclus*, *Steganosporium* (Barr 1982b).

**Literature:** Barr 1982b, 1993a; Boise 1985; Corda 1829; Eriksson 1981; Ramaley and Barr 1995; Shoemaker and LeClair 1975; Sivanesan 1984; Tanaka et al. 2005.

### Type species

***Splanchnonema pustulatum*** Corda, in Sturm, Deutschl. Fl., 3 Abt. (Pilze Deutschl.) 2(9), Tome 3: 115 (1829). (Fig. 90)

*Ascomata* 400–600  $\mu\text{m}$  high  $\times$  550–1000  $\mu\text{m}$  diam., solitary or scattered, immersed in cortex with a pseudostromal covering, with a small ostiole appearing on the host surface, flattened subglobose (Fig. 90a). *Peridium* 15–25  $\mu\text{m}$  thick, composed of small lightly pigmented thin-walled compressed cells (Fig. 90b). *Hamathecium* of dense, long cellular pseudoparaphyses 2–3  $\mu\text{m}$  broad, embedded in mucilage, anastomosing and branching. *Asci* 200–250  $\times$  30–45  $\mu\text{m}$  ( $\bar{x}$  = 219.6  $\times$  38.2  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, clavate to broadly cylindrical, with a short, narrowed, furcate pedicel up to 35  $\mu\text{m}$  long, without conspicuous ocular chamber (Fig. 90c and d). *Ascospores* 45–53  $\times$  20–24  $\mu\text{m}$  ( $\bar{x}$  = 48.5  $\times$  22.3  $\mu\text{m}$ ,  $n$ =10), obliquely uniseriate and partially overlapping to biseriate, clavate with a rounded apex and acute base, reddish brown, 2-septate, apical cell largest, broader than the lower cells, basal cell smallest, constricted at the septa, smooth-walled, surrounded by a regular hyaline gelatinous sheath, 3–6  $\mu\text{m}$  thick (Fig. 90e and f).

**Anamorph:** none reported.

**Material examined:** UK, Avon, nr Bath, Batheaston, on branch of *Ulmus*, C.E. Broome (L, No. 910.251-352, No. 910.251-371).

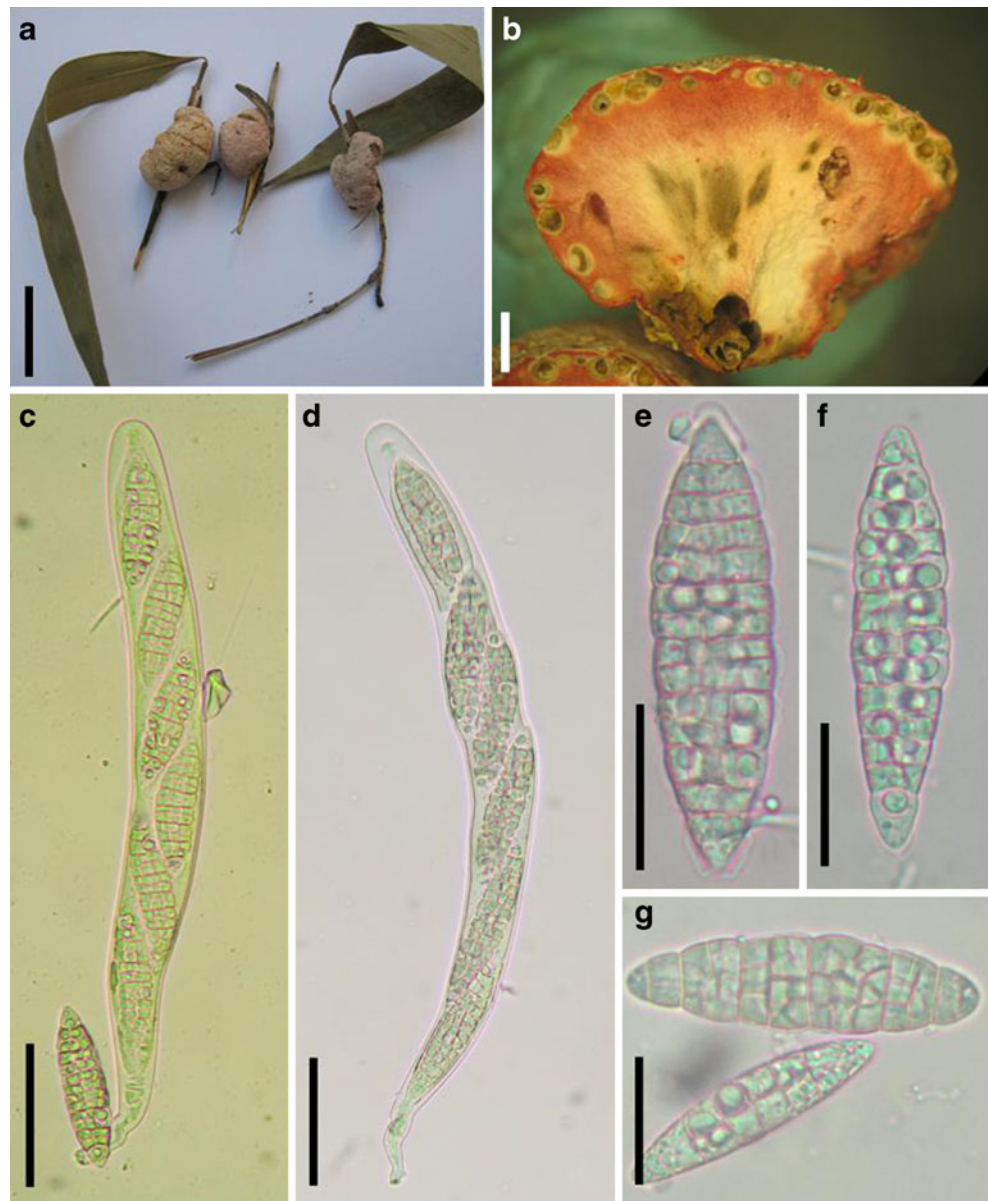
## Notes

### Morphology

A confusing outline of the history of *Splanchnonema* was provided by Shoemaker and LeClair (1975), which at the time was a valid, but little used name. Eriksson (1981) and Sivanesan (1984) stated (without comment) that the lectotype of *Splanchnonema* is *S. pupula* (Fr.) O. Kuntze. However, *S. pustulatum* is listed as the generic type in the



**Fig. 88** *Shiraia bambusium* (from IFRD 2040). **a** Ascostroma form a nubby structures on the twigs of host. **b** Vertical section of an ascostroma. Note the reddish staining of the inner tissue. **c, d** Cylindrical asci with a short pedicel. **e–g** Muriform fusoid hyaline ascospores. Scale bars: **a**=1 cm, **b**=1 mm, **c, d**=50  $\mu$ m, **e–g**=20  $\mu$ m



online databases MycoBank and Index Fungorum. We assume Eriksson (1981) gained his data from Shoemaker and LeClair (1973), who considered *S. pustulatum* to be a synonym of *S. pupula*. Since we were unable to locate material of Corda or Fries we used a later collection of C.E. Broome.

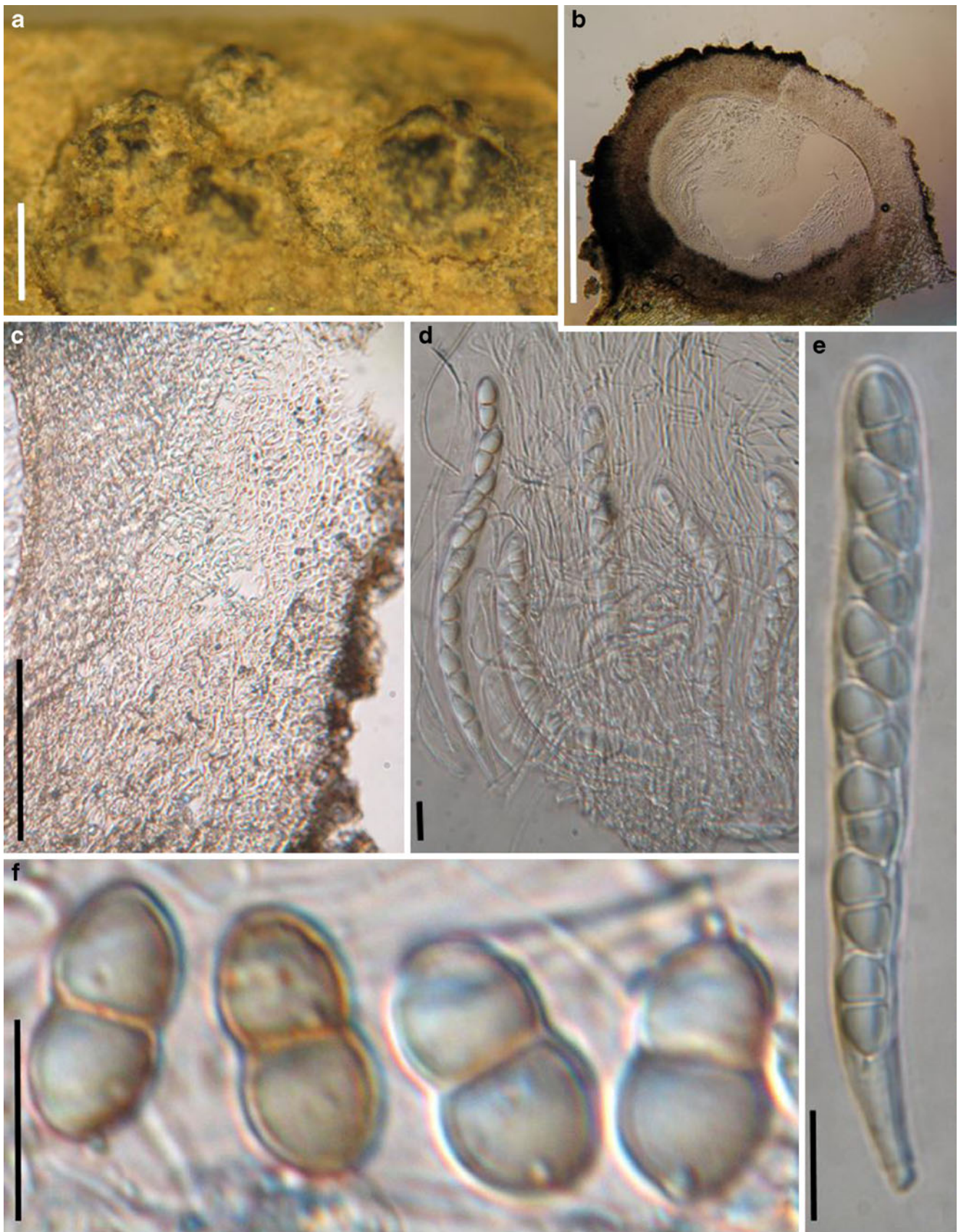
*Splanchnonema* can be distinguished from the morphologically comparable genera, i.e. *Pleomassaria* or *Splanchospora* by its depressed ascomata, and obovoid and asymmetrical ascospores (Barr 1982b). Currently, about 40 species are included in this genus. Barr (1993a) provided a key to 27 North American species, however, the inclusion of species with a range of ascospore types and immersed to superficial ascomata suggests the genus to be polyphyletic. Tanaka et al.

(2005) suspected that the genus might include species of *Pleomassaria*, thus this genus needs further study.

#### Phylogenetic study

*Splanchnonema platani* (= *Massaria platani*) is poorly supported to be related to *Lentitheciaceae* (Schoch et al. 2009).

**Fig. 89** *Sinodidymella verrucosa* (from W 16366, type). **a** Ascomata on the host surface. Note the radial ridges around the pseudostiolar region. **b** Section of an ascoma. **c** Section of peridium. Note the hyaline small cells and interwoven hyphae. **d** Cylindrical asci in pseudoparaphyses. **e** Eight-spored ascus with short pedicel. **f** Hyaline, 1-septate ascospores which turn pale brown when mature. Scale bars: **a**=1 mm, **b**=100  $\mu$ m, **c**=50  $\mu$ m, **d–f**=20  $\mu$ m





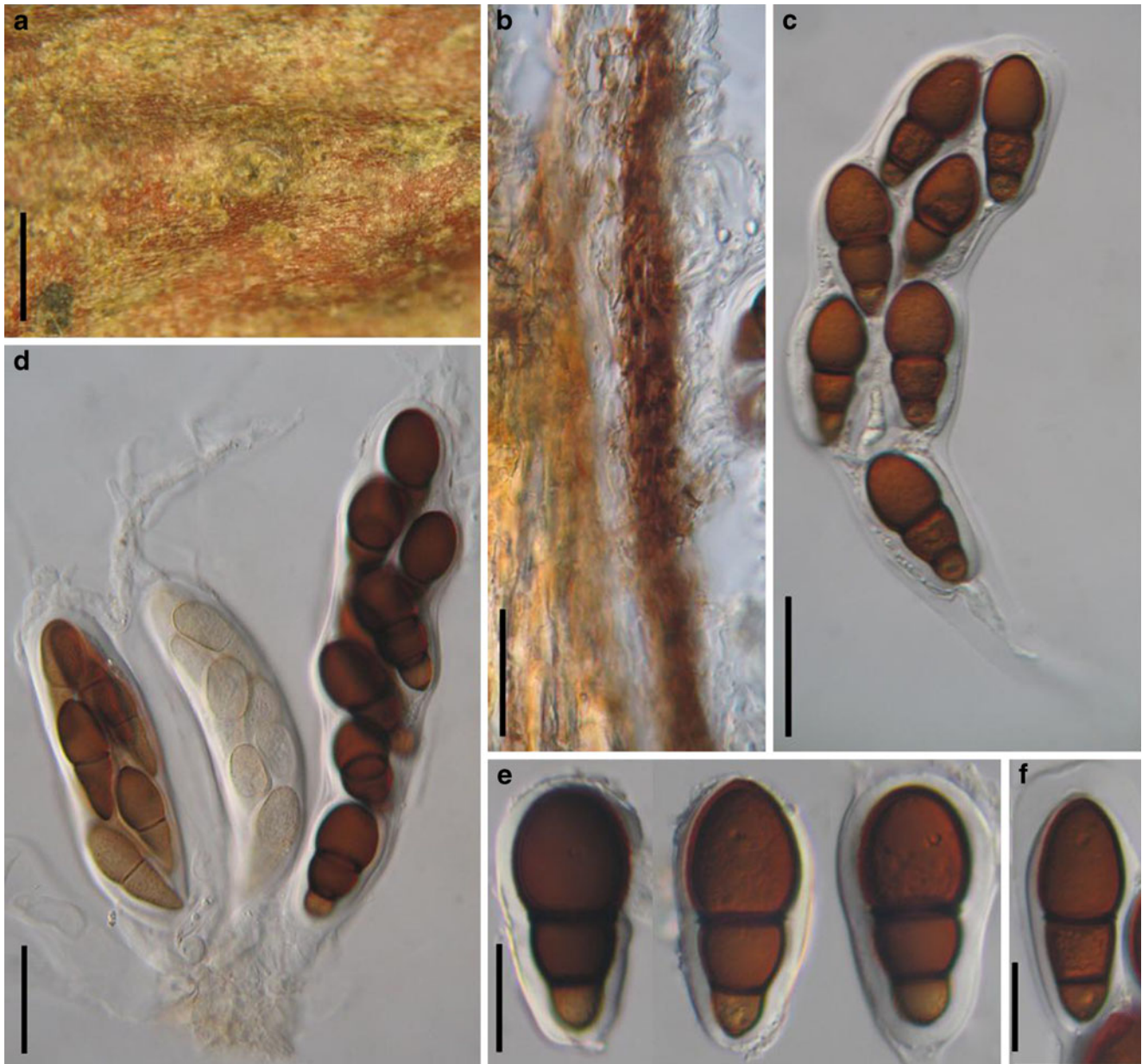
### Concluding remarks

*Splanchnonema pustulatum* has unique ascospores formed in immersed ascomata with thin walls, indicating that *Splanchnonema sensu stricto* should be confined to a few similar species. The type needs recollecting, sequencing and epitypifying in order to establish the phylogenetic relationships of this genus and to study what may be important defining characters. Also see entry under *Pleomassaria*.

***Sporormia*** De Not., Micromyc. Ital. Novi 5: 10 (1845). (*Sporormiaceae*)

### Generic description

Habitat terrestrial, saprobic (coprophilous). *Ascomata* small, solitary, scattered, immersed to erumpent, globose, subglobose, wall black; apex without obvious papilla, ostiolate. *Peridium* thin. *Hamathecium* of rare, broad, septate pseudo-paraphyses. *Asci* 8-spored, bitunicate, fissitunicate dehiscence not observed, short cylindrical, with a short, narrowed, furcate pedicel. *Ascospores* fasciculate, broadly filliform, reddish brown, multi-septate, easily separating into part-spores, without visible germ-slits or pores.



**Fig. 90** *Splanchnonema pustulatum* (from L, No. 910.251–352, No. 910.251–371). **a** Appearance of ascomata on the host surface beneath a slightly raised area with minute ostiolar opening. **b** Section of the partial peridium. Note the compressed cells. **c** Dehiscent ascus. **d**

Cluster of three asci joined in hymenium and pseudo-paraphyses. **e, f** Asymmetric ascospores. Note the conspicuous sheath. Scale bars: **a**= 1 mm, **b–d**=50  $\mu\text{m}$ , **e, f**=20  $\mu\text{m}$

**Anamorphs reported for genus:** none.

**Literature:** Ahmed and Asad 1968; Ahmed and Cain 1972; Kirschstein 1944; de Notaris 1849.

### Type species

*Sporormia fimetaria* De Not., Micromyc. Ital. Novi 5: 10 (1845). (Fig. 91)

*Ascomata* 100–150  $\mu\text{m}$  diam., solitary, scattered, immersed to erumpent, globose, subglobose, wall black; apex without obvious papilla, ostiolate (Fig. 91a). *Peridium* thin (other characters unknown). *Hamathecium* of rare, 2–3  $\mu\text{m}$  wide, septate pseudoparaphyses. *Asci* 70–100  $\times$  13–18  $\mu\text{m}$  ( $\bar{x}$  = 86.4  $\times$  14.9  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate dehiscence not observed, shortly cylindrical, with a short, narrowed, furcate pedicel up to 20  $\mu\text{m}$  long, no apical apparatus could be observed (Fig. 91b, c and d). *Ascospores* 50–58  $\times$  4–5  $\mu\text{m}$  ( $\bar{x}$  = 54.7  $\times$  4.8  $\mu\text{m}$ ,  $n$ =10), fasciculate, broadly filliform, reddish brown, with 16 cells, easily separating into partspores, central cells of the ascospores shorter than broad, rectangular in vertical section, round in transverse section, 4–5  $\times$  2.5–3.5  $\mu\text{m}$ , without visible germ-slits or pores, apical cells usually longer than broad, 5–6.5  $\mu\text{m}$  long, also without apertures (sheath is reported (Ahmed and Cain 1972), but not observed in this study) (Fig. 91e).

**Anamorph:** none reported.

**Material examined:** 1832, (RO, type, as *Hormospora fimetaria* De Not.).

### Notes

#### Morphology

*Sporormia* was formally established by de Notaris (1849), and only one species was described, i.e. *S. fimetaria*, which subsequently was selected as the generic type. *Sporormia sensu stricto* was accepted by several workers, and only includes members with a fasciculate ascospore arrangement, parallel to the ascus, and the part cells of the ascospores lacking germ-slits (Ahmed and Asad 1968; Ahmed and Cain 1972; Kirschstein 1944). Species whose ascospores are not fasciculate and have partspores with germ-slits were assigned to *Sporormiopsis* by Kirschstein (1944) and to *Sporormiella* by Ahmed and Cain (1972).

#### Phylogenetic study

The generic status of *Sporormia* in *Pleosporales* was verified based on a phylogenetic analysis of ITS-nLSU rDNA, mtSSU rDNA and  $\beta$ -tubulin sequences (Kruys and Wedin 2009). *Sporormia* clustered together with species of *Westerdykella* (including *Eremodothis* and *Pycnidiophora*), but lacks clear statistical support. Thus, the relationship of

*Sporormia* with other genera of *Sporormiaceae* is unclear and not resolved yet.

### Concluding remarks

Several coprophilous taxa (e.g. *Chaetopreussia* and *Pleophragmia* as well as *Sporormiella nigropurpurea*) in the *Pleosporales* were not included in the study by Kruys and Wedin (2009). Strains of these genera need to be collected and analyzed and their relationship with *Sporormia* established.

*Trematosphaeria* Fuckel, Jb. nassau. Ver. Naturk. 23–24: 161 (1870). (*Trematosphaeriaceae*)

### Generic description

Habitat terrestrial or freshwater, saprobic. *Ascomata* subglobose, unilocular, erumpent to superficial, with papillate ostiole. *Peridium* thin, comprising several cell types. *Hamathecium* of dense, delicate, filliform, septate pseudoparaphyses. *Asci* bitunicate, fissitunicate, cylindro-clavate, normally 8-spored. *Ascospores* ellipsoid-fusoid to biconic, septate, smooth to finely verruculose, brown.

**Anamorphs reported for genus:** hyphopodia-like (Zhang et al. 2008a).

**Literature:** von Arx and Müller 1975; Barr 1979a; Boise 1985; Clements and Shear 1931; Zhang et al. 2008a.

### Type species

*Trematosphaeria pertusa* (Pers.) Fuckel, Jb. nassau. Ver. Naturk. 23–24: 161 (1870). (Fig. 92)

$\equiv$  *Sphaeria pertusa* Pers., Syn. meth. fung. (Göttingen) 1: 83 (1801).

*Ascomata* 350–550  $\mu\text{m}$  high  $\times$  320–480  $\mu\text{m}$  diam., solitary, scattered, or in groups, initially immersed, becoming erumpent, to semi-immersed, subglobose, black; apex with a short ostiole usually slightly conical and widely porate, to 100  $\mu\text{m}$  high (Fig. 92a and b). *Peridium* 48–55  $\mu\text{m}$  wide laterally, to 80  $\mu\text{m}$  at the apex, thinner at the base, 30–40  $\mu\text{m}$  thick, coriaceous, 3-layered, comprising several cell types, one is of small heavily pigmented thick-walled cells of *textura angularis*, cells 4–8  $\mu\text{m}$  diam., cell wall 1.5–3  $\mu\text{m}$  thick in places with columns of *textura prismatica* orientated perpendicular to the ascomatal surface, apex cells smaller and walls thicker, forming thick-walled cells of *textura pseudoparenchymata*, and larger, paler cells of mixture of *textura epidermoidea* and *textura angularis* at the base (Fig. 92b, c and h). *Hamathecium* of dense, filamentous, 1.5–2.5  $\mu\text{m}$  broad, septate pseudoparaphyses, embedded in mucilage, branching and anastomos-

ing between and above the asci (Fig. 92d, e and f). *Asci* 100–145×15–17  $\mu\text{m}$  ( $\bar{x}$  = 118 × 15.5 $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, cylindro-clavate, with a short, thick, furcate pedicel which is 12–30  $\mu\text{m}$  long, with a truncate ocular chamber (Fig. 92d, e, f, g and i). *Ascospores* 27.5–32.5×7.5–8.5  $\mu\text{m}$  ( $\bar{x}$  = 29.5 × 8 $\mu\text{m}$ ,  $n=10$ ), biseriata to uniseriate near the base, fusoid with broadly to narrowly rounded ends, dark brown, 1–3-septate, secondary septum forming late or often absent, constricted at the median septum, the upper cell often shorter and broader than the lower one, smooth to finely verruculose, containing refractive globules (Fig. 92j and k).

**Anamorph:** Only hyphopodia-like structures (or conidia?) observed (Zhang et al. 2008a).

Colonies (of epitype) reaching 5 cm diam. after 20 days growth on MEA at 25°C, raised, woolly, deep grey, with irregular to rhizoidal margin, reverse darkened. Hyphopodia-like structures (or conidia?) produced after 6 months, hyaline to pale brown, lobed, 4–4.5(–5)  $\mu\text{m}$  long and 3–3.5  $\mu\text{m}$  diam.

**Material examined:** EUROPE, Upsala, on decaying wood, designated by Boise (1985), (L-Pers 910269–172, as *Sphaeria pertusa* Pers., **neotype**); FRANCE, Deux Sèvres, Sansais, Le Vanneau, Les Grandes Mottines, swamp, on bark of a dead stump of *Fraxinus excelsior*, 25 Apr. 2004, J. Fournier (IFRD 2002, **epitype**); Haute Garonne, Avignonet, Canal du Midi, on submerged wood of *Platanus* in a canal, 23 Nov. 2006, Michel Delpont, det. J. Fournier (IFRD2003).

## Notes

### Morphology

*Trematosphaeria* was formally established in ‘Rhenish fungi’ by Fuckel (1870) based on the broadly pertuse ascomata, and Fries (1823) assigned it under *Ascomycetes*, *Pyrenomycetes*, *Lophiostomataceae*. Subsequently, Winter (1885) placed *Trematosphaeria* in *Amphisphaeriaceae*. Berlese (1890), however, treated *Trematosphaeria* as a synonym of *Melanomma* (*Melanommataceae*). After establishment of *Loculoascomycetes* (Luttrell 1955), *Trematosphaeria* was assigned to *Pleosporaceae* (*Loculoascomycetes*, *Pleosporales*) (Holm 1957), and this was followed by von Arx and Müller (1975). *Trematosphaeria* was assigned to *Melanommataceae* by Barr (1979a), and this has been widely followed (Eriksson 2006; Kirk et al. 2001; Lumbsch and Huhndorf 2007).

*Trematosphaeria pertusa*, the lectotype species of *Trematosphaeria* (Clements and Shear 1931), is characterized by having semi-immersed to erumpent ascomata, filamentous pseudoparaphyses, cylindro-clavate asci, fusoid, 1-septate reddish brown to dark brown ascospores (Zhang et al. 2008a). All of these characters are quite different from those of *Melanomma*, the familial type of *Melanommataceae*.

**Fig. 91** *Sporormia fimetaria* (from RO, **type**). **a** Appearance of ascomata on the host surface. Note the scattered distribution. **b–d** Broad cylindrical asci with a short and thick pedicel. **e** Released filiform ascospores which may break up into part spores. Scale bars: **a**=0.5 mm, **b–d**=20  $\mu\text{m}$ , **e**=10  $\mu\text{m}$

### Phylogenetic study

*Trematosphaeria pertusa* forms a robust phylogenetic clade with *Falciformispora lignatilis* and *Halomassarina thalassiae*, and they are all assigned to *Trematosphaeriaceae* (Suetrong et al. 2009; Zhang et al. 2009a; Plate 1).

### Concluding remarks

*Trematosphaeria pertusa* is a terrestrial species which can also survive in a freshwater environment. However, both *Falciformispora lignatilis* and *Halomassarina thalassiae* are marine fungi. Their habitat difference may indicate their distant relationship, at least above genus level.

*Verruculina* Kohlm. & Volkm.-Kohlm., Mycol. Res. 94: 689 (1990). (*Testudinaceae*)

### Generic description

Habitat marine, saprobic. *Ascomata* medium-sized, solitary under clypeate, immersed to semi-immersed, subglobose to depressed ellipsoidal, papillate, ostiolate, periphysate, black, carbonaceous. *Peridium* thin, comprising a few layers of cells of *textura angularis*. *Hamathecium* of long cellular pseudoparaphyses, embedded in mucilage, hyaline, septate and sparsely branching. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, with short pedicels, ocular chamber not observed. *Ascospores* biseriata, ovoid or ellipsoidal, dark brown, 1-septate, constricted at the septum, verrucose or verruculose, with or without germ pore.

**Anamorphs reported for genus:** none.

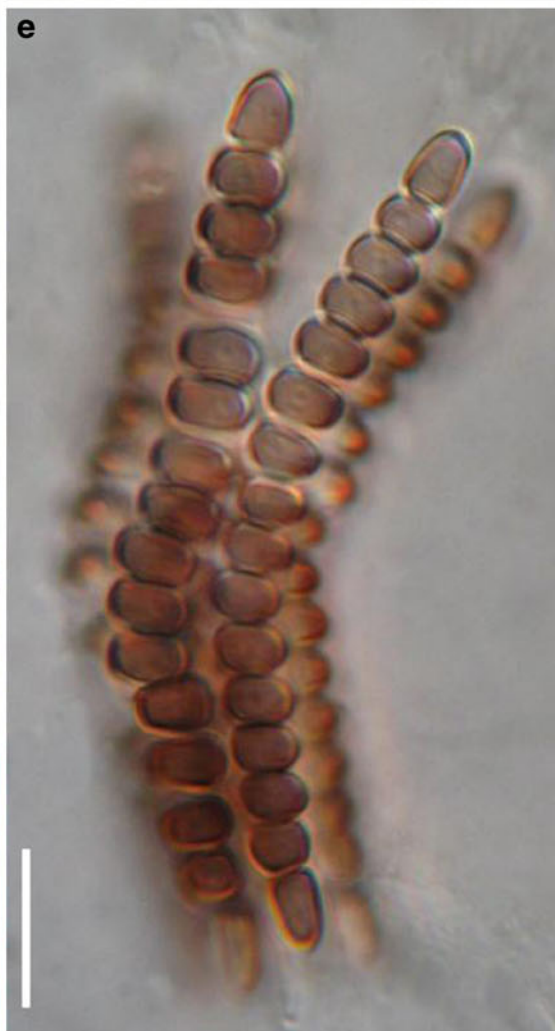
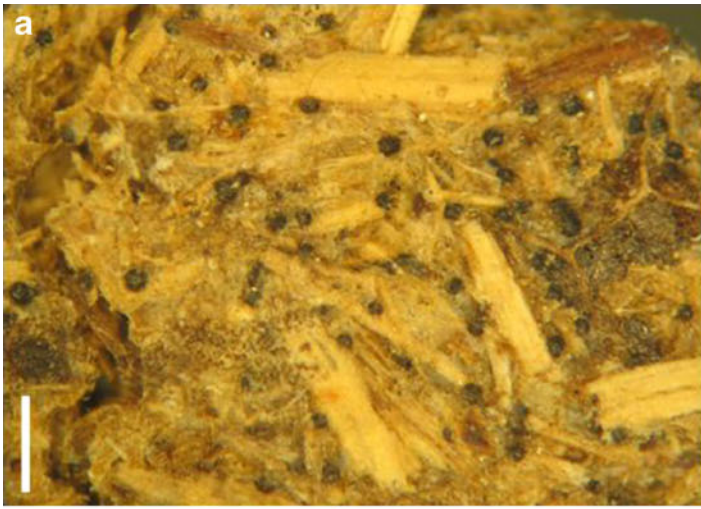
**Literature:** Kohlmeyer and Volkmann-Kohlmeyer 1990; Suetrong et al. 2009.

### Type species

*Verruculina enalia* (Kohlm.) Kohlm. & Volkm.-Kohlm., Mycol. Res. 94: 689 (1990). (Fig. 93)

≡ *Didymosphaeria enalia* Kohlm., Ber. dt. bot. Ges. 79: 28 (1966).

*Ascomata* 295–480  $\mu\text{m}$  high×140–520  $\mu\text{m}$  diam., solitary under clypeate, immersed to semi-immersed, subglobose to depressed ellipsoidal, ostiolate, papillate, periphysate, black, carbonaceous. *Peridium* thin, comprising a few layers of cells of *textura angularis*. *Hamathecium* of long cellular pseudoparaphyses, 1.5–2  $\mu\text{m}$  broad, embedded in mucilage, hyaline, septate and sparsely branching. *Asci* 177–135×12.5–15.5  $\mu\text{m}$ , 8-spored, bitunicate, fissitunicate, cylindrical, with short furcate pedicels, ocular chamber not observed (Fig. 93a).



*Ascospores* 16.5–23×7.5–10  $\mu\text{m}$ , biseriate, ovoid or ellipsoidal, dark brown, 1-septate, constricted at the septum, verrucose or verruculose, with or without germ pore (Fig. 93b).

**Anamorph:** none reported.

**Material examined:** SEYCHELLES, Victoria, on submerged branch of *Rhizophora mangle* L., Mar. 2004, K.D. Hyde (KDH 2137, slide).

## Notes

### Morphology

*Verruculina* was introduced to accommodate an oblique marine species, i.e. *Verruculina enalia* (Kohlmeyer and Volkmann-Kohlmeyer 1990). *Verruculina* is characterized by immersed, clypeate, carbonaceous, ostiolate and papillate ascomata. The peridium is composed of cells of *textura angularis*. Pseudoparaphyses are trabeculate and embedded in mucilage. Asci are 8-spored, cylindrical with short pedicels and ocular chamber, and ascospores are ellipsoidal, 1-septate, dark brown, verrucose or verruculose. The partly or completely immersed clypeate ascomata of *V. enalia* is comparable with those of *Didymosphaeria futilis*, but it differs from the later by the dark peridium, gelatinous matrix around the pseudoparaphyses, stipitate asci with an ocular chamber, and the verruculose ascospores (Kohlmeyer and Volkmann-Kohlmeyer 1990).

### Phylogenetic study

Based on multigene phylogenetic analysis, *Verruculina enalia* nested within *Testudinaceae* (Suetrong et al. 2009). Thus, its familial placement seems clarified.

### Concluding remarks

None.

***Westerdykella*** Stolk, Trans. Br. Mycol. Soc. 38: 422 (1955). (*Sporormiaceae*)

### Generic description

Habitat terrestrial, saprobic (coprophilous). *Ascomata* small, scattered on the upper layer of the culture medium, wall black. *Peridium* thin, composed of one layer of cells of polygonal, dark brown, thick-walled cells. *Hamathecium* not observed. *Asci* 32-spored, bitunicate nature undetermined, fissitunicate dehiscence not observed, subglobose to ellipsoid, arranged in the centre of the ascomata, with or without a short pedicel. *Ascospores* globose, brown, 1-celled, without germ pore.

**Anamorphs reported for genus:** *Phoma*-like (von Arx 1974).

**Literature:** von Arx 1973, 1981; Kruys et al. 2006; Kruys and Wedin 2009; Stolk 1955a.

**Fig. 92** *Trematosphaeria pertusa* (a, d, f–i from epitype, b, c, e, j from neotype). a Ascomata on the host surface. b Section of an ascoma. c, h Section of the peridium. c shows the peridium structure at sides, and h indicates the basal peridium structure. Note the hyaline and thin-walled cells in (h). d Asci amongst pseudoparaphyses. e Ascus with pedicle. f, g Dehiscent ascus. i Upper part of the ascus, showing the ocular chamber and the mucilage covering the apex. j, k Ascospores. Scale bars: a=0.5 mm, b, c=100  $\mu\text{m}$ , d–h=20  $\mu\text{m}$ , i–k=10  $\mu\text{m}$

## Type species

***Westerdykella ornata*** Stolk, Trans. Br. Mycol. Soc. 38: 422 (1955). (Fig. 94)

*Ascomata* 100–300  $\mu\text{m}$  diam., cleistothecoid, scattered on the upper layer of the culture medium, wall black (Fig. 94a). *Peridium* composed of one layer of cells of polygonal in front view, dark brown, thick-walled cells, ca. 5  $\mu\text{m}$  diam. *Hamathecium* not observed. *Asci* 25–32×16–22  $\mu\text{m}$ , 32-spored, bitunicate nature undetermined, fissitunicate dehiscence not observed, subglobose to ellipsoid, arranged in the centre of the ascomata, with a short furcate pedicel best seen in immature asci (Fig. 94b, c, d and f). *Ascospores* 6.2–7×6–6.8  $\mu\text{m}$ , globose, brown, 1-celled, ornamented with irregular spiral bands, which occur in four to five coils, without germ pore (Fig. 94e).

**Anamorph:** none reported.

On MEA colonies spreading, but somewhat erumpent, with moderate aerial mycelium and even, lobate margins; surface dirty white with luteous to orange patches; reverse orange to sienna. On PDA similar but with sparse aerial mycelium; surface with patches of orange to luteous and dirty white; reverse luteous with cream margins. On OA flat, spreading with sparse aerial mycelium; surface with luteous and dirty white patches and transparent margins; sporulating on OA, visible as black masses of aggregated ascomata; colonies reaching 4 cm diam. on all media (based on CBS 379.55).

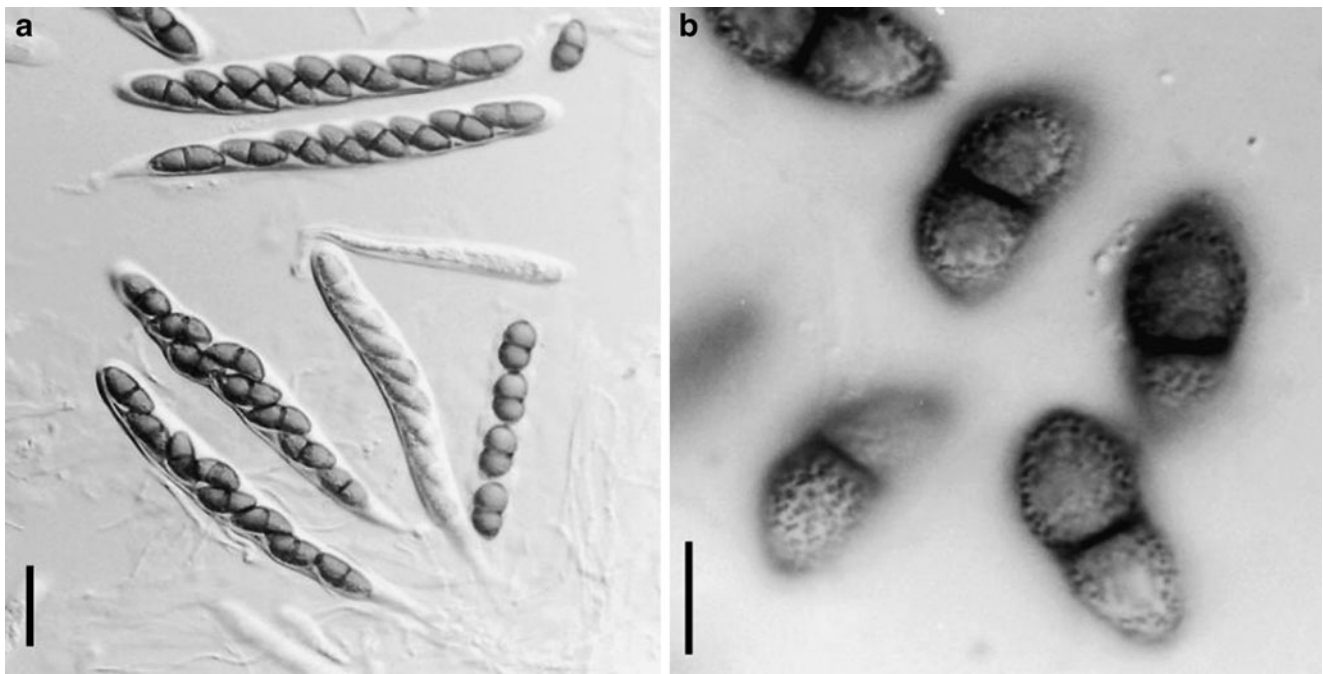
**Material examined:** MOZAMBIQUE, Inhaca, leg. H.J. Swart, mangrove mud (CBS 379.55, holotype).

## Notes

### Morphology

*Westerdykella* was introduced to accommodate a coprophilous fungus, which is characterized by cleistothecoid and membranous ascomata (Stolk 1955a). Asci are subglobose to ellipsoid, stalked, many-spored and evanescent. Ascospores are globose to subglobose, brown, ornamented with spiral bands, without germ pores (Stolk 1955a). *Westerdykella* was assigned under *Phaeosporaeae* of the *Eurotiaceae* (Stolk 1955a), and was assigned to *Sporormiaceae* by von Arx and Müller (1975). Based on the spore ornamentation, von Arx and





**Fig. 93** *Verruculina enalia* (from KDH 2137, slide). **a** Cylindrical asci with short pedicels. **b** One-septate verruculose ascospores. Scale bars: **a**=20  $\mu\text{m}$ , **b**=10  $\mu\text{m}$

van der Aa (1987) and Barr (2000) accepted *Westerdykella* as a separate genus, but this is not supported by molecular phylogenetic analysis (Kruys and Wedin 2009).

#### Phylogenetic study

Phylogenetic reconstructions indicated that both *Pycnidiophora* and *Eremodothis* should be treated as synonyms of *Westerdykella* (Kruys and Wedin 2009).

#### Concluding remarks

*Westerdykella* is another example where ascospore ornamentation can be phylogenetically uninformative. *Westerdykella* is proved a good genus of *Sporormiaceae* (Kruys and Wedin 2009).

*Wettsteinina* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. I 116: 126 (1907). (?*Lentitheciaceae*)

#### Generic description

Habitat terrestrial or freshwater? hemibiotrophic or saprobic. *Ascomata* generally small, scattered, immersed with a protruding broad papilla. *Peridium* very thin, composed of few layers of thin-walled large polygonal cells in surface view. *Hamathecium* deliquescent at maturity. *Asci* bitunicate, fissionate, subglobose to obpyriform, without a pedicel, with small truncate ocular chamber. *Ascospores* hyaline and turning pale brown when mature, septate, upper second cell enlarged, slightly constricted at the second septum, smooth, surrounded by a hyaline gelatinous sheath.

**Anamorph reported for genus:** *Stagonospora* (Farr et al. 1989).

**Literature:** Barr 1972; Müller 1950; Shoemaker and Babcock 1987, 1989b.

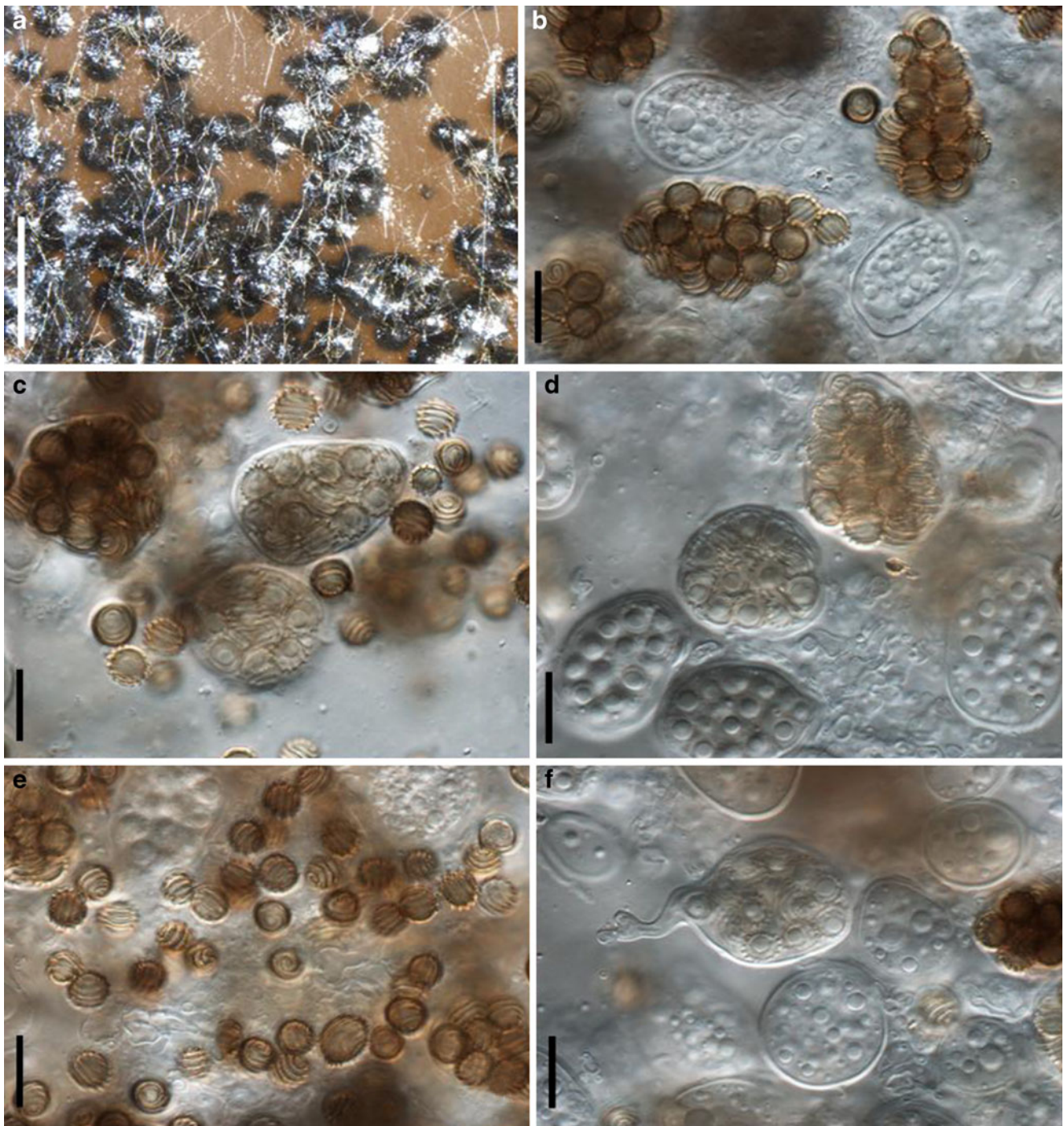
#### Type species

*Wettsteinina gigaspora* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. I 116: 126 (1907). (Fig. 95)

*Ascomata* 150–250  $\mu\text{m}$  diam., scattered, immersed with protruding broad papillae, 50–90  $\mu\text{m}$  diam. *Peridium* thin, composed of few layers of thin-walled large polygonal cells in surface view, 6–15  $\mu\text{m}$  diam. (Fig. 95a). *Hamathecium* deliquescent at maturity. *Asci* 140–200  $\times$  75–120  $\mu\text{m}$ , 8-spored, bitunicate, fissionate, subglobose to obpyriform, lacking a pedicel, with a small truncate ocular chamber (to 8  $\mu\text{m}$  wide  $\times$  5  $\mu\text{m}$  high) (Fig. 95b and c). *Ascospores* 90–110  $\times$  25–30  $\mu\text{m}$ , 2–4-seriate, hyaline and turning pale brown when mature, broadly clavate, 4-septate, primary septum distinct and constricted forming 1/3<sup>rd</sup> from the apex of the ascospore, complete, secondary septa less distinct and slightly constricted, incomplete, with one forming above and two forming below the primary septum, largest cell the second cell from apex, smooth, surrounded by a hyaline gelatinous sheath 5–8  $\mu\text{m}$  thick (Fig. 95d and e).

**Anamorph:** none reported.

**Material examined:** SLOVENIA, Postojna, on *Genista sagittalis* leg. Stapf. det. H. Rehm. (S, **holotype** of *Massarina gigantospora*).



**Fig. 94** *Westerdykella ornata* (from CBS 379.55, holotype). **a** Appearance of the ascomata on culture substrate surface. **b–f** Mature and immature asci as well as the released ascospores. Note the spiral bands around the ascospores. Scale bars: **a**=1 mm, **b–f**=10  $\mu\text{m}$

## Notes

### Morphology

Confusion exists in the generic type of *Wettsteinina*. Höhnel (1907) described *W. gigaspora* when introducing *Wettsteinina*, and listed it as the first species of *Wettsteinina*. Clements and Shear (1931) accepted *W. gigaspora* as

the generic type of *Wettsteinina*, which is followed by Shoemaker and Babcock (1987). But according to <http://www.indexfungorum.org> (June 2011), *W. gigantospora* is the generic type of *Wettsteinina*. Both *W. gigantospora* and *W. gigaspora* were treated as the synonyms of *W. mirabilis* (Niessl) Höhn. <http://www.indexfungorum.org> (June, 2011, Synonymy Contributor: CBS (2010)). We



tentatively described the generic type of *W. gigantospora* as a representing of the type of *W. gigaspora* here.

New family names, i.e. *Pseudosphaeriaceae* and *Wettsteininaceae* (as *Wettsteiniaceae*) and a new order, *Pseudosphaeriales* had been introduced to accommodate *Wettsteinina* and its synonym *Pseudosphaeria* (Höhnelt 1907; Locquin 1972). After a systematic study, *Wettsteinina* was included in *Pleosporaceae* based on its “*Pleospora*-type” centrum, and *Pseudosphaeriaceae* and *Wettsteininaceae* are treated as synonyms of *Pleosporaceae* (Shoemaker and Babcock 1987).

### Phylogenetic study

*Wettsteinina macrotheca* (Rostr.) E. Müll., *W. pachyasca* (Niessl) Petr. and *W. dryadis* (Rostr.) Petr. were reported to be closely related to *Pleomassaria siparia* (*Melanommataceae*) (Kodsueb et al. 2006a), and *W. lacustris* (Fuckel) Shoemaker & C.E. Babc. nested within *Lentitheciaceae* (Schoch et al. 2009). The generic type has not been sequenced.

### Concluding remarks

The most striking character for *Wettsteinina* is its asymmetrical ascospores, thick-walled obpyriform asci and lack of pseudoparaphyses at maturity. These characters are comparable with genera in the *Capnodiiales* and *Venturiales*. The phylogenetic significance of these characters are not fully understood, while the hemibiotrophic or saprobic life style may indicate its polyphyletic nature (Shoemaker and Babcock 1987). Strains from the genus, in particular the generic type require DNA sequence data so that the phylogenetic placement can be investigated.

*Wilimia* Dianese, Inácio & Dorn.-Silva, Mycologia 93: 1014 (2001). (*Phaeosphaeriaceae*)

### Generic description

Habitat terrestrial, hemibiotrophic or biotrophic. *Ascomata* small, scattered, immersed, globose to subglobose, papillate. *Peridium* thin, composed of a few layers of brown, thick-walled cells of *textura angularis* to *prismatica*. *Hamathecium* comprising filliform, septate, rarely branching, evanescent, cellular pseudoparaphyses embedded in mucilage. *Asci* bitunicate, fissitunicate, cylindrical to clavate, with a short, furcate pedicel and ocular chamber. *Ascospores* fusoid, pale brown, 1-septate.

**Anamorphs reported for genus:** see below.

**Literature:** Dianese et al. 2001.

### Type species

*Wilimia brasiliensis* Dianese, Inácio & Dorn.-Silva, Mycologia 93: 1014 (2001). (Fig. 96)

*Ascomata* 175–240  $\mu\text{m}$  high  $\times$  95–145  $\mu\text{m}$  diam., scattered, immersed, globose to subglobose; apex with a short papilla, 40–80  $\mu\text{m}$  long, ostiolate, periphysate, periphyses up to 90  $\mu\text{m}$  long (Fig. 96a and b). *Peridium* 6–15  $\mu\text{m}$  wide, 1-layered, composed of 3–7 layers of brown, thick-walled cells of *textura angularis* to *prismatica*, cells 4–9  $\mu\text{m}$  diam., cell wall 2–4  $\mu\text{m}$  thick (Fig. 96a and b). *Hamathecium* of long cellular pseudoparaphyses 2–3  $\mu\text{m}$  broad, septate, rarely branching, embedded in mucilage, evanescent. *Asci* 65–95  $\times$  9.5–14  $\mu\text{m}$  ( $\bar{x}$  = 78.5  $\times$  11.5  $\mu\text{m}$ ,  $n$ =10), 8-spored, bitunicate, fissitunicate, cylindrical to clavate, with a short, furcate pedicel and a small ocular chamber (Fig. 96c, d and f). *Ascospores* 22.5–28  $\times$  5–8.5  $\mu\text{m}$  ( $\bar{x}$  = 26.5  $\times$  6.8  $\mu\text{m}$ ,  $n$ =10), biseriolate, fusoid with narrowly rounded ends, pale brown, 1-septate, constricted at the septum, the upper cell often shorter and broader than the lower one, smooth, with or without sheath (Fig. 96d and e).

**Anamorph:** *Conidiomata* 170–200  $\mu\text{m}$  high  $\times$  85–130  $\mu\text{m}$  diam., eustromatic, immersed, subglobose to irregular, ostiolate, brown. *Peridium* thin, 1–2 wall layers, 6–8  $\mu\text{m}$  thick, thicker near the apex. *Ostiole* 50–63  $\mu\text{m}$  high  $\times$  30–35 broad. *Conidiogenous cells* ampulliform or lageniform, phialidic, aseptate. *Conidia* 13–20  $\times$  4–7  $\mu\text{m}$ , ellipsoid, oblong, ovoid, hyaline (Dianese et al. 2001).

**Material examined:** BRAZIL, Distrito Federal, Vargem Bonita, Fazenda Agua Limpa, on leaves of *Memora pedunculata* (Vell.) Miers, 18 May 1995, Carlos A. Inácio (UB Col. Microl 8438 **holotype**).

### Notes

### Morphology

*Wilimia* was formally established by Dianese et al. (2001) as a monotypic genus represented by *W. brasiliensis*, which causes leaf spots on *Memora pedunculata*. The peridium of *W. brasiliensis* comprises a few layers of brown, thick-walled *textura angularis* to *prismatica* cells, and it also has cellular pseudoparaphyses, clavate asci, 1-septate pale brown ascospores (Dianese et al. 2001).

### Phylogenetic study

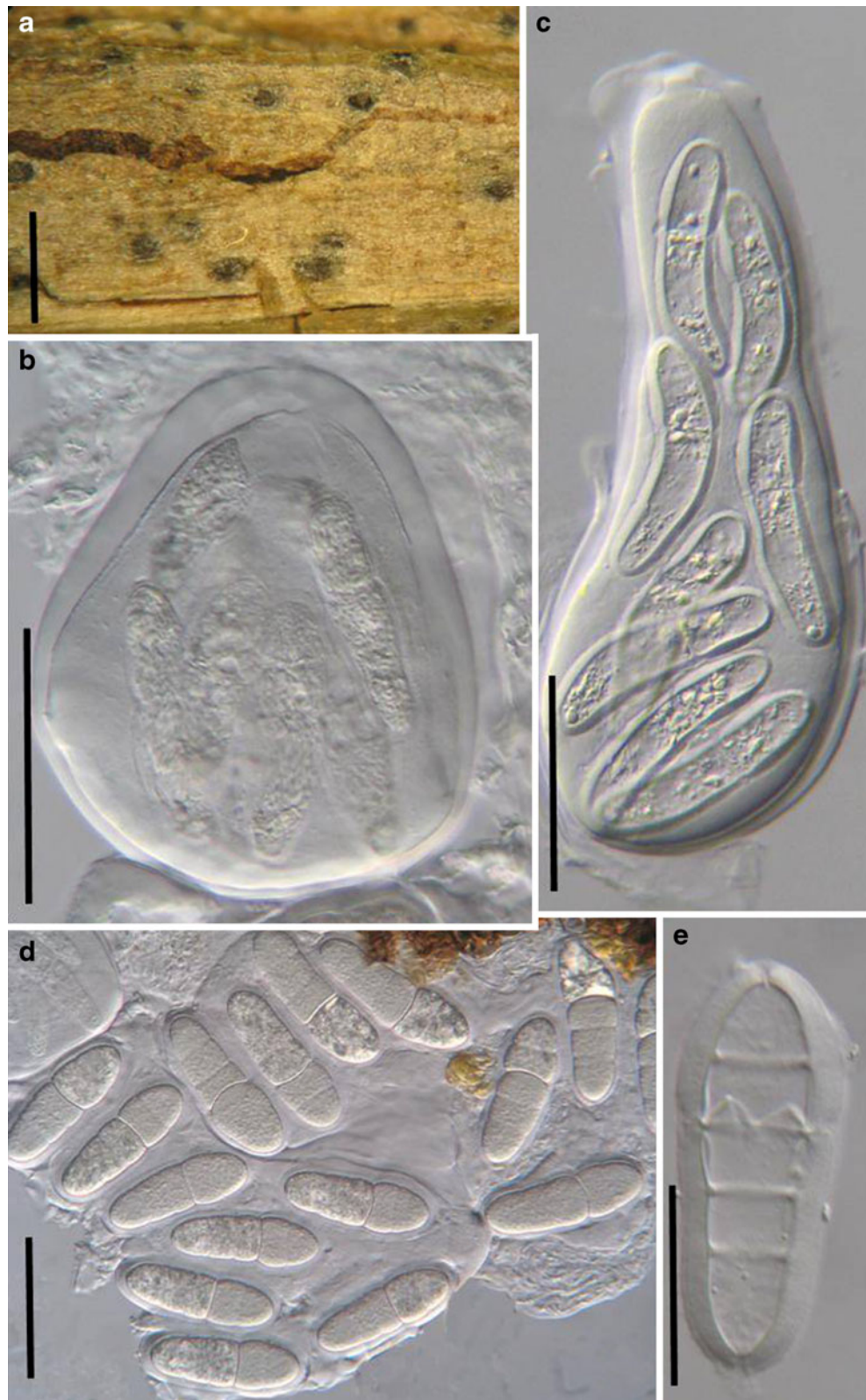
None.

### Concluding remarks

The dicotyledonous host habit of *Wilimia brasiliensis* seems in agreement with *Leptosphaeriaceae* rather than *Phaeosphaeriaceae*. But a verified conclusion can only be reached by further molecular phylogenetic study.

*Xenolophium* Syd., Bulletin of the Bernice P. Bishop Museum, Honolulu, Hawaii 19: 96 (1925). (*Pleosporales*, genera *incertae sedis*)

**Fig. 95** *Wettsteinina gigantospora* (from S, holotype of *Massarina gigantospora*). **a** Ascomata with protruding papilla scattered on the host surface. **b** Obpyriform thick-walled ascus with small apical apparatus. **c** Fissitunicate ascus. **d** Released hyaline ascospores. Note the distinct primary septum and less distinct secondary septa. **e** Ascospore with sheath. Scale bars: **a**=0.5 mm, **b–d**=100  $\mu$ m, **e**=50  $\mu$ m



### Generic description

Habitat terrestrial, saprobic on wood. *Ascomata* nearly superficial, scattered to gregarious, globose, large, with a

conspicuous compressed papilla and large slit-like ostiole. *Peridium* carbonaceous. *Hamathecium* of dense, long trabeculate pseudoparaphyses, branching and anastomosing between and among asci. *Asci* 8-spored, clavate, with very

long furcate pedicels. *Ascospores* fusoid to narrowly fusoid, light to dark brown, 1-septate, constricted at the septum.

**Anamorphs reported for genus:** none.

**Literature:** Chesters and Bell 1970; Huhndorf 1993; Mugambi and Huhndorf 2009b; Müller and von Arx 1962; Stevens 1925.

### Type species

*Xenolophium leve* Syd., Bulletin of the Bernice P. Bishop Museum, Honolulu, Hawaii 19: 97 (1925) (Fig. 97)

Current name: *Xenolophium applanatum* (Petch) Huhndorf, Mycologia 85: 493 (1993).

≡ *Schizostoma applanatum* Petch, Ann. Roy. Bot. Gard. (Peradeniya) 6: 231 (1916).

*Ascomata* 1–1.5 mm diam., scattered to clustered, erumpent to superficial, globose with base immersed in host tissue, wall black, carbonaceous, roughened with ridges, papillate. *Apex* with a conspicuous hysteriform papilla extending on the sides, 1–1.4 mm long, 0.4–0.5 mm wide, 0.2–0.3 mm high, smooth, ostiole slit-like, nearly as long as papilla length (Fig. 97a). *Peridium* 140–160  $\mu\text{m}$  thick, pseudoparenchymatous, composed of two distinct layers: outer crust 16–45  $\mu\text{m}$  thick, blackish, of heavily melanized, nearly opaque thick-walled angular cells, of uneven thickness forming irregular strands extending into the inner layer; inner layer subhyaline, composed of thick-walled prismatic to angular cells, with columns or patches of darker thick-walled cells extending inwardly from the outer layer; papilla wall 200–220  $\mu\text{m}$  thick, of heavily melanized angular thick-walled cells (Fig. 97b and c). *Hamathecium* of dense, very long trabeculate pseudoparaphyses 0.8–1.5  $\mu\text{m}$  broad, embedded in mucilage, anastomosing and branching between and above the asci. *Asci* 104–152  $\times$  9–12  $\mu\text{m}$  (excluding pedicel) ( $\bar{x}$  = 149  $\times$  10.2  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate dehiscence not observed, clavate, with a long, narrowed, furcate pedicel which is 50–75  $\mu\text{m}$  long (Fig. 97d). *Ascospores* 17–26  $\times$  4–5.5  $\mu\text{m}$  ( $\bar{x}$  = 22.5  $\times$  4.8  $\mu\text{m}$ ,  $n=10$ ), upper biseriolate and lower uniseriate, fusoid, straight to slightly curved, equally 1-septate, constricted at the septum, the upper cell slightly wider, with one or rarely two additional septa appearing on a small number of senescent ascospores, pale brown, median septum darker, constricted, smooth, without sheath or appendages (Fig. 97e, f and g).

**Anamorph:** none reported.

**Material examined:** MARTINIQUE, Morne Rouge, on rotten wood, leg C. Lécure, det Jacques Fournier, 29 Aug. 2007, IFRD 2038.

### Notes

#### Morphology

*Xenolophium* was formally established by Sydow (in Stevens 1925) to accommodate two species, i.e. *X. leve* and

*X. verrucosum*, of which *X. leve* is selected as the generic type (Huhndorf 1993). Because of its morphological similarity with some genera, such as *Ostropella* and *Schizostoma*, *Xenolophium* has been treated as a synonym of *Ostropella* (Müller and von Arx 1962) or even of *Lophiostoma* (Chesters and Bell 1970). Huhndorf (1993) clarified the circumscription of *Xenolophium* and treated *X. leve* as a synonym of *Schizostoma applanata*. *Xenolophium* mainly differs from *Ostropella* in lack of “organized cell composition and triangular pattern of melanization” in the peridium (Huhndorf 1993).

#### Phylogenetic study

The polyphyletic nature of *Xenolophium* has been demonstrated (Mugambi and Huhndorf 2009b). The generic type of *Xenolophium* (*X. leve*, current name *X. applanatum*) clustered together with *Ostropella albocincta* (generic type of *Ostropella*), and both locate in *Platystomaceae* (Mugambi and Huhndorf 2009b).

#### Concluding remarks

The large ascomata with slit-like ostioles, hamathecium of numerous and trabeculate pseudoparaphyses, clavate asci with long pedicels, and the pale brown, 1-septate ascospores of *Xenolophium leve* are all comparable with those of *Ostropella albocincta*. However, the phylogenetic results do not support them being congeneric (Mugambi and Huhndorf 2009b).

#### Synonyms

*Javaria* Boise, J.R., Acta Amazonica 14(Supl.): 50 (1984). (*Melanommataceae*)

**Current name:** *Astrosphaeriella* Syd. & P. Syd., Annl. mycol. 11: 260 (1913).

#### Generic description

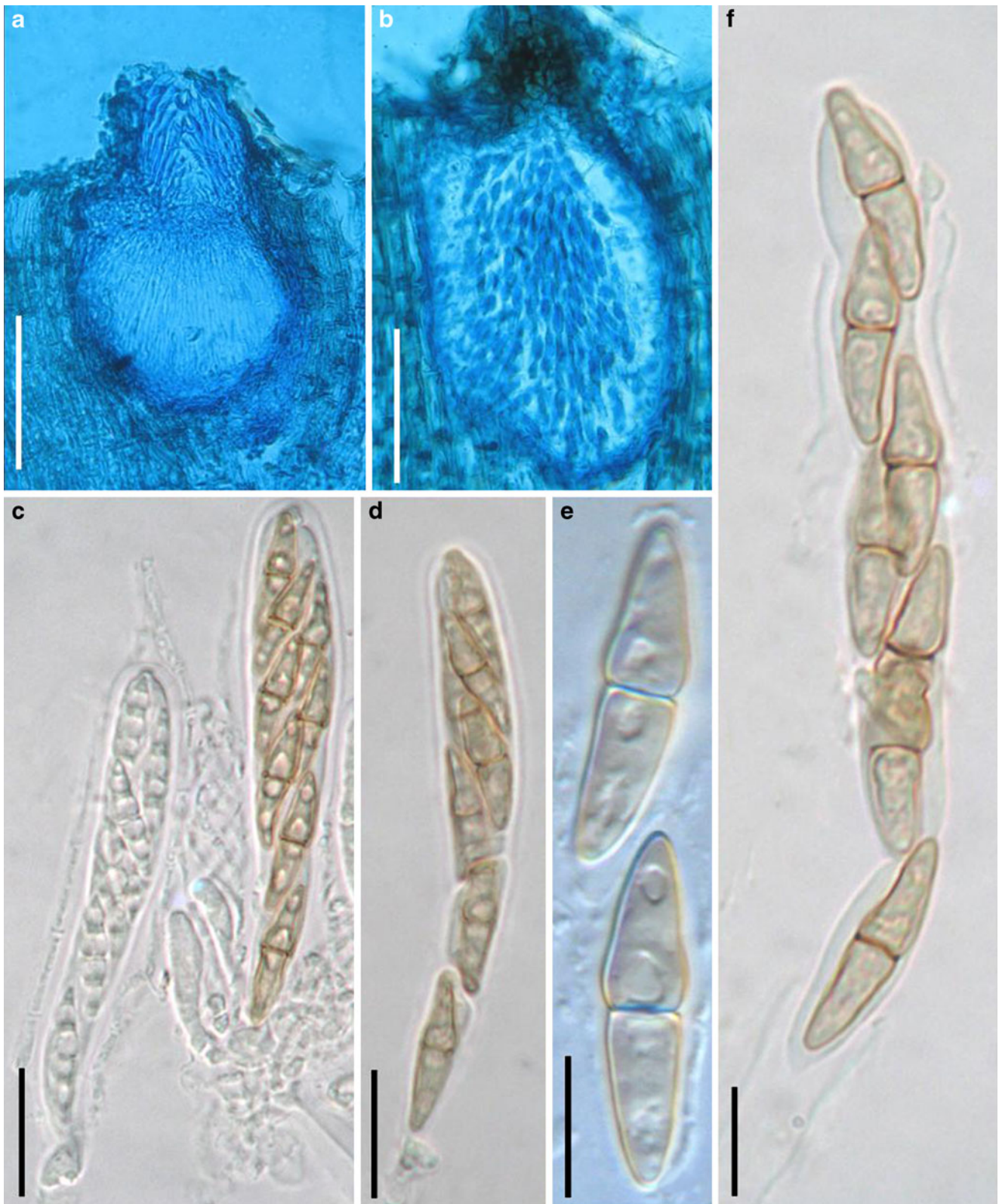
Habitat terrestrial, saprobic. *Ascomata* medium-sized, scattered, erumpent to nearly superficial, reflexed pieces of the ruptured host tissue usually persisting around the surface of the ascomata; ascomata broadly conical, with a flattened base not easily removed from the substrate, wall black, papillate. *Peridium* carbonaceous. *Hamathecium* of trabeculate pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, cylindro-clavate to narrowly fusoid, with a short, narrowed, furcate pedicel. *Ascospores* elongate-fusoid, hyaline, 1-septate, constricted at the septum.

**Anamorphs reported for genus:** none.

**Literature:** Barr 1990a; Boise 1984.

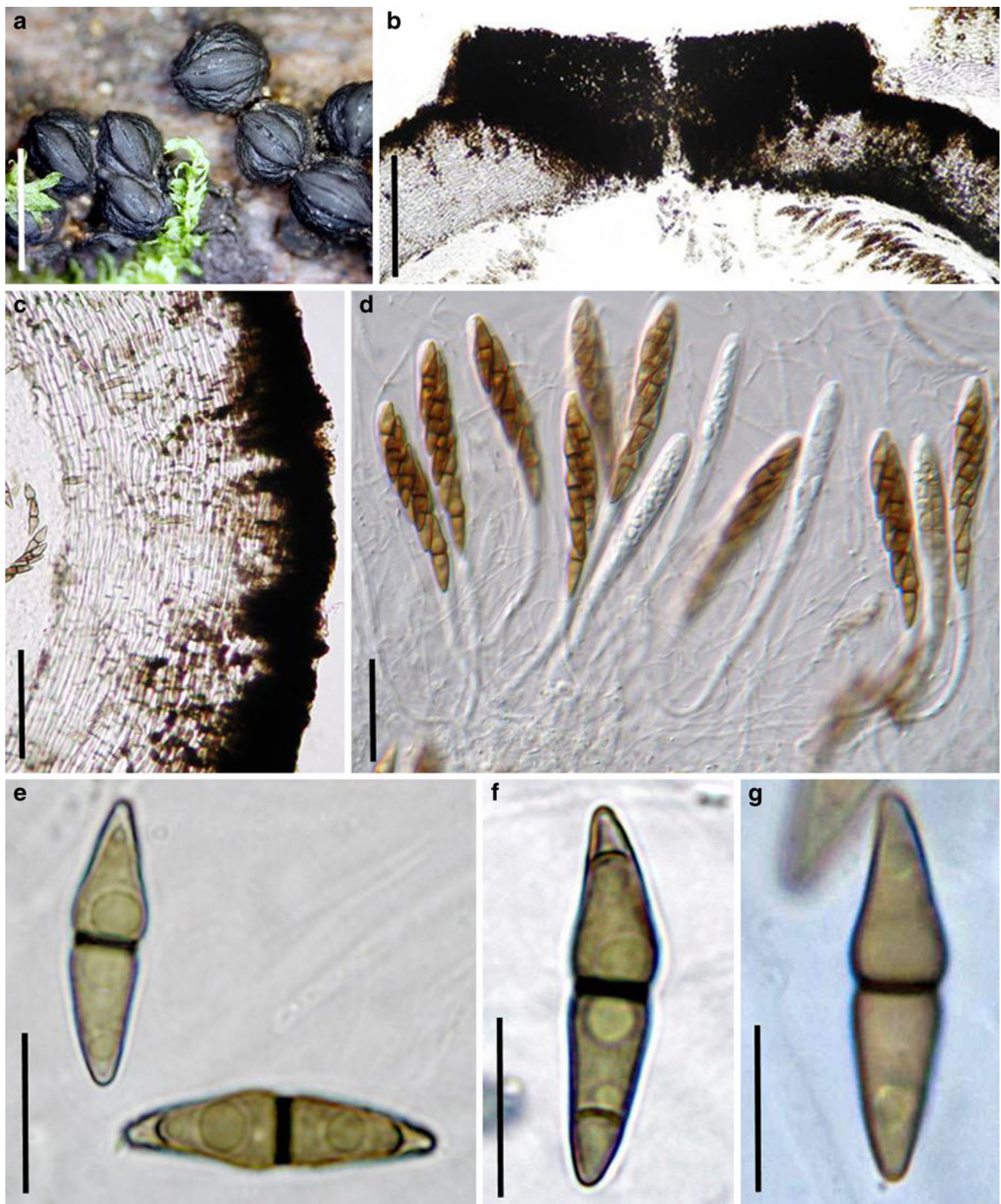
#### Type species

*Javaria samuelsii* Boise, J.R., Acta Amazonica 14(Supl.): 50 (1984) (Fig. 98)



**Fig. 96** *Wilimia brasiliensis* (from UB Col. Microl 8438, **holotype**). **a** Section of an ascoma. Note the setae in the ostiole. **b** Conidioma of the coelomycetous anamorphic stage. **c, d** Clavate asci with short

furcate pedicels. **e, f** Released 1-septate pale brown ascospores. Scale bars: **a, b**=100  $\mu\text{m}$ , **c, d**=20  $\mu\text{m}$ , **e, f**=10  $\mu\text{m}$



**Fig. 97** *Xenolophium applanatum* (from IFRD 2038). **a** Gregarious ascomata on the host surface. Note protruding papilla and slit-like ostiole. **b** Vertical section of the papilla and ostiole. **c** Section of the partial peridium. Note the two layers of the peridium. **d** Eight-spored

asci in trabeculate pseudoparaphyses. Note the long pedicels. **e–g** Pale brown ascospores. Scale bars: **a**=2 mm, **b**=200  $\mu$ m, **c**=50  $\mu$ m, **d**=20  $\mu$ m, **e–g**=10  $\mu$ m

Current name: *Astrosphaeriella samuelsii* Boise, Acta Amazon., Supl. 14(1–2, Suppl.): 50 (1986) [1984].

*Ascomata* 300–380  $\mu\text{m}$  diam., scattered, erumpent through the outer layers of the host tissues, to nearly superficial, reflexed pieces of the ruptured host tissue usually persisting around the surface of the ascomata; ascomata broadly conical, with a flattened base not easily removed from the substrate, wall black, papillate (Fig. 98a). *Peridium* 50–80  $\mu\text{m}$  thick, carbonaceous and crisp, 1-layered. *Hamathecium* of dense, long trabeculate pseudo-paraphyses, 0.8–1.5  $\mu\text{m}$  broad, embedded in mucilage, anastomosing between and above the asci. *Asci* 140–185  $\times$  17.5–20  $\mu\text{m}$  ( $\bar{x}$  = 158  $\times$  19.4  $\mu\text{m}$ ,  $n=10$ ), 8-spored, bitunicate, fissitunicate, cylindro-clavate to narrowly fusoid, with a short, narrowed, furcate pedicel up to 20  $\mu\text{m}$  long (Fig. 98b and c). *Ascospores* 48–55(–60)  $\times$  6–7.5(–10)  $\mu\text{m}$  ( $\bar{x}$  = 52.2  $\times$  7.7  $\mu\text{m}$ ,  $n=10$ ), biseriate, elongate-fusoid, gradually tapering towards the ends, hyaline, surrounded with sheath, 2–5  $\mu\text{m}$  thick, 1-septate, constricted at the septum (Fig. 98d).

**Anamorph:** none reported.

**Material examined:** Serra Araca, 60 m, terra firme, open forest, deep litter. Dry. 10–13 Mar. 1984, det. Jean R. Boise, G.J. Samuels (**isotype**).

## Notes

## Morphology

*Javaria* was introduced by Boise (1984) based on seven Amazonian collections on decaying palm petioles; it is comparable with *Astrosphaeriella* in numerous characters. But *Javaria* differs from *Astrosphaeriella* by its hyaline ascospores with sheath, and its apical ring can be stained with Congo Red, as well as its small ascomata. Barr (1990a) introduced a second species *J. shimekii* which occurs on woody substrate. Some mycologists treat *Javaria* as a synonym of *Astrosphaeriella* (Hyde and Fröhlich 1998).

## Phylogenetic study

None.

## Concluding remarks

The size of ascomata and pigmentation of ascospores has little significance at generic level classification (Zhang et al. 2009a). Likewise, the staining of endotunica with Congo Red has not been shown to have great significance. Thus, we accept *Javaria* as a synonym of *Astrosphaeriella*.

***Pycnidiophora*** Clum, Mycologia 47: 899 (1955). (*Sporormiaceae*)

**Current name:** *Westerdykella* Stolk, Trans. Br. Mycol. Soc. 38(4): 422 (1955).

## Generic description

Habitat terrestrial, saprobic (coprophilous). *Ascomata* small, cleistothecial, scattered on surface of agar media, semi-immersed, globose to subglobose, black. *Peridium* thin, composed of thin-walled, polyangular cells from front view. *Hamathecium* not apparent. *Asci* numerous, irregularly arranged, bitunicate nature undetermined, fissitunicate nature undetermined, globose, without pedicel. *Ascospores* gathering in the globose asci, smooth.

**Anamorphs reported for genus:** *Phoma*-like.

**Literature:** Cain 1961; Clum 1955; Stolk 1955b; Thompson and Backus 1966.

## Type species

***Pycnidiophora dispersa*** Clum, Mycologia 47: 900 (1955) [1955]. (Fig. 99)

Current name: *Westerdykella dispersa* (Clum) Cejp & Milko.

*Ascomata* 200–290  $\mu\text{m}$  diam., cleistothecial, scattered on surface of agar media, semi-immersed, globose to subglobose, black (Fig. 99a). *Peridium* thin, composed of thin-walled, poly-angular cells from front view (Fig. 99b). *Hamathecium* not apparent. *Asci* numerous, 11–14  $\mu\text{m}$  diam. ( $\bar{x}$  = 12.3  $\mu\text{m}$ ,  $n=10$ ), irregularly arranged, 32-spored when mature, bitunicate nature undetermined, fissitunicate nature undetermined, globose, without pedicel (Fig. 99b and c). *Ascospores* 4–5.5  $\times$  2.5–3  $\mu\text{m}$  ( $\bar{x}$  = 4.7  $\times$  2.8  $\mu\text{m}$ ,  $n=10$ ), in the globose asci, olivaceous, oblong, 1-celled, smooth (Fig. 99d).

**Anamorph:** *Phoma*-like coelomycetes.

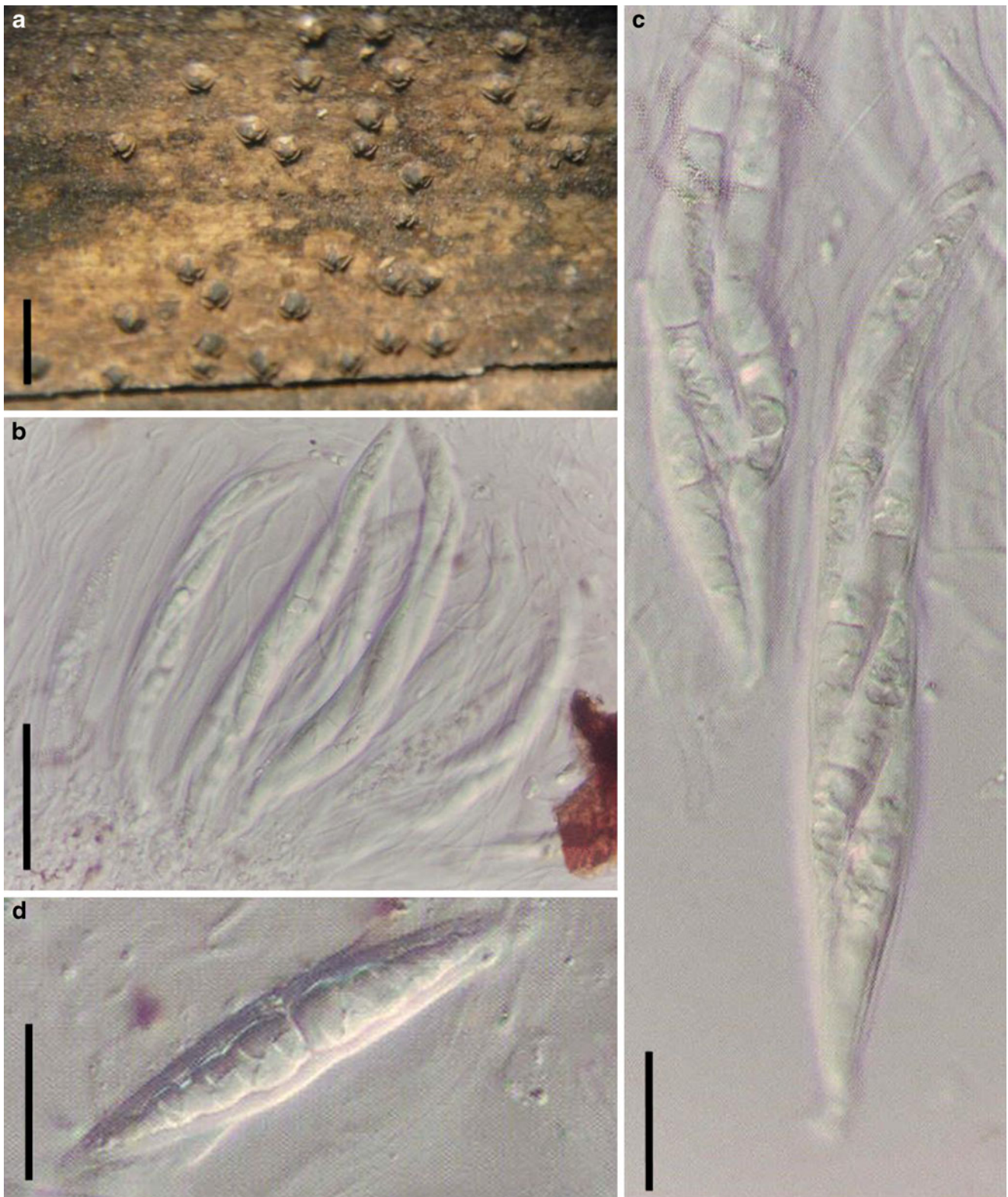
On MEA colonies spreading, flat with sparse aerial mycelium, covering the dish after 1 month; surface smoke-grey with dirty white margins; reverse olivaceous-grey with luteous patches. On PDA spreading without aerial mycelium, colonies transparent, sporulating profusely with black, globose ascomata and pycnidia of a *Phoma*-like anamorph. On OA similar, lacking aerial mycelium, sporulating profusely with black, globose ascomata (based on CBS 297.56).

**Material examined:** USA, Michigan, East Lansing, Science Greenhouse, isolated from damped off *Phlox* seedling, Dec. 1952, F.M. Clum (No. 27) (MSC 133.118, **type**).

## Notes

## Morphology

*Pycnidiophora* was formally established by Clum (1955) based on its “imperfect stage of pycnidium”, which was subsequently confirmed as the sexual stage (Cain 1961; Thompson and Backus 1966). Clum (1955) has described and tentatively assigned *P. dispersa* (Clum) Cain to



**Fig. 98** *Javaria samuelsii* (from isotype). **a** Ascoma on the host surface. Note reflexed pieces of the ruptured host tissue. **b, c** Cylindro-clavate asci within narrow pseudoparaphyses in gelatinous matrix. **d** Released ascospore with sheath. Scale bars: **a**=1 mm, **b**=50  $\mu$ m, **c**, **d**=20  $\mu$ m

*Aspergillaceae* (= *Eurotiaceae*), and Stolk (1955b) has proposed to assign the morphologically comparable species

*P. multispora* Saito & Minoura ex Cain to *Eurotiaceae* as well. Cain (1961), however, suspected that the 32 asco-

spores are actually the disarticulated segments of eight 4-celled ascospores, thus assigned it under *Preussia* (*Sporormiaceae*). After detailed study, Thompson and Backus (1966) confirmed that the so-called “eight 4-celled ascospores” do not exist in the development of the asci in both *P. dispersa* and *P. multisporum*. Thus, *Pycnidiophora* was assigned to *Eurotiaceae* (*Eurotiales*) (Thompson and Backus 1966).

### Phylogenetic study

Phylogenetic study based on the ITS-nLSU rDNA sequences indicated that *Pycnidiophora dispersa* nested within clade of *Westerdykella* (including the generic type, *W. ornata*) (Kruys and Wedin 2009). Morphologically, both genera have cleistothecoid ascomata, asci with short or without pedicels and ascospores 1-celled and no germ slits. Thus, *Pycnidiophora* is treated as a synonym of *Westerdykella* (Kruys and Wedin 2009).

### Concluding remarks

Although the pleosporalean status of *Pycnidiophora* is verified, morphological characters such as the cleistothecoid ascomata and irregularly arranged asci, which do not show typical bitunicate or fissitunicate characters, absence of pseudoparaphyses as well as the ascospores separating into partspores very early all challenge the traditional concept of *Pleosporales* (Zhang et al. 2009a). Obviously, most of these morphological characters overlap with those of the *Eurotiales*.

***Sporormiella*** Ellis & Everh., N. Amer. Pyren.: 136 (1892). (*Sporormiaceae*)

**Current name:** *Preussia* Fuckel, Hedwigia 6: 175 (1867) [1869–70].

### Generic description

Habitat terrestrial, saprobic (coprophilous). *Ascomata* medium-sized, solitary, scattered, or in small groups, semi-immersed to nearly superficial, globose, subglobose, black, coriaceous, ostiolate, periphysate. *Peridium* thin, composed of small heavily pigmented cells of *textura angularis*, apex cells smaller and walls thicker. *Hamathecium* of dense, septate, cellular pseudoparaphyses, embedded in mucilage. *Asci* 8-spored, bitunicate, fissitunicate, cylindro-clavate, with a narrowed, furcate pedicel. *Ascospores* cylindrical with rounded ends, brown, 3-septate, deeply constricted at each septa, with sigmoid germ slit in each cell.

**Anamorphs reported for genus:** none.

**Literature:** Ahmed and Cain 1972; Ellis and Everhart 1892; Khan and Cain 1979a, b; Luck-Allen and Cain 1975.

### Type species

***Sporormiella nigropurpurea*** Ellis & Everh., N. Amer. Pyren.: 136 (1892). (Fig. 100)

Current name: *Preussia nigropurpurea* (Ellis & Everh.) Kruys, Syst. Biod. 7: 476.

*Ascomata* 314–528  $\mu\text{m}$  high  $\times$  (250–)357–500  $\mu\text{m}$  diam., solitary, scattered, or in small groups, immersed, semi-immersed to nearly superficial, globose, subglobose, wall black, coriaceous, smooth, papillate, papilla 43–115  $\mu\text{m}$  long, 72–157  $\mu\text{m}$  broad, ostiolate, ostiole filled with periphyses (Fig. 100a and b). *Peridium* 20–28  $\mu\text{m}$  thick laterally, up to 40  $\mu\text{m}$  thick at the apex, composed of small heavily pigmented cells of *textura angularis*, cells 5–8  $\mu\text{m}$  diam., cell wall 1–3  $\mu\text{m}$  thick, apex cells smaller and walls thicker (Fig. 100c). *Hamathecium* of dense, long, septate, cellular pseudoparaphyses, 1.5–2  $\mu\text{m}$  broad, embedded in mucilage. *Asci* (70–)110–158  $\times$  9–12.5(–15)  $\mu\text{m}$  ( $\bar{x}$  = 114.3  $\times$  11.1  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate, cylindrical to cylindro-clavate, with a narrowed, furcate pedicel, 13–38  $\mu\text{m}$  long, ocular chamber apparent (Fig. 100d and e). *Ascospores* 15–20  $\times$  4–5.5  $\mu\text{m}$  ( $\bar{x}$  = 17.3  $\times$  4.9  $\mu\text{m}$ ,  $n$  = 10), obliquely uniseriate and partially overlapping to biseriate, shortly cylindrical with rounded ends, brown, 3-septate, deeply constricted at each septum, with sigmoid germ slit in each cell, smooth-walled (Fig. 100f and g).

**Anamorph:** none reported.

**Material examined:** USA, New field, New Jersey: Gloucester Co., on cow dung, Mar. 1891 (NY, **holotype**).

### Notes

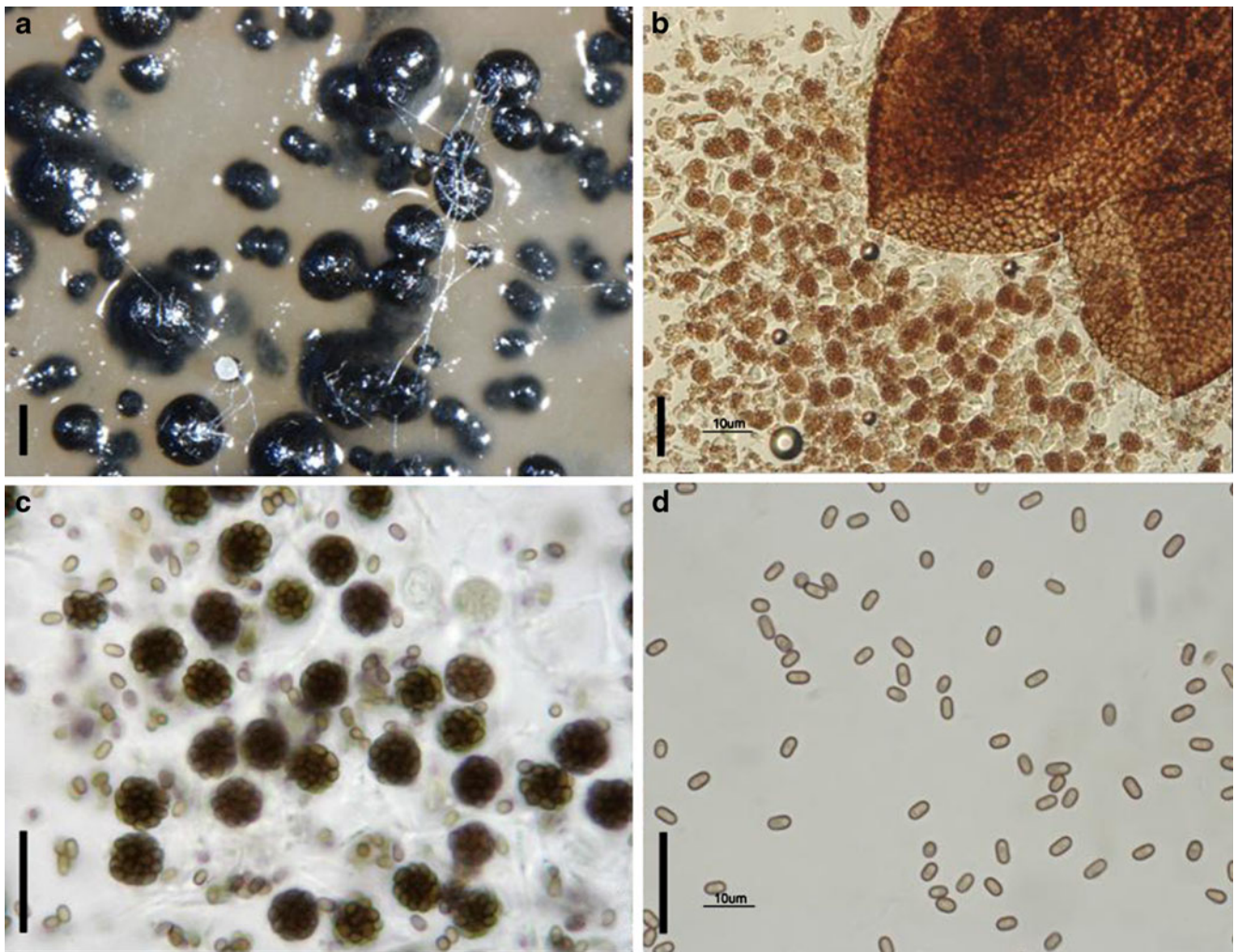
### Morphology

*Sporormiella* was formally established by Ellis and Everhart (1892) based on the single species, *Sporormiella nigropurpurea*, which is characterized by its “immersed to semi-immersed, papillate ascomata, cylindrical to cylindro-clavate asci with a pedicel, three to multi-septate ascospores with elongated germ slits through the whole cell” (Ahmed and Cain 1972; Khan and Cain 1979a, b). Barr (1990a) has indicated that *Sporormiella* might be a synonym of *Ohleriella*, while *Sporormiella* is assigned to *Sporormiaceae* as a separate genus (Eriksson 2006; Lumbsch and Huhndorf 2007). Currently, about 90 species are included in this genus (<http://www.mycobank.org>).

### Phylogenetic study

The phylogenetic analysis based on ITS-nLSU rDNA, mtSSU rDNA and  $\beta$ -tubulin sequences indicated that *Sporormiella* nested in *Preussia*, and a *Sporormiella*–*Preussia* complex is formed (Kruys and Wedin 2009). Thus, *Sporormiella* was assigned under *Preussia* (Kruys and Wedin 2009).





**Fig. 99** *Pycnidophora dispersa* (a from CBS 297.56; b–d from MSC 133.118, type). a Ascomata scattering on the surface of the substrate. b Crashed ascoma. Note the numerous released asci. c Globose asci

and released ascospores. d One-celled ascospores. Scale bars: a=200  $\mu\text{m}$ , b–d=20  $\mu\text{m}$

### Concluding remarks

It is clear that the presence or absence of an ostiole cannot distinguish *Sporormiella* from *Preussia* according to the findings of Guarro et al. (1997a, b) and Kruys and Wedin (2009). Thus, *Sporormiella* should be treated as a synonym of *Preussia* (Kruys and Wedin 2009).

*Spororminula* Arx & Aa, Trans. Br. Mycol. Soc. 89: 117 (1987). (*Sporormiaceae*)

**Current name:** *Preussia* Fuckel, Hedwigia 6: 175 (1867) [1869–70].

### Generic description

Habitat terrestrial, saprobic (coprophilous). *Ascomata* small to medium, solitary, scattered, immersed to erumpent, globose, subglobose, to ovate, black, membranous, papillate, ostiolate. *Peridium* thin, membranous, composed of

several layers of heavily pigmented, elongate cells of *textura angularis*. *Hamathecium* of dense trabeculate, aseptate, decomposing pseudoparaphyses. *Asci* bitunicate, broadly cylindro-clavate with a narrow furcated pedicel. *Ascospores* cylindrical to cylindro-clavate, with round ends, brown, multi-septate, easily breaking into partspores.

**Anamorphs reported for genus:** none.

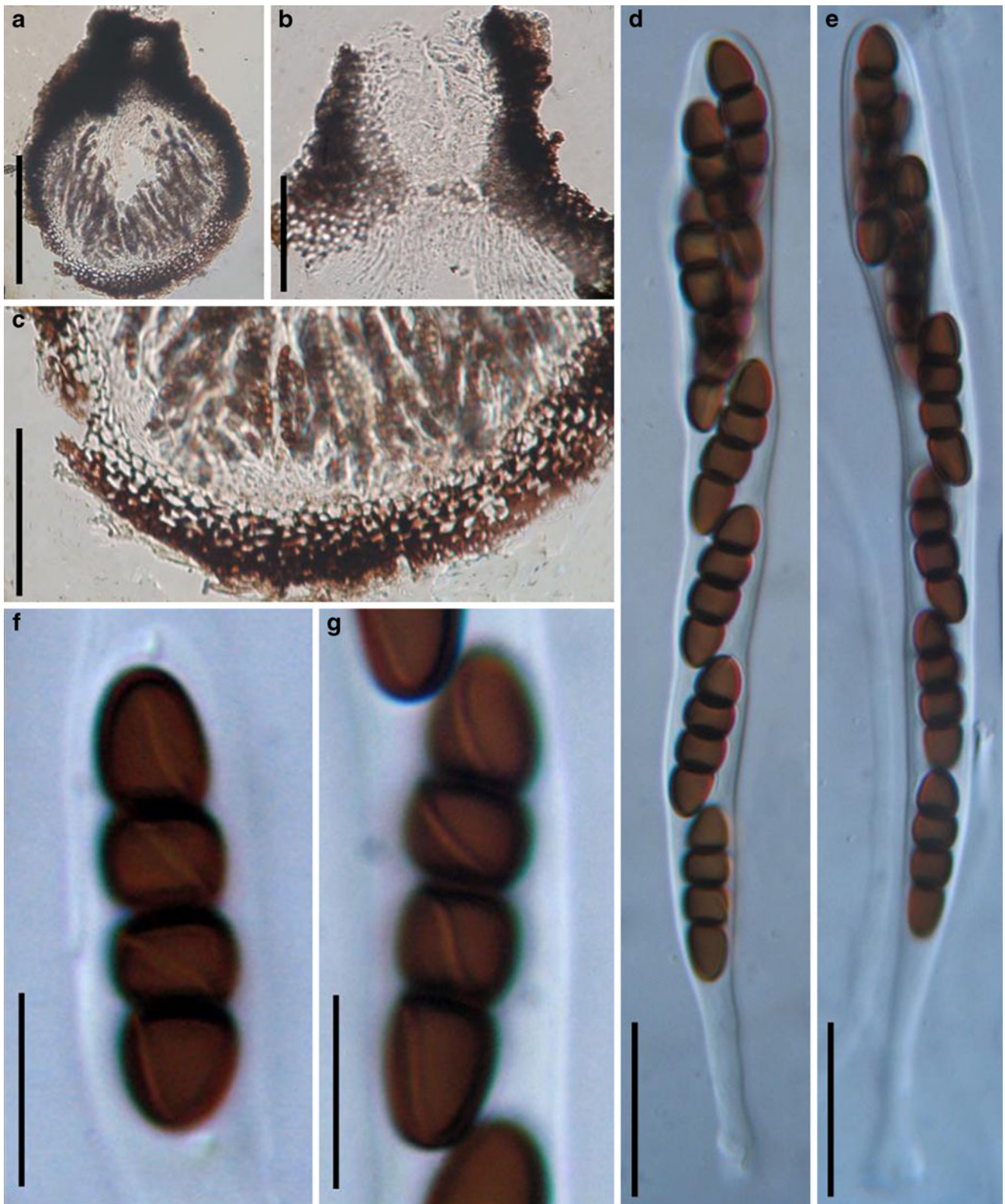
**Literature:** von Arx and van der Aa 1987.

### Type species

*Spororminula tenerifae* Arx & Aa, Trans. Br. Mycol. Soc. 89: 117 (1987). (Fig. 101)

**Current name:** *Preussia tenerifae* (Arx & Aa) Kruys, Syst. Biod. 7: 476.

*Ascomata* 290–400  $\mu\text{m}$  diam., solitary, scattered, initially immersed, becoming erumpent when mature, globose, subglobose to ovate, black, membranous, with a cylindrical or somewhat conical beak, 90–150(–230)  $\mu\text{m}$  broad and 110–



**Fig. 100** *Sporormiella nigropurpurea* (from NY, holotype). **a** Section of an ascoma. **b** Section of the papilla. Note the dense pseudoparaphyses. **c** Section of a partial peridium. **d, e** Eight-spored

cylindro-clavate asci with furcate pedicels. **f, g** Four-celled, brown ascospores. Note the sigmoid germ slit in each cell. Scale bars: **a**= 200  $\mu\text{m}$ , **b, c**=50  $\mu\text{m}$ , **d, e**=20  $\mu\text{m}$ , **f, g**=10  $\mu\text{m}$

190  $\mu\text{m}$  high (Fig. 101a). *Peridium* 20–33  $\mu\text{m}$  thick, 1-layered, composed of several layers of heavily pigmented, elongate cells of *textura angularis*, cells up to  $6.3 \times 5 \mu\text{m}$  diam., cell wall 1–1.5  $\mu\text{m}$  thick (Fig. 101b and c). *Hamathecium* of dense, long trabeculate pseudoparaphyses 1–2  $\mu\text{m}$  broad, hyaline, aseptate, decomposing when mature. *Asci* 165–220  $\times$  33–42.5  $\mu\text{m}$ , 8-spored, bitunicate, broadly clavate, with a small, thin and furcate pedicel, 35–50  $\mu\text{m}$  long, 3–5  $\mu\text{m}$  broad, ocular chamber not observed (Fig. 101d and e). *Ascospores* 68–93  $\times$  12.5–16  $\mu\text{m}$ , 3–4 seriate to uniseriate near the base, cylindrical to cylindro-clavate with rounded ends, brown, (6–)7 transverse septa, easily breaking into partspores, central cells triangular in transverse section but rectangular in vertical section, 14–16.5  $\times$  8–10  $\mu\text{m}$  long, apical cells 12.5–15  $\times$  11.5–17.5  $\mu\text{m}$  long (Fig. 101f and g).

**Anamorph:** none reported.

**Material examined:** SPAIN, Canary Islands, Tenerife Las Canadas, on rabbit? droppings, Mar. 1986, J.A. von Arx (HCBS 9812, **holotype**).

## Notes

## Morphology

*Spororminula* was formally established by von Arx and van der Aa (1987) according to its “ostiolate ascomata, elongated ascospore separated into part cells by transverse septa and without germ slits”, and was monotypified by *S. tenerifae*. Currently, only one species was included in this genus.

## Phylogenetic study

Based on a phylogenetic analysis of ITS-nLSU rDNA, mtSSU rDNA and  $\beta$ -tubulin sequences, *Spororminula tenerifae* nested in the clade of *Preussia*, thus *Spororminula* was treated as a synonym of *Preussia* (Kruys and Wedin 2009).

## Concluding remarks

To clarify its relationship with other genera of *Sporormiaceae*, further phylogenetic study is needed, which should include additional related taxa.

## Excluded and doubtful genera

*Kriegeriella* Höhn., Annl. mycol. 16: 39 (1918). (*Dothiomyces*, families *incertae sedis*, *Microthyriaceae*)

## Generic description

Habitat terrestrial, saprobic? *Ascomata* small, solitary, scattered, superficial, subglobose, black, roughened, apex

**Fig. 101** *Spororminula tenerifae* (from HCBS 9812, **holotype**). **a** Appearance of ascomata on the host surface. **b, c** Sections of the partial peridium. Note the elongate cells of *textura angularis*. **d, e** *Asci* with thin pedicels. **f, g** *Ascospores*, which may break into part spores. Scale bars: **a**=0.5 mm, **b**=100  $\mu\text{m}$ , **c**=50  $\mu\text{m}$ , **d–g**=20  $\mu\text{m}$

no obvious opening. *Peridium* thin, composed of a single type of lightly pigmented thin-walled cells. *Hamathecium* long cellular pseudoparaphyses, septate. *Asci* 8-spored, bitunicate, obpyriform. *Ascospores* hyaline, turning brown when mature, multi-septate, constricted at each septum.

**Anamorphs reported for genus:** none.

**Literature:** von Arx and Müller 1975; Barr 1975, 1987b; Eriksson 2006; Lumbsch and Huhndorf 2007.

## Type species

*Kriegeriella mirabilis* Höhn., Annl. mycol. 16: 39 (1918) (Fig. 102)

*Ascomata* 100–120  $\mu\text{m}$  high  $\times$  150–220  $\mu\text{m}$  diam., solitary, scattered, superficial, with basal wall flattened on the surface of the substrate, subglobose, black, roughened, apex no obvious opening (Fig. 102a and e). *Peridium* thin, composed of a single type of lightly pigmented thin-walled cells, cells up to 12  $\times$  5  $\mu\text{m}$  diam. in front view, cell wall less than 1  $\mu\text{m}$  thick, apex cells smaller and walls thicker (Fig. 102a and f). *Hamathecium* long cellular pseudoparaphyses, 1.5–2  $\mu\text{m}$  wide, septate. *Asci* 65–85  $\times$  31–36  $\mu\text{m}$  ( $\bar{x}$  = 63.1  $\times$  33  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate undetermined, obpyriform, no pedicel, no ocular chamber was seen (Fig. 102c and g). *Ascospores* 28–37.5  $\times$  8–11  $\mu\text{m}$  ( $\bar{x}$  = 32.6  $\times$  10  $\mu\text{m}$ ,  $n$  = 10), 8-seriate, fusoid with broadly rounded ends, hyaline, turning brown when mature, 5–6-septate, constricted at each septum, the upper first-cell longer and broader than the lower ones with semi-round shape, smooth (Fig. 102d, h, i).

**Anamorph:** see Fig. b.

**Material examined:** On the leaves of *Faulenden nadeln* von *Pinus silvestris*, bei Roñigstein, Sept. 1896, W. Rueges. (S reg. nr F12638, **isolectotype**).

## Notes

## Morphology

*Kriegeriella* was formally established by von Höhnelt (1918b) and was represented by two species, i.e. *K. mirabilis* and *K. transiens*; it was typified by *K. mirabilis* and assigned to *Microthyriaceae*. Subsequently, *Kriegeriella* was assigned to the subfamily of *Aulographioidae* (*Microthyriaceae*) (Batista et al. 1959), *Asterinaceae* (*Hemisphaeriales*) (Luttrell 1973) and *Pseudosphaeriaceae* (*Dothideales*) (Barr 1975).

After checking the original description and the type specimens of *K. mirabilis* and *K. transiens*, no significant



difference could be observed, and both are described from rotting needles of conifers (Barr 1975; Batista et al. 1959; Höhnelt 1918b). Morphologically, *Extrawettsteinina* is comparable with *Kriegeriella*. In particular, *E. pinastri* could not be distinguished from *K. transiens* or *K. mirabilis*. Thus, *K. transiens* including *Extrawettsteinina pinastri* was treated as synonyms of *K. mirabilis*, and was included in the section of *Kriegeriella* under the genus *Kriegeriella* (von Arx and Müller 1975; Barr 1975). The other section of *Kriegeriella*, *Extrawettsteinina*, includes two previous *Extrawettsteinina* species, i.e. *K. minuta* and *K. mediterranea*. Barr (1987b) introduced a family, i.e. *Kriegeriellaceae* (*Dothideales*) to accommodate *Kriegeriella* and *Extrawettsteinina*. This proposal is rarely followed, and *Kriegeriella* is usually assigned to *Pleosporaceae* (*Pleosporales*) (Eriksson 2006; Lumbsch and Huhndorf 2007).

### Phylogenetic study

None.

### Concluding remarks

*Kriegeriella* might belong to *Microthyriaceae*, although it would be unusual in this family in having 5-6-septate ascospores. Micropeltidaceae better accommodates the ascospores, however, the parallel arrangement of cells of the upper peridium are not typical. Asterinaceae may be most suitable as Luttrell (1973) suggested.

***Phaeotrichum*** Cain & M.E. Barr, Can. J. Bot. 34: 676 (1956). (*Dothideomycetes*, family *incertae sedis*, *Phaeotrichaceae*)

### Generic description

Habitat terrestrial, saprobic (coprophilous). *Ascomata* small, cleistothecial, solitary, or in small groups, superficial, with long straight or slightly flexed, thin, black appendages evenly scattered on the surface of the ascomata, globose, black. *Peridium* thin, carbonaceous-membranous, 1-layered, composed of dark brown thick-walled cells of *textura angularis*. *Hamathecium* not observed. *Asci* bitunicate form not clear, fissitunicate dehiscence not observed, broadly clavate, with a relatively thick pedicel. *Ascospores* oblong to ellipsoid, hyaline when young, turning reddish brown at maturity, 1-septate, deeply constricted at the septum, each end with a subhyaline and broadly rounded germ pore, readily forming partspores at the septum at maturity.

**Anamorphs reported for genus:** none.

**Literature:** Cain 1956; Malloch and Cain 1972.

### Type species

***Phaeotrichum hystricinum*** Cain & M.E. Barr, Can. J. Bot. 34: 677 (1956). (Fig. 103)

(Some information for the following description is from Cain 1956)

*Ascomata* 170–280  $\mu\text{m}$  diam., cleistothecial, solitary, or in small groups, superficial, with 15–20 long straight or slightly flexed, thin, black appendages evenly scattered on the surface of the ascomata, 0.5–1 mm long, 15–25  $\mu\text{m}$  wide at base, tapering to less than 5  $\mu\text{m}$  at the blunt apex, with few or without septa, globose, black, smooth (Fig. 103a). *Peridium* thin, carbonaceous-membranous, 1-layered, composed of dark brown thick-walled cells of *textura angularis*, cells 8–16  $\mu\text{m}$  diam., cell wall 0.5–1.5  $\mu\text{m}$  thick (data obtained from Cain 1956) (Fig. 103b). *Hamathecium* not observed. *Asci* 42–48  $\times$  14–17  $\mu\text{m}$ , 8-spored, bitunicate form not typical, lacking fissitunicate dehiscence, broadly clavate, with a relatively thick pedicel which is about 18  $\mu\text{m}$  (data obtained from Cain 1956). *Ascospores* 14–16  $\times$  4–5  $\mu\text{m}$ , 4-seriate, oblong to ellipsoid, hyaline when young, turning reddish brown at maturity, 1-septate, deeply constricted at the septum, each end with a subhyaline and broadly rounded germ pore, smooth, readily separating into partspores at the septum at maturity (Fig. 103c, d, e and f).

**Anamorph:** none reported.

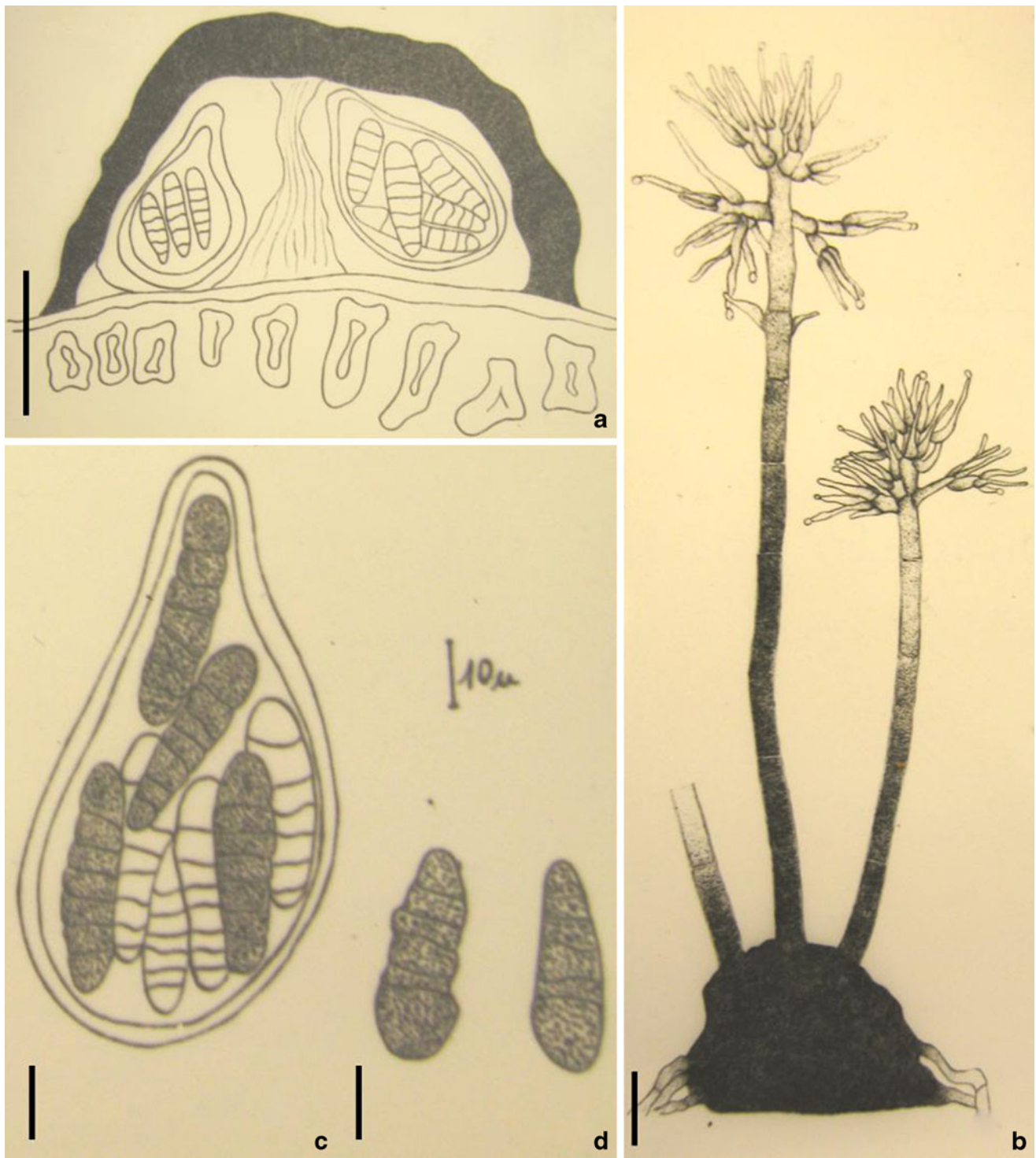
**Material examined:** CANADA, Ontario, Muskoka, Stoneleigh, on porcupine dung, 18 Aug. 1932, Cain (TRTC 4361, **holotype**).

Note: the ascomata of the specimen are fragile and no asci could be obtained.

### Notes

### Morphology

*Phaeotrichum* was formally established by Cain (1956) to accommodate two new coprophilous fungi, i.e. *P. hystricinum* and *P. circinatum* Cain, and *P. hystricinum* was selected as the generic type. *Phaeotrichum* is mainly characterized by its coprophilous habitat, superficial cleistothecial ascocarps covered by long hairy appendages, reddish brown 1-septate ascospore with a broadly rounded germ pore at each end, readily breaking into partspores (Cain 1956). According to Cain (1956), *Phaeotrichum* possesses untypical bitunicate ascus, and the ascospore releasing is described as “simply break down and allow the contents to become free in the cavity of the ascocarp”. This ascospore releasing mechanism is considered as evolutionarily developed compared to those that “discharge the ascospores through an apical pore” (Cain 1956). Although lacking



**Fig. 102** *Kriegeriella mirabilis* (from S reg. nr F12638, **isolecto-**  
**type**). **a** Section of a superficial ascoma. **b** Anamorphic stage. **c**  
Obpyriform ascus. Note the pigmented ascospores and hyaline  
ascospores coexisted in a single ascus. **d** Ascospores. Scale bars: **a**=

50  $\mu\text{m}$ , **b–d**=10  $\mu\text{m}$ . **e** Ascmata on the host surface. **f, g** Crashed  
ascma. Note the peridium structure. **h, i** Hyaline asymmetric  
ascospores. Scale bars: **e, f**=100  $\mu\text{m}$ , **g**=50  $\mu\text{m}$ , **h, i**=10  $\mu\text{m}$

a typical bitunicate ascus, *Phaeotrichum* is still  
assigned to *Pleosporales*, because the lack of bitunicate

ascus does not “taken by itself, exclude a fungus from  
close relationship” (Cain 1956).

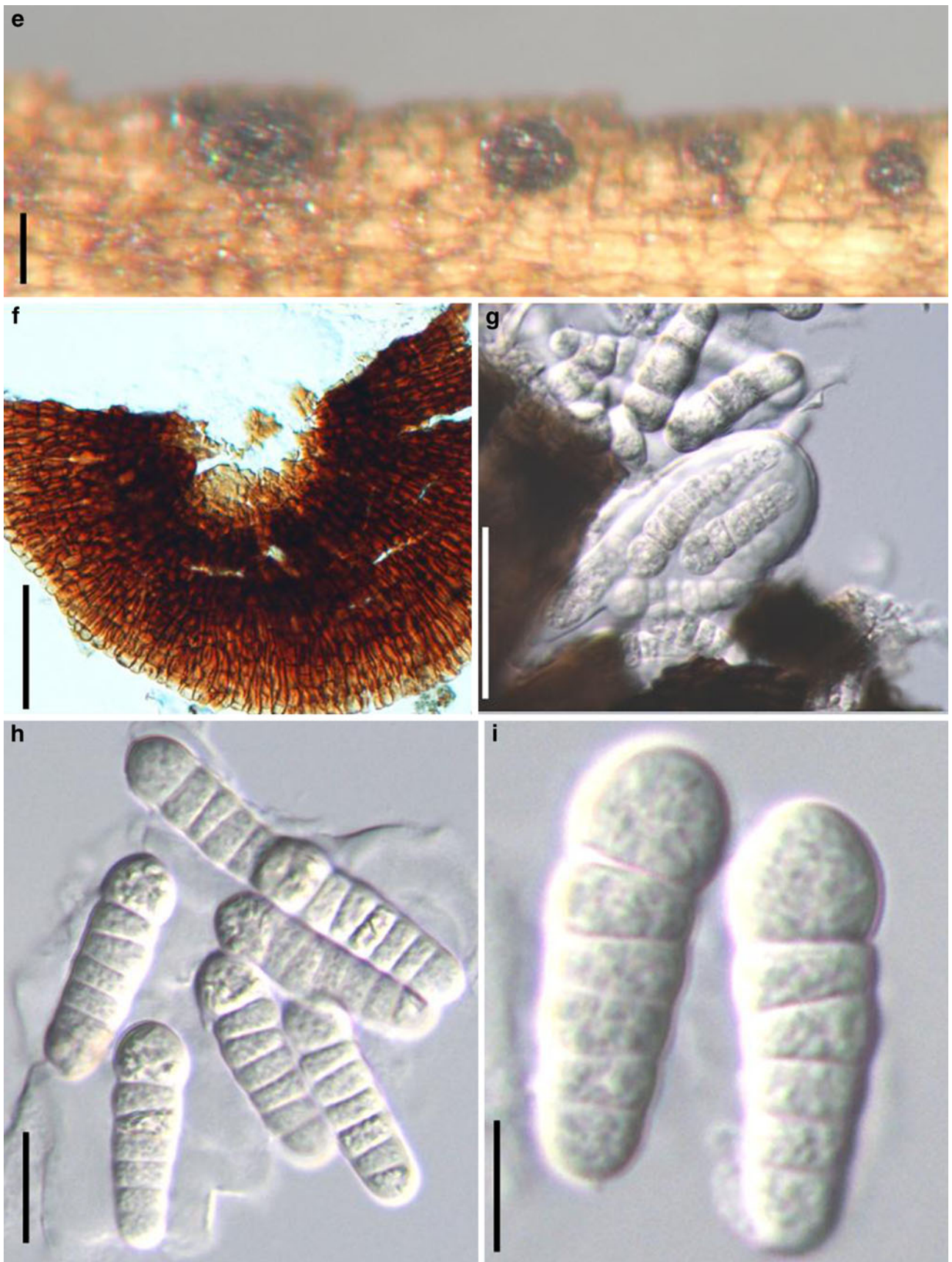


Fig. 102 (continued)

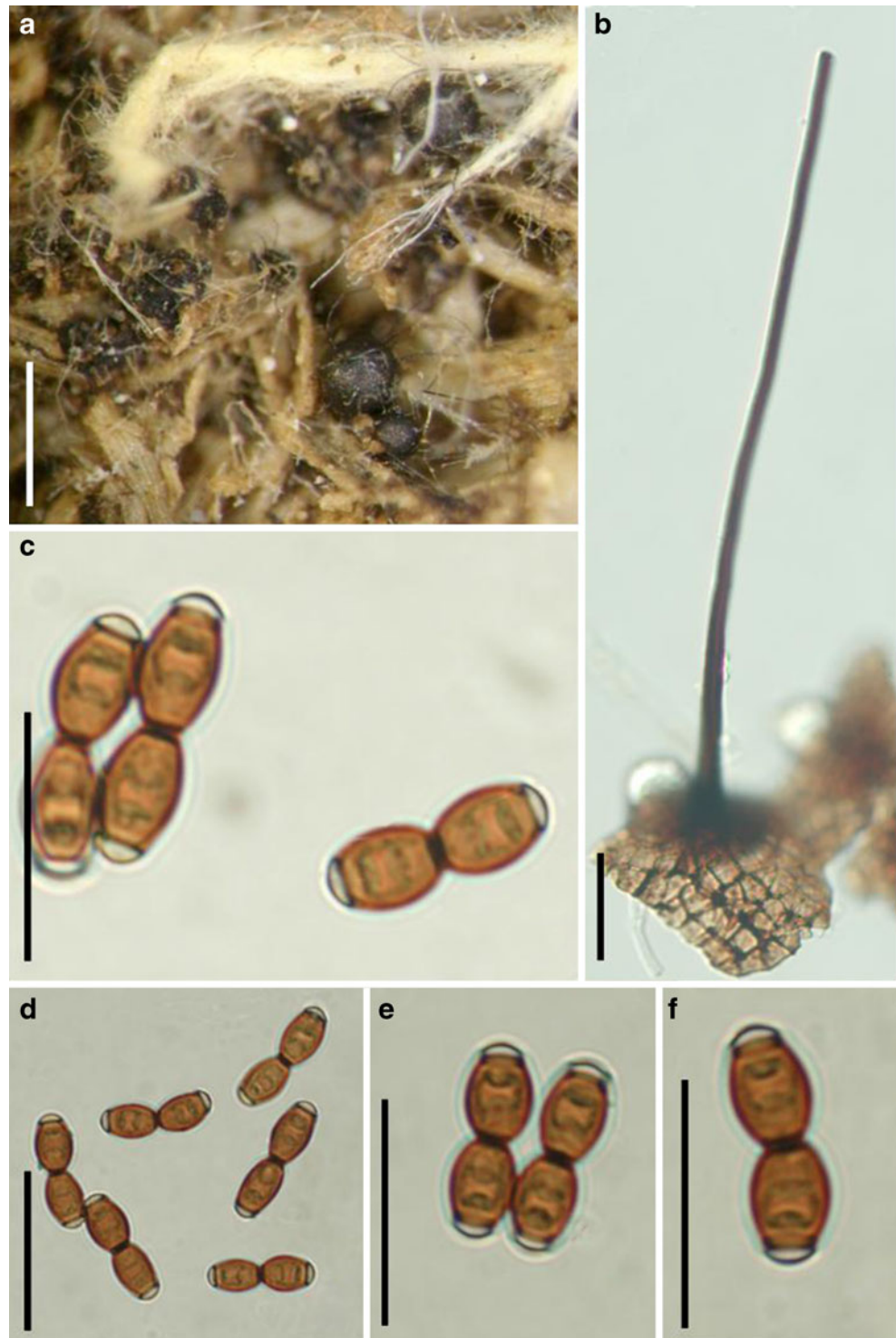
### Phylogenetic study

A single unverified isolate of *Phaeotrichum benjaminii* is placed well outside of *Pleosporales* in a broad phylogenetic study (Schoch et al. 2009).

### Concluding remarks

The superficial cleistothecial ascocarps covered by long hairy appendages, the absence of hamathecium as well as the nontypical bitunicate ascus are all distinct from members of

**Fig. 103** *Phaeotrichum hystricinum* (from TRTC 4361, **holotype**). **a** Superficial ascomata on host surface. Note the long and black appendages. **b** Part of peridium. Note the large cells in surface view. **c–f** Released reddish brown ascospores with hyaline end cells. Note the strongly constricted middle septum. Scale bars: **a**=0.5 mm, **b–f**=20  $\mu$ m





*Pleosporales*, but definite conclusions could only be obtained by further molecular phylogenetic analysis. In this study, we assign it to *Dothideomyces incertae cedis*.

***Zeuctomorpha*** Sivan., P.M. Kirk & Govindu, Bitunicate Ascomycetes and their Anamorphs: 572 (1984). (*Venturiaceae*)

### Generic description

Habitat terrestrial, hemibiotrophic. *Ascomata* small, gregarious, superficial, globose to slightly flattened, ostiolate, covered with setae. *Peridium* thin, composed of heavily pigmented pseudoparenchymatous cells of *textura angularis*. *Hamathecium* of rare, septate, branching and anastomosing pseudoparaphyses. *Asci* 8-spored, with a short thick pedicel, bitunicate, fissitunicate, broadly clavate to obclavate. *Ascospores* ellipsoid, dark brown, 1-septate, asymmetrical, deeply constricted at the septum.

**Anamorphs reported for genus:** *Acroconidiellina* (Sivanesan 1984).

**Literature:** Sivanesan 1984.

### Type species

***Zeuctomorpha arecae*** Sivan., P.M. Kirk & Govindu, in Sivanesan, Bitunicate Ascomycetes and their Anamorphs: 572 (1984). (Fig. 104)

*Ascomata* 175–300  $\mu\text{m}$  diam., gregarious, superficial, globose to slightly flattened, collapsed at the apex when dry, ostiolate, covered with numerous long setae (Fig. 104a). *Peridium* up to 25  $\mu\text{m}$  wide, composed of heavily pigmented pseudoparenchymatous cells of *textura angularis*, to 7  $\mu\text{m}$  diam. *Hamathecium* of rare, 2–5  $\mu\text{m}$  broad, septate, branching and anastomosing pseudoparaphyses. *Asci* 83–185  $\times$  29–40(–50)  $\mu\text{m}$  ( $\bar{x}$  = 134  $\times$  35.3  $\mu\text{m}$ ,  $n$  = 10), 8-spored, bitunicate, fissitunicate, broadly clavate to obclavate, with a short thick pedicel, up to 40  $\mu\text{m}$  long, apically rounded, with a small ocular chamber (to 4  $\mu\text{m}$  wide  $\times$  7  $\mu\text{m}$  high) (Fig. 104b, c and d). *Ascospores* 35–43  $\times$  12.5–18  $\mu\text{m}$  ( $\bar{x}$  = 36.5  $\times$  15.4  $\mu\text{m}$ ,  $n$  = 10), 2–4 seriate, ellipsoid, dark brown, 1-septate, deeply constricted at the septum, usually slightly asymmetric, smooth (Fig. 104e, f, g, h and i).

**Anamorph:** *Acroconidiellina arecae* (Sivanesan 1984).

**Material examined:** INDIA, Shimogee, on *Areca catechu* L. leaf, 1 Nov. 1979, H.C. Govindu (IMI 246067, holotype).

### Notes

### Morphology

*Zeuctomorpha* was formally established by Sivanesan (1984) based on its superficial setose ascomata, clavate

asci, ellipsoid and 1-septate ascospores, and presence of pseudoparaphyses, and was monotypified by *Z. arecae*. *Zeuctomorpha arecae* is widely distributed in tropical regions of East South Asia exclusively on the leaves of *Areca catechu* (Sivanesan 1984).

### Phylogenetic study

None.

### Concluding remarks

This taxon is unusual amongst the *Pleosporaceae* as it has hairy superficial ascomata, few pseudoparaphyses, broadly clavate to obclavate asci and 1-septate pigmented ascospores. All of these morphological characters are most comparable with species of *Acantharia*, which might be closely related to *Venturiaceae* (Zhang et al. data unpublished).

***Muroia*** I. Hino & Katum., J. Jap. Bot. 33: 79 (1958). (*Ascomycota*)

### Generic description

Habitat terrestrial, saprobic or parasitic. *Ascstromata* erumpent through the host surface in linear rows parallel to the host fibers. *Ascomata* small- to medium-sized, semi-immersed to erumpent, subglobose to rectangular, black, coriaceous, cells of ascostromata pseudoparenchymatous, cells of peridium composed of pigmented cells of *textura angularis*. *Hamathecium* of rare, pseudoparaphyses. *Asci* bitunicate, clavate to cylindro-clavate. *Ascospores* oblong to elongated oblong, hyaline, 1-celled, usually slightly curved.

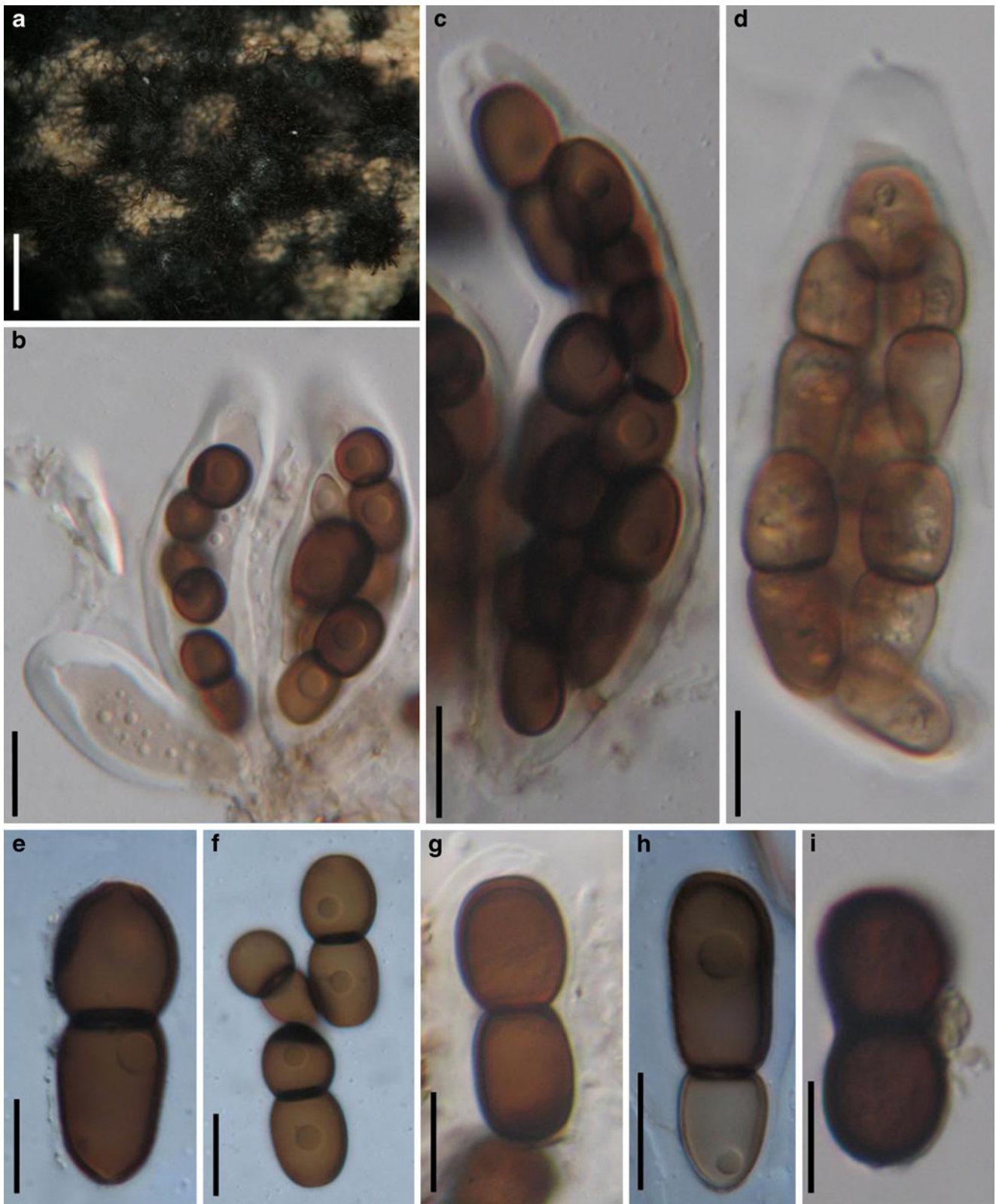
**Anamorphs reported for genus:** none.

**Literature:** Hino and Katumoto 1958.

### Type species

***Muroia nipponica*** I. Hino & Katum., J. Jap. Bot. 33: 79 (1958). (Fig. 105)

*Ascstroma* 1–6 mm long, 360–470  $\mu\text{m}$  broad, linear parallel to the host fibers with several linearly arranged ascomata (Fig. 105a). *Ascomata* 250–400  $\mu\text{m}$  diam., semi-immersed in substrate to erumpent, subglobose to rectangular with a furrow-shaped ostiole, black, coriaceous, cells of ascostromata pseudoparenchymatous. *Peridium* composed of pigmented cells of *textura angularis*. *Hamathecium* of rare, 3–4.5  $\mu\text{m}$  broad pseudoparaphyses. *Asci* (120–)150–190  $\times$  30–45  $\mu\text{m}$ , 8-spored, bitunicate, fissitunicate dehiscence not observed, clavate to cylindro-clavate, with a short, thin, knob-like pedicel, lacking an ocular chamber (Fig. 105b). *Ascospores* 43–50  $\times$  13–18  $\mu\text{m}$  ( $\bar{x}$  = 46.6  $\times$  15.2  $\mu\text{m}$ ,  $n$  = 10), biseriate, ob-



**Fig. 104** *Zeuctomorpha arecae* (from IMI 246067, holotype). **a** Gregarious ascomata on host surface. Note the numerous setae on the surface of ascomata. **b** Asci with ocular chamber and short peduncles.

**c, d** Ascus with ocular chamber and knob-like pedicel. **e–i** One septate ascospores which are slightly asymmetrical. Scale bars: **a**=0.5 mm, **b–i**=20  $\mu$ m

long to elongated oblong, hyaline, 1-celled, usually slightly curved (Fig. 105c,d and e).

**Anamorph:** none reported.

**Material examined:** JAPAN, Province Ugo. on moribund culm of *Sasa kurilensis*, 4 Aug. 1957, coll. H. Muroi, Det. I. Hino & K. Katumoto (TNS-F-230252, **isotype**).

## Notes

### Morphology

*Muroia* was introduced based on *M. nipponica*, which is a parasite on the lower part of *Sasa kurilensis* (Hino and Katumoto 1958). *Muroia* is characterized by its 1-celled ascospores. Considering the perithecial structure and linear ostiole, it was assigned to the *Lophiostomataceae*, and was regarded as closely related to the atherosporous *Lophiella* (Hino and Katumoto 1958).

### Phylogenetic study

None.

### Concluding remarks

The linear ascostroma and 1-celled, hyaline ascospores make it less likely to fit the concept of *Lophiostomataceae*. Because of the condition of the specimen, its bitunicate nature could not be confirmed.

Genera not studied

*Aglaospora* De Not., G. bot. ital. 2: 43 (1844).

Type species: *Aglaospora profusa* (Fr.) De Not., G. bot. ital. 2: 43 (1844).

*Aglaospora*, which was introduced by de Notaris (1844), has 35 species epithets (<http://www.mycobank.org/mycotaxo.aspx>) and was considered to be a synonym of *Massaria* (Voglmayr and Jaklitsch 2011) or separate (Barr 1990a). In a recent phylogenetic study, Voglmayr and Jaklitsch (2011) confirmed that *Aglaospora* is a synonym of *Massaria* and is treated as such here. The immersed ascomata with short beaks, together with ascostroma under pseudostromatic tissues, cylindrical asci with a large and refractive apical ring, trabeculate pseudoparaphyses within a gel matrix, and distoseptate ascospores, are all similar to species of *Massaria*. The large and conspicuous apical ring of the ascus of *Aglaospora* has the appearance of being unitunicate, and thus Shoemaker and Kokko (1977) treated it as a unitunicate taxon. Currently, its bitunicate status is widely accepted.

*Allewia* E.G. Simmons, Mycotaxon 38: 260 (1990).

Type species: *Allewia proteae* E.G. Simmons, Mycotaxon 38: 262 (1990).

*Allewia* was introduced by Simmons (1990) to accommodate *Lewia*-like species but with *Embellisia* anamorphs. *Embellisia* differs from other similar genera by a combination of characters including the percentage of dictyoconidia, shape of conidia, thickness of septa, umbilicate sites of conidiophore geniculation, proliferating chlamydoconidia and hyphal coils in culture (Simmons 1971). Based on multigene phylogenetic analysis, *A. eureka*, which is closely related to *A. proteae*, clustered together with species of *Alternaria*. Thus, *Allewia* should be treated as a synonym of *Lewia*.

*Anteaglonium* Mugambi & Huhndorf, System. Biodivers. 7: 460 (2009).

Type species: *Anteaglonium abbreviatum* (Schwein.) Mugambi & Huhndorf, System. Biodivers. 7: 460 (2009).

≡ *Hysterium abbreviatum* Schwein., Trans. Am. phil. Soc., New Series 4: no. 2094 (1832).

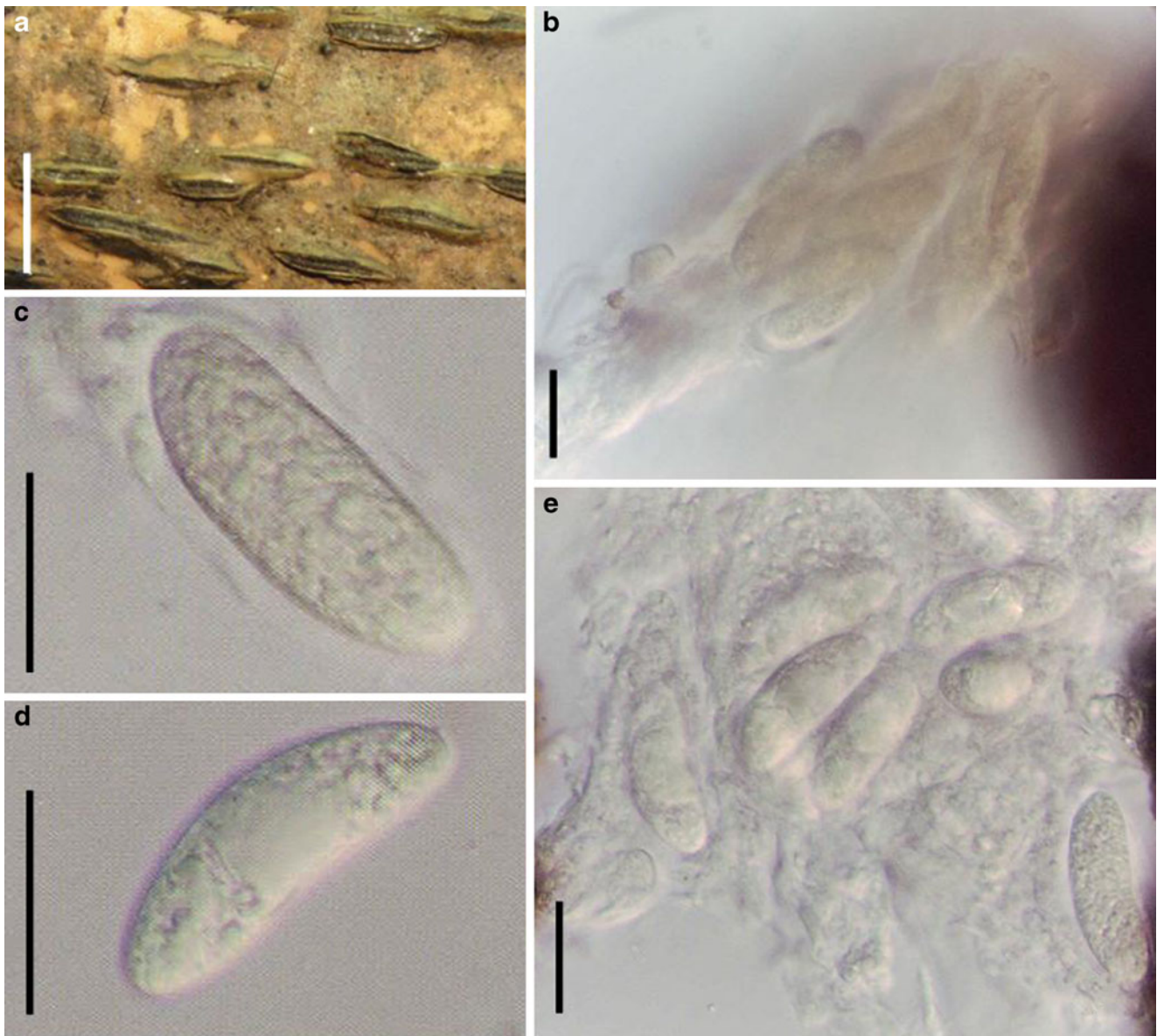
*Anteaglonium* was introduced to accommodate a monophyletic hysterothecial clade within *Pleosporales*, and four species (*A. abbreviatum*, *A. globosum* Mugambi & Huhndorf, *A. parvulum* (W.R. Gerard) Mugambi & Huhndorf and *A. latirostrum* Mugambi & Huhndorf) are included (Mugambi and Huhndorf 2009a). *Anteaglonium* is characterized by erumpent to superficial, globose to subglobose or elongate, fusoid to oblong ascomata, which are brown to shiny black, opening by a pronounced or indistinct longitudinal slit running entire length of fruit body or apex raised and laterally compressed; asci cylindrical with short pedicel, 8-spored, uniseriate or biseriate; ascospores fusoid to oblong, septate, constricted at the primary septum, hyaline or pigmented. A phylogenetic analysis based on DNA comparisons indicated that *Anteaglonium* resides as a separate clade but related to *Tetraplospora*, *Lophiotrema* and other species without clear resolution. Therefore, the familial placement of *Anteaglonium* remains unclear (Mugambi and Huhndorf 2009a).

*Arthopyrenia* A. Massal., Ric. auton. lich. crost. (Verona): 165 (1852).

Type species: *Arthopyrenia rhyponia* (Ach.) A. Massal., Ric. auton. lich. crost. (Verona): 166, fig. 329 (1852).

≡ *Verrucaria rhyponia* Ach., K. Vetensk-Acad. Nya Handl.: 150 (1809).

*Arthopyrenia* is a lichen genus with a *Trentepohlia* photobiont and is characterized by dimidiate perithecial ascomata, which are scattered to irregularly confluent, and have an upper thick clypeate wall composed of periderm cells intermixed with dark hyphae. The pseudoparaphyses are branched and asci are obpyriform, obclavate to subcylindrical and 8-spored. Ascospores are oblong, ovoid, slipper-shaped, 1-3-septate, hyaline and smooth-walled (Coppins 1988;



**Fig. 105** *Muroia nipponica* (TNS-F-230252, isotype). **a** Linear ascostroma parallel to the host fibers. **b** Crashed ascus with ascospores released. **c–e** Released hyaline ascospores. Scale bars: **a**=5 mm, **b–e**=30  $\mu$ m

Upreti and Pant 1993). Multigene phylogenetic studies indicated that *Arthopyrenia salicis*, a typical species of *Arthopyrenia*, is located within *Pleosporales* in close proximity to bambusicolous species in the genus *Rousoella*, with its familial status remaining undetermined (Del Prado et al. 2006; Schoch et al. 2009; Zhang et al. 2009a).

*Ascocratera* Kohlm., Can. J. Bot. 64: 3036 (1986).

Type species: *Ascocratera manglicola* Kohlm., Can. J. Bot. 64(12): 3036 (1986).

*Ascocratera* is a monotypic obligate marine fungus and is characterized by conical, crater-like, erumpent to superficial and carbonaceous ascomata, a depressed ostiole, a thick peridium, trabeculate pseudoparaphyses, bitunicate, fissitunicate and cylindrical asci, and ellipsoi-

dal, hyaline, 1-septate (3-septate when senescent) ascospores surrounded by a sheath (Kohlmeyer 1986). *Ascocratera* was reported to be one of the most common marine fungi of the upper intertidal zone of dead mangrove roots, trunks and branches (Kohlmeyer 1986). Based on a multigene phylogenetic analysis, *Ascocratera* nested within the clade of *Aigialaceae* (Schoch et al. 2009; Suetrong et al. 2009).

*Atradiidymella* M.L. Davey & Currah, Am. J. Bot. 96: 1283 (2009).

Type species: *Atradiidymella muscivora* M.L. Davey & Currah, Am. J. Bot. 96: 1283 (2009).

*Atradiidymella* was introduced as a pleosporalean genus parasitic on boreal bryophytes, and is characterized by

minute, unilocular, setose pseudothecia with 2–3 wall layers; brown, fusoid, 1-septate ascospores, and an anamorphic stage (*Phoma muscivora* M.L. Davey & Currah) (Davey and Currah 2009). Based on an ITS rDNA sequences analysis, *Atracidymella* nested within *Didymelaceae* (Davey and Currah 2009).

***Bertiella*** (Sacc.) Sacc. & P. Syd., in Saccardo, Syll. fung. (Abellini) 14: 19 (1899).

≡ *Bertia* subgen. *Bertiella* Sacc., Syll. fung. (Abellini) 1: 584 (1882).

Type species: *Bertiella macrospora* (Sacc.) Sacc. & Traverso, Syll. fung. (Abellini) 19: 147 (1910).

≡ *Bertia macrospora* Sacc., Michelia 1(no. 8): 452 (1882).

*Bertia* subg. *Bertiella* was raised to generic rank by Saccardo (1899), and is typified by *B. macrospora*. After studying the type specimen of *B. macrospora*, Eriksson and Yue (1986) assigned it to *Massarina* (as *M. macrospora* (Sacc.) O.E. Erikss. & J.Z. Yue). Concurrently, *Bertiella* is treated as a synonym of *Massarina*. Hyde et al. (2002) assigned *Bertia macrospora* to *Lophiostoma* as (*L. bertiellum* Aptroot & K.D. Hyde).

The superficial ascomata, cylindro-clavate asci and hyaline 1-septate ascospores which may become 3-septate and pale brown when senescent and, in particular, the woody habitat indicate that *B. macrospora* may be related to *Lophiostoma sensu* Holm and Holm (1988). A single isolate of *Bertiella macrospora* clusters with *Byssosphaeria* in the *Melanommataceae* in a recent DNA based phylogeny (Mugambi and Huhndorf 2009b). The relationship between *Bertiella* and *Byssosphaeria* needs further study.

***Byssothecium*** Fuckel, Bot. Ztg. 19: 251 (1861).

Type species: *Byssothecium circinans* Fuckel, Bot. Ztg. 19: 251 (1861).

The isotype of *Byssothecium circinans* is in FH as excicatae (Fungi rhenani 730c); it was described by Boise (1983) and could not be loaned. *Byssothecium circinans* is regarded as a saprobe or weak parasite of *Medicago sativa* (Semeniuk 1983), and a *Pleospora*-type centrum was observed (Boise 1983). A *Chaetophoma*-like anamorph was produced in culture, however, no culture or herbarium specimen is listed (Boise 1983). Boise (1983) regarded *Byssothecium circinans* as closely related to *Teichospora*, however, confirmation is required. An isolate of *Byssothecium circinans* was sequenced and a multigene phylogeny placed it in close proximity to members of *Massarinaceae* (Schoch et al. 2009; Zhang et al. 2009a; Plate 1).

***Caryospora*** De Not., Micr. Ital. Novi 9: 7 (1855).

Type species: *Caryospora putaminum* (Schwein.) De Not., Micr. Ital., Dec. 9: 7 (1855).

After studying the *Caryospora* species in North America, Barr (1979b) indicated that species of *Caryospora* may

closely relate to *Trematosphaeria*. Boise (1985) distinguished *Caryospora* from *Trematosphaeria* based on the structure of ascospores. Currently, 17 taxa, from freshwater, marine, or terrestrial habitats (Raja and Shearer 2008), are included within *Caryospora* and might be polyphyletic.

***Celtidia*** J.D. Janse, Ann. Jard. Bot. Buitenzorg 14: 202 (1897).

Type species: *Celtidia duplicisporea* J.D. Janse, Ann. Jard. Bot. Buitenzorg 14: 202 (1897).

*Celtidia* is a monotypic genus, which is characterized by its echinulate ascospores (Hawksworth 1979). It is only known from an illustration accompanying the original description from root nodules of *Celtis* in Java. A new collection is needed for further study of this genus.

***Chaetopreussia*** Locq.-Lin., Revue Mycol., Paris 41: 185 (1977).

Type species: *Chaetopreussia chadefaudii* Locq.-Lin., Revue Mycol., Paris 41: 187 (1977).

*Chaetopreussia* is a monotypic genus characterized by cleistothecoid ascomata with seta, and 3-septate ascospores without germ slits. Recent molecular analysis has shown that cleistothecoid ascomata and the presence of germ slits lack significance at the generic rank (Kruys and Wedin 2009). *Chaetopreussia* is possibly another synonym of *Preussia*.

***Clathrospora*** Rabenh., Hedwigia 1(18): 116 (1857).

Type species: *Clathrospora elyanae* Rabenh., Hedwigia 1: 116 (1857).

The most striking character of *Clathrospora* is its ascomata opening with an intraepidermal discoid lid and muriform applanate ascospores with more than one row of longitudinal septa (Shoemaker and Babcock 1992). The form of opening and applanate ascospores, however, might have limited significance at generic rank and thus, *Clathrospora* may be closely related to *Pleosporaceae*. Phylogenetic analysis based on nLSU, nSSU and mtSSU indicate that *C. diplospora* (Ellis & Everh.) Sacc. & Traverso nests in *Pleosporaceae* (Kruys et al. 2006). *Clathrospora elyanae* is saprobic on monocots (Shoemaker and Babcock 1992).

***Cochliobolus*** Drechsler, Phytopathology 24: 973 (1934).

Type species: *Cochliobolus heterostrophus* (Drechsler) Drechsler, Phytopathology 24: 973 (1934).

*Cochliobolus* and its asexual relatives are well studied taxa in *Pleosporales* because of their economic importance. *Cochliobolus* includes both saprobic and pathogenic species that are significant monocot pathogens worldwide, which attack corn, rice, barley, sugarcane, wheat, and oats, all major cereal crops. *Cochliobolus* is characterized by globose or subglobose ascomata with a well defined long ostiolar papilla or cylindrical neck, a peridium composed of

pseudoparenchymatous cells, filliform, septate and branched pseudoparaphyses, and thin-walled cylindrical or broadly clavate asci. Ascospores are distinctively hyaline or pale brown, filliform, and strongly helicoid to loosely coiled in the asci (Sivanesan 1984). The anamorphs of *Cochliobolus* belong to *Bipolaris* and *Curvularia* (Sivanesan 1984). *Bipolaris* and *Curvularia* can be distinguished by characters of conidial morphology, conidial germination, hilum structure, conidial septum and wall structure, conidial septum ontogeny (Sivanesan 1987). Multigene phylogenetic analysis indicated that *Cochliobolus heterostrophus* and *C. sativus* (S. Ito & Kurib.) Drechsler ex Dastur nested within the clade of *Pleosporaceae* (Zhang et al. 2009a; Plate 1). Thus, its familial placement is confirmed.

***Comoclathris*** Clem., Gen. fung. (Minneapolis): 37, 173 (1909).

Type species: *Comoclathris lanata* Clem. [as ‘Comochlathris’], Gen. fung. (Minneapolis) (1909).

*Comoclathris* is temporarily placed in *Diademaceae*, and its pivotal characters are the circular lid-like opening and appanate reddish-brown to dark reddish-brown muriform ascospores with single longitudinal septa (versus two or more rows of longitudinal septa of *Clathrospora*) (Shoemaker and Babcock 1992). Barr (1990b) treated it as a synonym of *Graphyllum*. *Comoclathris* has been linked with an *Alternaria*-like anamorphs (Simmons 1952), which may suggest its close relationship with *Pleosporaceae*.

***Coronopapilla*** Kohlm. & Volkm.-Kohlm., Mycol. Res. 94: 686 (1990).

Type species: *Coronopapilla avellina* Kohlm. & Volkm.-Kohlm., Mycol. Res. 94: 687 (1990).

*Coronopapilla* is characterized by immersed ascomata with a conical papilla, thin peridium, 8-spored and thick-walled, cylindrical and fissitunicate asci. Ascospores are ellipsoidal, 1-3-septate, brown and distoseptate. *Coronopapilla avellina* is an obligate marine species, and was originally assigned to *Didymosphaeriaceae* (Kohlmeyer and Volkman-Kohlmeyer 1990). The marine habitat of *Coronopapilla* makes it readily distinguishable from *Didymosphaeria futilis* (the generic type of *Didymosphaeria*). Thus, the familial placement of *Coronopapilla* is yet to be determined.

***Cucurbitaria*** Gray, Nat. Arr. Brit. Pl. (London) 1: 508, 519 (1821).

Type species: *Cucurbitaria berberidis* (Pers.) Gray, Nat. Arr. Brit. Pl. (London) 1: 508, 519 (1821).

≡ *Sphaeria berberidis* Pers., Neues Mag. Bot. 1: 83 (1794).

A narrow generic concept of *Cucurbitaria* was accepted by Welch (1926), who restricted *Cucurbitaria* to five closely related species, which have turbinate ascomata that

develop cespitosely in a massive subiculum or over compressed stromatic tissues and have a thick and obconoid base. A broader generic concept was accepted by Mirza (1968), who also included species with globose or ovoid to pyriform ascomata that are gregarious on the substrate with only sparse subiculum and lack an obconoid region in the base of the locule. Barr (1990b) accepted an intermediate concept, and described 11 related species from North America. Currently, 450 species are accepted in *Cucurbitaria* (<http://www.mycobank.org/mycotaxo.aspx>), and the genus was assigned to *Cucurbitariaceae*. In this study, an isolate of *C. berberidis* clustered with some species of *Pyrenochaeta* and *Didymosphaeria futilis*, and they get moderate bootstrap support (Plate 1). *Cucurbitariaceae* may be another family within *Pleosporineae*.

***Curreya*** Sacc., Syll. fung. (Abellini) 2: 651 (1883).

Type species: *Curreya conorum* (Fuckel) Sacc., Syll. fung. (Abellini) 2: 651 (1883).

*Curreya* is a contentious genus which had been assigned to *Pleospora* (Barr 1981). von Arx and van der Aa (1983), however, maintained it as distinct, because of its *Coniothyrium* anamorph, and considered *Curreya* should be closely related to *Didymosphaeria*, *Melanomma*, *Paraphaeosphaeria* or *Massarina*. Because of the small sclerotial cells of its peridium, the narrower, thinner-walled asci and its *Coniothyrium*-like anamorph, Barr (1990b) assigned it to the *Leptosphaeriaceae*. Previous phylogenetic studies indicated that a strain of *Curreya pityophila* (J.C. Schmidt & Kunze) Petr. nested within *Massarineae* (Kruys et al. 2006).

***Decorospora*** Inderb., Kohlm. & Volkm.-Kohlm., Mycologia 94: 657 (2002).

Type species: *Decorospora gaudefroyi* (Pat.) Inderb., Kohlm. & Volkm.-Kohlm., Mycologia 94: 657 (2002).

≡ *Pleospora gaudefroyi* Pat., Tabl. analyt. Fung. France (Paris) 10: 40 (no. 602) (1886).

*Decorospora gaudefroyi* (as *Pleospora gaudefroyi*) had been considered a synonym of *Pleospora herbarum*, despite its striking sheath of ascospores (Wehmeyer 1961). Molecular phylogenetic analysis based on partial SSU and ITS rDNA sequences indicated that *Decorospora gaudefroyi* was a sister taxon in the *Pleosporaceae* represented by *Alternaria alternata* (Fr.) Keissl., *Cochliobolus sativus*, *Pleospora herbarum*, *Pyrenophora tritici-repentis* (Died.) Drechsler and *Setosphaeria rostrata* K.J. Leonard (Inderbitzin et al. 2002). *Decorospora* was introduced as a monotypic genus represented by *Decorospora gaudefroyi*, which is characterized by black ascomata becoming superficial on the substrate at maturity, septate and branched pseudoparaphyses, fissitunicate, clavate asci, as well as yellowish brown ascospores with seven transverse septa and one to three longitudinal septa in each

segment, enclosed in a sheath with 4–5 apical extensions (Inderbitzin et al. 2002). *Decorospora gaudefroyi* is an obligate marine fungus, growing at or above the high water mark (Inderbitzin et al. 2002).

***Diadema*** Shoemaker & C.E. Babc., Can. J. Bot. 67: 1349 (1989).

Type species: *Diadema tetramerum* Shoemaker & C.E. Babc. [as ‘tetramera’], Can. J. Bot. 67: 1354 (1989).

During their study of *Leptosphaeria* and *Phaeosphaeria*, Shoemaker and Babcock (1989c) found some alpine fungi with typical pleosporalean characters (such as perithecoïd ascomata, bitunicate asci and presence of pseudoparaphyses) having relatively large, very dark brown ascospores, mostly with a peculiar disc-like opening (as reported in some species of *Wettsteinina*, Shoemaker and Babcock 1987). Thus, they introduced a new genus *Diadema* (typified by *D. tetramerum*) to accommodate them (Shoemaker and Babcock 1989c). Currently, *Diadema* is assigned to *Diademaceae*, and differs from other genera in the family in having ascospores which lack longitudinal septa (Shoemaker and Babcock 1992). The large, dark brown ascospores and the disc-like opening, however, may be an adaptation to environmental factors.

***Diademosa*** Shoemaker & C.E. Babc., Can. J. Bot. 70: 1641 (1992).

Type species: *Diademosa californiana* (M.E. Barr) Shoemaker & C.E. Babc. [as ‘californianum’], Can. J. Bot. 70: 1641 (1992).

≡ *Graphyllum californianum* M.E. Barr, Mem. N. Y. bot. Gdn 62: 40 (1990).

*Diademosa* is the only genus in *Diademaceae* that has terete (cylindrical, circular in cross section) ascospores (Shoemaker and Babcock 1992).

***Didymella*** Sacc., Michelia 2(no. 6): 57 (1880).

Type species: *Didymella exigua* (Niessl) Sacc., Syll. fung. (Abellini) 1: 553 (1882).

≡ *Didymosphaeria exigua* Niessl, Öst. bot. Z.: 165 (1875).

The type specimen of *Didymella* (*D. exigua*) is lost and a neotype specimen was selected by de Gruyter et al. (2009). *Didymella* was characterized by the immersed or erumpent, globose or flattened and ostiolate ascomata with dense, rare (or lack?) of pseudoparaphyses. Asci are cylindrical, clavate or saccate, and 8-spored. Ascospores are hyaline, 1-septate (symmetrical or asymmetrical) and constricted at the septum. *Didymella* has been assigned under *Mycosphaerellaceae*, *Pleosporales* (Sivanesan 1984), *Phaeosphaeriaceae* (Barr 1979a; Silva-Hanlin and Hanlin 1999), *Venturiaceae* (Reddy et al. 1998) or *Pleosporales* genera *incertae sedis* (Lumbsch and Huhndorf 2007). Based on a multigene phylogenetic analysis, the *Didymella* clade forms

a familial rank within *Pleosporineae*, thus the *Didymellaceae* was introduced (Aveskamp et al. 2010; de Gruyter et al. 2009; Zhang et al. 2009a; Plate 1). Anamorphs of *Didymellaceae* include *Ascochyta*, *Ampelomyces*, *Boeremia*, *Chaetastholisia*, *Dactuliochaeta*, *Epicoccum*, *Microsphaeropsis*, *Peyronellaea*, *Phoma*, *Piggotia*, *Pithoascus*, *Pithomyces* and *Stagonosporopsis* (Aveskamp et al. 2010; de Gruyter et al. 2009; Hyde et al. 2011).

***Didymocrea*** Kowalski, Mycologia 57: 405 (1965).

Type species: *Didymocrea sadasivanii* (T.K.R. Reddy) Kowalski, Mycologia 57: 405 (1965).

≡ *Didymosphaeria sadasivanii* T.K.R. Reddy, Mycologia 53: 471 (1962).

*Didymocrea* is a monotypic genus, and was separated from *Didymosphaeria* based on its “unitunicate asci”, presence of pseudoparaphyses and absence of spermatia, and assigned under *Hypocreales* (Kowalski 1965). Following Kowalski (1965), Luttrell (1975) also studied the centrum development of *Didymocrea*, and concluded that it should be a true pleosporalean fungus with functionally unitunicate asci, and retained it in *Didymosphaeria*. After studying the type specimen of *Didymocrea sadasivanii*, Aptroot (1995) concluded that it should be closely related to the loculoascomycetous genus *Zopfia*. Rossman et al. (1999) also kept it as a unique genus in *Pleosporales*. Based on a multigene phylogenetic analysis, *D. sadasivanii* nests within *Montagnulaceae* (Kruys et al. 2006; Schoch et al. 2009).

***Dothivalsaria*** Petr., Sydowia 19: 283 (1966) [1965].

Type species: *Dothivalsaria megalospora* (Auersw.) Petr., Sydowia 19: 283 (1966) [1965].

≡ *Valsaria megalospora* Auersw., Leipzig. Bot. Tauschver. 5. (1866).

*Dothivalsaria* is monotypic and is represented by *D. megalospora* (Petraček 1965). The taxon is characterized by immersed, medium- to large-sized ascomata which usually aggregate under blackened stromatic tissues and have trabeculate pseudoparaphyses. Asci are cylindrical, while ascospores are brown, ellipsoid, and 1-septate and uniseriate in the asci (Barr 1990a). The ascostroma of *D. megalospora* is comparable with those of *Aglaospora profusa* as has been mentioned by Barr (1990a), but their relationships are unclear.

***Epiphegia*** G.H. Otth, Mitt. naturf. Ges. Bern: 104 (1870).

Type species: *Epiphegia alni* G.H. Otth, Mitt. naturf. Ges. Bern: 104 (1870).

*Epiphegia* was reinstated to accommodate a species which has *Phragmoporthe*-like ascocarps and *Massarina*-like asci, pseudoparaphyses and ascospores (Aptroot 1998). Ascomata are grouped within stromatic tissues, pseudoparaphyses are cellular, asci are bitunicate and ascospores are hyaline and trans-septate (Aptroot 1998).

**Eremodothis** Arx, Kavaka 3: 34 (1976) [1975] (IMI 90223 = CBS 610.74 type).

Type species: *Eremodothis angulata* (A.C. Das) Arx, Kavaka 3: 34 (1976) [1975].

≡ *Thielavia angulata* A.C. Das, Trans. Br. Mycol. Soc. 45: 545 (1962).

The type species of *Eremodothis* (*E. angulata*) was originally isolated from rice field soil in Fulta, India and it was assigned to *Sporormiaceae* because of the orange pigmentation of the colony (von Arx 1976). The cleistothecoid ascomata, sphaerical asci and 1-celled ascospores of *E. angulata* are comparable with those of *Pycnidophora*. Based on a multigene phylogenetic study, both *Eremodothis* and *Pycnidophora* were treated as synonyms of *Westerdykella* (Kruys and Wedin 2009).

**Extrawettsteinina** M.E. Barr, Contr. Univ. Mich. Herb. 9 (8): 538 (1972).

Type species: *Extrawettsteinina minuta* M.E. Barr, Contr. Univ. Mich. Herb. 9(8): 538 (1972).

*Extrawettsteinina* was introduced to accommodate three species, i.e. *E. minuta*, *E. pinastri* M.E. Barr and *E. mediterranea* (E. Müll.) M.E. Barr, which are saprobic on the dead leaves of gymnosperms and angiosperms, in North America and Europe (Barr 1972). Subsequently, a fourth species was introduced, viz. *E. andromedae* (Auersw.) M.E. Barr (Barr 1987a). *Extrawettsteinina* is characterized by superficial, conical ascomata, containing a few saccate bitunicate asci, ellipsoidal, obovate-clavate, septate, smooth and hyaline ascospores which turn dull brown at maturity (Barr 1972). The diagnostic character of *Extrawettsteinina* is its conic ascocarps which are superficial on the substrate, and radiating arrangement of wall cells, which makes it distinguishable from comparable genera such as *Stomatogone* and *Wettsteinina*.

**Graphyllum** Clem., Botanical Survey of Nebraska 5: 6 (1901). Type species: *Graphyllum chloës* Clem., Botanical Survey of Nebraska 5: 6 (1901).

*Graphyllum* was first described as a hysteriaceous fungus with elongate ascomata, but von Höhnell (1918b, 1919) recognized its similarity to *Clathrospora*. Petrak (1952) transferred *Graphyllum* to *Pleospora*, and noted that the elongate ascomata and closely grouped rows of small ascomata are not sufficient to recognize the genus. Barr (1987b, 1990b) supported this proposal and considered *Graphyllum* differs from *Clathrospora* by shape, septation and pigmentation of ascospores. A narrow generic concept of *Graphyllum* was adapted by Shoemaker and Babcock (1992), which is characterized by hysterothecia, applanate ascospores that are at least 3-septate in side view and have some longitudinal septa in front view, and it was assigned under *Hysteriaceae* (order *Pleosporales*, Shoemaker and Babcock 1992). But subsequent classification systems

tend to assign it to *Diademaceae* (e.g. Lumbsch and Huhndorf 2007, 2010). This seems unlikely as pointed out by Zhang et al. (2011) and the genus could be placed in one of five families containing hysterotheciod ascomata. Recollection and molecular studies are needed.

**Halomassarina** Suetrong, Sakay., E.B.G. Jones, Kohlm., Volk.-Kohlm. & C.L. Schoch, Stud. Mycol. 64: 161 (2009). Type species: *Halomassarina thalassiae* (Kohlm. & Volk.-Kohlm.) Suetrong, Sakay., E.B.G. Jones, Kohlm., Volk.-Kohlm. & C.L. Schoch, Stud. Mycol. 64: 161 (2009).

≡ *Massarina thalassiae* Kohlm. & Volk.-Kohlm., Can. J. Bot. 65: 575 (1987).

*Halomassarina* is another marine genus which morphologically fits *Massarina sensu lato*, and is typified by *H. thalassiae*, which is characterized by subglobose to pyriform, immersed or erumpent, ostiolate, periphysate, papillate or epapillate, coriaceous ascomata, simple, rarely anastomosing pseudoparaphyses, 8-spored, cylindrical to clavate, pedunculate, thick-walled, fissitunicate asci, and ellipsoidal, (1-)3-septate, hyaline ascospores. Based on a multigene phylogenetic analysis, *Halomassarina thalassiae* clustered together with *Trematosphaeria pertusa* and another marine fungus *Falciformispora lignatilis*, and they are all assigned to *Trematosphaeriaceae* (Suetrong et al. data unpublished).

**Hypsostroma** Huhndorf, Mycologia 84: 750 (1992).

Type species: *Hypsostroma saxicola* Huhndorf, Mycologia 84: 750 (1992).

*Hypsostroma* was introduced as a tropical wood-inhabiting genus by Huhndorf (1992). *Hypsostroma* has several striking characters including the large superficial ascomata which form on a subiculum, pseudoparenchymatous peridial cells, trabeculate pseudoparaphyses, clavate asci with long pedicels and a conspicuous apical apparatus, and ascospores that separate into partspores with a germ slit in each partspore (Huhndorf 1992). Phylogenetic study indicated that *Hypsostroma* should be a new genus and the *Hypsostromataceae* was reinstated to accommodate *Hypsostroma* (Mugambi and Huhndorf 2009b; Plate 1).

**Julella** Fabre, Anns Sci. Nat., Bot., sér. 6 9: 113 (1879) [1878]. Type species: *Julella buxi* Fabre, Anns Sci. Nat., Bot., sér. 6 9: 113 (1879) [1878].

*Julella* has been assigned to *Thelenellaceae*, a family of *Ostropomycetidae* (Lumbsch and Huhndorf 2007), and *Arthopyreniaceae* (= *Xanthopyreniaceae sensu* O. Eriksson, *Pleosporales*) (Barr 1985). *Julella* is characterized by its immersed, medium-sized ascomata with pseudoparenchymatous peridial cells, cellular pseudoparaphyses, and hyaline and muriform ascospores (Barr 1985). With the exception of hyaline ascospores, these characters are typical of *Montagnulaceae*. The taxonomic affinity of the generic



type of *Julella* needs confirmation following recollection. *Julella avicenniae* (Borse) K.D. Hyde is a marine fungus. A DNA based phylogeny containing most currently accepted families placed two isolates of *J. avicenniae* as sister to the families in the *Pleosporineae* with good support, which might suggest a novel family within *Pleosporales* (Suetrong et al. 2009). However, *J. avicenniae* is not the generic type and therefore this conclusion must be treated with caution as only *J. avicenniae* can be considered pleosporalean.

**Lautitia** S. Schatz, Can. J. Bot. 62: 31 (1984).

Type species: *Lautitia danica* (Berl.) S. Schatz, Can. J. Bot. 62: 31 (1984).

≡ *Leptosphaeria danica* Berl., Icon. fung. (Abellini) 1: 87 (1892).

*Lautitia* is monotypified by *L. danica*, which is characterized by subglobose, immersed, ostiolate ascomata with a pseudoclypeus, a thin peridium, broad, cellular pseudoparaphyses, and 8-spored, bitunicate, cylindrical to clavate asci. Ascospores are hyaline, 1-septate, and obovate and the fungus is parasitic on algae (Schatz 1984). Marine or maritime fungi have been reported in *Phaeosphaeria*, such as *P. spartinae* (Ellis & Everh.) Shoemaker & C.E. Babc. and *P. ammophila* (Lasch) Kohlm. & E. Kohlm. (Zhang et al. 2009a). In addition, the prosenchymatous peridium of *L. danica* agrees with that of *Phaeosphaeriaceae* (Schatz 1984).

**Lepidosphaeria** Parg.-Leduc, C. r. hebd. Séanc. Acad. Sci., Paris, Sér. D 270: 2786 (1970).

Type species: *Lepidosphaeria nicotiae* Parg.-Leduc, Pubbl. Staz. Zool. Napoli, 1 270: 2786 (1970).

*Lepidosphaeria* is a genus likely in *Testudinaceae*, which is distinguished from other genera of this family by its smaller ascospores, which lack furrows, and have minute granulate ornamentation (Hawksworth 1979). In DNA sequence-based phylogenies, *L. nicotiae* clustered with species of *Ulospora* and *Verruculina* (Schoch et al. 2009; Zhang et al. 2009a), but more recent work including species of *Platystomaceae* lacks support (Plate 1).

**Letendraea** Sacc., Michelia 2: 73 (1880).

Type species: *Letendraea eurotioides* Sacc., Michelia 2: 73 (1880).

*Letendraea* was introduced for *L. eurotioides*, which is characterized by superficial, globose to conical ascomata, filliform pseudoparaphyses, obclavate to cylindrical, 8-spored asci, and fusoid to oblong, 1-septate ascospores (Saccardo 1880). Because *L. helminthicola* (Berk. & Broome) Weese clustered with *Karstenula rhodostoma*, *Letendraea* was assigned to *Melanommataceae* (Kodsueb et al. 2006b). But subsequent multigene phylogenetic analysis indicated that both *L. helminthicola* and *L. padouk* Nicot & Parg.-Leduc nested within *Montagnulaceae*

(Schoch et al. 2009; Zhang et al. 2009a; Plate 1), and its familial status seems confirmed.

**Lindgomyces** K. Hirayama, Kaz. Tanaka & Shearer, Mycologia 102: 133 (2010).

Type species: *Lindgomyces ingoldianus* (Shearer & K.D. Hyde) K. Hirayama, Kaz. Tanaka & Shearer, Mycologia 102: 733 (2010).

≡ *Massarina ingoldiana* Shearer & K.D. Hyde, Mycologia 89: 114 (1997).

*Lindgomyces* was introduced to accommodate a freshwater lineage, which belongs to *Massarina ingoldiana sensu lato*, and is characterized by scattered, subglobose to globose, erumpent, papillate, ostiolate ascomata, cellular pseudoparaphyses, and 8-spored, fissitunicate, cylindrical to clavate asci. Ascospores are fusoid to narrowly fusoid, hyaline and 1-septate but become 3–5-septate when senescent (Hirayama et al. 2010). A new family, *Lindgomycetaceae*, was introduced to accommodate *Lindgomyces* (Hirayama et al. 2010).

**Lophiella** Sacc., Michelia 1: 337 (1878).

Type species: *Lophiella cristata* (Pers.) Sacc., Michelia 1: 337 (1878).

≡ *Sphaeria cristata* Pers., Syn. meth. fung. (Göttingen) 1: 54 (1801).

The generic type of *Lophiella*, *L. cristata*, was treated as a synonym of *Lophiostoma angustilabrum* var. *crenatum* (Pers.) Chesters & A.E. Bell (see <http://www.indexfungorum.org/names/Names.asp>).

**Loratospora** Kohlm. & Volkm.-Kohlm., Syst. Ascom. 12: 10 (1993).

Type species: *Loratospora aestuarii* Kohlm. & Volkm.-Kohlm., Syst. Ascom. 12: 10 (1993).

*Loratospora* was introduced as a marine genus and is monotypified by *L. aestuarii* (Kohlmeyer and Volkmann-Kohlmeyer 1993). The generic type is characterized by ellipsoid, immersed to erumpent, carbonaceous ascomata, which are ostiolate, and with or without a papilla. Pseudoparaphyses comprise small subglobose cells forming irregular chains and finally breaking apart, and asci are 8-spored, clavate to ellipsoidal, and fissitunicate. Ascospores are hyaline, cylindrical, 3-septate and surrounded by a mucilaginous sheath (Kohlmeyer and Volkmann-Kohlmeyer 1993). The distinctive pseudoparaphyses of *Loratospora aestuarii* makes it readily distinguishable from other taxa. Based on a multigene phylogenetic analysis, *Loratospora aestuarii* nested within the clade of *Phaeosphaeriaceae* (Schoch et al. 2009; Suetrong et al. 2009; Plate 1), and ascospores of *L. aestuarii* are in agreement with those of *Phaeosphaeria* as has been mentioned by Kohlmeyer and Volkmann-Kohlmeyer (1993).

**Macrospora** Fuckel, Jb. nassau. Ver. Naturk. 23–24: 139 (1870) [1869–70].

Type species: *Macrospora scirpicola* (DC.) Fuckel, Jb. Nassau. Ver. Naturk. 23–24: 139 (1870) [1869–70].

≡ *Sphaeria scirpicola* DC., in Lamarck & de Candolle, Fl. franç., Edn 3 (Paris) 2: 300 (1805).

*Macrospora* had been assigned to *Diademaceae* based on its appanate and muriform ascospores with 1-row of longitudinal septa, with a sheath, 2–3  $\mu\text{m}$  wide and constricted at first septum and ascospores are paler and larger than those of *Comoclathris* (Shoemaker and Babcock 1992). *Macrospora* was however, considered as a synonym of *Pyrenophora* by Eriksson and Hawksworth (1991) which was assigned in *Pleosporaceae*, and this proposal was widely followed (Eriksson 2006; Lumbsch and Huhndorf 2010). *Nimbya* anamorphs were reported for *Macrospora* (Johnson et al. 2002).

**Massaria** De Not., G. bot. ital. 1: 333 (1844).

Type species: *Massaria inquinans* (Tode) De Not., G. bot. ital. 1: 333 (1844).

≡ *Sphaeria inquinans* Tode, Fung. mecklenb. sel. (Lüneburg) 1: Fig. 85 (1790).

Colonies on MEA erumpent, not spreading; surface irregular, folded; margins even, feathery; surface olivaceous grey, with thin, umber margin; reverse olivaceous-grey. On PDA similar; surface olivaceous grey, margin dirty white; reverse smoke-grey to olivaceous grey; colonies reaching 1 cm diam. On OA similar, surface olivaceous grey in centre, margins wide, dirty white; colonies reaching 12 mm diam. on all media tested; colonies sterile (based on CBS 125591).

*Massaria* was formally established by de Notaris (1844), and is typified by *M. inquinans*. Numerous fungi with brown septate ascospores surrounded by gelatinous sheath were included in the genus (Barr 1979b; Shoemaker and LeClair 1975). Shoemaker and LeClair (1975) accepted a narrow concept for *Massaria*, with only a few species characterized by large, symmetric, 4-celled ascospores surrounded by a massive gelatinous sheath. Barr (1979b, 1990a) had considered *Aglaospora* a separate genus, but this subsequently proved congeneric with *Massaria* (Voglmayr and Jaklitsch 2011). Based on intensive sample collection and multi-gene phylogenetic analysis, Voglmayr and Jaklitsch (2011) accepted *Massaria* as the sole genus within *Massariaceae*, which is characterized by a set of well defined morphological and ecological characters; Europe is regarded as the centre of diversity.

**Misturatosphaeria** Mugambi & Huhndorf, Stud. Mycol. 64: 108 (2009).

Type species: *Misturatosphaeria aurantonotata* Mugambi & Huhndorf, Stud. Mycol. 64: 108 (2009).

*Misturatosphaeria* was introduced to accommodate a group of fungi which are phylogenetically closely related to

*Amniculicolaceae*, *Lophiostomataceae sensu stricto* and *Sporormiaceae* (Mugambi and Huhndorf 2009b; Zhang et al. 2009a). Species of *Misturatosphaeria* are characterized by erumpent to superficial ascomata which are scattered or in groups, with or without papilla; asci cylindrical or clavate, 8-spored; pseudoparaphyses numerous, septate, ascospores brown or hyaline, phragmosporous or dictyosporous, with or without sheath. The terrestrial saprobic habitat on wood, as well as its distinct morphological characters may indicate that this genus belongs to an undescribed family. A close relationship with the marine anamorphic species *Floricola striata* is unexpected and may suggest that some of the species in this genus could have marine affinities (Plate 1).

**Navicella** Fabre, Anns Sci. Nat., Bot., sér. 6 9: 96 (1879) [1878].

Type species: *Navicella julii* Fabre, Anns Sci. Nat., Bot., sér. 6 9: 96 (1879) [1878].

*Navicella* is characterized by medium- to large-sized, immersed to erumpent, globose ascomata, apex elongated or rarely rounded, asci clavate or cylindrical, pseudoparaphyses trabeculate, ascospores reddish to dark brown, ellipsoid to fusoid, multi-septate, the primary septum is euseptate, and others distoseptate, obliquely uniseriate or biseriata (Barr 1990a). *Navicella* is saprobic on bark, and was considered closely related to the *Lophiostomataceae* (Holm and Holm 1988). Based on the wide endotunica, thin apical ring and distoseptate ascospores, Barr (1990a) transferred it to the *Massariaceae*. The morphological characters of *Navicella* do not match the *Massariaceae sensu stricto* (Voglmayr and Jaklitsch 2011).

**Neotestudina** Segretain & Destombes, C. r. hebd. Séanc. Acad. Sci., Paris 253: 2579 (1961).

Type species: *Neotestudina rosatii* Segretain & Destombes, C. r. hebd. Séanc. Acad. Sci., Paris 253: 2579 (1961).

*Neotestudina* is characterized by medium- to large-sized, superficial, gregarious, cleistothecoid and globose ascomata which split on opening. Asci are 4- or 8-spored, and cylindrical or oblong, pseudoparaphyses are sparse and trabeculate, and ascospores are dark brown, ellipsoid, 1-septate, with a small germ pore at each end, and uniseriate or crowded in the asci (Barr 1990a). Based on the cleistothecoid ascomata, *Neotestudina* was assigned under *Zopfiaceae* (von Arx and Müller 1975) or *Testudinaceae* (Hawksworth 1979). Barr (1990a) assigned it to *Didymosphaeriaceae* based on its ascospore morphology. A DNA based phylogeny showed that sequence obtained from *Neotestudina rosatii* resides as sister to *Ulospora bilgramii* (D. Hawksw., C. Booth & Morgan-Jones) D. Hawksw., Malloch & Sivan. and other species that may represent *Testudinaceae* or *Platystomaceae* (Kruys et al. 2006; Plate 1).

**Paraphaeosphaeria** O.E. Erikss., Ark. Bot., Ser. 2 6: 405 (1967).

Type species: *Paraphaeosphaeria michotii* (Westend.) O.E. Erikss., Cryptogams of the Himalayas 6: 405 (1967).

≡ *Sphaeria michotii* Westend., Bull. Acad. R. Sci. Belg., Cl. Sci., sér. 2 7: 87 (1859).

*Paraphaeosphaeria* was separated from *Leptosphaeria* (Eriksson 1967a), and it is also quite comparable with *Phaeosphaeria*. *Paraphaeosphaeria* can be distinguished from *Phaeosphaeria* by its ascospores. Ascospores of *Paraphaeosphaeria michotii* have two septa, and they are biseriata, straight, subcylindrical with broadly rounded ends, rather dark brown and punctate. The primary septum is laid down closer to the distal end than to the proximal, and the larger, proximal hemispore is divided by one transversal septum. There are more septa in the proximal hemispore of other species such as *Par. castagnei* (Durieu & Mont.) O.E. Erikss., *Par. obtusispora* (Speg.) O.E. Erikss. and *Par. vectis* (Berk. & Broome) Hedjar. Anamorphic characters can also distinguish *Paraphaeosphaeria* and *Phaeosphaeria*. *Paraphaeosphaeria* has *Paraconiothyrium* or *Coniothyrium*-related anamorphs, but *Phaeosphaeria* has *Hendersonia-Phaeoseptoria* anamorphs (Eriksson 1967a). Shoemaker and Babcock (1985) re-described some Canadian and extralimital species, and excluded *Par. longispora* (Wegelin) Crivelli and *Par. oblongata* (Niessl) Crivelli from *Paraphaeosphaeria* based on their longitudinal septa as well as beak-like papilla and wall structures. Molecular phylogenetic results based on multi-genes indicated that *Paraphaeosphaeria* should belong to *Montagnulaceae* (Zhang et al. 2009a; Plate 1).

**Passeriniella** Berl., Icon. fung. (Abellini) 1: 51 (1890).

Type species: *Passeriniella dichroa* (Pass.) Berl., Icon. fung. (Abellini) 1: 51 (1890).

≡ *Leptosphaeria dichroa* Pass.

*Passeriniella* was introduced by Berlese in 1890 based on the black, ostiolate and papillate ascomata, 8-spored asci, as well as transverse septate ascospores, with pigmented central cells and hyaline terminal cells. Two species were included, i. e. *P. dichroa* and *P. incarcerata* (Berk. & M.A. Curtis) Berl. (Berlese 1890). Subsequently, more species were introduced including some marine taxa such as *P. mangrovei* G.L. Maria & K.R. Sridhar, *P. obiones* (P. Crouan & H. Crouan) K.D. Hyde & Mouzouras and *P. savoryellopsis* K.D. Hyde & Mouzouras (Hyde and Mouzouras 1988; Maria and Sridhar 2002). Currently, eight species are included (<http://www.mycobank.org>, Jan. 2011). Both *P. dichroa* and *P. incarcerata* were considered as synonyms of *Leptosphaeria obiones* (P. Crouan & H. Crouan) Sacc. (Kohlmeyer and Kohlmeyer 1979). The familial placement of the marine species *P. savoryellopsis* could not be resolved in a DNA based phylogeny but it did suggest a close relationship to *Acrocordiopsis patilii* (Suetrong et al. 2009) in *Pleosporales*.

**Peridiothelia** D. Hawksw., Bull. Br. Mus. nat. Hist., Bot. 14: 120 (1985).

Type species: *Peridiothelia fuliguncta* (Norman) D. Hawksw., Bull. Br. Mus. nat. Hist., Bot. 14: 121 (1985).

≡ *Microthelia fuliguncta* Norman, Öfvers. kongl. Svensk. Vetensk.-Akad. Förhandl., Stockholm 41(no. 8): 36 (1884).

When dealing with the names under *Microthelia*, *Peridiothelia* was introduced to accommodate species having non-clypeate peridium which composed cells of *textura globulosa* but sometimes *angularis*, “dark reddish brown except below the generative locule where the wall is poorly developed or almost absent at maturity, colour not changed significantly in potassium hydroxide, centrum turning blue in iodine” (Hawksworth 1985a). Three species were included, i. e. *P. grandiuscula* (Anzi) D. Hawksw., *P. fuliguncta* and *P. oleae* (Körb.) D. Hawksw., and *Peridiothelia* was referred to *Phaeosphaeriaceae* (Hawksworth 1985a, b). However, its familial placement is not confirmed yet.

**Phaeodothis** Syd. & P. Syd., Annl. mycol. 2: 166 (1904).

Type species: *Phaeodothis tricuspidis* Syd. & P. Syd., Annl. mycol. 2: 166 (1904).

*Phaeodothis* is characterized by its 1-septate euseptate ascospores with a sparse hamathecium consisting of thin pseudoparaphyses and immersed to superficial ascomata (Aptroot 1995). The genus had been previously assigned to *Didymosphaeria*, but Aptroot (1995) considered it to be closely related to *Phaeosphaeriaceae*. A strain named *Phaeodothis winteri* (a synonym of *P. tricuspidis* Syd. & P. Syd.) nested within the clade of *Montagnulaceae* (Schoch et al. 2009).

**Platychora** Petr., Annl. mycol. 23: 102 (1925).

Type species: *Platychora ulmi* (Schleich.) Petr., Annl. mycol. 23(1/2): 103 (1925).

*Platychora* is characterized by immersed to erumpent crust-like ascostroma with globose locules scattered inside (Barr 1968). Asci are oblong to saccate or nearly cylindrical and bitunicate, and ascospores are hyaline 1-septate apiosporous and turn olivaceous when old. *Platychora* had been previously assigned to *Venturiaceae* by Barr (1968), but molecular phylogenetic analysis indicated that a strain named *Platychora ulmi* (the generic type of *Platychora*) belongs to *Didymella-ceae* (Winton et al. 2007; Plate 1). The generic type needs recollecting and epitypifying to stabilize the generic name.

**Platystomum** Trevis., Bull. Soc. R. Bot. Belg. 16: 16 (1877).

Type species: *Platystomum compressum* (Pers.) Trevis., Bull. Soc. R. Bot. Belg. 16: 16 (1877).

≡ *Sphaeria compressa* Pers., Syn. meth. fung. (Göttingen) 1: 56 (1801).

*Platystomum* was introduced by Trevisan in 1877, and has been considered a synonym of *Lophidium*, as the

ascospores of *Platystomum* have both transverse and vertical septa (Barr 1990a, b; Chesters and Bell 1970). However, the boundary between *Lophiostoma* and *Platystomum* is not clear (Chesters and Bell 1970). Holm and Holm (1988) treated *Platystomum* as a synonym of *Lophiostoma*, and concurrently, the *Platystomaceae* should be treated as a synonym of *Lophiostomataceae*. Based on a phylogenetic analysis, however, the generic type of *Platystomum* (*P. compressum*) separated from other species of *Lophiostoma*, and nested with the clade of *Platystomaceae* (Mugambi and Huhndorf 2009b) which may be closely related to species in the *Testiduniaceae* (Plate 1).

***Polyposphaeria*** Kaz. Tanaka & K. Hirayama, Stud. Mycol. 64: 192 (2009).

Type species: *Polyposphaeria fusca* Kaz. Tanaka & K. Hirayama, Stud. Mycol. 64: 193 (2009).

*Polyposphaeria* is characterized by globose ascomata surrounded by numerous brown hyphae and a reddish pigment on the host surface around the ascomata (Tanaka et al. 2009). Asci are cylindro-clavate with fissitunicate dehiscence and ascospores are narrowly fusoid surrounded by a sheath. The anamorph is *Piricauda*-like (Tanaka et al. 2009). The cylindro-clavate asci, narrowly fusoid ascospores as well as its thin and numerous pseudoparaphyses are comparable with those of *Massarina sensu lato*, especially *Lentithecium* (Zhang et al. 2009a). The terrestrial and bambusicolous habitat of *Polyposphaeria* and *Piricauda* anamorph readily distinguishes the genus from *Lentithecium*.

***Pontoporeia*** Kohlm., Nova Hedwigia 6: 5 (1963).

Type species: *Pontoporeia biturbinata* (Durieu & Mont.) Kohlm., Nova Hedwigia 6: 5 (1963)

≡ *Sphaeria biturbinata* Durieu & Mont., Flora Algérieae 1: 497 (1849).

*Pontoporeia* was introduced by Kohlmeyer in 1963, and is monotypified by *P. biturbinata*. *Pontoporeia* was treated as a synonym of *Zopfia* (Malloch and Cain 1972), which is followed by Hawksworth and Booth (1974). Based on its asci originating at the periphery of the subglobose locus, filaments occupying the center of the ascocarps, the irregular peridial structure, the ascospores having 2-layered walls with a germ pore at each end and its marine habitat, *Pontoporeia* was kept as a separate genus within *Pleosporaceae* (Kohlmeyer and Kohlmeyer 1979). A DNA based phylogeny placed an isolate on a long branch in relationship with other marine species, *Halothia posidoniae* and *Mauritiana rhizophorae*, but a familial placement awaits further resolution (Suetrong et al. 2009).

***Pseudotruchia*** Kirschst., Annl. mycol. 37: 125 (1939).

Type species: *Pseudotruchia stromatophila* Kirschst., Annl. mycol. 37: 125 (1939).

*Pseudotruchia* can be distinguished from *Byssosphaeria*, *Herpotrichia* and *Lojkania* by its lacking of subiculum, larger ascomata usually with compressed apices, the peripheral arrangement of asci and trabeculate pseudoparaphyses (Barr 1984). Phylogenetic study of strains *Pseudotruchia mutabilis* and some *Herpotrichia* species indicated that these species are closely related, and both nested within *Melanommataceae* (Mugambi and Huhndorf 2009b). But in this study, *Pseudotruchia guatopoensis* nested in the *Testudinaceae* (or *Platystomaceae*) (Plate 1). The types of both *Herpotrichia* and *Pseudotruchia* need recollecting, redescribing and epitypifying in order to stabilize the use of these generic names and clarify their familial status.

***Pseudoyuconia*** Lar.N. Vassiljeva, Nov. sist. Niz. Rast. 20: 71 (1983).

Type species: *Pseudoyuconia thalictri* (G. Winter) Lar. N. Vassiljeva [as ‘thalicti’], Nov. sist. Niz. Rast. 20: 71 (1983).

≡ *Leptosphaeria thalictri* G. Winter, Hedwigia 10: 40 (1872).

*Pseudoyuconia* was introduced by Vassiljeva (1983), and was monotypified by *P. thalictri*. Currently, *Pseudoyuconia* is included in *Pleosporaceae* (Lumbsch and Huhndorf 2010).

***Pyrenophora*** Fr., Summa veg. Scand., Section Post. (Stockholm): 397 (1849).

Type species: *Pyrenophora phaeocomes* (Rebent.) Fr., Summa veg. Scand., Section Post. (Stockholm): 397 (1849).

≡ *Sphaeria phaeocomes* Rebent., Prodr. fl. neomarch. (Berolini): 338 (1804).

*Pyrenophora* is characterized by immersed, erumpent to nearly superficial ascomata, indefinite pseudoparaphyses, clavate to saccate asci usually with a large apical ring, and muriform terete ascospores. Morphologically, the terete ascospores of *Pyrenophora* can be readily distinguished from *Clathrospora* and *Platyspora*. The indefinite pseudoparaphyses and smaller ascospores of *Pyrenophora* can be readily distinguished from those of *Pleospora* (Sivanesan 1984). Based on both morphology and molecular phylogeny, *Pyrenophora* is closely related to *Pleosporaceae* (Zhang et al. 2009a).

***Rechingeriella*** Petr., in Rechinger et al. Annl. naturh. Mus. Wien 50: 465 (1940).

Type species: *Rechingeriella insignis* Petr., Annl. naturh. Mus. Wien, Ser. B, Bot. Zool. 50: 465 (1940).

*Rechingeriella* is characterized by its erumpent to superficial, cleistothecioid ascomata and thin, branching pseudoparaphyses (Hawksworth and Booth 1974). Asci are

obovate, thick-walled, bitunicate and evanescent, and ascospores are globose, simple, dark brown to black (based on the type specimen of *R. insignis*) (Hawksworth and Booth 1974). Based on these characters, *R. insignis* was treated as a species of *Zopfia* (as *Z. insignis* (Petr.) D. Hawksw. & C. Booth). *Rechingeriella* has been assigned to *Botryosphaeriaceae* by von Arx and Müller (1975). Further study should be conducted on the type specimen of *R. insignis* in order to clarify its taxonomic status and fresh collections are needed for epitypification.

***Rhytidiella*** Zalasky, Can. J. Bot. 46: 1383 (1968).

Type species: *Rhytidiella moriformis* Zalasky, Can. J. Bot. 46: 1383 (1968).

*Rhytidiella* was introduced based on *R. moriformis*, which causes perennial rough-bark of *Populus balsamifera* (Zalasky 1968), and produces macroconidia belonging to *Phaeoseptoria*. Subsequently, three more species were introduced, viz. *R. baranyayi* A. Funk & Zalasky, *R. hebes* P.R. Johnst. and *R. beloniza* (Stirt.) M.B. Aguirre (Aguirre-Hudson 1991; Funk and Zalasky 1975; Johnston 2007), Both *R. baranyayi* and *R. hebes* seem closely related to *R. moriformis* on both biology and morphology (Funk and Zalasky 1975; Johnston 2007), but *R. beloniza* is saprobic on *Cordyline australis* bark (Aguirre-Hudson 1991). *Rhytidiella* was temporarily assigned to *Cucurbitariaceae* (Barr 1987b).

***Richonia*** Boud., Revue mycol., Toulouse 7: 224 (1885).

Type species: *Richonia variospora* Boud., Revue mycol., Toulouse 7: 265 (1885).

*Richonia* is characterized by its 1-septate, relatively large ascospores which are broadly rounded at both ends, and have a thick ornamented undulating sheath giving an irregularly ridged appearance to mature spores (Hawksworth 1979). *Richonia variospora* has been isolated from several localities in France, but it is rare (Hawksworth 1979). *Richonia* was assigned under *Zopfiaceae* (von Arx and Müller 1975; Hawksworth 1979), and there are presently no better suggestions for its familial placement. The taxon needs recollecting and epitypifying.

***Rimora*** Kohlm., Volkm.-Kohlm., Suetrong, Sakay. & E.B. G. Jones, Stud. Mycol. 64: 166 (2009).

Type species: *Rimora mangrovei* (Kohlm. & Vittal) Kohlm., Volkm.-Kohlm., Suetrong, Sakay. & E.B.G. Jones, Stud. Mycol. 64: 166 (2009).

≡ *Lophiostoma mangrovei* Kohlm. & Vittal [as ‘*mangrovis*’], Mycologia 78: 487 (1986).

*Rimora* was introduced based on a marine fungus *R. mangrovei* (syn. *Lophiostoma mangrovei*), and is characterized by its erumpent ascomata with elongated flat tops, cellular pseudoparaphyses and cylindrical asci (Suetrong et al. 2009). Ascospores are fusoid, hyaline, 3-septate and

surrounded with an evanescent sheath (Kohlmeyer and Vittal 1986; Suetrong et al. 2009). *Rimora* forms a robust clade with other marine fungi, such as species of *Aigialus* and *Ascocratera*, and a new family, *Aigialaceae* was introduced to accommodate them (Suetrong et al. 2009).

***Rousoellopsis*** I. Hino & Katum., J. Jap. Bot. 40: 86 (1965).

Type species: *Rousoellopsis japonica* (I. Hino & Katum.) I. Hino & Katum., J. Jap. Bot. 40: 86 (1965).

≡ *Didymosphaeria japonica* I. Hino & Katum., Bulletin of the Faculty of Agriculture, Yamaguchi University 5: 229 (1954).

*Rousoellopsis* was introduced by Hino and Katumoto (1965) based on three bambusicolous fungal species, i.e. *R. japonica*, *R. macrospora* (I. Hino & Katum.) I. Hino & Katum. and *R. tosaensis* (I. Hino & Katum.) I. Hino & Katum. These three species have immersed and gregarious ascomata, clavate to cylindro-clavate asci, numerous and filliform pseudoparaphyses, and 1-septate, asymmetrical ascospores (Hino and Katumoto 1965). All these characters point *Rousoellopsis* to *Pleosporales*, but its familial placement cannot be determined.

***Sacchettoecium*** Fr., Fl. Scan.: 349 (1836).

Type species: *Sacchettoecium sepincola* (Fr.) Fr. [as ‘*saepincola*’], Summa veg. Scand., Section Post. (Stockholm): 398 (1849).

≡ *Sphaeria sepincola* Fr. [as ‘*saepincola*’], Observ. mycol. (Havniae) 1: 181 (1815).

*Sacchettoecium* is characterized by its subglobose, immersed to erumpent ascomata, absence of pseudoparaphyses and hyaline, muriform to phragmosporous ascospores. It has been assigned to the *Dothioraceae* (Barr 1987b; Müller and von Arx 1950). Molecular phylogenetic analysis indicated that a strain named *S. sepincola* nested within *Didymellaceae* (Schoch et al. 2009; Plate 1). The generic type needs recollecting, redescribing and epitypifying.

***Setosphaeria*** K.J. Leonard & Suggs, Mycologia 66: 294 (1974).

Type species: *Setosphaeria turcica* (Luttr.) K.J. Leonard & Suggs, Mycologia 66: 295 (1974).

≡ *Trichometasphaeria turcica* Luttr., Phytopathology 48: 282 (1958).

*Setosphaeria* was segregated from *Keissleriella* on the basis of lacking a clypeus, lysigenous development of the ostiole, occurrence of setae on the perithecial wall, the absence of paraphyses in the ostiole, and the hyphomycetous conidial states, and four species were included, i.e. *S. prolata*, *S. holmii*, *S. pedicellata* (R.R. Nelson) K.J. Leonard & Suggs and *S. turcica* (Leonard and Suggs 1974). Currently, nine species are included in *Setosphaeria* (<http://www.mycobank.org>, Jan/2011). *Setosphaeria*

*monoceras* Alcorn nested within *Pleosporaceae* based on multigene phylogenetic analysis (Schoch et al. 2009; Plate 1).

***Syncarpella*** Theiss. & Syd., Anns mycol. 13: 631 (1915).  
Type species: *Syncarpella tumefaciens* (Ellis & Harkn.) Theiss. & Syd., Anns mycol. 13(5/6): 633 (1915).

≡ *Sphaeria tumefaciens* Ellis & Harkn., J. Mycol. 2: 41 (1886).

*Syncarpella* was introduced by Theissen and Sydow (1915) as a genus of *Montagnellaceae* within *Dothideales*. A detailed description of *S. tumefaciens* can be seen in Barr and Boise (1989). *Syncarpella* was considered closely related to *Leptosphaeria*, and was treated as a synonym (Clements and Shear 1931). *Syncarpella* is characterized by its abundant globose, ovoid to turbinate ascomata with minute papillae which are seated on a common basal stroma and which are erumpent through fissures in the host tissues (Barr and Boise 1989). The peridium is thicker at the base, pseudoparaphyses are cellular, and asci are bitunicate, clavate to oblong with a furcate pedicel. Ascospores are pale brown to brown, oblong to narrowly obovoid, ends obtuse, transversely septate, smooth-walled. All these characters fit *Cucurbitariaceae*, where Barr and Boise (1989) transferred *Syncarpella*.

***Teichospora*** Fuckel, Jb. nassau. Ver. Naturk. 23–24: 160 (1870) [1869–70].

Type species: *Teichospora trubicola* Fuckel, Jb. nassau. Ver. Naturk. 23–24: 161 (1870) [1869–70].

*Teichospora* was introduced by Fuckel (1870), and was typified by *T. trubicola*, with four more species included, i.e. *T. brevisrostris* Fuckel, *T. dura* Fuckel, *T. morthieri* Fuckel and *T. obducens* (Schumach.) Fuckel. Only *T. brevisrostris* and *T. trubicola* were kept in *Teichospora* (Barr 1987b). After studying the type specimens, Barr (1987b) indicated that *Teichospora* was different from *Strickeria* with *Teichospora* belonging to *Pleosporales*, and *Strickeria* closely related to *Melanomma* (*Melanommatales*). Currently, more than 250 names are included within *Teichospora* (<http://www.mycobank.org>, Jan/2011), but almost no molecular phylogenetic study has been conducted on this genus.

***Testudina*** Bizz., Atti Inst. Veneto Sci. lett., ed Arti, Sér. 6 3: 303 (1885).

Type species: *Testudina terrestris* Bizz., Fungi venet. nov. vel. Crit. 3: 303 (1885).

*Testudina terrestris* is characterized by its reticulately ridged ascospores, which readily distinguish it from other genera of *Zopfiaceae* (Hawksworth 1979). The species is usually associated with other fungi, or on the wood of *Abies?* and *Pinus* or on the fallen leaves of *Taxus* in Europe

(Hawksworth and Booth 1974; Hawksworth 1979).

***Tetraplosphaeria*** Kaz. Tanaka & K. Hirayama, Stud. Mycol. 64: 177 (2009).

Type species: *Tetraplosphaeria sasicola* Kaz. Tanaka & K. Hirayama, Stud. Mycol. 64: 180 (2009).

*Tetraplosphaeria* was introduced by Tanaka et al. (2009) to accommodate bambusicolous fungi with immersed to erumpent, globose to subglobose and smaller (mostly < 300  $\mu\text{m}$ ) ascomata. The peridium is thin, and is composed of thin-walled cells of *textura angularis*. The pseudoparaphyses are cellular, and asci are fissitunicate, 8-spored, cylindrical to clavate with short pedicels. Ascospores are narrowly fusoid, hyaline and surrounded with a sheath. Species of *Tetraplosphaeria* have *Tetraploa sensu stricto* anamorphic stage, which is quite unique in *Tetraplosphaeriaceae* (Tanaka et al. 2009).

***Tingoldiagio*** K. Hirayama & Kaz. Tanaka, Mycologia 102: 740 (2010).

Type species: *Tingoldiagio graminicola* K. Hirayama & Kaz. Tanaka, Mycologia 102(3): 740 (2010).

*Tingoldiagio* is a genus of freshwater ascomycetes characterized by flattened, globose, immersed to erumpent ascomata, and numerous cellular pseudoparaphyses (Hirayama et al. 2010). Asci are fissitunicate and cylindrical, and ascospores are 1-septate, which usually turn 3-septate and pale brown when old, usually with a sheath (Hirayama et al. 2010). Based on both morphology and multigene phylogenetic analysis, *Tingoldiagio* should be treated as a synonym of *Lentithecium* (Shearer et al. 2009a; Zhang et al. 2009a).

***Tremateia*** Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. 38: 165 (1995).

Type species: *Tremateia halophila* Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. 38: 166 (1995).

*Tremateia* was introduced as a facultative marine genus which is characterized by depressed globose, immersed ascomata, numerous and cellular pseudoparaphyses, fissitunicate and clavate asci, ellipsoid muriform ascospores, and a *Phoma*-like anamorph (Kohlmeyer et al. 1995). These characters point *Tremateia* to *Pleosporaceae* (Kohlmeyer et al. 1995). DNA sequence based phylogenies placed *T. halophila* as sister to *Bimuria novae-zelandiae* in *Montagnulaceae* (Schoch et al. 2009; Suetrong et al. 2009).

***Triplosphaeria*** Kaz. Tanaka & K. Hirayama, Stud. Mycol. 64: 186 (2009).

Type species: *Triplosphaeria maxima* Kaz. Tanaka & K. Hirayama, Stud. Mycol. 64: 188 (2009).

*Triplosphaeria* was introduced as a bambusicolous genus characterized by immersed ascomata, numerous cellular

pseudoparaphyses, bitunicate, cylindrical to clavate asci with a short pedicel, fusoid, hyaline, 1-septate ascospores surrounded with a sheath, and with a *Tetraploa*-like anamorph (Tanaka et al. 2009). Together with *Tetraplospheeria*, *Pseudotetraploa*, *Quadricrura* and *Polyplospheeria*, *Triplospheeria* was assigned to the *Tetraplospheeriaceae* (Tanaka et al. 2009).

***Ulospora*** D. Hawksw., Malloch & Sivan., in Hawksworth, Can. J. Bot. 57: 96 (1979).

Type species: *Ulospora bilgramii* (D. Hawksw., C. Booth & Morgan-Jones) D. Hawksw., Malloch & Sivan., Can. J. Bot. 57: 96 (1979).

*Ulospora* was introduced as a monotypic genus to accommodate taxa of *Testudinaceae* whose ascospore has 3–6 fissures (Hawksworth 1979). Genera of *Testudinaceae* are distinguished based on the morphology of ascospores, although the validity of this classification needs to be confirmed by molecular study. DNA sequence based phylogenies placed sequences from an unverified culture of *U. bilgramii* in a clade together with *Verruculina enalia*, and *Lepidosphaeria nicotiae* and it may have a close relationship to species in *Platystomaceae* (Mugambi and Huhndorf 2009b; Schoch et al. 2009; Plate 1).

***Zopfia*** Rabenh., Fungi europ. exsicc.: no. 1734 (1874).

Type species: *Zopfia rhizophila* Rabenh., Fungi europ. exsicc.: no. 1734 (1874).

*Zopfia* was introduced by Rabenhorst (1874) as a monotypic genus (typified by *Z. rhizophila*), and it was assigned to the *Perisporiaceae* by Saccardo (1882) and Winter (1884). Arnaud (1913) described the *Zopfiaceae* to accommodate *Zopfia*, and considered that it should be excluded from the *Perisporiaceae*. A relatively broad generic concept was accepted by Hawksworth and Booth (1974), in which they take the ascospore size and ornamentation variation as criteria under generic rank classification, and they treat *Celtidia*, *Lepidosphaeria*, *Marchaliella*, *Neotestudina*, *Pontoporeia*, *Pseudophaeotrichum*, *Rechingeriella*, *Richonia* and *Testudina* as synonyms of *Zopfia*. A narrow generic concept was adopted by Hawksworth (1979), and *Zopfia* is characterized by 1-septate ascospores, which are apiculate at both ends, smooth-walled by light microscope, with minute irregular pitting by SEM, and larger than other species of *Zopfia sensu* Hawksworth and Booth (1974). Three species were accepted, viz. *Z. albiziae* Farr, *Z. biturbinata* (Dur. & Mont.) Malloch & Cain and *Z. rhizophila*, and they all occur on roots of plants (Hawksworth 1979). DNA sequences from an unverified culture of *Zopfia rhizophila* placed it in close proximity to species in *Delitschiaceae* without strong statistical support (Kruys et al. 2006; Schoch et al. 2009; Plate 1).

***Zopfiofoveola*** D. Hawksw., Can. J. Bot. 57: 98 (1979).

Type species: *Zopfiofoveola punctata* (D. Hawksw. & C. Booth) D. Hawksw., Can. J. Bot. 57: 98 (1979).

≡ *Zopfia punctata* D. Hawksw. & C. Booth, Mycol. Pap. 153: 23 (1974).

*Zopfiofoveola* was hesitantly separated from *Zopfia* as a monotypic new genus based on its evenly distributed ornamentation with pale minute pits readily visible under the light microscope, and the more elongate shape and less pronounced apical papilla than those of *Zopfia* (Hawksworth 1979). The type specimen of this species however, cannot be redescribed, because “the type species is only known from a microscopic preparation obtained from earthworm excrements in Sweden” as has been mentioned by Hawksworth (1979).

## General discussion

Molecular phylogenetic studies based on four to five genes indicate that 20 families should be included in *Pleosporales* (Schoch et al. 2009; Shearer et al. 2009; Suetrong et al. 2009; Tanaka et al. 2009; Zhang et al. 2009a). Together with five unverified families (marked with “?”), 26 families are currently assigned under *Pleosporales* (Table 4). The *Phaeotrichaceae* lacks pseudoparaphyses, has cleistothecial ascomata with long setae, and conspicuous ascospores with germ pores at each end. These characters do not agree with the current concept of *Pleosporales* (Zhang et al. 2009a), and therefore *Phaeotrichaceae* is excluded from *Pleosporales* (Table 4).

## Families in *Pleosporales*

Based on LSU and SSU rDNA, *RPB1*, *RPB2* and *TEF1* sequence analysis, *Pleosporineae* is emended, and in this study, seven families are tentatively included, i.e. *Cucurbitariaceae*, *Didymellaceae*, *Didymosphaeriaceae*, *Dothidotiaceae*, *Leptosphaeriaceae*, *Phaeosphaeriaceae* and *Pleosporaceae* (Zhang et al. 2009a; Plate 1). In this study, *Massarineae* was emended to accommodate another five families, viz. *Lentitheciaceae*, *Massarinaceae*, *Montagnulaceae*, *Morosphaeriaceae*, *Trematosphaeriaceae*. The subordinal affinity of other families remained undetermined. Most of the families accepted within *Pleosporales* received high bootstrap support (Plate 1). The characters used to define a family, however, do not appear to have clear cut boundaries, as the ascomatal and hamathecial characters also seem to be poorly defined in some families. For example, both trabeculate and cellular pseudoparaphyses coexist in the *Amniculicolaceae*. *Pycnidiophora*, a genus of *Sporormiaceae*, has cleistothecial ascomata with spherical asci irregularly arranged in it. Brown phragmosporous ascospores are reported in *Amniculicolaceae*, *Leptosphaeriaceae*, *Lophios-*

*tomataceae*, *Melanommataceae*, *Montagnulaceae*, *Phaeosphaeriaceae* and *Pleosporaceae*. Similarly muriform ascospores occur in *Aigialaceae*, *Amniculicolaceae*, *Didymellaceae*, *Lophiostomataceae*, *Montagnulaceae*, *Pleosporaceae* and *Sporormiaceae*. Anamorphs of *Pleosporales* are also variable to a large degree at the family level. Both hyphomycetous and coelomycetous anamorphs co-exist in *Didymellaceae*, *Melanommataceae* or *Pleosporaceae*. *Phoma* and *Phoma*-like anamorphs exist in *Didymellaceae*, *Leptosphaeriaceae*, *Phaeosphaeriaceae*, *Pleosporaceae* and *Melanommataceae* (de Gruyter et al. 2009; Zhang et al. 2009a). It is clear that some characters, e.g. cleistothecial or perithecial ascomata, shape, colour and septation of ascospores, shape or arrangement (regular or irregular) of asci, or even presence or absence of pseudoparaphyses have evolved on numerous occasions which make the use of morphological characters in segregating families complicated. It is therefore unclear with our present state of knowledge which characters are taxonomically important at the family level or whether a suit of characters are necessary to define a family. DNA sequence comparisons are essential in delineating these taxa in combination with other characters. It is hoped that additional characters, i.e. biochemical, genomic and subcellular will be used to further distinguish these groups into natural taxa. Below we discuss each of the families, their genera and their considered important characteristics.

***Aigialaceae*** Suetrong, Sakay., E.B.G. Jones, Kohlm., Volkm.-Kohlm. & C.L. Schoch 2010

The *Aigialaceae* was introduced by Suetrong et al. (2009) based on its carbonaceous ascomata without papilla, cylindrical asci with apical apparatus, trabeculate pseudoparaphyses and ascospores with a sheath. The type genus (*Aigialus*) of the *Aigialaceae* was previously incorporated within the *Massariaceae* (Lumbsch and Huhndorf 2007). Currently, three genera are assigned under *Aigialaceae*, viz. *Ascocratera*, *Aigialus* and *Rimora* (Suetrong et al. 2009). The genera included in *Aigialaceae* have a wide range of morphological variation, with very few shared features as mentioned above, but all are found in mangrove habitats (Suetrong et al. 2009). The ascospores, however, vary widely from having 1 to 3 transverse septa and being hyaline to muriformly septate and brown (Suetrong et al. 2009). It is still unclear which characters unify the family and therefore placement of unsequenced genera is difficult. Further molecular work is needed to better understand this family.

***Amniculicolaceae*** Yin. Zhang, C.L. Schoch, J. Fourn., Crous & K.D. Hyde 2009

Members of *Amniculicolaceae* form a well supported clade, and all are freshwater fungi which usually stain the woody substrate purple (Zhang et al. 2009a, c). Genera of *Amniculicolaceae* have ascomata with compressed papilla

**Table 4** Families currently accepted in *Pleosporales* (syn. *Melanommatales*) with included genera

<i>Pleosporales</i> subordo. <i>Pleosporineae</i>
? <i>Cucurbitariaceae</i>
<i>Cucurbitaria</i> Gray
<i>Curreya</i> Sacc.
? <i>Rhytidiella</i> Zalasky
<i>Syncarpella</i> Theiss. & Syd.
<i>Didymellaceae</i>
? <i>Appendispora</i> K.D. Hyde
<i>Didymella</i> Sacc. ex D. Sacc.
<i>Didymosphaerella</i> Cooke
<i>Leptosphaerulina</i> McAlpine
<i>Macroventuria</i> Aa
? <i>Platychora</i> Petr.
<i>Didymosphaeriaceae</i>
<i>Didymosphaeria</i> Fuckel
<i>Phaeodothis</i> Syd. & P. Syd.
<i>Dothidotthiaceae</i>
<i>Dothidotthia</i> Höhn.
<i>Leptosphaeriaceae</i>
<i>Leptosphaeria</i> Ces. & De Not.
<i>Neophaeosphaeria</i> Câmara, M.E. Palm & A.W. Ramaley
<i>Phaeosphaeriaceae</i>
<i>Barria</i> Z.Q. Yuan
? <i>Bricookea</i> M.E. Barr
? <i>Chaetoplea</i> (Sacc.) Clem.
? <i>Eudarluca</i> Speg.
<i>Entodesmium</i> Reiss
? <i>Hadrospora</i> Boise
<i>Lautitia</i> S. Schatz
<i>Loratospora</i> Kohlm. & Volkm.-Kohlm.
<i>Metameris</i> Theiss. & Syd.
<i>Mixtura</i> O.E. Erikss. & J.Z. Yue
<i>Nodulosphaeria</i> Rabenh.
<i>Ophiobolus</i> Reiss
<i>Ophiosphaerella</i> Speg.
<i>Phaeosphaeria</i> I. Miyake
<i>Phaeosphaeriopsis</i> Câmara, M.E. Palm & A.W. Ramaley
<i>Pleoseptum</i> A.W. Ramaley & M.E. Barr
<i>Setomelanomma</i> M. Morelet
<i>Wilmia</i> Dianese, Inácio & Dornelo-Silva
<i>Pleosporaceae</i>
<i>Cochliobolus</i> Drechsler
<i>Crivellia</i> Shoemaker & Inderbitzin
<i>Decorospora</i> Inderbitzin, Kohlm. & Volkm.-Kohlm.
<i>Extrawettsteinina</i> M.E. Barr
<i>Lewia</i> M.E. Barr & E.G. Simmons
<i>Macrospora</i> Fuckel
<i>Platysporoides</i> (Wehm.) Shoemaker & C.E. Babc.
<i>Pleospora</i> Rabenh. ex Ces. & De Not.
<i>Pseudoyuconia</i> Lar. N. Vasiljeva
<i>Pyrenophora</i> Fr.
<i>Setosphaeria</i> K.J. Leonard & Suggs
<i>Pleosporales</i> subordo. <i>Massarineae</i>
<i>Lentitheciaceae</i>
<i>Lentithecium</i> K.D. Hyde, J. Fourn. & Yin. Zhang



Table 4 (continued)

*Katumotoa* Kaz. Tanaka & Y. Harada  
*Keissleriella* Höhn.  
 ?*Wettsteinina* Höhn.  
*Massariaceae*  
*Byssothecium* Fuckel  
*Massarina* Sacc.  
*Saccharicola* D. Hawksw. & O.E. Erikss.  
*Montagnulaceae*  
*Bimuria* D. Hawksw., Chea & Sheridan  
 ?*Didymocrea* Kowalsky  
*Kalmusia* Niessl  
*Karstenula* Speg.  
*Letendrea* Sacc.  
*Montagnula* Berl.  
*Paraphaeosphaeria* O.E. Erikss.  
*Tremateia* Kohlm., Volkm.-Kohlm. & O.E. Erikss.  
*Morosphaeriaceae*  
 ?*Asteromassaria* Höhn  
*Helicascus* Kohlm.  
*Morosphaeria* Suetrong, Sakay., E.B.G. Jones & C.L. Schoch  
*Trematosphaeriaceae*  
*Falciformispora* K.D. Hyde  
*Halomassarina* Suetrong, Sakay., E.B.G. Jones, Kohlm., Volkm.-Kohlm. & C.L. Schoch  
*Trematosphaeria* Fuckel  
 Other families  
*Aigialaceae*  
*Aigialus* Kohlm. & S. Schatz  
*Ascocratera* Kohlm.  
*Rimora* Kohlm., Volkm.-Kohlm., Suetrong, Sakay. & E.B.G. Jones  
*Amniculicolaceae*  
*Amniculicola* Y. Zhang & K.D. Hyde  
*Murispora* Yin. Zhang, C.L. Schoch, J. Fourn., Crous & K.D. Hyde  
 ?*Massariosphaeria* (E. Müll.) Crivelli  
*Neomassariosphaeria* Yin. Zhang, J. Fourn. & K.D. Hyde  
 ?*Arthopyreniaceae* (*Massariaceae*)  
*Arthopyrenia* A. Massal.  
*Dothivalsaria* Petr.  
 ?*Dubitatio* Speg.  
*Massaria* De Not.  
*Navicella* Fabre  
*Roussoëlla* Sacc.  
 ?*Roussoellopsis* I. Hino & Katum.  
*Delitschiaceae*  
*Delitschia* Auersw.  
*Ohleriella* Earle  
*Semidelitschia* Cain & Luck-Allen  
 ?*Diademaceae*  
*Clathrospora* Rabenh.  
*Comoclathris* Clem.  
*Diadema* Shoemaker & C.E. Babc.  
*Diademosia* Shoemaker & C.E. Babc.  
*Graphyllum* Clem.  
*Hypsostromataceae*  
*Hypsostroma* Huhndorf  
*Lindgomycetaceae*  
*Lindgomyces* K. Hirayama, Kaz. Tanaka & Shearer 2010  
*Lophiostomataceae*

Table 4 (continued)

*Lophiostoma* Ces. & De Not.  
*Melanommataceae*  
 ?*Astrosphaeriella* Syd. & P. Syd. (Syn. *Javaria*)  
 ?*Anomalemma* Sivan.  
 ?*Asymmetricospora* J. Fröhl. & K.D. Hyde  
*Bertiella* (Sacc.) Sacc. & P. Syd.  
 ?*Bicrouania* Kohlm. & Volkm.-Kohlm.  
*Byssosphaeria* Cooke  
*Calytronectria* Speg.  
 ?*Caryosporella* Kohlm.  
*Herpotrichia* Fuckel  
 ?*Mamillisphaeria* K.D. Hyde, S.W. Wong & E.B.G. Jones  
*Melanomma* Nitschke ex Fuckel  
*Ohleria* Fuckel  
*Pseudotrichia* Kirschst.  
*Pleomassariaceae*  
 ?*Lichenopyrenis* Calatayud, Sanz & Aptroot  
 ?*Splanchnonema* Corda  
 ?*Peridiothelia* D. Hawksw.  
*Pleomassaria* Speg.  
*Sporormiaceae*  
*Chaetopreussia* Locq.-Lin.  
*Eremodothis* Arx  
*Pleophragma* Fuckel  
*Preussia* Fuckel  
*Sporormia* De Not.  
*Westerdykella* Stolk  
 ?*Teichosporaceae*  
*Chaetomastia* (Sacc.) Berl  
*Immotthia* M.E. Barr  
*Loculohyphoxylon* M.E. Barr  
*Sinodidymella* J.Z. Yue & O.E. Erikss.  
*Teichospora* Fuckel  
*Tetraplosporiaceae*  
*Polyplospora* Kaz. Tanaka & K. Hirayama  
*Tetraplospora* Kaz. Tanaka & K. Hirayama  
*Triplospora* Kaz. Tanaka & K. Hirayama  
 ?*Zopfiaceae* (syn. *Testudinaceae*)  
*Caryospora* De Not.  
*Celtidia* J.M. Janse  
 ?*Coronopapilla* Kohlm. & Volkm.-Kohlm.  
*Halothia* Kohlm.  
*Lepidosphaeria* Parg.-Leduc  
 ?*Mauritiana* Poonyth, K.D. Hyde, Aptroot & Peeraly  
*Pontoporeia* Kohlm.  
 ?*Rechingeriella* Petr.  
*Richonia* Boud.  
*Testudina* Bizz.  
*Verruculina* Kohlm. & Volkm.-Kohlm.  
*Ulospora* D. Hawksw., Malloch & Sivan.  
*Zopfia* Rabenh.  
*Zopfiöfoveola* D. Hawksw.  
*Pleosporales genera incertae sedis*  
*Acrocordiopsis* Borse & K.D. Hyde  
*Aglaospora* De Not.  
*Anteaglonium* Mugambi & Huhndorf  
*Ascorhombispora* L. Cai & K.D. Hyde  
*Atracididymella* Davey & Currah

**Table 4 (continued)**


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<i>Belizeana</i> Kohlm. & Volkm.-Kohlm.
<i>Biatriospora</i> K.D. Hyde & Borse
<i>Byssolophis</i> Clem.
<i>Carinispora</i> K.D. Hyde
<i>Cilioplea</i> Munk
<i>Decaisnella</i> Fabre
<i>Epiphegia</i> Nitschke ex G.H. Oth
<i>Isthmosporella</i> Shearer & Crane
<i>Julella</i> Fabre
<i>Lineolata</i> Kohlm. & Volkm.-Kohlm.
<i>Lophiella</i> Sacc.
<i>Lophionema</i> Sacc.
<i>Lophiotrema</i> Sacc.
<i>Moristroma</i> A.I. Romero & Samuels
<i>Neotestudina</i> Segretain & Destombes
<i>Ostropella</i> (Sacc.) Höhn.
<i>Paraliomyces</i> Kohlm.
<i>Passeriniella</i> Berl.
<i>Quintaria</i> Kohlm. & Volkm.-Kohlm.
<i>Sacothecium</i> Fr.
<i>Salsuginea</i> K.D. Hyde
<i>Shiraia</i> P. Henn.
<i>Xenolophium</i> Syd.
Family excluded
<i>Phaeotrichaceae</i>
<i>Echinoascotheca</i> Matsush.
<i>Phaeotrichum</i> Cain & M.E. Barr
<i>Trichodelitschia</i> Munk
Genera excluded
<i>Kriegeriella</i> Höhn.
<i>Muroia</i> I. Hino & Katum.
<i>Zeuctomorpha</i> Sivan., P.M. Kirk & Govindu

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and cylindrical to cylindro-clavate asci. *Neomassariosphaeria typhicola* was traditionally assigned to *Massariosphaeria* (as *M. typhicola*), and *Massariosphaeria* is characterized by staining the woody substrate purple (Crivelli 1983; Leuchtmann 1984). Eriksson (1981 p. 135) had pointed out that “Purple-staining species of *Pleospora*, treated by Webster (1957), are not congeneric with *P. herbarum* (Eriksson 1967b: 13), and certainly do not even belong to the *Pleosporaceae*”. This is mirrored in *Murispora rubicunda*, a previous *Pleospora* species (as *P. rubicunda*) staining the woody substrate purple, closely related to the *Amniculicolaceae* in a subsequent phylogenetic study (Zhang et al. 2009a). The anamorphs of this family are possibly *Anguillospora longissima*, *Spirosphaera cupreorufescens* and *Repetophragma ontariense* (Zhang et al. 2009a).

#### ?*Arthopyreniaceae* (or *Massariaceae*) W. Watson 1929

The *Arthopyreniaceae* was introduced as a lichenized family of *Pyrenocarpaceae*, which comprises *Acrocordia*, *Arthopyrenia*, *Athrismidium*, *Bottaria*, *Celothelium*, *Lau-*

*rera*, *Leptorhaphis*, *Microthelia*, *Microtheliopsis*, *Polyblastiopsis*, *Pseudosagedia*, *Raciborskiella* and *Tomasellia* (Watson 1929). Subsequently, *Arthopyreniaceae* was assigned under *Dothideales* (suborder *Pseudosphaeriineae*) (von Arx and Müller 1975). The generic type of *Massaria* (*M. inquinans*) and *Torula herbarum* and *Arthopyrenia salicis* together with members of *Roussoella* as well as *Roussoellopsis* form a robust clade, which makes their familial placement uncertain (*Massariaceae* or *Arthopyreniaceae*) (Schoch et al. 2009; Zhang et al. 2009a).

#### ?*Cucurbitariaceae* G. Winter 1885

The *Cucurbitariaceae* is characterized by its aggregated ascomata which form from a basal stromatic structure, ostiolate, fissitunicate and cylindrical asci, and pigmented, phragmosporous or muriform ascospores (Cannon and Kirk 2007). Currently, no molecular study has been able to resolve its ordinal status, but some characters are similar to *Leptosphaeriaceae* or *Phaeosphaeriaceae* (Cannon and Kirk 2007). *Cucurbitaria elongata* clustered within *Pleosporales* (Schoch et al. 2006).

#### *Delitschiaceae* M.E. Barr 2000

The *Delitschiaceae* was established to accommodate some species of the *Sporormiaceae*, which is characterized by its ascomata with periphysate ostioles, ocular chamber surrounded by a dome and usually in having four refractive rods, ascospores with or without a septum, having a germ slit in each cell and being surrounded by a mucilaginous sheath (Barr 2000). Species of the *Delitschiaceae* are hypersaprotrophic on old dung or exposed wood (Barr 2000). Based on a molecular phylogenetic studies, *Delitschia didyma* and *D. winteri* form a robust clade basal to other pleosporalean fungi (Schoch et al. 2009; Zhang et al. 2009a). The familial status of two other genera, *Ohleriella* and *Semidelitschia*, remains undetermined.

#### ?*Diademaceae* Shoemaker & C.E. Babcock 1992

The *Diademaceae* was introduced by Shoemaker and Babcock (1992) based on its ascomata opening as a flat circular lid and bitunicate asci, ascospores are fusiform, brown, mostly applanate, and having three or more transverse septate and with or lacking longitudinal septa and usually having a sheath. Five genera had been included viz. *Clathrospora*, *Comoclathris*, *Diadema*, *Diademosa* and *Macrospora* (Shoemaker and Babcock 1992).

#### *Didymellaceae* Gruyter, Aveskamp & Verkley 2009

The generic type of *Didymella* (*D. exigua*) together with some *Phoma* or *Phoma*-related species form a robust familial clade on the phylogenetic tree, thus the *Didymellaceae* was introduced to accommodate them (de Gruyter et al. 2009). Subsequently, *Didymellaceae* was assigned to

*Pleosporineae* (suborder of *Pleosporales*) (Zhang et al. 2009a). A detailed study was conducted on the *Didymellaceae* based on LSU, SSU rDNA, ITS as well as  $\beta$ -tubulin, which indicated that many *Phoma* or *Phoma*-related species/fungi reside in this clade of the *Didymellaceae* (Aveskamp et al. 2010).

#### ***Didymosphaeriaceae* Munk 1953**

The *Didymosphaeriaceae* was introduced by Munk (1953), and was revived by Aptroot (1995) based on its distoseptate ascospores and trabeculate pseudoparaphyses, mainly anastomosing above the asci. The familial status of the *Didymosphaeriaceae* is debatable, and Lumbsch and Huhndorf (2007) assigned it to the *Montagnulaceae*, while von Arx and Müller (1975) treated it as a synonym of the *Pleosporaceae*. In this study, *Didymosphaeria futilis* (the generic type of *Didymosphaeria*) is closely related to the *Cucurbitariaceae* (Plate 1). Herein, we accept it as a separate family containing three genera, namely *Appendispora*, *Didymosphaeria* and *Phaeodothis*. More information could only be obtained by further molecular work based on correctly identified strains.

#### ***Dothidotthiaceae* Crous & A.J.L. Phillips 2008**

*Dothidotthiaceae* was introduced to accommodate the single genus *Dothidotthia*, which is characterized by gregarious, erumpent, globose ascomata, hyaline, septate pseudoparaphyses, 8-spored, bitunicate, clavate asci, ellipsoid, 1-septate ascospores, and has anamorphic *Thyrostroma* (Phillips et al. 2008). In this study, *Dothidotthiaceae* is closely related to *Didymellaceae*, but it is still treated as a separate family (Plate 1).

#### ***Hypsostromataceae* Huhndorf 1994**

*Hypsostromataceae* was introduced based on two tropical genera (i.e. *Hypsostroma* and *Manglicola*), which have superficial, large, elongate ascomata with a soft-textured, pseudoparenchymatic wall, trabeculate pseudoparaphyses and stipitate asci attached in a basal arrangement in the centrum; asci with an apical chamber and fluorescing ring; and fusiform, septate ascospores (Huhndorf 1994). *Hypsostromataceae* was assigned to *Melanommatales sensu* Barr (Huhndorf 1994). In a subsequent phylogenetic study, *Hypsostromataceae* was recovered as a strongly supported monophyletic group nested within *Pleosporales* (Mugambi and Huhndorf 2009b).

#### ***Lentitheciaceae* Yin, Zhang, C.L. Schoch, J. Fourn., Crous & K.D. Hyde 2009**

Phylogenetic analysis based on multi-genes indicate that freshwater taxa, e.g. *Lentithecium fluviatile*, *L. arundinaceum*, *Stagonospora macropycnidia*, *Wettsteinina lacustris*, *Keissleriella cladophila*, *Katumotoa bambusicola* and *Ophiosphaerella sasicola* form a well supported clade, which most likely represent a familial rank (Zhang et al. 2009a).

Their morphology, however, varies widely, e.g. ascomata small- to medium-sized, ascospores fusoid to filliform, hyaline to pale yellow, 1- to multi-septate (Zhang et al. 2009a). In particular, they are saprobic on monocotyledons or dicotyledons. Currently, no conspicuous, unique morphological character has been noted in *Lentitheciaceae*, which makes it difficult to recognize based on morphology.

#### ***Leptosphaeriaceae* M.E. Barr 1987a**

The *Leptosphaeriaceae* was introduced by Barr (1987a) based on *Leptosphaeria*. The familial status of the *Leptosphaeriaceae* is subsequently supported by molecular phylogenetic studies, in which members of the *Leptosphaeriaceae* form a paraphyletic clade with moderate bootstrap support (Dong et al. 1998; de Gruyter et al. 2009; Schoch et al. 2009; Zhang et al. 2009a). *Coniothyrium palmarum*, the generic type of *Coniothyrium* nested within this family (de Gruyter et al. 2009). Further molecular phylogenetic study is needed, in which more related taxa are included.

#### ***Lindgomycetaceae* K. Hirayama, Kaz. Tanaka & Shearer 2010**

*Lindgomycetaceae* was introduced as a monotypic family represented by *Lindgomycetes* (Hirayama et al. 2010). *Lindgomycetaceae* is another freshwater family in *Pleosporales*, which is characterized by its subglobose to globose, ostiolate and papillate ascomata, numerous, septate, branching and anastomosing pseudoparaphyses, fissitunicate, cylindrical to clavate, 8-spored asci, fusiform to cylindrical, uni- to multiseptate, hyaline to brown ascospores usually covered with an entire sheath and/or bipolar mucilaginous appendages (Hirayama et al. 2010).

#### ***Lophiostomataceae* Sacc. 1883**

The *Lophiostomataceae* had been characterized by its slot-like ostiole on the top of a flattened neck (Holm and Holm 1988). Based on this, 11 genera were assigned under the *Lophiostomataceae*, viz. *Byssolophis*, *Cilioplea*, *Entodesmium*, *Herpotrichia*, *Lophiella*, *Lophionema*, *Lophiostoma*, *Lophiotrema*, *Massariosphaeria*, *Muroia* and *Quintaria* (Holm and Holm 1988). The *Lophiostomataceae* was thought to be heterogeneous, as the “papilla form is an unstable and highly adaptive character” (Holm and Holm 1988). Most recent phylogenetic analysis support the monophyletic status of the *Lophiostomataceae sensu stricto* (which tends to comprise a single genus of *Lophiostoma*) (Zhang et al. 2009a, b). The familial placement of other genera, however, remains unresolved.

#### ***Massarinaceae* Munk 1956**

The *Massarinaceae* was established based on *Keissleriella*, *Massarina*, *Metasphaeria*, *Pseudotrichia* and *Trichometasphaeria* (Munk 1956). Subsequently, the *Massarinaceae* is sometimes treated as a synonym of *Lophiostomataceae* (Barr

1987b). Based on a multigene phylogenetic study, the generic type of *Massarina* (*M. eburnea*) together with *M. cisti*, *Neottiosporina paspali* and *Byssothecium circinans* form a well supported clade (Zhang et al. 2009a, b). It seems that a relatively narrow familial concept should be accepted.

#### **Melanommataceae** G. Winter 1885

The traditional circumscription of the *Melanommataceae* was based on its globose or depressed perithecial ascomata, bitunicate and fissitunicate asci, pigmented phragmosporous ascospores as well as the trabeculate pseudoparaphyses (Barr 1990a; Sivanesan 1984). However, the family has recently proved polyphyletic (Liew et al. 2000; Kodsueb et al. 2006a; Krüys et al. 2006; Wang et al. 2007). *Bimuria*, *Ostropella*, *Trematosphaeria* and *Xenolophium* occur outside *Melanommataceae* (Mugambi and Huhndorf 2009b; Zhang et al. 2009a). Species of *Byssosphaeria*, *Bertiella*, *Herpotrichia*, *Pseudotrichia*, *Pleomassaria* as well as *Melanomma* resided in the clade of *Melanommataceae* (Mugambi and Huhndorf 2009b; Schoch et al. 2009; Zhang et al. 2009a). The familial status of many genera previously listed under this family remains to be sorted out (Lumbsch and Huhndorf 2007).

#### **Montagnulaceae** M.E. Barr 2001

The *Montagnulaceae* was introduced to accommodate some pleosporalean genera with ascomata immersed under a clypeus, a pseudoparenchymatous peridium with small cells, cylindrical or oblong asci with pedicels and brown ascospores (Barr 2001). Three genera were included, i.e. phragmosporous *Kalmusia*, dictyosporous *Montagnula* and didymosporous *Didymosphaerella* (Barr 2001). Our molecular phylogenetic analysis based on multi-genes indicated that species from *Kalmusia*, *Phaeosphaeria*, *Bimuria*, *Didymocrea*, *Paraphaeosphaeria*, *Karstenula*, *Letendreaea* as well as *Montagnula* resided in the monophyletic clade of the *Montagnulaceae* (Schoch et al. 2009; Zhang et al. 2009a).

#### **Morosphaeriaceae** Suetrong, Sakay., E.B.G. Jones & C.L. Schoch 2009

Four marine species, viz. *Massarina ramunculicola* (as *Morosphaeria ramunculicola*), *Massarina velatasporea* (*Morosphaeria velatasporea*), *Helicascus kanaloanus* and *H. nypae* together with the freshwater species *Kirschsteiniotelia elaterascus* form a well supported clade, which most likely represent a familial rank (Suetrong et al. 2009). Thus, *Morosphaeriaceae* was introduced to accommodate these taxa (Suetrong et al. 2009). In this study, *Asteromassaria pulchra* is basal to other species of *Morosphaeriaceae*, and gets well support (Plate 1). Thus we tentatively assign *Asteromassaria* under *Morosphaeriaceae*.

#### **Phaeosphaeriaceae** M.E. Barr 1979a

The *Phaeosphaeriaceae* was introduced to accommodate some pleosporalean genera which have saprobic, parasitic or hyperparasitic lifestyles and have small- to medium-sized, subglobose or conical ascomata, bitunicate asci and hyaline or pigmented ascospores with or without septation (Barr 1979a). Fourteen genera were included, viz. *Comoclathris*, *Didymella*, *Eudarlucia*, *Heptameria*, *Leptosphaeria*, *Loculohypoxylon*, *Metameris*, *Microthelia*, *Nodulosphaeria*, *Ophiobolus*, *Paraphaeosphaeria*, *Rhopoglyphus*, *Scirrhodopsis* and *Teichospora* (Barr 1979a), which were subsequently assigned to various families, such as *Loculohypoxylon* and *Teichospora* to the *Teichosporaceae*, *Paraphaeosphaeria* to the *Montagnulaceae*, *Leptosphaeria* to the *Leptosphaeriaceae*, *Comoclathris* to the *Diademaceae*, *Didymella* to the *Didymellaceae* and *Heptameria* and *Rhopoglyphus* to genera *incertae sedis* of *Dothideomycetes* (Aveskamp et al. 2010; de Gruyter et al. 2009; Lumbsch and Huhndorf 2007; Zhang et al. 2009a). Based on multi-gene phylogenetic analysis, a relatively narrow familial concept is accepted, which is mostly associated with monocotyledons, with perithecial, small- to medium-sized ascomata, and septate ascospores which are fusiform to filliform (Zhang et al. 2009a). Four genera were accepted, *Ophiosphaerella*, *Phaeosphaeria*, *Entodesmium* and *Setomelanomma* (Zhang et al. 2009a). Together with *Cucurbitariaceae*, *Didymellaceae*, *Didymosphaeriaceae*, *Dothidothiaceae*, *Leptosphaeriaceae* and *Pleosporaceae*, the *Phaeosphaeriaceae* is assigned under *Pleosporineae* (Zhang et al. 2009a).

#### **Pleomassariaceae** M.E. Barr 1979a

Both *Asteromassaria* and *Splanchnonema* were designated as representative genera of *Pleomassariaceae* (Barr 1979a). Currently, four genera are included in *Pleomassariaceae*, viz. *?Lichenopyrenis*, *?Splanchnonema*, *?Peridiothelia* and *Pleomassaria* (Table 4). The generic type of *Pleomassaria* (*P. siparia*) clustered with species of *Melanommataceae* in previous and present studies (Schoch et al. 2009; Zhang et al. 2009a; Plate 1). Zhang et al. (2009a) has attempted to assign *Pleomassariaceae* to *Melanommataceae* (Zhang et al. 2009a). Based on the distinct morphology and anamorphic stage of *Pleomassaria siparia* as well as the divergence of dendrogram, we hesitantly reinstate *Pleomassariaceae* as a separate family in this study.

#### **Pleosporaceae** Nitschke 1869

The *Pleosporaceae* is one of the earliest introduced families in *Dothideomycetes*. The *Pleosporaceae* was originally assigned under *Sphaeriales*, which accommodated species with paraphyses and immersed perithecia (Ellis and Everhart 1892; Lindau 1897; Winter 1887). Subsequently, many of the *Pleosporaceae* species were transferred to the *Pseudosphaeriaceae*, which was subsequently elevated to ordinal rank as *Pseudosphaeriales* (Theissen

and Sydow 1918). Luttrell (1955) introduced the *Pleosporales* (lacking a Latin description), which is characterized by its *Pleospora*-type of centrum development. Based on this, the *Pleosporaceae* and the *Lophiostomataceae* as well as other five families were placed in *Pleosporales* (Luttrell 1955). *Pleosporaceae* is the largest and most typical family in *Pleosporales*. Wehmeyer (1975) stated that the *Pleospora*-type centrum development is verified in a small number of genera, and centrum development in the majority of genera is unknown; thus the placement of families or genera is quite arbitrary. In addition, the circumscription of *Pleosporaceae* is not clear-cut, and “.....ascostromata of many different types, which are previously placed in various other families (*Trichosphaeriaceae*, *Melanommataceae*, *Cucurbitariaceae*, *Amphisphaeriaceae* etc.) are to be found here” (Wehmeyer 1975). Thus, the heterogeneous nature of *Pleosporales* is obvious (Eriksson 1981), and had been confirmed by subsequent molecular phylogenetic studies (e.g. Kodsueb et al. 2006a). Based on the multi-gene phylogenetic analysis, some species from *Lewia*, *Cochliobolus*, *Pleospora*, *Pyrenophora* and *Setosphaeria* resided in the *Pleosporaceae* (Zhang et al. 2009a).

#### ***Sporormiaceae* Munk 1957**

The *Sporormiaceae* is the largest coprophilous family in *Pleosporales*, which bears great morphological variation. Ascospores vary from cleistothecoid to perithecioid, asci are regularly or irregularly arranged, clavate or spherical, ascospores with or without germ slits or ornamentations. Based on phylogenetic analysis, *Sporormiaceae* is most likely monophyletic as currently circumscribed (Kruys et al. 2006; Kruys and Wedin 2009).

#### **?*Teichosporaceae* M.E. Barr 2002**

The *Teichosporaceae* was introduced by segregating some non-lichenized members of the *Dacampiaceae* which are apotrophic on woody stems and periderm or hypersaprotrophic on other ascomycetous fungi (Barr 2002). The *Dacampiaceae* together with its synonym, *Pyrenidiaceae* was only maintained to accommodate its lichenicolous genera (Barr 2002). This proposal does not have any molecular phylogenetic support.

#### ***Tetraplosphaeriaceae* Kaz. Tanaka & K. Hirayama 2009**

The *Tetraplosphaeriaceae* was introduced to accommodate five genera, i.e. *Tetraplosphaeria*, *Triplosphaeria*, *Polyplosphaeria* and the anamorphic genera *Pseudotetraploa* and *Quadricrura* (Tanaka et al. 2009). The *Tetraplosphaeriaceae* is characterized by its *Massarina*-like teleomorphs and its *Tetraploa*-like anamorphs with setae-like appendages, and its monophylogenetic status has been recently confirmed based on DNA phylogenetic studies (Tanaka et al. 2009).

#### ***Trematosphaeriaceae***

Three species, viz. *Falciformispora lignatilis*, *Halomasarina thalassiae* and *Trematosphaeria pertusa* form a robust clade, which forms a sister group with other pleosporalean families (Schoch et al. 2009; Suetrong et al. 2009). *Trematosphaeriaceae* is waiting to be formally proposed (Suetrong et al. data unpublished).

#### **?*Zopfiaceae* G. Arnaud ex D. Hawksw. 1992**

The *Zopfiaceae* was introduced by Arnaud (1913), but was invalid due to the lack of a Latin diagnosis (see comments by Eriksson and Hawksworth 1992). The *Zopfiaceae* was formally introduced by Eriksson and Hawksworth (1992), and is characterized by its cleistothecial ascomata, thick-walled peridium, globose or saccate asci and one-septate, dark brown ascospores (Cannon and Kirk 2007). Currently, eleven genera are included, but the family is likely polyphyletic (Kruys et al. 2006).

#### **Excluded family**

#### ***Phaeotrichaceae* Cain 1956**

The cleistothecoid ascomata, ascospores with germ pore at each end and the absence of pseudoparaphyses indicate that the *Phaeotrichaceae* may not be closely related to *Pleosporales*. This was confirmed by DNA based phylogenies (Schoch et al. 2009). Thus, we exclude it from *Pleosporales*.

#### **Final remarks**

#### ***Problems and concerns***

Recently, many new pleosporalean lineages from freshwater (Shearer et al. 2009; Zhang et al. 2009a), marine (Suetrong et al. 2009) or from bambusicolous hosts (Tanaka et al. 2009) have been reported. In particular, large-scale phylogenetic analysis indicate that numerous unresolved clades still exist, which may also indicate that a large number of fungal lineages are not resolved. As has been estimated, 95% of all fungi are unreported (Hawksworth 1991), and a large portion of them might exist only as hyphae (or *DNA-only fungi*, Taylor 1993). Under the influence of human activities, environmental situations are changing quickly, which may result in numerous fungal taxa losing their habitats and/or become endangered. More field work is urgently needed.

#### ***A future polyphasic approach to study Pleosporales***

The use of DNA sequence comparisons have proved invaluable in modern concepts of fungal taxonomy. It is now clear many fungi do not produce reproductive structures or

only do so under very rare circumstances and many fungi cannot be cultured (Begerow et al. 2010). More and more morpho-species have proven to be cryptic taxa, and already a large percentage of fungal diversity is documented only by DNA sequences. DNA sequence analysis is an essential way to resolve these problems. But are they enough for fully informed fungal taxonomy? Each single morphological character may be the outcome of the expression of one to numerous genes, which might be composed of thousands of base pairs. DNA barcoding methods are “a breakthrough for identification, but they will not supplant the need to formulate and rigorously test species hypothesis” (Wheeler et al. 2004). Thus, integration of classical morphological approaches and DNA and protein based sequence comparisons are critical to produce a modern taxonomy that reflects evolutionary similarities and differences (DeSalle et al. 2005; Godfray 2002). In particular, the advent of comparative genomics and advances in our understanding of secondary metabolites and host or habitat spectra allow the possibility to tie phylogenetic hypotheses derived from DNA and protein sequence to the biology of the organisms. (Bitzer et al. 2008; Stajich et al. 2009; Zhang et al. 2009a, b).

**Acknowledgement** We are grateful to the Directors and Curators of the following herbaria for loan of specimens in their keeping: BAFC, BISH, BPI, BR, BRIP, CBS, E, ETH, FFE, FH, G, H, Herb. J. Kohlmeyer, HHUF, IFRD, ILLS, IMI, K(M), L, LPS, M, MA, NY, PAD, PC, PH, RO, S, TNS, TRTC, UB, UBC, UPS and ZT; to Dr. L. Cai, Dr. A.J.L. Phillips, Dr. C. Shearer and some other mycologists for their permission to use or refer to their published figures, to J.K. Liu, H. Zhang, Y.L. Yang and J. Fournier for helping me loan or collect specimens, to H. Leung for technical help. The third coauthor acknowledges the Intramural Research Program of the NIH, National Library of Medicine. The Global Research Network and King Saud University are also thanked for support.

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